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THE

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Edited for the Council of the Aëronautical Society of Great Britain.

By ERIC STUART BRUCE, M.A. Oxon, Fellow of the Royal Meteorological Society.

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NOTICES
OF
The Aëronautical Society of Great Britain.

At a meeting of the Council of the Aëronautical Society of Great Britain, held at the Society of Arts, John Street, Adelphi, on Friday, December 7th, 1906, the following gentlemen were elected members of the Society.

Lord MONTAGU OF BEAULIEU.
Mr. LIONEL CALISCH.
Mr. WILLIAM EDWARD BURGESS.
Colonel SELDEN ALLEN DAY.
Lieutenant GEORGE GIPPS, R.N.
Mr. WALTER JAMES GRIFFITHS.
Mr. ALFRED HARDIE.
Mr. JOCELYN HOPE HUDSON.
Mr. SAMUEL ERIC NEAL.
Mr. WILLIAM R. PATTERSON.
Lieutenant ARTHUR RICE, R.N.
Mr. HAROLD F. SMALMAN-SMITH.

The following gentleman was elected a member of the Council:—

Bt. Colonel J. E. CAPPER, C.B., R.E.

FORTHCOMING GENERAL MEETING.

The second meeting of the 42nd session of the Aëronautical Society of Great Britain will be held at the Society of Arts, John Street, Adelphi, in March next, the date of which will be duly announced. The following papers will be read:—"Wings *v.* Screws," by Colonel J. D. Fullerton, R.E., M.Aër.Soc.; "Theory of Sailing Flight," by Mr. José Weiss, M.Aër.Soc.; and "A Study of Model Gliders," by Mr. A. V. Roe.

KITE DISPLAY.

It has been arranged to hold a kite display at Sunningdale on the occasion of the summer meeting of the Aëronautical Society of Great Britain in July next. Members and others who may wish to display kites at this meeting are requested to communicate with the Honorary Secretary of the Aëronautical Society of Great Britain, 53, Victoria Street, Westminster, London, S.W., as soon as possible.

To members there will be no entrance fee for this display, but to non-members there will be an entrance fee of five shillings for the privilege of displaying their kites on the ground acquired by the Council of the Aëronautical Society of Great Britain.

All kites displayed will have to be approved by the Council of the Aëronautical Society of Great Britain.

THE LIBRARY.

The following publications have been presented to the library:—

By Major B. Baden-Powell, "Right to Fly" (Nadar), "First Aërial Voyage in England" (Lunardi), "Crochets in the Air" (J. Poole), "Balloon Ascents" (Rush), and "Aëronautics" (Mason).

By the editor of *Knowledge and Scientific News*, "The Science Year Book, 1907."

By Colonel F. C. Trollope, "Institut Aërodynamique de Koutchino," "Quatrième Conférence de la Commission International pour L'Aérostation Scientifique," publications of the International Commission, for scientific aëronautics, January, 1904.

By Dr. Richard Assman, "Ergebnisse der Arbeiten des Königlich Preuhiscen Aëronautischen Observatoriums bei Lindenburg."

By the Meteorological Office, "Publications of the International Commission for Scientific Aëronautics," January, 1905.

From D. Riabauchinsky, "Bulletin de L'Institut Aérodynamique de Koutchino."

From the French Minister of Commerce, "Congrès International D'Aéronautique, Septembre, 1900."

By D. Pecho Vives Y. Vich, "Avance de los Resaltados Obtendos en las Observaciones del Eclipse Total de Sol de 30 De Agosto de 1905."

ERIC STUART BRUCE,
Honorary Secretary.

GENERAL MEETING.

The opening meeting of the 42nd session of the Aëronautical Society of Great Britain was held at the Society of Arts, John Street, Adelphi, on Friday, December 7th, 1906. The President, Major B. Baden-Powell, occupied the chair.

The PRESIDENT: Gentlemen, the Honorary Secretary will now read the minutes of the last meeting.

The Hon. Secretary read the minutes.

On the Use of Kites in Meteorological Research.

By WILLIAM NAPIER SHAW, Sc.D., F.R.S.

The exploration of the upper air by means of kites was formally adopted as part of the regular scheme of operations of the Meteorological Office in the summer of 1905, when Mr. W. H. Dines, F.R.S., whose work in connection with a joint committee of the Royal Meteorological Society and the British Association is well known, was appointed to organise and control experiments in that line of meteorological research. The objects to be kept in view were stated to be:—

(1) "The maintenance of a depot for the construction and testing of apparatus.

(2) "The investigation of the upper air over the British Isles by a series of simultaneous ascents on the days of the international ascents (kites and unmanned balloons being used if practicable). Three stations for each day of ascent are to be arranged if possible within a range of 200 miles in the first instance, one of them being on the coast. For the two of these ascents not at the depot station, the central depot would supply apparatus and instruct the observers, but would not be responsible for making any payment to the observers.

(3) "The supply of apparatus and instruments for the observations of the upper air to vessels of the Navy or of the Mercantile Marine, of which the officers might be willing to take charge of the ascents, and the instruction of the observers."

The scheme of co-operation outlined by the statement of objects has been realised in nearly all particulars. Working at his own house at Oxshott, Mr. Dines has carried out a large number of kite ascents with remarkably little loss and no serious misadventure, except an unfortunate injury to his hand. He has now transferred his base to Watlington, in Oxfordshire, where conditions are more favourable for operations involving the use of a greater length of steel wire than at Oxshott.

Mr. C. J. P. Cave, who had already made some successful experiments with kites in Barbados, has established an effective station at Ditcham Park, in Hampshire, and has worked in hearty co-operation with Mr. Dines. Mr. S. H. R. Salmon also joined the scheme from the first, and, considering the restriction imposed by the use of a hand winch, has carried out a number of successful ascents from the Brighton downs, and has, in particular, explored the upper air on several occasions of sea fog with very interesting results.

In the meantime Dr. G. C. Simpson, lecturer in Meteorology in the University of Manchester, took up the work in connection with the joint committee to which already reference has been made, and a considerable amount of work had been done in selecting a suitable site at Glossop Moor for experiments in the Derbyshire hills and in re-making the old winding gear, lent for the experiments, after a collapse attended with some thrilling experiences at the first ascent. By the time the new apparatus was ready, Dr. Simpson had accepted an appointment as assistant to the Meteorological Reporter to the Government of India, and Mr. J. E. Petavel, of the Physical Laboratory of the University of Manchester, took charge of experiments at Glossop Moor in the summer when kite ascents were not practicable at Oxshott for want of wind.

At sea Captain A. Simpson, of the steamship *Moravian*, an enthusiastic meteorologist and a skilled observer, has made some preliminary experiments with apparatus supplied from Oxshott, the central depot, and a set of apparatus was prepared for Lieut. the Hon. C. F. Cavendish, of H.M.S. *Suffolk*, who expressed his willingness to make a trial of observations at sea, but in the multitude of occupations in other directions I fear that the instruments have not yet been dispatched to that officer.

Thus the observations so far secured have been the kite observations at Oxshott, Ditcham Park, Brighton, and Glossop Moor, of which there have been altogether upwards of 150. Mr. Petavel did, indeed, send up an unmanned balloon from Manchester, which came down safely near Huddersfield, but the curiosity of the North was too much for the perishable record which was so overlaid with superfluous marking as not to be decipherable.

Colonel Capper, of the Aldershot Balloon Factory, has also contributed observations upon change of direction of wind with height.

The meteorograph which was designed by Mr. Dines for use in the kite ascents, has been enriched by the addition of a simple means of recording the wind velocity. It consists of a light sphere attached by a long cotton thread to a pen controlled by a spring. Thus pressure, temperature, humidity, and wind velocity are all recorded on the chart carried by the kite.

Mr. Dines has also designed and constructed new and extraordinarily light instruments, for recording variation of pressure and temperature, which were exhibited at the Office on July 6 preparatory to their being sent as part of the British Government exhibit to the International Exhibition at Christchurch, New Zealand, but with them the present paper is not immediately concerned.

From the commencement of the current year a brief summary of the results obtained by the various observers taking part in the co-operation for the exploration of the upper air has been published from week to week in the weekly weather report of the Meteorological Office. That form of publication was chosen because the Weekly Report includes maps of the barometric, thermometric, and weather conditions over Europe for each day of the week. The scale of the maps is small, but it is enough to indicate the general conditions prevailing during the ascents of which the results are given, and to enable those who wish to follow up the meteorological suggestions which arise from the results to form a preliminary idea of the line to be pursued.

The summary of the ascents given in the Weekly Report is almost unmercifully brief. It gives only the bare figures for temperature, humidity, wind velocity, and wind direction at the ground level and at the fixed heights 1,660 feet (500 metres), 3,320 feet (1,000 metres), 5,000 feet (1,500 metres), and so on, with a short note in a "remarks" column of any conspicuous feature of the ascent.

The question may fairly be asked whether there is any useful information to be got out of such a curt record, or if it would not be better to wait till the observers have had time and opportunity to discuss the bearing of all their observations on various meteorological questions before calling in the printer at all. It is to that question that I propose to direct your attention to-night. I will not speak of the use of a brief summary, such as that which you see in the Report, as an index which would enable anyone who wished to make a study of the subject to select the ascents likely to give him the information wanted for an answer to any particular question. I will take the more directly pertinent question whether the information given enlarges our knowledge of the upper air. From this point of view I have only the same advantages as the ordinary reader of the Weekly Weather Report; that is to say, I base what I have to say upon what is published, and not on the more expressive information contained in the original records, of which, as a matter of fact, I have seen very few.

Before entering upon the consideration of the results I shall not stay to argue whether a knowledge of the upper air is of any practical advantage. I take that for granted, but I should like to explain that what I mean by knowledge of the upper air is not merely a remembrance of what has once been found to occur there, but rather a guide to what does occur there "as a rule." That is to say, our experience is of little use unless we can draw some general conclusions from it, and thus get some guide towards practical application or future investigation.

I hope to show you that the records of the year's work, even in the curt form of publication which you have seen, do advance our knowledge from both those points of view.

I am indebted to Mr. Gold, Superintendent of Instruments at the Meteorological Office, for enabling me to show you some of the general results of the year's work, by providing me with a number of diagrams to which I will direct your attention.

Let me put down some questions to which we will endeavour to obtain answers from the diagrams. I will set them out as an examination paper.

(1) Does the temperature of the air decrease regularly or irregularly with height? Gradually or suddenly? Within what limits is the rate of variation with height confined at different stages? Is the rate of variation the same for different directions of the wind, or different for different winds in any regular manner?

(2) Does the wind velocity increase aloft in the same manner for winds from the various directions? Is there any height at which the wind velocity practically ceases to increase? Is there any sudden transition in direction or in velocity?

(3) Does the humidity of the air always increase with height and consequent reduction of temperature until saturation is reached, and after saturation is reached and cloud formed does the saturation continue to greater heights, or can we find evidence of dry layers above moist ones?

(4) In those sections of the atmosphere where there is no extraordinary change in the temperature with height is the composition of the atmosphere homogeneous, or, to be more precise, are the proportions of water vapour and dry air at different levels such as would be the case if the air within the section were churned up and thoroughly mixed and then allowed to settle, or is the atmosphere, as we find it, stratified in layers of different composition?

Now let us turn to the diagrams to see what suggestions we can get for answers to these questions. To many of them any expert in aëronautics would doubtless be able to give an answer off-hand from his own experience, but I wish you to consider whether answers can be obtained from the meagre information of the published results of the kite ascents.

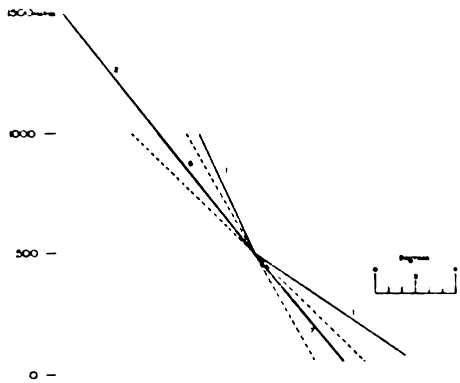
The diagrams have an element of novelty about them in that the condition of the air at 1,660 feet (500 metres) has been taken as the datum in each case, instead of that at the surface. The reason for this is that the surface is liable to all sorts of local disturbing causes. There may be local effects in the way of warming—indeed, the thermograph trace may not be in proper working order at the start; the wind velocity at the surface is a purely local matter depending upon the screening due to trees, buildings, or other obstacles, or what may be called for brevity the friction of the ground. Indeed, it is only at Oxshott, where there is a stationary anemometer, that the surface velocity of the wind is given. There are difficulties about determining the velocity with the kite close to the ground. And in like manner the local influence of the ground upon the humidity or air-composition as regards water vapour may be very great; consequently the condition of affairs at the ground level gives bad datum values to which to refer the variations shown above. The 500 metre level has been chosen instead, because it is next in the published tables. I am not prepared to say that the selection of that particular level is the most appropriate. That is a question upon which I should like the opinion of those who are in a position to study the details of the records.

The first three sets of diagrams, then, show the *variations* in temperature, wind velocity, and humidity from the values of those quantities in the several ascents at the 500 metre level. Heights are shown by vertical distances and increases of temperature, wind velocity, and humidity by distances measured from left to right and *vice versa* according to a scale indicated on the drawings.

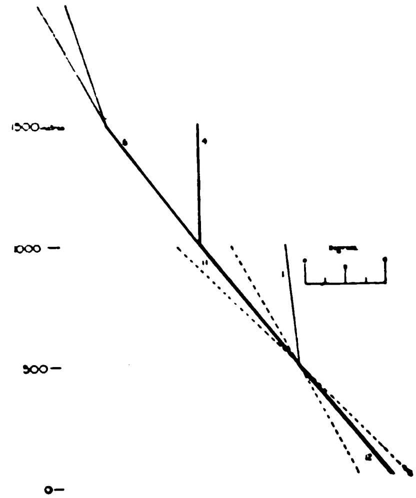
In order to get the general results, rather than the individual details, the diagrams originally drawn to show the values for the individual ascents have been generalised in those represented on the screen by drawing lines to represent changes approximately indicated by the members of a group of ascents. The lines are thus average lines, and the number of ascents which each line represents for each stage is given by a figure against the line. Thus, in the temperature diagram for Oxshott, S.W. winds, the full line, between the two dotted lines, represents the mean result of twenty ascents, and the full line beyond the dotted line represents the mean result of eleven ascents.

TEMPERATURE.

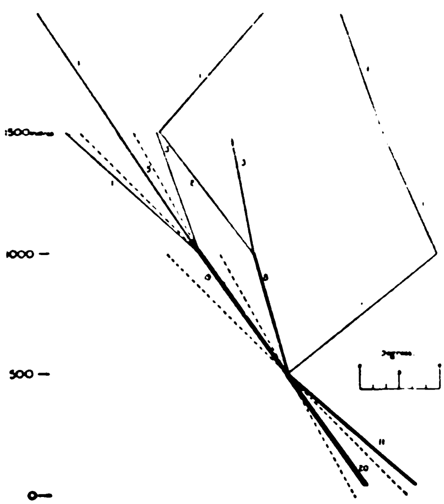
OXSHOTT.



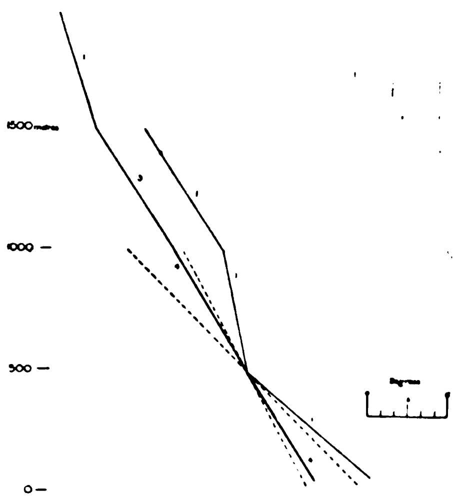
N W. Winds.



N.E. Winds.



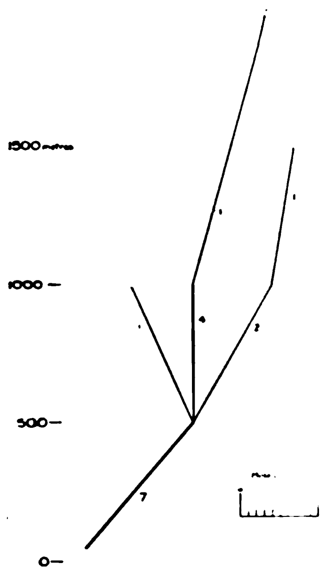
S.W. Winds.



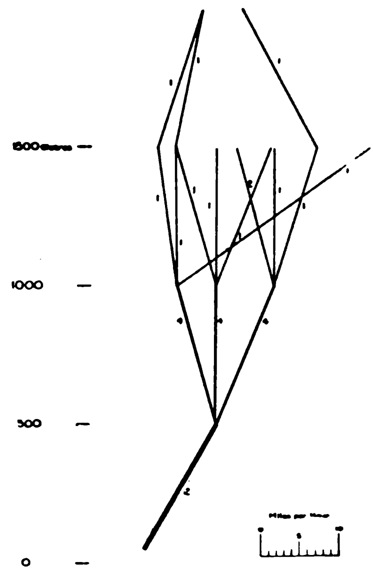
S.E. Winds.

WIND VELOCITY.

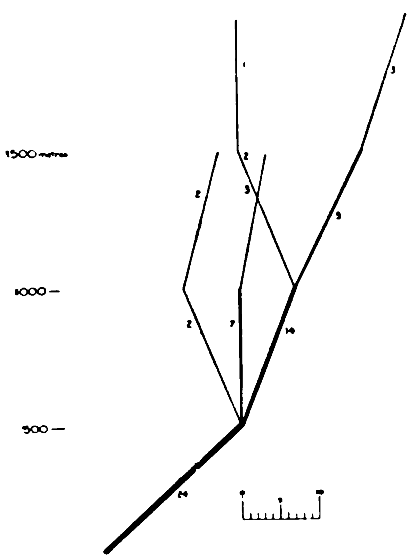
OXSHOTT.



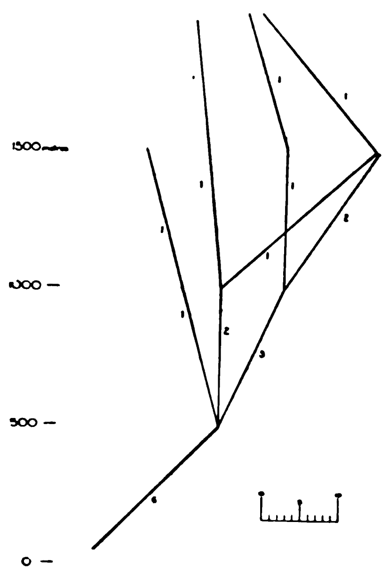
N.W. Winds.



N.E. Winds.



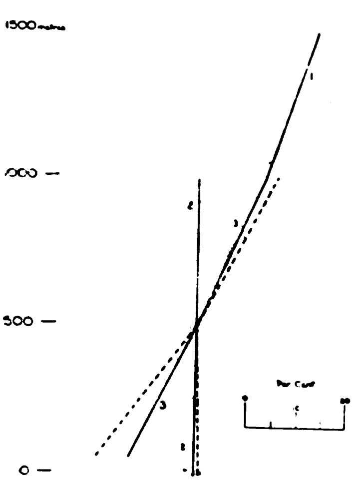
S.W. Winds.



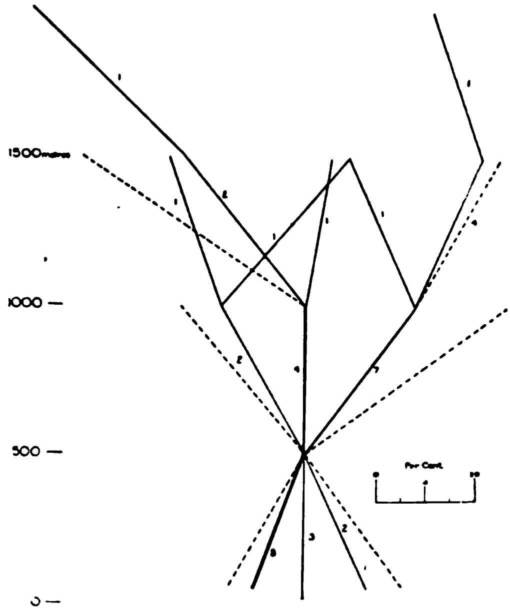
S.E. Winds.

HUMIDITY.

OXSHOTT.

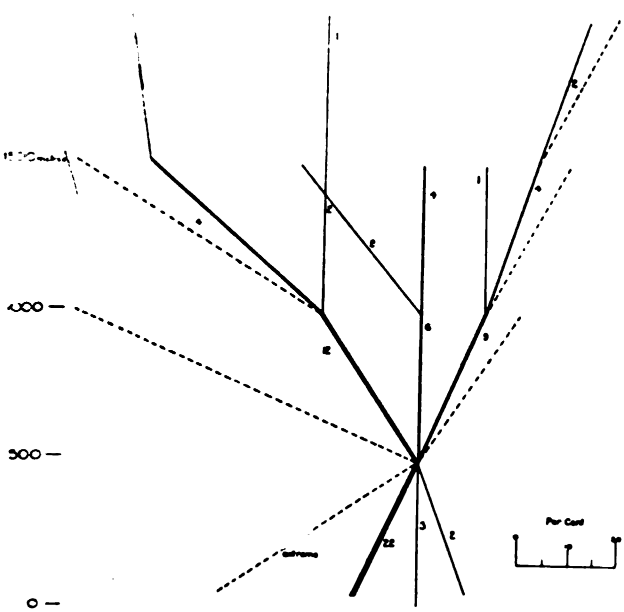


N.W. Winds.

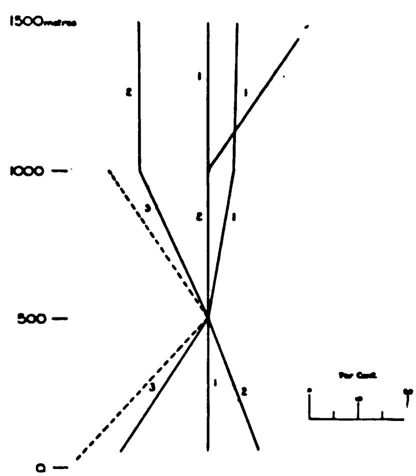


N.E. Winds.

Dotted lines show extreme variations.



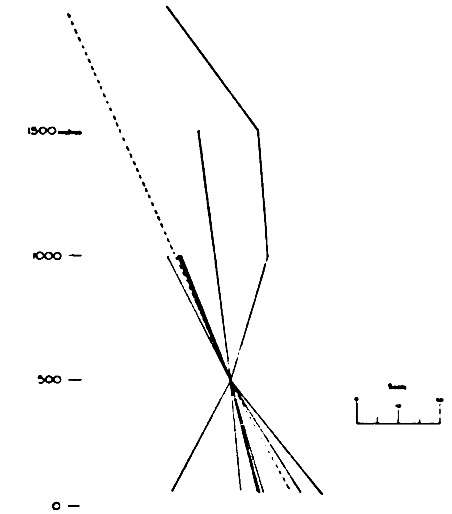
S.W. Winds.



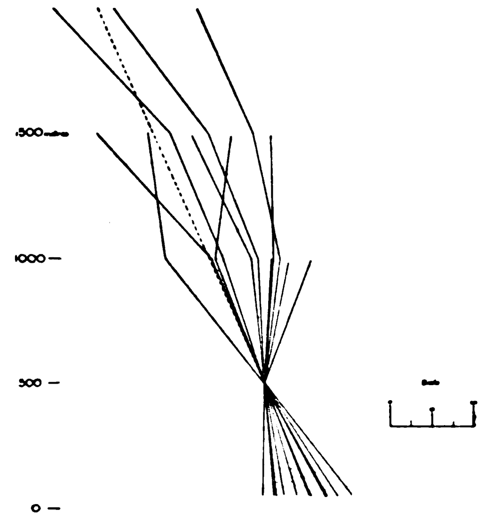
S.E. Winds.

RATIO $\frac{\text{MASS OF VAPOUR}}{\text{MASS OF AIR}}$ PER CUBIC METRE.

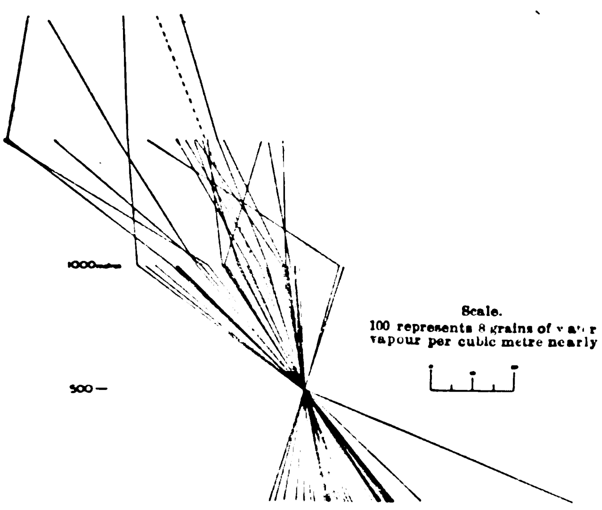
OXSHOTT.



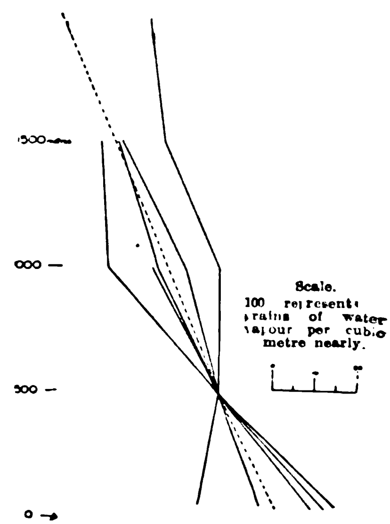
N.W. Winds.



N.E. Winds.



S.W. Winds.



S.E. Winds.

The dotted line shows how the ratio would change with saturation from the beginning and adiabatic temperature gradient.

In order to give the reader an immediate impression of the numerical distribution, the thickness of the lines in the diagrams has been adjusted so that the thickest lines indicate the most numerous groups.

Let me next explain the dotted lines in the diagrams. In those relating to temperature they correspond with certain lines of theoretical variation of temperature known as the adiabatic lines for dry air and saturated air respectively. The line of less slope, indicating more rapid fall of temperature with increasing height, is a line of adiabatic change for "dry" air. If a mass of air could be isolated and completely protected against any gain or loss of heat during its travels, its temperature would diminish as it rose and increase as it fell simply in consequence of its expansion under the release of pressure in the first case, and its compression under the added pressure in the second. The change of temperature with height would be indicated by the dotted line of less slope for ascending or descending air so long as the air caused no cloud of water drops. When the air carries water drops the temperature changes are less, because evaporation or condensation of water interferes, and we get a thinning of the cloud instead of the full warming in descent and thickening of the cloud instead of the full cooling in ascent. Air actually ascending or descending with any considerable rapidity is practically freed from any accessions or losses of heat, consequently we may anticipate that its change of temperature with height should be along the dotted line of less slope if it is free from water drops, or along the dotted line of greater slope if it contains water drops. We cannot easily explain changes of temperature in an isolated mass of air more rapid than the "dry" adiabatic rate or less rapid than the "saturated" adiabatic rate; consequently the presence of lines in the temperature diagrams outside the region between the two dotted lines affords material for speculation and further investigation. It must be remarked that in plotting the results of a kite ascent we do not record the successive temperatures of the same specimen of air, or even of the same section, but of different points of successive sections as the whole stream flows past the kite, so that all sorts of variations may be expected unless the stream under investigation is steady and persistent. We need not, therefore, be surprised at irregular changes, but in due time we might be able to account for them in some rational manner. Thus the cases when the variations shown in the diagrams are outside the limits of the two adiabatics may be regarded as affording material for another examination paper in the future.

On the humidity diagrams the changes shown in the humidity of the air are much more violent and sudden than in the diagrams of the other elements. The dotted lines on those diagrams indicate the extreme variations recorded in the ascents reported in the published results.

The diagrams here reproduced represent the results for Oxshott, grouped according to the direction of the wind which raised the kites, for the four quadrants, N. to E., E. to S., S. to W., and W. to N. On this occasion time does not allow of the comparison of the results with those obtained at the other stations mentioned. Moreover, the numbers of ascents for the different quadrants are very unequal, and, therefore, such general conclusions as may be drawn from them are liable to modification with more extended experience.

With these preliminary explanations let us turn to our examination paper.

(1) The winds in the N.E. quadrant show remarkably regular decrease of temperature nearly at the "dry" adiabatic rate up to 5,000 feet (1,500 metres), but at each stage there are ascents which indicate a cessation of the decrease. For the S.E. quadrant the ascents are few (only five), but with one exception they show a decrease nearly at the "saturation" adiabatic rate, slackening off at 1,500 metres. For the S.W. quadrant, below 500 metres, there are two groups, one of 20 with an average gradient intermediate between the "dry" and "saturation" adiabatics, and one of 11 with gradient greater than the "dry" adiabatic, which may be due to special surface heating. Above 500 metres there is a marked bifurcation: 19 go on in continuation of the line of the large group of the first stage, but eight show very slight fall of temperature, and for one there is a marked inversion of temperature change. The next stage is also marked by irregularities. The N.W. wind seems again to be more steady as to its gradient, with one marked exception. Thus we may fairly say that the temperature changes lie for the most part between the "dry" and "saturated" adiabatic rates, that the northern winds show the steadier changes, but that sudden and comparatively violent changes,

most frequent in the S.W. quadrant, which happens to be also the quadrant of most frequent ascents, are liable to occur.

(2) The diagrams of wind velocity are particularly interesting. The average line for the winds of the N.E. quadrant shows only an increase of nine miles per hour up to 500 metres; beyond that the average variation is practically very small, though there are special cases of sudden change in either direction which indicate a distinct change of current. The S.E. quadrant shows an average increase of 16 miles per hour up to 500 metres; beyond that very little increase on the average, and a general diminution in the cases of three ascents, which went beyond 1,500 metres. For the S.W. quadrant an increase of 18 miles per hour shown in the average for 24 ascents for the first stage there is comparatively little variation in the average, although for five ascents to 1,500 metres and three beyond that stage the velocity does go on increasing right up to the highest limit. The theoretical bearing of this result is of great interest. The N.W. quadrant again shows considerable increase for the first stage, but beyond that, on the average, practically none.

Thus it appears that whatever be the law of variation of velocity with height the increase of velocity which at Oxshott is greatest for south-westerly winds and least for north-easterly, has practically ceased at 500 metres, except in certain cases, which suggest the existence of special meteorological conditions requiring further investigation.

Temporary fluctuations of wind velocity are apparently to be expected at any height. At Glossop Moor, where observations were conducted in August and September, the wind, if sufficient to raise a kite at all, rises so rapidly at considerable heights as frequently to wreck the kite, thus rendering observations at that station particularly difficult.

(3) The humidity diagrams do not admit of any such simple descriptions as those for temperature and wind velocity. All sorts of variations are shown at all heights, except in the case of north-westerly winds, of which there are, however, very few examples. That is the only quadrant for which no diminution of humidity is shown at any stage of an ascent. That result may be purely fortuitous. In the indications of bewildering variety of changes shown in the other diagrams as, for example, in that for the S.W. quadrant, we may have a tendency towards a maximum of humidity at 500 metres; there are 22 examples of humidity increasing for the first stage, 12 of diminution for the next stage. Higher up the tendency of the air to become drier is still more marked. Six ascents show drier air at the third stage, four no change, and only four increased humidity at that stage.

For the N.E. quadrant the tendency towards diminished humidity does not show itself until after the second stage is passed.

The great irregularities in the variations of humidity with height are doubtless due to the facility with which cloud forms in air, cooled by the expansion due to the diminishing pressure of rising air. In this respect the properties of moisture are different from those of the other constituents of the air, and the proportion of moisture to dry air in a certain mass of the mixture may be taken as a criterion for determining the points suggested in the fourth question of the paper.

(4) To answer this question special diagrams have been prepared representing the variation with height of the ratio of the mass of vapour to the mass of air per cubic metre. For these the lines of the separate ascents are shown because it is difficult to select representative average lines as in the case of the other elements. The run of the lines may be compared with one or other of two theoretical lines. Of these two lines the first represents what would happen if the air could be regarded as having been thoroughly stirred; in that case the ratio of water vapour to air in a cubic metre would be the same at all heights, and the limiting or test line in that case would be simply a vertical line. The second represents the changes that would be incidental to a cloudy atmosphere, *i.e.*, complete saturation, at every stage. In this case the actual amount of water present compared with the dry air would diminish with height, because the temperature falls and less water is required to saturate air at lower temperature. The second line has been calculated by Mr. Gold and plotted as a dotted line in the diagram.

It will be seen that we cannot generalise the lines on the diagram at any stage by referring them to the vertical line or the saturation line. Clearly the composition of the air does not remain the same at all heights. For the most part there is less water in proportion to dry air up above than lower down, but there are evidently striking exceptions in the one direction or in the other.

We have thus definite evidence of more or less horizontal stratification in the atmosphere, which is borne out by numerous examples in the other diagrams, the sudden changes of wind velocity, the sudden changes of relative humidity, and the changes of temperature gradient all point to stratification, disturbed, perhaps, but not obliterated by the convection currents which must be produced by various sources of local heating at the surface or elsewhere. And if we consider for a moment, we can gather plenty of ocular evidence of stratification. The ordinary stratus cloud must represent a more or less horizontal layer of stratified air covering a vast area, many thousands of square miles; an overcast day without rain must mean the persistence of that stratification for a very long time without much change. The evidence from our kite ascents shows us that there are many examples of stratification in the atmosphere, and, indeed, it is not too much to say that the two well-known forms of cloud, the cumulus and the stratus, represent two types of condition in the atmosphere which must be represented in the kite ascents if we extract all their meaning.

The convective condition i lustrated by the cumulus cloud is of limited horizontal extent. It is sometimes referred to in the notes of the observers, and it is represented in the results by those cases in which the temperature gradient is adiabatic, either "saturated" for rising air in clouds, or "dry" for descending air. The stratified condition represented below by stratus cloud is shown in the kite results by the changes in the composition of the air at different levels.

I am sorry that I have not time or space to refer to the comparison of the results for different stations. As a matter of fact that part of the initial programme which referred to simultaneous ascents at three stations has not been carried out as fully as could be wished, because each observer has had to wait an opportunity, and the opportunities have seldom been coincident, so that the comparison of the results from the different stations would practically involve merely the comparison of the general results drawn from each. But I should like to refer again to the cases of ascents at Brighton under the conditions of sea fog. The only examples that I happened to notice in the course of the year showed a conspicuous *increase* of temperature in the fog at the first stage of 500 metres. This is as it should be if sea fog is due to the cooling of the surface layer of a warm current by cold sea water, and there is a good deal of evidence for that view of the origin of many sea fogs, but in compiling the results Mr. Gold came across other examples of Mr. Salmon's observations, which showed no increase of temperature for the first stage, but in one case a decrease nearly approaching the adiabatic rate. It may be remarked that a sea fog might not extend so high as 1,000 feet, and that there may be room for a reversal of the gradient between the ground level and the first stage. These and other suggestions which would account either for an abnormally high surface temperature or an abnormally low reading at 500 metres, require further examination.

I have made no remarks about the variation of wind direction. The estimations of direction in the upper air are, in any case, difficult, and when the top kite is hidden by clouds, not possible. As a general rule, but not always, the wind veers slightly aloft. No case is reported of a kite reaching a current of markedly different direction by sudden transition. Thus it would appear that the sudden changes which take place in the composition of the atmosphere or the velocity of the wind are not accompanied by equally sudden and extensive changes in wind direction.

I have now completed the examination paper, and I think we may regard the general conclusions as to the tailing off of the increase of wind with height and the differences in the increase of velocity for different directions and for the first stage as information of very considerable importance. In a similar way we may regard the evidence for the stratification of the atmosphere drawn from the humidity results and confirmed by them for wind velocity and temperature as equally striking and valuable. It only remains to consider what indications the results give us for future guidance.

First and most evidently, whether the general statements that have been made here on rather slender foundation can be laid down with greater security; whether the exceptions as in the case of the increase of temperature aloft in a sea fog can be explained without abandoning the general statement, as, for example, by some accidental initial warming of the thermograph.

Next we want to know more exactly the shape of the curve of variation of wind velocity with height for the various directions from which the wind comes. For this purpose the jump from the ground to 500 metres is too great: we want to know about the intermediate portion. Next we want to know what are the meteorological conditions under which the wind fails at higher levels or goes on increasing up to the highest limit. Also some more precise information about the wind direction at the upper levels is very desirable. It is evident to the casual observer on some days that the upper clouds move directly opposite to the lower clouds. How is the transition between the two effected? By a gradual alteration in direction, or by a falling off in the velocity until a calm layer is reached and then gradual increase in the new direction?

Next we want a more careful study of the boundary region between two stratified layers of different composition. If, as I have said, the atmospheric processes may be resolved into convection and stratification, the careful examination of either or both would be most valuable. For this the observer would have to train himself to recognise the signs of a marked stratification and a marked convection and manipulate the kite to get a prolonged record in the region to be specially examined.

Finally there is the part of the programme of co-operation still to be taken in hand, namely, concurrent observations at the same time in different places. Such comparisons as are possible from the published results show that the phenomena at the two stations, Oxshott and Ditcham Park, though similar, are not identical, and the examination of the records for salient points of difference is well worth the effort required to make it. Perhaps it may be possible to arrange for the opportunities to occur simultaneously at the four stations where ascents are now made, and I hope before another year elapses that further progress may be made with the work by means of unmanned balloons so that a greater height may be brought under review.

As it is, I wish most cordially to congratulate the observers at the several stations who have contributed in their various ways to the results which I have sketched in this paper upon the year's work.

Mr. Dines: Dr. Shaw has taken 500 metres as a starting point, so to speak. It is not possible to publish results of observations in very great detail, and it is, therefore, necessary to take some point to start from, for the sake of comparisons. It may occur to you to wonder why some lower point might not be taken. It would be an advantage if we could leave a kite at a few hundred feet above the surface so as to get the temperature conditions uninfluenced by the surface, and I should like to do so if it were possible, but in practical work, as a rule, it is not possible. On calm days one often has to wait some time before one gets a chance of going through the surface wind, and the kite soon falls to the ground. Then on days when the wind is strong, particularly when there is a west wind, it is most likely to be broken, because the wind is gusty. I always try to get a kite through that region of surface wind as quickly as possible.

Dr. Shaw pointed out one case in which the temperature decrease exceeded the adiabatic rate. I think this must be some instrumental error, and that it is not the rule. I may point out that the temperature shown at 500 feet was not simultaneous with the temperature at the surface, so that it does not follow that the actual temperature at that height showed a greater decrease than the adiabatic decrease at the same time, because the two observations were not simultaneous.

With reference to the question of the wind decrease, unfortunately there are considerable limitations in the use of kites. To begin with, we cannot fly without some wind, and if the wind fails, we cannot keep in any particular stratum of air, hence it may be that in those charts the height is limited to 1,000 metres because of the wind decrease above that height. There are many cases when the wind fails at 1,000 metres or so. That is incontestably the case with winds from the east and north-east; it seldom happens with a south-west wind.

These ascents were all made in the daytime. I do not think that makes any difference above 500 metres, but the temperature decrease is far more rapid in the day-time, because it is warmer in the day at the surface, and it is an established fact that when we get a few thousand feet up, the surface temperature vanishes, and the air temperature is the same night and day.

With reference to the change of wind above, there was one undisputable case with a north-east wind, in which the wind increased rapidly. This was due to the fact that a rain squall passed over when the kite was highest.

Generally speaking, the humidity increases as the instrument rises, until the cloud level is reached. Then if you do not reach the clouds you may be fairly certain of the height by the decreasing humidity. When a kite passes through clouds, a few hundred feet above the cloud level, the air is curiously dry. Temperature inversion occurs just above the cloud level, and you find dry air. Then frequently you get a sudden rise of temperature, and then a decrease, and I imagine that there are two or three cloud levels, as the same thing may happen time after time.

The observations as to cumulus clouds and the uprushes of air are interesting, but they are not so pleasant to the man who is flying the kites as to the man who works them up. It has happened to me several times that my kite has got into one of these uprushes and been carried up 1,000 feet or so, and in a few minutes the wire has broken, which is not exactly what one wishes.

As to the question of co-operation. It would be useful if we could get ascents on the same day and at the same time, but it is a difficult matter, because my observers, to whom I am grateful for making the observations, are voluntary observers, some have regular business, and they cannot always set apart a time for kite flying. Also if a time is pre-arranged, it probably happens there is no wind at that time.

I think Mr. Cody is here, and if he will give us the result of his experience as to decrease and increase of wind with different directions it would be interesting.

Mr. Cody: I have frequently found that the kites get to a certain height and will not go higher. I have known occasions where a man has gone up at night-time 500 feet in a dead calm; we let the lifter go, and the man went right up with no wind at all with his carrier kite, so there must be wind high up. Only a few days ago we had balloons up with a perfect gale blowing to 400 feet, and at the ground we could not have flown a piece of tissue paper. I went up to see the conditions, and found the wind did not blow at all at starting, but higher up there was a great deal. If the Society is interested in meteorological research, I could guarantee to give them readings at 100 feet or at any height up to 1,000 or 2,000 feet, either in a dead calm or a heavy wind. I could tie my kite to any height that was wanted. So that if there is any interest in having a certain height, if the Society will communicate with me, I will give them the necessary readings.

Mr. Read: I would like to say one word about the importance of these readings. It shows the interdependence of one branch of science on another. Meteorologists bring us fresh information, especially that of the increase of wind at 500 metres, and this is a practical point for aëronauts. It has another bearing, too, with regard to the future; when we are going through the wind at a great rate—for instance, in the future, when we make our week-end trips in balloons—we shall have to consider what precautions must be taken to prevent collisions. When we are travelling 100 miles an hour, it is all very well on a railway, but in the air if you come across another apparatus travelling the same pace as yourself, there is bound to be a collision. The only rule of the road, then, will be the upper and lower airs. On the ground or water we have only two directions, but in the air there are four. It is important that we should get a knowledge of these layers of the atmosphere before we start on our journeys, and we are indebted to the author of the paper for having shown us that we have layers of this kind.

With regard to the sea fog, I think there is a solution for both cases. An east wind will bring us rain on the east coast, when the water is warm, but not when the water is cold.

Mr. Douglas Archibald: Some years ago I found that the result of the observations up to a height of 1,500 feet above the ground was that the velocity of the wind always increased up to that height. The increase of velocity was greatest with a south-west wind, exactly as Dr. Shaw found. I am glad to see that in almost every respect the observations taken now under the direction of the Weather Office agree with and corroborate the ones I took then. We made these observations for three years, and mostly in the summer time, but sometimes in the spring, and, therefore, there were a good many variations in the wind, and I collected them under different heads, and certainly proved that the north-east current is the shortest, and the south-west is the tallest. I certainly think that what Dr. Shaw has shown us to-night has a bearing rather on aëronautics than on pure meteorology, because he did not show us how these observations would enlarge our knowledge of the conditions of the weather so much as the physical conditions of the atmosphere, and from that point of view they appear to me a necessary accompaniment of any aëronaut. It is much in the same way as the hydrographer to the Admiralty shows the currents of the sea that aid the mariner who is floating his ship, and the more that is known of the conditions up above by the aid of kites, certainly the better for the journeys of those flying machinists who are going to greatly develop their machines shortly. When they do, the first thing they will find out will be what a great variation occurs in different parts of the atmosphere. So far as the actual observations of kites have shown up to date, I think the work that has been done recently in America is one of the best instances in which the observations from kites have shown fruit. Professor Bigelow has taken all the observations that have been made over in America and a great many that have been made in Europe, and by combining them he has shown the conditions of the atmosphere with regard to the cyclones and anti-cyclones; in fact, he has developed a new theory as to cyclones and anti-cyclones which had never been attempted before. So far as I have seen, I think it is some of the best work in meteorological science that has been done in the last few years. I am glad that kite observations have been the basis of this work. The idea was started a few years ago; I may claim a little towards starting it, the only observation of the kind before my own being in 1847, which had practically been forgotten when I started mine in 1883. By the aid of these observations all over the world, meteorological science has advanced by leaps and bounds, and I think it is a pleasant fact that Dr. Shaw has included these observations in the ordinary weekly weather maps so that they may be utilised by the public and made part of the development of the science.

Mr. BUCHANAN: I think the most important observation that has been made to-night is the proposal of Mr. Cody to give readings at definite heights, and I presume over a period of 24 hours. We have had ordinary kite flying and balloon observations lasting over an hour or two, and we now have an opportunity of getting what is the most important thing, a 24-hours' record.

There is one other remark I should like to make. When Dr. Shaw was pointing out the fall of temperature in one case Mr. Dines showed that it might be accidental. There is a similar thing in the observations at Grand Moulet, which is like a mountain station, but the observations at Bosch have a difference of temperature of quite as much as 2°C. per 100 metres.

Colonel TROLLOPE: For some years Professor Hergesell, of Strasburg, has been sending out man-carrying balloons and kites on a certain day to make meteorological observations. Mr. Bruce has these papers, and if we can correspond with him with regard to a date, I think we shall get valuable data.

Dr. SHAW: It is too late at present to detain the audience by going fully into the points that have been raised. I think the discussion has been more interesting than the original paper. I am glad Mr. Douglas Archibald said what he did. I knew the time would be short, and I purposely compressed what I had to say in the smallest possible compass, or I should have been glad to compare my results with the results he obtained some years ago. I did keep myself off the meteorological side of things as much as possible. I think the question as to whether there is a limit to the velocity of the wind is one of the most important theoretical meteorological questions before any investigator. I think Mr. Dines' explanations were only suggestive, and I am looking forward to next year's work.

The PRESIDENT: You will all agree that this paper is one of great interest, and I may say important, considering both the name of the reader and the names of those who have taken part in the discussion. Some of our most eminent meteorologists have come here to-night to discuss these matters. There are letters from other authorities who express their regret at not being able to be present at this lecture. It seems to me of especial value that the wind has been found to increase up to 500 metres, and probably does not increase much more. We have known that it did increase as one went up, but there was a doubt as whether it went on increasing or if there was a limit. Now it seems there is a limit to the rate of increase.

There is one point I should like to bring forward, that very often in a balloon ascent, when you get above the clouds, if there is a decided layer of clouds hanging around, when you rise above this, the direction of the wind changes. I am only speaking from a limited experience of three or four times, but it would be interesting to know whether aëronauts have found a change in the direction of the wind where there is a large bank of clouds.

I can only now propose a vote of thanks to the lecturer for his valuable paper to-night.

The vote of thanks was carried unanimously.

The Gordon-Bennett Cup of 1906.

By Bt. COLONEL J. E. CAPPER, C.B., R.E.

The Gordon-Bennett Cup is the "cordon bleu" of the aëronautical world.

It was presented by Mr. James Gordon-Bennett, the proprietor of the *New York Herald*, to the International Aëronautical Federation, to be competed for yearly under the following conditions:—

(1) That it should be an International Challenge Cup.

(2) Every competing nation to have the right to enter three balloons; no balloon to be more than 77,000 cubic feet and none less than 31,500 cubic feet.

(3) Each balloon must be piloted by a member of the nation which he represents.

(4) All balloons to start on the same date, and the cup to be won by the balloon which descends furthest from the starting point.

If the weather conditions are unsuitable for a long-distance contest, the Committee may decide it shall be won by the balloon which stays longest in the air.

(5) The Cup to be competed for under the auspices of the Club which holds it. The first contest, viz., in 1906, taking place under the auspices of the Aëro Club of France.

(6) The Cup to be held by the Club and not by any individual.

(7) Any nation winning it three years in succession to keep it.

The race for the Cup this year started from Paris. It excited a great deal of interest in the aëronautical world, and the entry was very fine. France, Germany, Great Britain, and Spain each sent three balloons, America two, and Belgium and Italy each one.

The British representatives were Mr. Frank Hedges Butler, accompanied by Mr. Griffith Brewer, in the "City of London"; Professor A. K. Huntington, accompanied by Mr. M. C. Pollock, in the "Zephyr"; and the Hon. C. S. Rolls, accompanied by Colonel J. E. Capper, in the "Britannia."

All the British balloons were constructed specially for this race, and were of 77,000 cubic feet capacity.

Among the foreign pilots the best known were M. Santos Dumont and Comte Henri de la Vaulx.

The competing balloons were all spherical with the exception of the "City of London" (Mr. Butler's), which was pear-shaped.

M. Santos Dumont had his car fitted with an engine and lifting screws to utilise instead of ballast.

The smallest balloon used was of 52,500 cubic feet capacity.

Most of the balloons were of varnished cotton; two were of varnished silk, and two of rubbered cotton. Twelve were entirely new, and nearly all were in excellent condition.

The contest was fixed for September 30, the hope being that the strong easterly winds usual at that time of year would give a long course westwards over Europe, and thus permit of a record run being made.

In anticipation of these winds and of a journey in the air extending over two days, during the second of which we might expect to reach great heights, we had laid in an ample provision of food and drink. We also had cylinders of oxygen, and a very ample supply of warm clothing.

We ourselves had forgotten to lay in a stock of water, though well provided with milk. Professor Huntington, who had had the foresight to provide an ample quantity, most kindly gave us a large tin at the last moment, and this we found most valuable. Mr. Butler had also ordered two pints of champagne to be placed in each of the British cars, and when wearied out, the next evening, we much appreciated the extra fillip it gave us.

The balloons had to be in Paris on September 29, each being certified by its Club committee as complying with the regulations, and they were there inspected by the organising Committee.

The French Aëro Club kindly invited all contestants to a dinner on the 29th, and there they were hospitably entertained and a few pleasant speeches made, notably by Prince Jerome Bonaparte and by Mr. Roger Wallace, who delighted all by the facility with which he rendered his witticisms in a foreign idiom.

The arrangements for the contest were admirably organised by the Club Secretary, M. Besancon; whilst the English competitors owe a great deal to the Secretary of the British Aëro Club, Mr. Perrin.

The 30th was a great day. The west end of the Tuileries Garden was simply full of balloons, 16 great, glossy spheres, mostly of a translucent yellow, one of chocolate colour, and two of a brilliant chrome, and so close together that it seemed almost impossible to start them.

Gas mains were laid along this part of the garden, with branches to each balloon, and by three o'clock all the huge globes were filled.

Each balloon was furnished with the flag of its nation and a huge number on the car to make identification easy; whilst a number of sappers from the military Parc d'Aërostation were told off to assist in handling the balloons, each man wearing on the arm a brassard with the number of the balloon to which he was appointed.

A crowd of gaily-dressed visitors was accommodated on the raised terraces on three sides of the enclosure allotted to the balloons, but neither gold nor interest could gain admission to this enclosure to any but the competitors, a few journalists, and the appointed officials.

At 3 o'clock a flight of 3,000 carrier pigeons was launched in the air. Several of these were so attracted by the unusual scene in the Tuileries Garden that instead of starting on their proper journey they paid the balloons a visit, some of them even remaining on the balloons during their departure.

The interval before the departure of the first balloon was occupied by the ascent of numerous pilot balloons of comical shapes, which elicited shouts of amusement from the populace, and a swarm of beautiful small toy balloons, sent up by "La Vie au Grand Air." There must have been hundreds of these despatched at the same moment, and the diverse currents of the air were well shown by the way in which they scattered.

The general direction of the wind as shown by these pilots was W. by S., and great was the disappointment; numerous prophecies being made that the contest would be a short one, and end on the shores of the Atlantic.

We ourselves, thanks to a telegram sent by the Meteorological Society, hoped to get currents trending in a north-westerly direction at the higher altitudes, and we were, therefore, careful to provide ourselves with a map of England, besides the general map of Europe, and large scale maps of Northern and Western France.

No time was lost in ballasting up, and punctual to the minute at 4 o'clock the first balloon, "The Elfe," of Italy, manned by Mr. Vonwiller and Lieut. Cianetti, sailed gracefully off amid the cheers of the populace. Thence on, at regular intervals of five minutes, a fresh balloon, brought to the same point of departure, sailed off on its appointed mission, till all had been despatched.

The "Britannia," on which I was a passenger, was the fifth, and henceforward my description can only be of our own doings.

Starting at 4.20 we were wafted slowly from the Gardens, over the Place de la Concorde, which was a mass of human beings, close to the Eiffel Tower at the elevation of its summit, over the Bois de Boulogne and St. Cloud, then over Nancy, where dusk began to enclose us. Ahead and astern were our competitors, seeming to be going in all directions. Mr. Rolls, with his eye fixed on the statoscope, continually threw out small shovelfuls of sand, to compensate for the cooling of the gas, till by 6.30 eight of our thirty-seven bags of ballast had been expended. My duties were to keep the log and ascertain our course—no difficult matter while daylight lasted.

About 6 the sun set in all its splendour, and we had recourse to electric lights to read our maps and instruments. Half an hour later the moon rose, throwing a silvery radiance on the earth beneath, but even with its assistance the course was hard to track.

We had been going steadily just south of west when darkness surrounded us, and when railways below us gave the next opportunity of locating our position, we found none on the map that tallied with those on the ground. For some little time we were in doubt, but about 8 p.m. we came to a large well-lighted town which, knowing our probable rate of progress and the time from the last point we had identified, must surely be recognisable. We searched the map, but no such town could we find in our line, and it was evident we had changed direction after dark. Consulting the next map to the north we identified the town by its size and the direction of the railways and roads as undoubtedly Evreux, and questions shouted down (which were reported in the French press as cries for help) brought back the reassuring news that we were really there, and were going in a north-westerly direction. This was the best of news, as it promised fair for a run to the West of England, or even to Ireland, instead of our journey being brought to an abrupt termination by the Atlantic.

From that point on we were never in doubt as to our position, and we hoped shortly to make the mouth of the Seine and a long crossing of the Channel to Devonshire. Our hopes, alas! were doomed to be frustrated. For some reason we rose to about 3,000 feet and were taken at that altitude more and more to the north, finally reaching the Seine about 10 miles west of Rouen, and here we lingered, drifting slowly along, nearly becalmed for several hours, going finally north-east.

At 11.20 we saw below us a balloon hurrying N.W., and it became a question whether we should descend and follow it, or remain up in the hope of getting a stronger current in the morning which would bear us N.E. to Norway. On the whole, we decided for the latter. We knew it was improbable that anyone else would have got this easterly set, whilst several, if not all, would cross to England. Our chances there were only equal to theirs, but if we could get to Norway we must distance everyone.

There was nothing to do, the balloon stayed at its elevation; we had thrown out no ballast since evening; and in turns we tried to sleep, the smallness of the car and its numerous contents making our efforts in this direction somewhat ineffective.

About 2.30 a.m. we moved off again, the treacherous wind taking us nearly due north, and it became apparent that we must try for England after all, greatly handicapped by the drift we had already taken to the east.

At 3 a.m. the revolving light west of Dieppe saluted us some 20 miles off, and at 4.30 the moon fell behind a heavy bank of clouds, appearing for a few moments beneath them as she sank far west into the sea, sending a gleam of glittering silver over the water as she disappeared. Then the pale light of dawn appeared in the east, the country gradually became visible, till at 5.20 we left the coast of France west of Dieppe and ventured on the Channel crossing.

It is curious to think that by that hour two of our competitors had already descended in England, having kept low down in the faster breeze whilst we had been sauntering over the reaches of the Seine.

The morning was hazy, and 10 miles out we lost the coast of France, England being still invisible behind the mist. Far away to the north we saw another balloon (the "Zephyr"), and knew that at least one had crossed before us.

On the sea nothing was visible except an occasional fishing boat and steamer.

We found we were going too far to the east, and coming down in order to strike westward, trailed for some time in the Channel, passing close to a steamboat and exchanging greetings with the crew.

There is something peculiarly fascinating in crossing the sea out of sight of all land as we were; the feeling is even more peaceful than going over land, whilst the gentle murmur of the waves far below adds to the restful sensations of a balloon voyage.

After keeping low down for a considerable time we decided to ascend to see if we could find the English coast, as it is difficult to estimate one's course with only the sea to guide one.

Ascending to 5,000 feet we saw again our friendly competitor away to the N.E., and then, alas! far to the N.W., made out the white cliff of Beachy Head. Again the valve was pulled to bring us down into the more westerly currents, the higher ones still trending eastwards, and we kept down till England was close in front, on one occasion shouting to a steamer to avoid our trail rope. A look at the map and our knowledge of the coast showed Hastings in front, and rapidly a telegram was written and, together with half-a-crown, fastened to a small rubber balloon, and ballast thrown to take us over the town. The small balloon fluttered to the ground, and we saw it safely descend in the garden of a small house on the outskirts of the town.

The crossing had taken just five hours.

Over England our course was again easterly, and we had to keep as near the ground as possible, which entailed a liberal expenditure of gas and ballast in order to keep up to the north. Trailing was mostly out of the question, as entailing too much damage, but we were enabled to enjoy short periods, striving to make every inch to the west we could. Passing over the Medway near Chatham we had a splendid view of the channels of even that muddy stream, an object lesson as to the utility of a balloon for conning purposes; then coming down we trailed across the Thames and the marsh land on either side. And so on northwards, hoping against hope to make as far west as Ely, so that we could run up Lincolnshire and possibly to York—but it was not to be. Bury St. Edmunds was crossed late in the afternoon, and dusk overtook us, tired with our exertions and disappointed in our hopes, with no prospect of even touching the Wash. The wind had risen to 30 miles an hour, and we sped on in the gathering gloom 1,000 feet above the earth, till with but seven miles of unknown country between us and the open sea, we had reluctantly to come down. Tearing past a cottage we shouted to the occupants to come on half a mile to help us, and there, in an open root field, we touched the ground. I was too mixed up with attempting to keep myself from the shock of landing and at the same time keep ready to fling the heavy anchor, to notice exactly what happened, but Mr. Rolls ripped the balloon at exactly the right moment, the grapnel tore through the roots for a few yards, the car fell gently on its side, and the balloon, no longer beautiful, spread out an inert mass to leeward of it. Our journey was over, assistance came, we packed with the aid of our electric torches, and the hospitable vicar of Shernborne (Mr. Waters) entertained us for the night.

Next morning we learnt, on arrival at the station, of the "mysterious disappearance" of the "Britannia," and learnt, too, for a certainty that at least two balloons had beaten us. Lieutenant Lahm, of America, assisted by Major Hersey, a meteorological expert, who is acting engineer to the Wellman Polar Expedition, gained a well-earned victory, due both to his own determination and management, and to the unrivalled knowledge of air currents possessed by his aide. He descended near Whitby.

Second was M. Vonwiller, of Italy, with his companion, Lieut. Cianetti, of the Italian Military Parc d'Aërostation, who reached as far as the Humber. It is probable that had they kept at a low elevation they would have been the winners, but an experience near Alton, where they got mixed up with someone's chimneys, decided them to keep up higher, and, getting to about 12,000 feet, they drifted steadily east of north. On the descent their ripping panel failed to tear quite through, and some gas remained in the envelope long enough to carry the balloon and car across a cottage, the inmates of which were considerably alarmed to see a huge flapping monster apparently attempt to devour their house. No one was injured to any extent, but the experience was a sufficiently unpleasant one.

Third place was given to the "Britannia," after very careful calculations, the "Walhalla," manned by Comte de la Vaulx and Comte d'Oultremont, having descended quite close near Great Walsingham. It was a near thing, but the British balloon was held to have won by about a mile—much to our delight.

Three other balloons crossed the Channel —the "Zephyr" (Prof. Huntington) descending in Kent, and the "Ville de Chateauroux" (M. Balsan) with the "Montaner" (M. Kindelan) descending in Sussex.

The remainder all descended in France, nearly all on the coast, for fear of being carried to the Atlantic, whilst if they had only known their position, most might have safely crossed to England.

The Belgian balloon apparently leaked, and made but a short run, whilst an accident M. Santos Dumont met with to his arm from his motor necessitated his descent in order to see a doctor.

It is interesting to note the number of each nation who crossed the Channel:—

Italy: The only one entered.
France: Two out of three.
Great Britain: Two out of three.
America: One out of two.
Spain: One out of three.
Belgium: None—one entered.
Germany: None out of three.

The contest, though not involving any great distances, was most interesting, and the race went to the bold and to those who best judged and utilised the currents of the air.

The Cup remains in the hands of the Aëro Club of America, who will organise the next year's contest.

It is to be hoped our champions will make a bold bid to gain it, and that the entries will be as good as this year, and the contest carried through with the same spirit of friendly rivalry as in the initial contest of 1906.

The PRESIDENT: I will propose a vote of thanks to Colonel Capper for having kindly given us a full account of his very interesting trip.

The vote was carried unanimously.

The Aëroplane Experiments of M. Santos Dumont.

By ERIC STUART BRUCE, M.A. Oxon., F.R.Met.Soc.

At whatever value the aëronautical achievements of M. Santos Dumont may be placed in the history of aërial navigation, there can be no doubt that there is a personality about the Brazilian aëronaut that has done more to convince the world of the possibilities of human flight than any other cause. Whenever M. Santos Dumont begins to experiment there is a thrill of enthusiasm throughout the civilised world, and everywhere we hear the cry that the conquest of the air is at hand. Such a faith as this was, indeed, inspired when, in 1901, M. Santos Dumont rounded the Eiffel Tower in his navigable balloon to win the Deutsch prize. When his navigable balloon experiments ceased, the public faith again grew dim. It has been but a few days ago again revived with still more general accord by his experiments with a motor-driven aëroplane. And yet, since M. Santos Dumont won the Deutsch prize, and before he began experimenting with his aëroplane, two undoubtedly greater achievements in aërial navigation have been accomplished than have fallen to his lot. I refer to the development of the Lebaudy navigable balloon and the experiments of the brothers Wright in America.

Though, in the former case has been evidenced the cleverest piece of engineering work that has yet been done with a navigable balloon, and in the latter case the accomplishment of a flight of 25 miles in a motor-driven aëroplane, yet these two examples of really practical progress did not raise the public pulse to any like degree as did the navigable balloon experiments of M. Santos Dumont in 1901, and his comparatively short aëroplane flights in Paris the other day.

I will not attempt in this paper to account for the psychological reasons which have given M. Santos Dumont an almost mesmeric influence on mankind, because they do not come within the scope of this Society. But whether or no it is the work of the man or his individuality that has convinced the world of the possibilities of the aëroplane, in any case I think he must be congratulated that he has succeeded in doing so. And this is a moment of special jubilation for the Aëronautical Society of Great Britain, who, forty-two years ago, was the pioneer of the world's aëronautical societies. For by this Society more attention has been paid to the subject of aërial navigation by bodies heavier than air than has been by any other aëronautical society in the world.

Our library is full of the records of the valuable papers read before this Society in the past, that little by little have contributed to the issues that are just beginning to be realised at the present time. We feel bound to think that had the light petroleum motor not come so tardily, the dreams of many of those members whose lips are for ever closed might ere now have come to pass.

But one industry has to wait for another. So interdependent are the affairs of human life! The light petroleum motor is, indeed, one of the chief factors in the development of the aëroplane. Its want was felt as long ago as 1868, when a £100 prize was offered by this Society for a light engine and boiler for an aëroplane, a prize won by Mr. Stringfellow. But light steam motors did not supply the want that is being satisfied in modern petroleum motors.

At the present moment when the flights of M. Santos Dumont are creating an interest in aëronautics that is, perhaps, without precedent, it is, I think, all important to real progress that those who are experimenting or about to experiment should keep their heads and balance enthusiasm with the requisite amount of prudence and reason.

We must remember that the period of public excitement which was evoked by M. Santos Dumont's former evolutions round the Eiffel Tower was followed by a period of fatal accidents and consequent depression. It is important in the interests of aëronautical science that the present second period of exultation should be followed by neither. We have still in our memory the tragedies of "La Paix" and the "De Bradsky." The deaths of Severo and De Bradsky and their respective engineers were caused by neglect of ordinary precautions in the one case and the absence of common engineering knowledge in the other.

Though just a little progress has been made in aëroplane manipulation, still the work that has yet to be done before we can claim to have secured the stability of our structures amidst the ocean of air, with its subtle currents as yet unstudied and unfathomed, is gigantic in its proportions. Is not this the truth? And at the present moment, when there is an exaggeration going on about progress made, which is, I fear, misleading the public, it is important that within the walls of a learned society the truth should be spoken.

At this moment of encouragement let us, in this Society, both collectively and individually, apply ourselves with increased zeal to the task the founders of this Society set us in 1866, but at the same time with precaution and with the methods of science. In eight years' time this Society will be keeping its jubilee. In what better way could we keep our jubilee than by showing the world that the work of 50 years has brought us near the goal?

I hear that M. Santos Dumont has lately given advice to those who take part in competitions to fly low. That advice is sound, for it is commensurate with our present progress. Just as the child learns to walk by tumbles, so the first flyers will not escape their falls. By flying very near the ground, man must first learn to use his wings. But the time will come when he will seek higher flight. Will not his best precaution then be to fly over the surface of water, accompanied by the rescue boat? I know this method has been lately criticised on account of the danger of the flyer being entangled in his machine in the water and drowned before rescue can be accomplished. But it would seem that when man first seeks higher flight it will be the choice of two evils, and of two evils one must choose the least. Tumbles at a certain height over solid earth *must* mean *destruction*. Tumbles over water may mean drowning, but there is, perhaps, an equal chance of rescue and preservation.

Concerning the apparatus and actual experiments of M. Santos Dumont, neither at present gives scope for a lengthy paper. In the October number of this journal there appeared a picture of the machine. The supporting surface may be described as a multiple box kite. It reminds us of the part which Mr. Hargrave, an honoured member of this Society, has played in the development of the aëroplane, for from kite we are passing to flying machine. The success of the box kite in scientific aërial exploration has done much to familiarise us with the idea of the possible stability of bodies heavier than air, and enticed man to abolish the string and apply instead the motor.

In M. Santos Dumont's machine the two wings are slightly inclined so as to form a V. Each of the wings is fixed at one end of a long protruding girder. This girder carries the car, and at its other end is the box-shaped rudder. This rudder can be moved in any direction, the up and down movements regulating the rising and falling of the machine. The two-bladed aluminium propeller is fixed behind the wings, and is worked by a petrol motor, which, in the earlier experiments, was of 24-h.p., but which has now been replaced by an Antoinette motor of 50-h.p.

The machine has already been the subject of much criticism; for instance, the following criticism was made by Colonel Fullerton during his recent lecture at the Royal United Service Institution. He then said, "On the whole, this machine worked fairly well; the lifting power is, however, indifferent, and the steering apparatus is much too powerful for such a small machine. The centre of gravity appears to be unduly close to the centre of pressure."

I have received the following criticism in a letter from Mr. A. J. Winship. He says:

"I had the pleasure, some time ago, of working with Mr. E. P. Frost, of West Wratting Hall, Cambs., a member of the Aëronautical Society, in his experiments with natural and close-imitation-natural wing machines; and in the course of the work I learnt from him this most momentous fact, to which Mr. Frost was, I believe, the first to draw attention, and that is that for any degree of safety in the use of these parts it is absolutely essential for the posterior edge as well as the extreme ends of aëroplanes to be as near infinite flexibility as it is possible to make them. On this point birds depend for their safety and automatic balance when soaring. The importance of this fact is further powerfully emphasised by the remembrance of the death of Dr. Lilienthal, and our poor Pilcher, both of whom used machines with unyielding posterior edges. The latter made his last ascent on a windy day, and was earnestly entreated by Mr. Frost previously not to attempt an ascent in such a machine, on such a day at any rate, as disaster would, he said,

surely follow. Pilcher disregarded this advice with the result, as you know, of his death.

You may be sure, therefore, with what grave concern I saw the illustrations of the defective apparatus M. Santos Dumont is now using; and I am writing to you in the hope that you may, by some means or other, see your way to bring this matter before M. Dumont's notice. Mr. Frost will, I know, be only too pleased to do all in his power to prevent the disaster which both he and I feel sure will accrue from persistent use of his machine in its present form."

Regarding the actual achievements of M. Santos Dumont with his machine, there has been a great discrepancy in the reports of the distances he has flown. Therefore, I have obtained through the courtesy of M. De Besançon, Secretary of the French Aëro-Club, the exact measurements of his third and fourth ascents of November 12th, 1906, at Bagatelle. The first and second ascents took place in the morning, and were not chronometrically registered. The third and fourth ascents, which took place in the afternoon of the same day, were officially checked by the Sport Committee of the Aëro Club.

In the third attempt the start was at 4.9 p.m. There were two flights. The first of about 50 metres, not chronometrically registered. The second of 82 metres 60, in $7\frac{1}{2}$ seconds, chronometrically registered, which is at the rate of 11 metres 47, the second, or 41 kilometres 292, the hour.

In the fourth attempt the start was at 4.45 p.m. There was a flight of 220 metres, in 21 seconds $\frac{1}{5}$, chronometrically recorded; that is, 10 metres 38 the second, or 37 kilometres 358, the hour.

The third experiment, therefore, at this moment, is the official record of speed, and the fourth the official record of distance and time in the air.

After the reading of this paper the President exhibited a model of the Santos Dumont aëroplane made by himself, which excited great interest.

Mr. Cody: I have seen M. Santos Dumont's machine, and I consider it is an excellent structure, and just as likely a machine to fly successfully as anything I have seen. I believe in a large spread, and in carrying light weight.

The President: I should like to propose a vote of thanks to Mr. Bruce for his paper.

The vote was carried unanimously.

The Stability of the Conic Shape in Kites and Flying Machines.

By REGINALD M. BALSTON, M.Aër.Soc.

In following such able lecturers as Dr. Napier Shaw and Col. Capper, with the added interest of lantern illustrations, I feel that, in presenting myself to you, I labour under a serious disadvantage, and I must ask you to deal indulgently with me, the more so that I am a newcomer amongst you.

Though it is only lately that I have had the honour of becoming a member of this Society, I am not, however, altogether a novice in matters where aëronautics are concerned.

As long ago as 1889 I had finished a model of a flying machine, and since then I have been studying them pretty closely. To the best of my recollection it is Jules Verne who was responsible for arousing my interest in the subject, although I fear I am ungrateful enough to remember nothing about his book beyond the fact that it inspired me to base my first attempts at flying machines upon his theories of screws as lifters. Soon, however, I discarded this type of machine in favour of those with wings, and the study of kites also naturally occupied a large share of my attention. I found them to be of absorbing interest. Perhaps the greatest fascination about a kite or flying machine lies in one's efforts to make it behave as one is convinced that it should, which it very often fails to do. But such an element of uncertainty is no new thing. We know by her books that in the times of Jane Austen the simplest forms of aëronautics demanded a considerable exercise of patience, for in her novel, "Emma," she illustrates the calm and self-control of one of her characters by setting him to fly kites for a little boy. Even in these days of modern kites and their developments the difficulty of preserving one's equanimity where such things are concerned has not entirely disappeared. Often a kite goes so closely to the fulfilment of one's best hopes—it rises with a rocket-like sweep into the air, hangs motionless for a moment, then sinks slowly, preparatory to a second rush upwards, when the next gust of wind comes. But now, perhaps, its rise is not so straight, the wind catches it at a slightly different angle, and, to meet the current, the kite turns on one side and then back again, when the true wind strikes it once more. In its endeavours to find each new position it gets up a pendulum-like motion, moving from side to side, until eventually it overbalances, and turns head downwards towards the ground. Possibly it may, once or twice, recover itself, but in the end it is bound to descend head foremost, and it is indeed fortunate if the wooden frame is not, in consequence, snapped in two.

But why is it that a kite proves so refractory? Surely it is because, in nine cases out of ten, its stability is defective, and so, to put it briefly, it cannot stay the right way up.

This question of instability, however, does not present an insurmountable difficulty. There is, to my mind, a way in which it can be obviated, though I need not say that, in approaching the subject of the conical shape with regard to stability, I am fully aware that I am introducing no fresh principle to your notice. But the point which I wish to draw your attention is that the theory of the dihedral angle, with which we are all familiar, should be carried somewhat further. The dihedral angle is confined to sections of a flying machine in one direction only, namely, that one which passes through the wings, and, in consequence, the stability is merely lateral. Two points only of support are considered, whereas to ensure complete stability a third one must be recognised. In birds this point is supplied by the tail, while in the generality of insects the two hind wings have the function in question.

The most stable form in which any expanse of material can be spread out to form an efficient resistance to the air is that of a flat inverted cone, or, to put it in another way, the underside of an inverted cone is the form of surface which combines most stability and opposition to falling. The apex of the cone must lie somewhere near the centre of the surface exposed, and all portions of the surface which lie nearer to the circumference must be superposed on those nearer to the apex when the machine is in equilibrium. The more acute the angle at the apex, the greater the stability obtained, but what is gained in stability is lost in resistance to falling. These two shapes I have here will illustrate this. (Experiments shown.)

Now if you depart slightly from the conic shape and make your model with sides which curve upwards, instead of following straight lines, a very stable shape is obtained. An umbrella is a good example of this. Its stability is perfect, and it will even retain its equilibrium, though its centre of gravity is so high as to be actually above its centre of support.

An alternative in which will probably be found the meeting-point of the two requirements, stability and efficient aëroplaner arrangement, is a conic surface, if it may so be described, decreasing in gradient as you proceed from the apex towards the circumference. With some difficulty, but with excellent results, I have reproduced this shape in a wire model. I do not, however, intend to proceed further in this direction, since my object to-night is merely to draw attention to the fact that in the conic surface lies the secret of stability.

To make use of it in its entirety is, of course, unnecessary. For all practical purposes well-chosen portions are all that are required. A chair or table supported at four or even three points will, under ordinary conditions, maintain its equilibrium, and the same thing holds good with the supporting surfaces of a kite.

The reason why the conic shape conduces thus admirably to stability is not far to seek. A body suspended in air is bound to commence a downward passage, owing to the influence of gravity to which it is subjected. By impelling its aëroplane surface in one direction or another, the machine may be caused to rise, but the ascent is merely due to the fact that fresh layers of air are placed beneath the surfaces more quickly than the flying machine is able to fall through them; and in a body's descent that part of it which offers least resistance to the air through which it is passing will naturally fall first. By shaping the body as a cone, its surface is so formed that it finds its balanced resistance to its downward passage by falling point—or, rather, I should say—apex foremost. We will all agree that in making a shape of aëroplane which will fall slowly in equilibrium, we have gone a long way towards finding the right aëroplaner arrangement for a body intended to be put in motion horizontally.

We have here a slide of the Cody kite. This kite is one in use by His Majesty's Government, which, of course, ensures to it all up-to-date improvements. You see that Mr. Cody has made use of the angle in one direction, and has turned the wings upwards. You have, in consequence, a kite which will fly steadily without rushing from side to side. It would be interesting to know whether Mr. Cody has ever attempted to introduce an angle in the other direction, for, though it might have the disadvantage of slightly decreasing the lifting efficiency, it would put all fear of swooping out of the question. Possibly the kite does not, even as it is, do such a thing in Mr. Cody's hands, but such kites are liable to this defect, whereas if they were so made that their after aëroplanes met the wind at a lesser angle than the front ones, it would not happen. The after aëroplanes would be the first to lose their lifting power when the head of the kite was depressed, thus allowing the weight of the stern of the kite to restore the balance. In a butterfly's flight we find a clear example of this principle. I have set the wings of a specimen in an approximate conical shape, a position which the insect doubtless assumes instinctively. You see how it falls to the ground in perfect equilibrium. (Experiments shown.)

As I have said before, in propounding this theory of the stability of the conical shape I am anxious that my meaning should not be taken too literally. I wish, rather, to draw attention to the fact that in this form lies the clue which will aid us to adapt to our own requirements those perfect natural mechanics which are disclosed to us in the hovering of the insect and the sweeping flight of the bird; for, after all, it is to Nature that we must turn for teaching where aëronautics are concerned.

Mr. Douglas Archibald: The box kite is so satisfactory that it is a question whether there is any necessity for any other. In America there was a pretty exhaustive book about kites, in which all the different shapes were tried, and I think the most satisfactory they got was a pentagonal shape. Professor Marvin takes this shape. It is a box kite with a pentagonal front, and he found it the most satisfactory of any.

Mr. Balston: In a box kite there is one disadvantage: you are bound to have your surfaces over each other, and when you are going slow, or stopping, the top ones lose their power.

The President: Talking of umbrellas, I once broke the handle off an umbrella and tied a string to the end. It formed an extremely stable kite. The more the umbrella revolves the more it is bound to remain in the same position. There is one matter which Mr. Balston did not mention. A kite will remain on the level at which you put it, and, therefore, if you stand at an elevation and fly your kite, you can fly it on your own level perfectly stable if you weight it in the right way, though it is rather difficult to get the balance. I originally thought that might be a method of getting a rope ashore from a ship. If a ship were stranded on a lee shore you might get a rope ashore with an ordinary umbrella, and it would be a handy apparatus. I made a number of experiments with convex kites, and found that the more convex it was—that is, the more bent back the edges were, the less it was liable to rise and get a good angle.

I will now ask you to record your vote of thanks to Mr. Balston for the interesting paper and models he has shown us.

The vote of thanks was carried unanimously.

Colonel Trollope: Ladies and gentlemen, you will all join with me in giving a vote of thanks to our able chairman, who has presided over this most interesting meeting.

Mr. E. P. Frost: I shall be very pleased, ladies and gentlemen, to second that proposition.

The vote of thanks having been carried unanimously, the proceedings then terminated.

The Balloons in The Gordon-Bennett Race.

With reference to the report on "Some Technical Features of the Competing Balloons," by Major B. Baden-Powell, in the October number of the "Aëronautical Journal," Messrs. Short Brothers have written to point out that each of the British balloons supplied by them (the "Britannia" and the "Zephyr") were fitted with awnings over the valves.

Applications for Patents.

(Made in October, November, and December, 1906.)

The following list of Applications for Patents connected with Aëronautics has been specially compiled for the Aëronautical Journal by Messrs. Bromhead & Co., Patent Agents, 33, Cannon Street, London, E.C.

OCTOBER.

21884. October 4th. William Cochrane. Improvements in and relating to Dirigable Flying Machines and Airships.

22352. October 10th. E. A. Forster. Aeroplane Flying Machine.

22517. October 11th. F. Simmons and J. W. Murcutt. Improvements in Controllers or Governors for Steam and other engines or Motors, Motor Propelled Vehicles and vessels of all kinds, including Submarines, Flying Machines, and the like.

22977. October 17. W. R. Gibson. Improvements in Box Kites or analogous Aerial Toys.

23037. October 18th. J. L. Garsed. Improvements in Wings, Vanes, or Propellers for Aerial Machines.

23036. October 18th. J. L. Garsed. Improvements in the method of and means employed for propelling and steering Aerial Machines.

23085. October 18th. J. B. Passat. New Aeroplane-Orthoptere.

23415. October 22. J. S. Chenhall. Improvements in Electrical Aerial Apparatus for the conveyance of passengers, goods, and the like.

23476. October 23rd. C. A. Witchell. Improvements in connection with Mechanisms for Learning to Fly.

23493. October 23rd. B. L. Gillman. Improved Kite.

23855. October 26th. A. J. Bergeron. Tailless Kite which can be taken to pieces.

23872. October 26th. R. M. Balston. Improvements in relation to Kites and similar apparatus for Aerial Flight.

24122. October 30th. J. L. Garsed. Improvements in Aeroplanes or Aerostats.

24140. October 30th. A. B. Taylor and William Tooley. Musical Kites.

24489. November 2nd. J. L. Garsed. Improvements in Aeroplanes or Aerostats.

NOVEMBER.

25387. November 10th. A. H. P. Blunt. Improved Flying Machine.

26099. November 19th. A. V. Roe Improvements in Flying Machines.

26588. November 23rd. S. R. Smith and G. Perry. Flying Machines.

26602. November 23rd. D. E. Hipwell. Improvements in Flying Machines.

26612. November 23rd. A. M. Lodge. Improvements in and relating to the maintenance of stability in Airships, Flying Machines, and the like.

26764. November 24th. M. Vaniman. Improvements in Aeroplanes.

26784. November 26th. B. R. Adams. Improved form of Propeller for Flying Machines.

27000. November 27th. J. R. Porter. Improvements in Airships and in apparatus for propelling the same.

27141. November 29th. A. A. Fris. Improvements in Flying Machines.

27266. November 30th. H. H. Johnson. Improvements in Air ships.

27312. November 30th. W. P. Thompson. Improvements in or appertaining to Aerostats.

DECEMBER.

27528. December 3rd. H. van de Weyde. Improvements in Balloons both ordinary and dirigible.

27554. December 4th. W. A. Slater. Application of the principle of the Screw Propeller.

27612. December 4th. J. N. Walker. Improvements in Flying Machines.

27751. December 6th. J. S. Hainsworth. Improvements in Airships.

27816. December 6th. J. Deixler. Improvements in Airships.

27817. December 6th. J. Deixler. Improvements in Propeler-driven Airships.

27886. December 7th. B. R. Adams. Form of apparatus for propelling and controlling a Flying Machine.

27978. December 8th. A. Birkbeck. Improvements in Machines for Aerial Navigation.

28270. December 11th. W. Friese-Greene. Improvements in and relating to Air Cars or Airships.

28386. December 12th. E. Jones. Improvements in Flying Machines.

28710. December 15th. T. W. K. Clarke. Improvements in Aeronautical Machines.

The following are some articles of special interest which have appeared during last few years:—

The Paris International Aëronautical Congress. January, 1901.

The Experiments with the Zeppelin Airship. April, 1901.

Aëronautics in France. By Wilfred de Fonvielle. July, 1901.

The Chief Scientific Uses of Kites. By A. Lawrence Rotch. October, 1901.

Aërial Navigation by Means of Bodies heavier than Air. By Sir Hiram Maxim.

Atmospheric Currents. By William Marriott. January, 1902.

The Berlin Congress of the International Aëronautical Commission. July, 1902.

The "Peace" Balloon of the late Senhor Augusto Severo. By Dr. Carlos Sampaio. October, 1902.

Recent Aëronautical Progress. By Major B. Baden-Powell. January, 1903.

Contributions of Balloon Investigations to Meteorology. By Dr. W. N. Shaw, F.R.S.

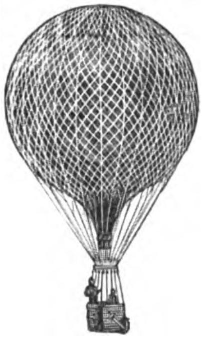
Photographs of the Paths of Aërial Gliders. By Professor G. H. Bryan, F.R.S., and W. E. Williams. July, 1904.

Scientific Balloon Ascents. By Charles Harding. October, 1904.

Automatic Stability. By E. C. Hawkins, J.P. April, 1905.

Notes on a Bird-Like Flying Machine. By Dr. F. W. H. Hutchinson, M.A. July, 1905.

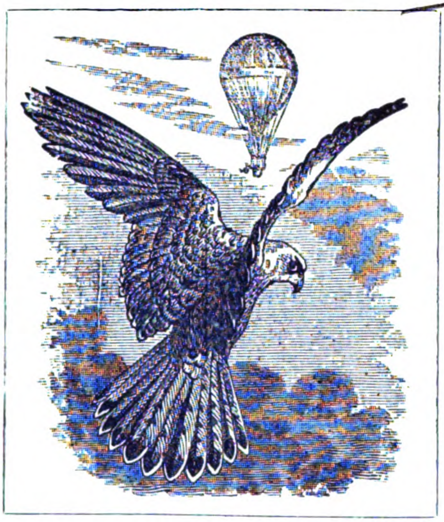
The Santos Dumont, No. xiv. October, 1905.



CIAL NUMBER, containing Photographs of the Kite Display of the Aëronautical Society of Great Britain, July 1st, 1907. Price to Non-Members and Non-Subscribers, 2/-

NTERED AT STATIONERS' HALL.]

THE AËRONAUTICAL JOURNAL



Edited for the Council of the Aëronautical Society of Great Britain

By ERIC STUART BRUCE, M.A. Oxon, Fellow of the Royal Meteorological Society.

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Contents.

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NOTICES OF The Aëronautical Society of Great Britain.

At a meeting of the Council of the Aëronautical Society of Great Britain, held at 53, Victoria Street, Westminster, S.W., on April 26, 1907, the following gentlemen were elected Members of the Society:—

MR. JAMES ROBERTSON PORTER, A.M.I.C.E.
LIEUT. NEVILLE F. USBORNE, R.N.

At a meeting of the Council of the Aëronautical Society of Great Britain, held at 53, Victoria Street, Westminster, S.W., on June 24, 1907, the following gentlemen were elected Members of the Society:—

MR. THOMAS WIGSTON KINGLAKE CLARKE, B.A., A.M.I.C.E.
MR. BERT G. COURTRIGHT.
MR. ALFRED DENYS COWPER.
MR. MAURICE F. FITZGERALD.
MR. LOUIS FERGUSON GOWANS.
MR. LAWRENCE LESH.
MR. ALBARDO MANZATO.

THE LIBRARY.

The following publications have been presented to the Library:—

By R. Oldenbourg, "Die Luftschiffahrt." (A. Hildebrandt.)

By W. R. Turnbull, "Researches on the Forms and Stability of Aëroplanes." (W. R. Turnbull.)

By the Meteorological Office, "Publications of the International Commission for Scientific Aëronautics, January, 1905."

By Colonel F. C. Trollope, Various Publications of the International Commission for Scientific Aëronautics.

By Messrs. Blackwood, "Ballooning as a Sport." (Major B. Baden-Powell.)

On receipt of the sad news of the Aldershot balloon disaster the Aëronautical Society of Great Britain, through its Hon. Secretary, communicated its sympathy to Colonel J. E. Capper, Superintendent of the Government Balloon Factory and Member of Council of the Aëronautical Society of Great Britain.

THE INVESTIGATION OF THE UPPER ATMOSPHERE.

The International Commission of Scientific Aërostation at its meeting at Milan in 1906, resolved to carry on during the years 1907 and 1908 the investigation of the upper atmosphere in the Northern Hemisphere on a much more extended scale than has been hitherto attempted. On account of the great importance of such researches for the progress of meteorology, the Royal

Meteorological Society has been invited to take part in this scheme.

The Council of that Society are desirous of securing the co-operation of observers in different parts of the British Empire north of the Equator, and they propose, if possible, to organise and equip special stations for this purpose.

In connection with the investigation, ballons-sonde to carry self-recording instruments, and also smaller balloons are to be used, the heights and drift of which will be determined by two theodolites placed at the ends of a fixed base. The ascents in 1907 are to be made on three consecutive days in each of the months of July, September and November, one balloon to be sent up on each of these days.

The Aëronautical Society of Great Britain has been asked by the Royal Meteorological Society whether some more members of the former Society will be willing to take part in this work. Most of those who are at present engaged in the investigation of the upper air in this country are members of the Aëronautical Society. Amongst these being Mr. W. H. Dines, F.R.S., Mr. Charles Cave, and Mr. S. H. R. Salmon, and it may be pointed out that the first observer who sent up a ballon-sonde in this country was Mr. Patrick Alexander, a member of the Aëronautical Society.

It is to be hoped, therefore, that other members will be willing to join with the Royal Meteorolgical Society in their investigations. It may be pointed out that such researches besides being of Meteorological value have an important bearing on the navigation of the air, for knowledge of the laws which govern the movements of the atmosphere is one of the first steps towards its conquest.

ERIC STUART BRUCE,
Honorary Secretary

GENERAL MEETING.

The concluding meeting of the 42nd session of the Aeronautical Society of Great Britain was held on Chobham Common on July 1st, by kind permission of Lord Onslow and the Sunningdale Golf Glub.

There was a large assembly of the members and their friends. It was estimated that from first to last there were upwards of three thousand visitors present.

On this occasion there was a display of scientific kites in the air and other aëronautical experiments.

Those who displayed kites in the air were Mr. W. H. Dines, F.R.S., M. Aër. Soc., Mr. Charles J. P. Cave, M. Aër. Soc., Mr. S. H. R. Salmon, M. Aër. Soc., Mr. R. M. Balston, M. Aër Soc., and Mr. Charles Brogden.

A meteorograph and two kites of the kind in common use at the station of the Meteorological Office at Pyrton Hill were exhibited by Mr. W. H. Dines.

METEOROGRAPH.

Recording height, temperature, humidity, and wind velocity.

KITE No. 22.

Nine-foot kite. Seventy-seven sq. ft. of lifting surface. Weight, 11 lbs. The kite had been in use at Pyrton Hill, Watlington, Oxon, since March, 1907, and had made about 20 ascents. It is used for light and moderate winds, and with a good wind and about 10,000 ft. of wire will lift the meteorograph to a vertical height of 6000 ft. When over 3000 ft. high these kites will fly quite steadily with winds of less than 40 miles per hour; there are a few records showing 50 miles per hour, but in general they either become unstable or the strain breaks the wire if the velocity exceeds 45 miles per hour. The angular altitude at which they fly is shown below, the figures being the averages for the year 1905.

Length of wire—					
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
2000	3000	4000	5000	6000	7000
Angle—					
60°	57°	52°	49°	47°	45°

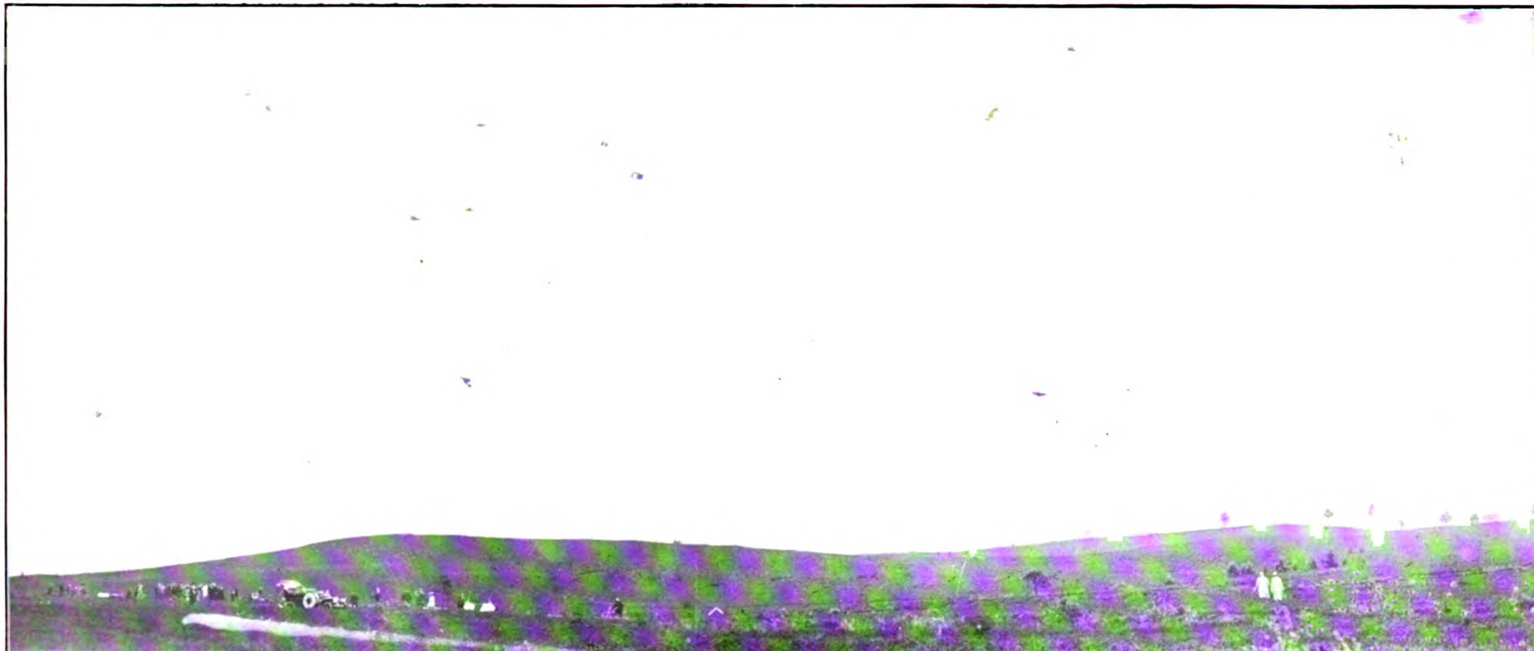
KITE No. 23.

Seven-foot six-inch kite. Fifty-two sq. ft. Weight, 9 lbs. This kite has made 18 ascents. With 5000 ft. of wire it carries the instruments to a height ranging from 3000 ft. to 3500 ft. It will fly in winds ranging from 25 to 50 miles per hour.

Note.—The upper winds are much stronger and also much steadier than those at the surface. Inland, at 1500 ft. high, the velocity is often double what it is at the surface, and it is the upper winds which are referred to above.

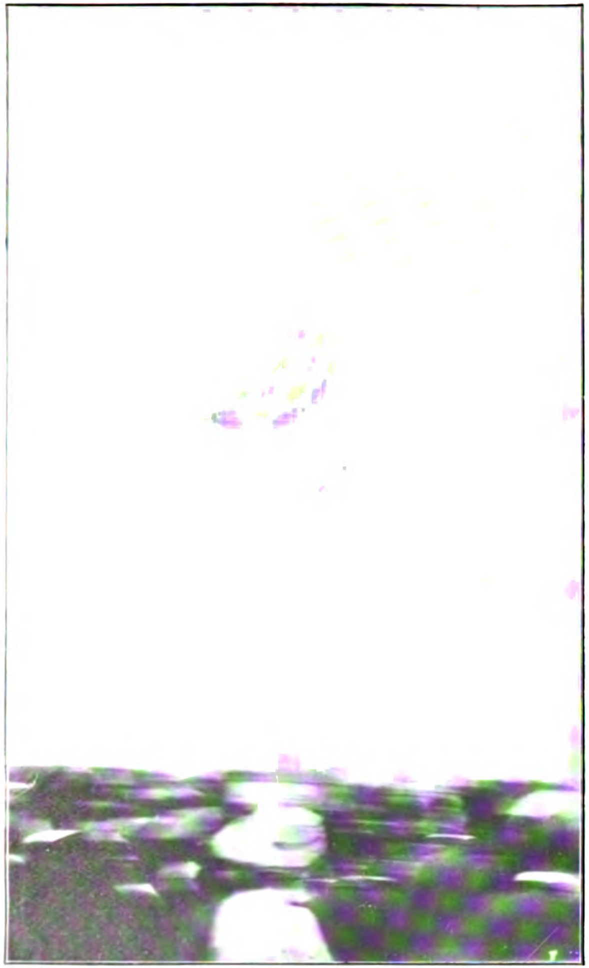
Mr. Charles Cave also exhibited a box kite of the type used by Mr. Dines.

Mr. Salmon's exhibit was remarkable for originality and the number of the forms of kites exhibited. One of these kites was made specially for this display, and has nine wings at each side of a backbone, 18 ft. high. The wings have a span from tip to tip of 10 ft. Mr.

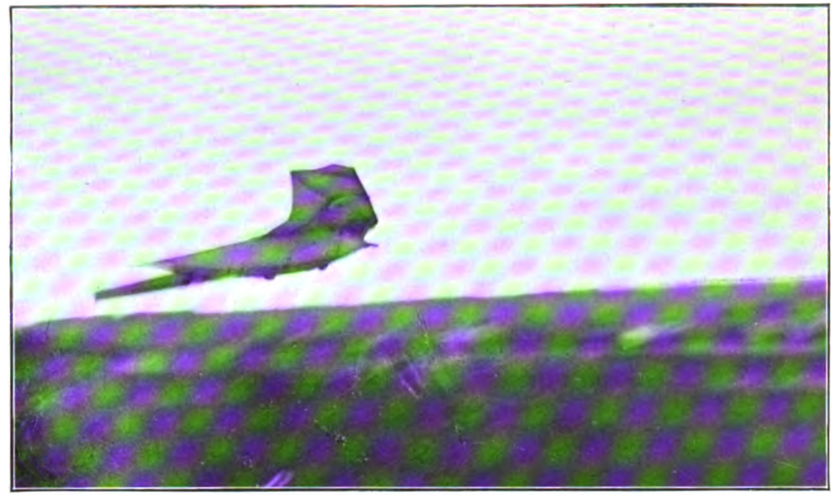


The Kite Display of the Aeronautical Society of Great Britain on Chobham Common, July 1st, 1907.

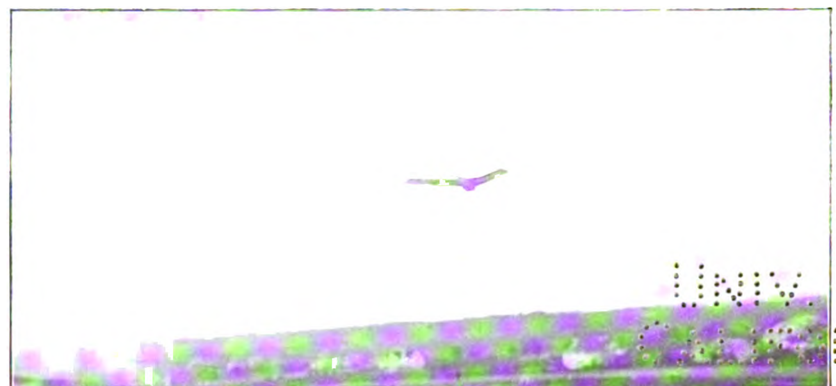
General View showing eleven Scientific Kites in the air at one time.



Ascent of Ballon Sonde with Self-Recording Instrument at Kite Display, July 1st, 1907.



Mr. José Weiss' Model Glider in Flight at the Kite Display, July 1st, 1907.



Another View of Mr. José Weiss' Model Glider in Flight at the Kite Display.

Salmon claims that this type of kite is an excellent one for light winds, and is very easy to manipulate. A kite of the same pattern has often enabled him to raise his meteorograph 500 metres when a box kite would not have left the ground.

Mr. Salmon's claims for this form of kite were well borne out by actual test in the display when a light wind was blowing. The kite attained a considerable height—some 3000 ft.—and was remarkably steady. Colonel A. P. Loyd, one of the spectators of the display, suggested that such a form of multiple wing kite might possibly be found to be advantageous for a war kite on account of its comparative invisibility.

Amongst the other kites displayed in Mr. Salmon's undoubtedly fine exhibit were several types of box kites and a Hargrave kite made by Mr. Hargrave. Some of his box kites had the acute angle to the front and some the obtuse.

Another kite shown by the same exhibitor was a quinquangular box kite and the Barclay honeycombed kite, an illustration of which will appear in our next issue.

Mr. Charles Brogden, who in the Society's Kite Competition at Findon in 1903 attained the highest flight with his six-winged bird kite, again gave a demonstration of the admirable flying qualities of this kite, a full description of which will be found in the January number of this Journal, 1904.

Mr. Brogden estimated the height attained on the latter occasion at about 3000 ft. (perpendicular), 3800 ft. of wire being out. The angle of the kite was fairly constant at 56 to 60 degrees from the horizontal.

Mr. Balston exhibited Zenith kites and Butterfly kites. The former are adapted for flights in strong winds, and the latter for use in only light winds. These kites were much admired on account of their graceful form, and they flew well. His Butterfly kite rising is shown in the accompanying illustration from a photograph taken on the spot by the Society's special photographer.

At the commencement of the display, the spectacle of eleven large scientific kites in the air at the same time was a unique one. The general view of the display obtained by the Society's photographer and here reproduced will give some idea of the novel sight.

A ballon-sonde carrying instruments was sent up by Mr. Charles Cave. A small rubber balloon was used having a capacity of between six and seven cubic feet when unstretched, but it would expand to a considerably larger size. The balloon was filled with hydrogen and had a linen parachute placed over it and a meteorograph hung below. A balloon of this kind continually expands as it rises, finally bursting, when the instruments are brought gently to the ground by means of the parachute. The instrument used on this occasion was the light meteorograph designed by Mr. W. H. Dines for balloon work; it records pressure and temperature by means of two fine points which scratch lines on a small copper plate; this plate is moved laterally by the expansion of an aneroid box; the thermometer consists of a steel rod and a thin strip of aluminium, their difference of length, multiplied by a lever, regulates the distance between the two points. The temperature is therefore measured by the distance between the two scratches, and this is read off under a low power of the microscope; the temperature may be read to about half a degree Fahrenheit.* The instrument is enclosed in an aluminium cylinder to protect it from the direct rays of the sun and to prevent it from getting damaged when it comes to the earth. The total weight of the instrument with the cylinder is only about 2 ozs. A label offering a reward for the recovery of the instrument completes the equipment of the balloon. The ascent of the balloon was observed with theodolites placed at each end of a base of about 1560 feet set out at right angles to the direction of the wind. One theodolite was an ordinary transit instrument; the other has been specially designed by M. de Quervain for observing balloons; it has a reflecting prism in the axis of the telescope so that the observer is always looking in a horizontal position even if the balloon is passing through the zenith. The vertical and horizontal circles are graduated to degrees only, thus enabling readings to be taken very quickly, a matter of some importance when observing a balloon that is moving rapidly across the field of the telescope.

The balloon sent up at Chobham Common was found to ascend at a rate of about 450 feet per minute; from observations of the motion of the balloon it appeared that the wind was north east half north near the

*A full description of this instrument is to be found in Symons's Meteorological Magazine for July, 1906.

ground but that it backed to about north at 3000 feet; at the same time the velocity which was twelve to fifteen miles per hour near the ground gradually fell off till it was little more than six miles an hour at 3000 feet. The sky was covered with cumulus clouds which were reached by the balloon in about seven-and-a-half minutes at 3300 feet.

Some years ago M. Teisserenc de Bort began to take observations of *ballons-sonde* from two stations at some distance apart, and was thus able to plot out the course of the balloon as long as it remained visible. By using balloons whose rate of ascent has been previously determined it is possible to trace the course of the balloon, and thus to find the wind velocity and direction at different heights, by means of observations taken with a single theodolite; this method has been employed by Professor Hergesell, M. de Quervain and others. Mr. Cave sent up a small pilot balloon about an hour after the ballon-sonde and was able to follow it till it was lost in some alto-cumulus clouds at over 6000 feet. The balloon was a small rubber balloon of a little over four cubic feet capacity, and when filled with hydrogen to lift 85 grammes in addition to its own weight it ascends at the rate of about 500 feet per minute.

The filling and the ascent of the ballon sonde excited the greatest interest, evidenced by the subsequent anxiety displayed in Sunningdale as to the safety of the despatched recording instruments, an anxiety relieved on July 4 when the following telegram from Mr. Cave was received by the Honorary Secretary of the Society. "Monday's balloon fell Upminster, Essex, forty-one miles east by north half north."

Mr. José Weiss may certainly be congratulated on the success of his experiments with model gliders. His demonstration of the possibility of the maintenance of balance for a considerable distance with a model launched from a hill top was one that should encourage himself and others in further research into the difficult problems of the aëroplane.

He exhibited three model gliders having wing areas of 3·6, 8·4, and 12·8 square feet with total weights of 2½ lbs., 6 lbs., and 15 lbs. respectively, the lead ballast in each case representing about two thirds of the total weight.

When launched from the highest hillock available the best glides obtained were some 200 yards in length with drop of from 30 to 50 feet.

The small model raised some 200 feet by Mr. Brogden's large kite and released from that height, righted itself instantly in each case and gave some very fine glides, the longest being probably about 600 yards.

The 15lbs. model under a similar test also gave a fair glide.

The accompanying illustrations show Mr. Weiss' model glider in flight. The site selected for the kite display proved to be admirable for the purpose, and it has been pointed out by the *Morning Post* that the nature of the ground with its unequal heather-grown surface constituting a retarding influence on the wind was also very advantageous in the starting of the large kites.

The Society is much indebted to Mr. C. S. Rolls for his kindness in placing one of his motor cars at its disposal for the conveyance of visitors.

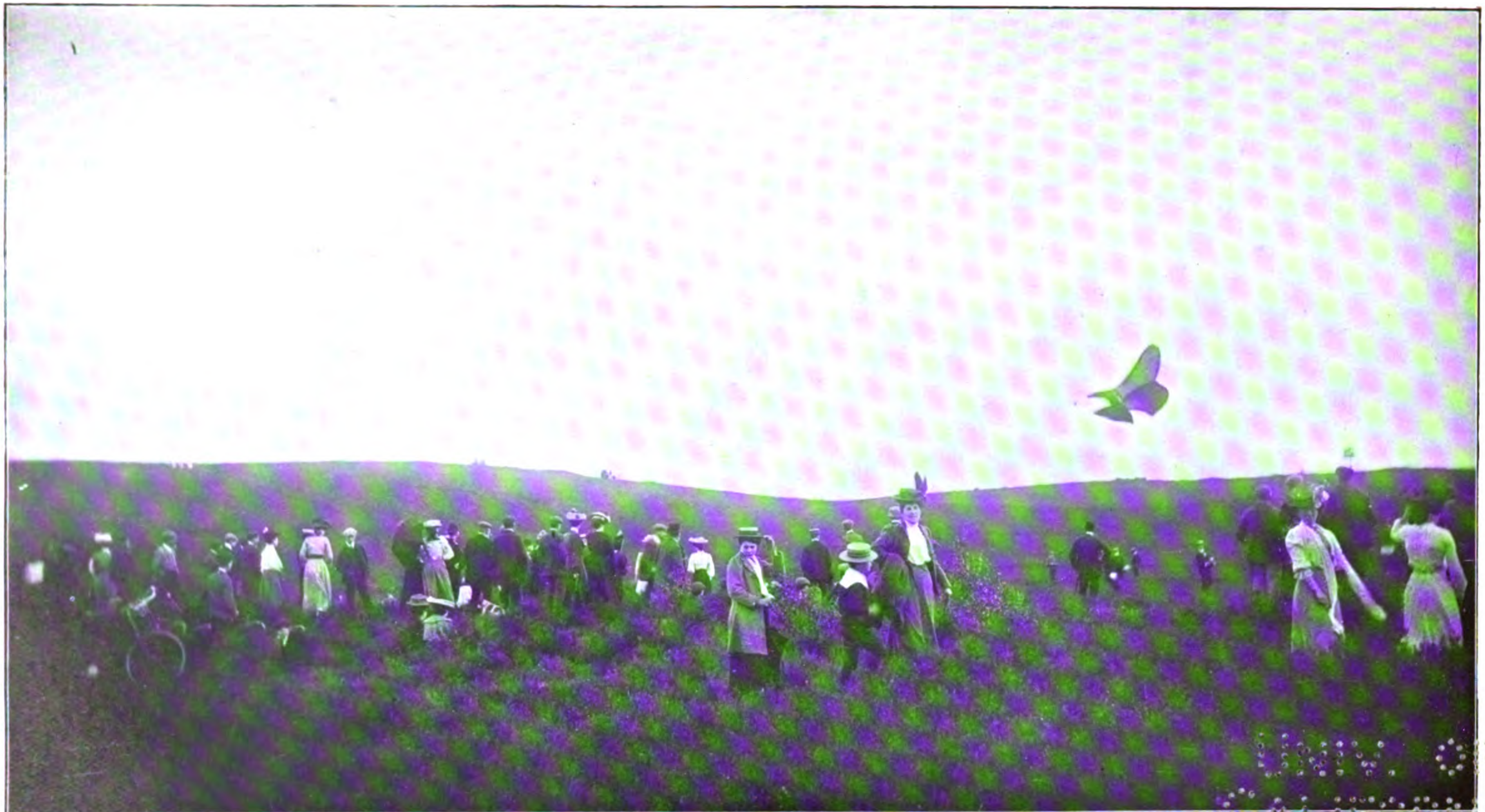
Amongst those present were Captain Ostertag, the German Military Attaché; Colonel R. E. Capper, C.B., R.E., Superintendent of the Government Balloon Factory; Colonel F. C. Trollope, Mr. E. P. Frost, Mr. W. H. Dines, F.R.S., Major B. Baden-Powell, Colonel J. D. Fullerton, R.E., Mr. Eric Stuart Bruce, Hon. C. S. Rolls, the Hon. S. and Mrs. Erskine, Mr. S. F. Cody, Mr. W. F. Reid, Mr. R. Inwards, Major R. F. Moore, Mr. Shaw Kennedy, Sir David and Lady Barclay, Mrs. Cave, and Mrs. Charles Cave, Mrs. Edwards, Mr. De Salis, Captain and Mrs. Montagu, Colonel A. P. Loyd, Mr. H. Blackett, Colonel and Mrs. Walker, and Miss Merewether.

Letters and telegrams of regret were received from the following, who had intended being present, but who were prevented at the last moment from attending owing to their official duties. The Norwegian Minister, Dr. Fridtjof Nansen, the Austrian Military Attaché, Dr. W. N. Shaw, F.R.S., Director of the Meteorological Office, Professor C. V. Boys, F.R.S., and also from Dr. H. R. Mill, President of the Royal Meteorological Society.

M. Santos Dumont's No. 16.

By a Member of the Aero Club of France.

Students of the aëroplane may have been disappointed to hear that M. Santos



The Kite Display. Mr. Balston's Kite.

Some of the Council of the Aeronautical Society of Great Britain and their Friends at the Kite Display, July 1st, 1907.

Col. Capper. The German Military Attaché. Col. Trollope.

Mr. Dine Hon. C. S. Rolls. Mrs. Bruce. Major Baden Powell. Mr. Frost. Col. Fullerton. Mr. Bruce.

Dumont had at any rate temporarily abandoned the strictly aëroplane principle for a new form of steerable balloon combining both aëroplane and balloon. The heavier-than-air principle is, however, maintained in this cross-breed construction, and it cannot rise in the air until sufficient forward movement on the ground has been attained.

The apparatus consists of the now well-known cigar-shaped envelope, 21 metres long, having a master diameter of 3 metres, and a capacity of 99 metres. Inside the outer envelope is the ballonet, made of gold-beater skin, and 2·60 metres in diameter. This secures the rigidity of the outer envelope.

The inflated envelope is attached to a bamboo frame, strengthened towards the middle by iron tubing. Here is placed the 50 horse-power Antoinette motor—the identical one which drove the "Bird of Prey" from the ground and through the air for 220 metres last November. Behind the motor is a small bicycle saddle for the aëronaut and the controlling wheels. The bicycle wheel on which the frame is mounted is furnished with a pneumatic tyre. Beneath the balloon both back and front two horizontal rudders or planes are fixed, and there is a vertical rudder for lateral movements at the rear. It is found that the entire apparatus, including the aëronaut, weighs about 80 kilogrammes, and it is this dead weight which has to be overcome by the forward movement through the air acting upon the horizontal planes. It is considered that the apparatus solves the difficulties of side balance, and will facilitate keeping the entire machine horizontal in the air.

The first trial on June 8 was not very conclusive. M. Santos Dumont first drove the machine along the ground at the low speed of 10 to 12 kilometres. After the machine had traversed 30 metres M. Santos Dumont, thinking that the machine was well balanced and that all the assistants who were holding it at the back had let go, increased the speed. The assistants, however, had not released their hold. They did so, however, at the moment the speed was increased, and the machine immediately plunged downwards against the ground, the envelope of the balloon was burst, and the framework injured.

M. A. Cléry, in *L'Aérophile*, attributes the accident to the defective position of the screw, which facilitated downward plunges of the machine, while the column of air driven by the propeller towards the fixed surface of the back aëroplane, by sending up the back of the machine, tends to depress the whole.

Distribution of Weight in Aeroplanes.

By Maurice F. Fitzgerald, B.A.

This note deals with the question of the most suitable proportions of the whole weight to be allotted to the engine, wings, and other load, respectively, in aëroplanes driven by propellers. The results must, of course, be regarded as merely approximate, and suited for roughing out the preliminaries of the design, at best; the principal point brought out being the circumstance that there is, in given cases, a best proportion between these items, which will permit of the largest possible load being carried by a machine of given total weight. It is assumed, for simplicity, that the machine is flying horizontally in still air; that the pressure of the air on the wings is at right angles to their surface, taken to be plane; that this pressure is proportional to their area, to the square of the speed, and to the line of the angle of their inclination to the horizontal, jointly; and that direct head resistance due to framework, &c., may be ignored, or allowed for in estimating the efficiency of the propeller.

The data generally taken to be given would be the weight per square foot of the wings, the weight per B.H.P. of the engine, the speed, and the load to be carried. For convenience in calculation it will be found simpler to take, instead of weight of engine per B.H.P., the foot pounds of work per second per pound weight of engine; and to investigate, in the first instance, the value of the ratio of weight of wings to total weight, including the load, engine, and wings all together, when the load is a maximum.

The following symbols are employed.

V = velocity in feet per second.

A = area of wing surface in square feet.

β = angle and inclination of wing plane to horizontal.

w = weight of wings per square foot in pounds.

E = weight of engine in pounds.

e = foot pounds per second per pound weight of engine so that Ee = total foot pounds per second.

Ee is taken to mean the effective foot pounds available as thrusting power; about double this would be necessary as B.H.P.

L = load carried, other than wings and engine, in pounds.

P = air pressure on wings, in pounds.

K = a constant determined by experiment, defined by Eqn. (I.), below.

W = total weight = Aw + E + L, being wings, plus engine, plus other load.

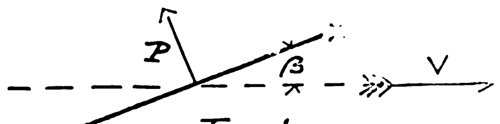


Fig. 1

In Fig. I. × × represents an edgewise view of the wing plane, flying horizontally in the direction of the arrow V, the plane being inclined at angle β to the horizontal, and subject to air pressure P in consequence. In accordance with the assumptions made above

$$P = KV^2A \sin \beta \qquad \text{Eqn. (I.).}$$

The vertical component of P is P cos β, and if β be a fairly small angle, such as 5 to 10 degrees, cos β is unity within one or two per cent., and sin β is practically equal to β taken in circular measure, so that, as the value of K is uncertain within much wider limits than this, it is amply sufficiently accurate to take P as the direct supporting force vertically and put

$$P = W = KV^2A\,\beta \qquad \text{Eqn. (II.).}$$

The horizontal component of P is P sin β, $= KV^2A \sin^2\beta$, and, being opposed to the forward motion of the plane, has to be balanced by the propeller thrust, hence

$$\text{Thrust} = KV^2A\,\beta^2$$

and work done by thrust = thrust × velocity gives work done in foot pounds per second $= KV^3A\beta^2 = Ee$ Eqn. (III.).

Now

$$KV^3A\beta^2 = \frac{\{KV^2A\beta\}^2}{KVA}$$ identically on squaring the numerator and dividing by the denominator; that is, as $KV^2A\beta = 2W$, by Eqn. (II.).

$$Ee = KV^3A\beta^2 = \frac{W}{KVA}, \text{ so that } E = \frac{W^2}{KVAe} \qquad \text{Eqn. (IV.).}$$

Also

$$W = Aw + E + L.$$

Substitute in this the value of E by Eqn. (IV.) and solve for L, the external load.

$$L = W - Aw - \frac{W^2}{KVAe} \qquad \text{Eqn. (V.).}$$

Now seek the condition that L, the load, shall be a maximum, given that the total weight is fixed, as well as the speed, and the energy of the engine per lb. of its own weight, the wing area being varied, and its weight per square foot known. That is, differentiate with respect to A and put $\frac{dL}{dA} = 0$.

This gives

$$\frac{dL}{dA} = 0 = -w + \frac{W^2}{KVA^2e}, \text{ from which}$$

$$Aw = \frac{W^2}{KVAe} = E \text{ by Eqn. (IV.).}$$

Eqn. (VI.).

That is to say, the weight of the wings should be equal to the weight of the engine, in order that the remainder of the total weight may be a maximum; and in that case, multiplying Eqn. (VI.) across by Aw, we find

$$A^2w^2 = \frac{W^2w}{KVe} \text{ or } Aw = W\sqrt{\frac{w}{KVe}}.$$

Eqn. (VII.),

thus determining the weight of the wings, and therefore that of the engine, which is the same. The load is then the remainder of W, that is

$$L = W - 2W\sqrt{\frac{w}{KVe}} = W\left(1 - 2\sqrt{\frac{w}{KVe}}\right),$$

Eqn. (VIII.),

from which

$$W = \frac{L}{1 - 2\sqrt{\dfrac{w}{KVe}}}, \text{ thus finding the}$$

total weight required to carry a given load. For example, if the load be 200 lbs., with wings weighing ⅓ lb. per square foot, and engine giving 20 foot pounds per second per lb. of its own weight as available thrusting power, speed 40 miles per hour (say, 60 feet per second nearly enough), we have L = 200; w = ⅓; V = 60; e = 20; and we may take K = 0·0017 for velocities in feet per second.

This makes, in Eqn. (VIII.),

$$W = \frac{200}{1 - 2\sqrt{\frac{1}{3} \times \dfrac{1}{0{\cdot}0017 \times 60 \times 20}}}$$

$$= \frac{200}{0{\cdot}19} = 1052 \text{ lbs. total weight.}$$ Deduct-

ing the 200 lbs. of load, leaves 852 lbs. to be divided equally between engine and wings, which thus weigh 426 lbs. each. The wings have three square feet per pound weight, and their area is thus 1280 square feet, nearly; the engine gives 8520 foot pounds per second work, which, as 550 foot pounds per second is one horse power, is 15½ horse power by propeller. About double this would have to be the B.H.P. of the engine itself—say, 35 B.H.P. The weight of the engine being 426 lbs, is thus 12 lbs. per B.H.P. nearly.

The most uncertain elements in the calculation are the value of K, and the efficiency of the propeller, as to which extent experiments give very discordant results.

In the case of models, there is practically no external load, that is, $L = 0$ in the equations above used. In that case Eqn. (V.) becomes $W - Aw - \frac{W^2}{KAVe} = 0$, which, on multiplying across by Aw and rearranging, becomes a quadratic for Aw,

$$A^2w^2 - WAw + \frac{W^2w}{KVe} = 0 \qquad \text{Eqn. (IX.)}$$

having two roots, usually unequal, for Aw, whose sum is W, the total weight, so that if one be chosen as weight of wings, the other is weight of engine.

It will be found, on trial, that if the smaller root be chosen for the wings, the inclination, β, required is too large for the formula for the pressure, Eqn. (II.), to be trusted as accurate enough, since it does not correctly represent the value of the weight supported for values of β exceeding 10° at most, or thereabouts.

Taking the larger root in Eqn. (IX.)

$$Aw = \frac{W}{2}\left\{1 + \sqrt{1 - \frac{4w}{KVe}}\right\} \qquad \text{Eqn. (X.).}$$

This is $= \frac{W}{2}$ exactly only in the case when $4w = KVe$; that is $\frac{w}{e} = \frac{KV}{4}$, and if $\frac{w}{e}$ be greater than this, the quantity under the square root becomes negative, which translated into physical facts, means that the machine cannot fly at all.

In other words if $V = 30$ (say 20 miles per hour) $K = 0{\cdot}0017$ as before, $\frac{w}{e}$ must be less than 0·013.

In small models, w may be easily made as small as $\frac{1}{16}$ to $\frac{1}{10}$ lb. (say 1 oz. to 1½ oz.) per square foot, and values of e from 5 to 8 foot pounds per second per lb. of engine suffice for flying.

Taking the extreme case of wings being so light, no matter what their area, as to be of weight negligble compared to that of the engine, or engine and load combined, $A = \frac{1}{KVe} \cdot \frac{W^2}{W - L}$ if there be a load, or $= \frac{W}{KVe}$ in the case of the model; there is no special maximum or minimum condition connected with the ratio of engine weight to load in this case.

The only useful purpose which might be served by Eqn. (X.) would be, perhaps, to determine the value of K, if the energy of the engine at different speeds of flight were accurately known; but there seem to be considerable difficulty in effecting this measurement with exactness, and Eqn. (IV.) will equally well answer the purpose of determining K, if the power be known. This formula (Eqn. IV.) is that from which Langley deduced his well known conclusion that, with a given size and weight of plane, the horsepower required varies inversely as the speed.

The principal points brought out therefore in this note are:—

(a) That in aëroplanes carrying an external load we may expect that the best distribution of weight between wings, engine, and load will be, approximately, that the weight of engine will be about equal to the weight of the wings, but that considerable uncertainty, pending further experiment, attaches to the proportion of load to total weight, and that it depends in any case on the speed and on the energy of engine.

(b) That this rule does not hold in the case of models flying unloaded, in which the weight of the wings would probably exceed that of the engine, but not necessarily, so that no certain rule can be expected to be derived from experiments on unloaded models, regarding the proper ratio of engine and wing weights.

The Jamestown Aëronautical Congress.

The following particulars of the Jamestown International Aëronautical Congress have been received:—

The Congress will be held in the Hall of Congresses of the Jamestown Exposition, at Norfolk, Virginia, commencing at

10 a.m., October 28, 1907, and continuing two days.

Papers and exhibits are solicited from specialists and amateurs throughout the world. All papers, and especially those requiring translation, should be received by the Secretary not later than September 15.

The following subjects are suggested as suitable for addresses, papers, and discussions:—

1. Opening address: General *résumé* of the history and present status of aërial locomotion.

2. Informal addresses by representatives from other nations, reviewing the recent development of the science, the present projects, investigations, aëronautic establishments and enterprises in their respective countries.

3. Description of laboratories, instruments, and methods of experimentation for determining laws and data useful in the science of aëronautics.

4. Laws of flow, pressure, and friction of air as determined by recent experiments; formulæ for computing the support and resistance of hulls, and framing of balloons and flying machines.

5. Theory and design of aërial propellers, screws, wings, or other forms, giving efficiencies, actual and computed, and the practical advantages of the different types.

6. Aëronautic motors; steam, internal combustion, electric, turbine, &c.; their effectiveness, reliability, weight per horse power, &c.

7. Materials for aëronautic construction, whether for balloons or flyers, including the strength and weight of fabrics, metals, woods, &c.

8. Principles of aëronautic structural design; forms of greatest strength and lightness with least atmospheric resistance.

9. Behaviour of air currents observed at various altitudes; the prevalence, trend, and force of winds, &c.

10. General comparison of the various types of aërial craft, their functions and usefulness, whether for traffic, pleasure, or war; their possible speed, range, cargo, reliability, &c.

11. Full technical accounts of the construction and operation of recent successful and partially successful dynamic flying machines, with an estimate of their possibilities and future development.

12. Special features of flying and gliding machines, illustrated by theory and experiment, including stability, manipulation, propulsion, safety, launching, landing, &c.

13. Soaring and gliding machines; practicability of travelling over land and sea without motive power, as practised by vultures and gulls; efficiency of human gliders compared with sailing birds; proposals for developing the science and art of soaring.

14. Design and manufacture of balloons, illustrated description of balloon factories and their products, details of construction, inflation, management, cost, recent improvements, &c.

15. Manœuvring of balloons in diverse circumstances of weather and locality, particularly in racing, long distance flight, and flight toward a specified goal.

16. Observations, records, and signals in balloons, meteorological, photographic, military; description of instruments used.

17. Full technical accounts of the motor balloons; their design and construction, their best achievements, their possibilities, their probable use in exploration, war, &c.

18. Observations and experiments on the flight of birds; analysis of their flying mechanism, and its application to human flight; speed and economy of bird flight.

19. Aëronautic allied devices and novelties; kites, their design and use; parachutes, wind wagons, boomerangs, aëronautic models and toys, flying creatures other than birds.

20. Social and economic features of aërial locomotion; amusements and sports; history of aëronautic racing; history of aëronautic clubs and societies, their present membership, activity, and usefulness; census of aëronautic publications, industries, and various enterprises; governmental aëronautic establishments, their aims, equipment, and expenditures; value of aërial navigation to individual nations and to the world.

Papers may be presented covering only one or two of the various sub-divisions of the above twenty topics.

The presentation of papers to the Congress, on the above topics and allied ones, after approval by the Committee, will be made by abstract or by reading in full, as may seem advisable. The discussion of the papers will be necessarily limited in time, and it is hoped that the speakers will furnish a summary of their remarks to be preserved with the papers.

The publication of the papers and discussions will be made by a special committee, who will decide how much of the proceedings shall be printed, and will edit the same. Decided preference will be given to those papers stating the results of actual experiment, or presenting rigorous mathematical proof, because facts and positive knowledge are deemed more instructive than projects or vague theories.

A reception and luncheon will be given to the members of the Congress immediately after the morning session on Monday, October 28.

Cards of admission to the Congress will be issued in advance by the Secretary of the Committee upon application to him, approval by the Committee, and the payment of a contribution of $3·00 to the publication fund. These cards will entitle the holder to attend the Congress and to receive all its subsequent publications.

All communications should be addressed to Ernest La Rue Jones, Secretary of Committees, 12 East 42nd Street, New York City.

Letter to the Editor.

THE METEOROLOGICAL CONDITIONS ABOVE ST. LOUIS.

To the Editor of the "Aëronautical Journal."

SIR,—In your April number you quote from the Aëronautical Map issued by the Aëro Club of St. Louis concerning the probable drift of the balloons which will start from that place next October in competition for the Gordon-Bennett Cup. Permit me first to point out that the length of a balloon voyage is to be reckoned in a straight line from the starting point to the place of landing, and therefore the distance accomplished by John Wise, who travelled from St. Louis to Henderson, New York, in 1859 was only about 970 miles, instead of the 1150 miles stated. The map also gives the tracks followed by some of the *ballons-sonde* which have been dispatched from St. Louis by Messrs. Clayton and Fergusson of this Observatory since 1904, but since less than half of the balloons returned to us figure on the chart, and since, moreover, no indication is given of the heights reached by these balloons, it seems worth while to furnish some details of the experiments, in view of their bearing on the probable course and speed of the racing balloons next autumn.

The balloons used in my experiments were the rubber balloons of Professor Dr. Assmann, which are well known in Europe, and were filled with hydrogen gas. Each carried a self-recording barometer and thermometer, constructed on Teisserenc de Bort's system, which a parachute, covering the upper portion of the balloon, brought safely to the ground after the balloon had burst on reaching the maximum height commensurate with its expansion. We sent up 56 of these balloons during the years 1904, 1905, and 1906, and, by remarkable good fortune, 53 balloons with their instruments were found and returned to this Observatory, on payment of a small reward to the finders. The records of barometric pressure and temperature were usually decipherable, and from the automatically-recorded times of the ascent of the balloon at St. Louis and its descent at a place, whose distance and direction from St. Louis are known, the average direction and velocity of its drift can be calculated.

Classifying according to altitude all the ascensions at different seasons of the year, I have obtained the figures for the movement of the air at different heights above St. Louis which are embodied in the accompanying table. No. 1 embraces the balloons whose maximum height was less than 18,000 ft.; No. 2 those in which the maximum height was between 16,000 and 33,000 feet; No. 3 those between 33,000 and 49,000 feet; and No. 4 those greater than 49,000 feet.

It will be seen that the velocity, and consequently the distance travelled, increases up to the third level, above which there is a slight decrease in velocity, and that the lowest balloons took the most southerly course (S. 79° E.), while the level 2 balloons went nearly due east (S. 87° E.). Naturally, there were great individual differences in velocity and direction. Thus, in level 1, which will hardly be exceeded by the manned balloons next October, one *ballon-sonde*, which reached a height of 7600 feet on Nov. 23, 1904, travelled 55 miles at an average velocity of 51 miles an hour, while the next day another balloon at a slightly greater altitude followed the same course but went 90 miles further. The minimum velocity was shown by a balloon on May 17, 1906, which, though it rose to a height of 14,700 feet, travelled only 15 miles north-east at an average speed of but 11 miles an hour. It appears probable, however, that the balloons which compete in the internationl cup race will travel at the rate of about 25 miles per hour towards a point slightly south of east, the distance, of course, depending upon the length of time that the balloons can keep afloat. In level 3, two of our *ballons-sonde* which reached heights of about seven miles in November, 1904, travelled at an average speed of 100 miles an hour, one 280 miles east, the other 255 miles south-south-east. As this is the average velocity in the upper and lower air strata, the velocity at the maximum altitude in both cases probably much exceeded 100 miles an hour, but such velocities are shown by the measurements of the drift of cirrus clouds at Blue Hill to be not unusual in winter over the United States.

Assuming that the mean temperature for October at St. Louis is 59° F., the temperature at two miles will be about 35° F. and at four miles about 15° F. Though far beyond the reach of the manned balloons, it may be interesting to state that in January, 1905, at a height of about nine miles − 110° F. was recorded by one of our balloons, which is perhaps the lowest natural temperature ever observed, and that the following July − 75° F. was registered at a height of less than nine miles.

Level.	Number of Ascensions Utilized.	Mean Max. Altitude. (Feet.)	Mean Altitude. (Feet.)	Mean Distance Travelled. (Miles.)	Mean Velocity. (Miles per Hour).	Mean Direction from St. Louis.
4	9	52,500	26,000	117	47	S. 81° E.
3	16	40,500	20,000	155	56	S. 85° E.
2	18	23,500	12,000	101	38	S. 87° E.
1	8	11,500	6,000	42	25	S. 79° E.

A. LAWRENCE ROTCH,
Director.

Blue Hill Meteorological Observatory,
Hyde Park, Mass., U.S.A.
May 11, 1907.

NOTES.

Mr. Knabenshue's New Airship Gas Engine.—Mr. A. Roy Knabenshue's gas engine, which he has lately built for his new airship, is remarkable for combining what is the desideratum in airship engines, lightness and high horse-power. Its weight is said to be only 54 pounds, but it is also said to be capable of yielding 12 to 16 horse-power. The *New York Herald* has obtained the following facts concerning the engine :—"The engine is of a two-cycle pattern, and runs nicely at 100 revolutions a minute. The engine is valveless, and starts absolutely without fail with a half-turn. It will work with any carburettor. One of the features of the engine is the spark coil, which is also a freak. The coil, instead of containing, as do most coils, two windings of wire, a primary and a secondary, contains six windings, the last five of which are looped in series with a battery of condensers. The carburettor throttle and spark timer are also inventions of Mr. Knabenshue. The oil lubricator is different from most others in that it sends the lubricant into the machine with the gas mixture."

The Striking by Lightning of an Italian War Balloon.—History has not yet had to record very many instances of balloons being struck by lightning. On the occasion, however, of the opening by the King and Queen of the national target firing competition organised in connection with the Italian national *fête*, there was a melancholy example of the possibility. During the ceremony a small military balloon, with Captain Ulivelli in the car, was sent up in spite of the threatening weather, and soon reached an altitude of some 1000 feet. When the balloon was passing over a hill, simultaneously with a flash of lightning flames were seen to burst from the balloon, followed by a loud report. The car and the remnants of the balloon descended to the ground with great velocity. The hapless aëronaut was unconscious when he reached the ground, and died shortly after his removal to the hospital.

The Bombardment of War Balloons.—The *Morning Post* recently described the experiments in the bombardment of war balloons which have recently been in progress at Lydd Camp. The war balloon was sent up three miles from where the guns were in action. When it was at a height of about four hundred yards, the artillery opened fire upon it with shrapnel. The first shell missed the balloon, but the second caught it squarely and brought it down "a mass of wreckage."

The International Sporting Exhibition at Berlin.—In the Berlin International Sporting Exhibition, which opened on May 20, there was an Aëronautical Section illustrative of aëronautics of to-day in Germany. Amongst the exhibits were a model of the Zeppelin airship about 3 metres in length, a model of the Parseval airship about 1½ metres in length. The Lindenberg Observatory sent an interesting exhibit of aërology. An interesting item is the completely equipped car used for high ascents. Amongst the flying machines is the original kite of Jatho and the Lilienthal gliding machine.

The Observation of St. Elmo's Fire on a Balloon.—In *La Conquête de L'Air* of June 1 there is a note describing the observation of St. Elmo's fire on the rigging of a balloon. This phenomenon is frequently seen by sailors on the masts of ships, but it does not appear to have been often witnessed on a balloon by aëronauts. On the 20th of June at 5 o'clock in the evening the aëronauts, Messieurs M. N. Charles Levée, Alan Hawley, and Frank Corley, ascended in the balloon "La Mouche" from the grounds of the Aëro-Club of France. About midnight, just after the balloon had passed over Brussels, the aëronauts saw electric fires on the rigging of the balloon, accompanied with crackling sounds resembling the discharges of an electric battery. The height of the balloon at the time was 1110 metres, and the balloon had just experienced a storm of rain. The phenomenon lasted about a quarter of an hour. The aëronauts at first felt anxiety lest the St. Elmo's fire should ignite the gas in the balloon, but it was soon recognised that the luminosity was not accompanied with sufficient heat to be a source of danger. During the luminous appearances ozone was liberated in sufficient quantities to be disagreeable.

Superposed Aëroplanes.—Owing to the revived interest in aëroplanes, some may perhaps think that the aëroplane is a new invention. Such may well read the few remarks on aërial flight which Mr. F. H. Wenham, a honorary member of the Aëronautical Society of Great Britain, recently wrote in the *English Mechanic*. He calls attention to the paper he read before the Aëronautical Society of Great Britain shortly after its foundation in 1866, one that Mr. Octave Chanute has well called classical. In this paper Mr. Wenham pointed out the impracticability of imitating the flight of a bird by means of a single pair of wings. "In order to obviate the impossibility of using a flat plane extended laterally in imitation of the wing of a bird, I superposed a series of webs above each other, which I named 'aëroplanes.' I made three machines on this principle, each of sufficient surface to carry a man. These I described at the time; but they had the fault of deficient equilibrium, and a liability to skid sideways. This I proposed to remedy by hinging the aëroplanes at mid-length, and tilting them up at an angle. A model so constructed descends steadily without side drift. Then comes the question of fore-and-aft stability. Instead of arranging the aëroplanes directly one above the other, as I had shown, if the lower ones were set progressively some distance back, the tendency to trip would be considerably lessened. As to the mode of propulsion, I doubt whether rotating screw-vanes are the most efficient, as they involve complicated gear, and are too gradual in their action on the air. For the smallest size of flying machine, I think a flapping wing action more suitable, having a slow rising and a very quick down stroke, for a sudden impact on the air. This can be effected by a simple mechanical action."

Screw Propellers v. Aëroplanes.—The *Times* Engineering Supplement recently called attention to two important papers presented to the French Académie des Sciences by Lieut. Tsoucales, of the Greek Navy, and by Lieut. Vlahavas, of the Greek Artillery. Both papers have been published in Les Comptes Rendus.

The first deals with the question of screw propellers and screws revolving on a fixed axis. In it the theory of screw propulsion is exhaustively treated. It contains formulæ showing the effective work done by the screw, the maximum force developed in the direction of its axis, and the amount of useful work from power output.

There is an instructive table in this paper, by means of which it can be ascertained which type of screw will give the maximum effect for a given power output.

The second paper is one that is likely to give rise to much discussion in Aëronautical circles. It is a comparative study of aëroplanes and bladed air propellers (Heliocoptère).

Having calculated the most favourable inclination for the surfaces of aëroplanes, they conclude that the aëroplane presents no advantages as compared with the screw. "With only 6 per cent. of the work put into the aëroplane the screw will give the same amount of sustentation and the same effect of translation. Moreover, in the case of the screw there is no need of planes of support, which entail useless weight and interfere with the stability. Finally the authors, making use in all cases of analysis, prove that the theory relied upon hitherto by experimenters with aëroplanes must be rejected, since in effect it conducts to perpetual motion. They thus claim to demolish a theory which until now has been accepted as axiomatic, and having shown this to be so there remains no advantage whatever in the use of the aëroplane."

Mammoth Balloons.—A balloon of very large dimensions has recently been made by Mr. Gaudron for Mr. W. Tanner. It has a capacity of 108,000 cubic feet, a diameter of 56 feet, and a superficial area of 33,330 square feet. The lifting power of the balloon will be 4,320 lbs. It is claimed that this is the largest balloon that has ever been made in this country. It was, however, run very close by the balloon of some 100,000 cubic feet capacity made some years ago for Mr. Eric Stuart Bruce by the late Mr. Dale.

The Travel Exhibition.—At the Travel Exhibition held in May last at the Horticultural Hall, Westminster, considerable attention was paid to aëronautics. A room was, in fact, set apart for a loan collection of models, photographs, diagrams, charts, and old prints. Conspicuous amongst the loan collection was the exhibit of photographs, &c., contributed by the Aëronautical Society of Great Britain. This was the same collection which won a silver medal at the Milan Exhibition in 1906. In the same room Mr. C. S. Rolls exhibited his valuable collection of prints which were exhibited a few years ago at one of the meetings of the Aëronautical Society of Great Britain. In another part of the Exhibition Mr. Balston showed kites and aëroplanes, Mr. Roe model aëroplanes, and Mr. W. Cochrane a corrugated flying machine. In the gardens of the Exhibition there was a captive balloon under the management of Mr. P. Spencer, which made frequent ascents.

Foreign Aëronautical Publications.

(In this list a selection of some of the more notable articles is only given.)

L'Aéronaute (Paris).

April, 1907.—La Thermométrie du ballon (W. de Fonvielle).—Discussion et examen critique des récentes expériences d'aéroplanes (Chauvière).—La Conquête de l'air par l'hélice (Vicomte de Ponton d'Amécourt).—Analyse Sommaire d'un article de Graham Bell (Trochery).

May.—Revendication aéronautique (Comte de Carelli).—Aéronef Malécot (C. Chavoutier).—La Conquête de l'air par l'hélice (Suite).

June.—Résistance opposée par l'air aux corps en mouvement.—Communication sur les expériences de photographie à grande base (Arthur Batut).—La Conquête de l'air par l'hélice (Suite).

L'AÉROPHILE (Paris).

April.—Portraits de Femmes Aéronautes: Mme. Marie-Anne Lafaurie.—Les aéromoteurs de J. Ambroise Farcot (L. Lagrange).—Machines Volantes d'aujourd'hui et de demain.

May.—Portraits d'Aéronautes Contemporains: Vicomte Ch. de Vidal de Lirac (A. de Masfrand).—Aëroplanes aujourd'hui et demain.

June.—Portraits d'Aéronautes Contemporains: Ernest Zens. (A. de Masfrand).—Sur la Stabilité des Aéroplanes (P. Vole).—L'Aéroplane Edmond Seux.

ILLUSTRIERTE AERONAUTISCHE MITTEILUNGEN (Strassburg).

April.—Wilhelm V. Bezold (Arthur Berson). Die Form des Tragkörpers von Luftschiffen (P. Denninghoff und H. Elias).—Die Pläne Wellmanns für 1907.—Aus der flugtechnischen Praxis (R. Schelies).—Der Neue Motorgleitflieger von Etrich-Wels (Dr. R. Nimführ).—Über Vortreib-Schrauben (F. Ferber.)

May.—Die Versuche mit dem Lebaudy-Luftschiffe im Jahre, 1905 (Voyer).—Die Drachenflieger (G. Wellner).—Warum der Antoinette-Motor der leichteste und bisher der einzig branchbare Motor für Fleigmaschinen ist (Captain Ferber).

June.—Die Meteorologischen Verhältnisse über St. Louis (A. L. Rotch).—Kgl. Aëronautisches Observatorium Lindenberg. — Lustige und traurige Episoden aus den ersten Jahren der Ballon-Aera (1785) (Max Leher).

WIENER LUFTSCHIFFER-ZEITUNG (Vienna).

April.—Meerfahrten einer Dame—Ein Grosses Sterben (W. De Fonvielle).— Hauptmann Georg Von Schrimpf.

May. — Sensationelle Fahrt — Georg Von Tschudi. — Die Motorluftschiff - Studiengesellschaft Zu Berlin.—Photographischer Wettbewerb Balsan.

BOLLETINO DELLA SOCIETÀ AERONAUTICA ITALIANA (Rome).

April.—Dinamica degli aerostati dirigibili (G. A. Crocco).—Intorno alla forma delle superfici sostentatrici.—Sulle traiettorie degli aerostati naviganti in aere cicloniche (P. Burgatti).—I venti in Italia (Dr. F. Eredia).

Applications for Patents.

(*Made in April, May, and June.*)

The following list of Applications for Patents connected with Aëronautics has been specially compiled for the AËRONAUTICAL JOURNAL by Messrs. BROMHEAD & Co., Patent Agents, 33, Cannon Street, London, E.C.

APRIL.

J. D. ROOTS. **Improved Aerial Machine.**

7473. W. J. STILL. **Improvements in or connected with propelling, raising, depressing and steering apparatus for aerial machines and for other purposes.**

7887. April 10th. F. W. H. HUTCHINSON. **Improvements in and relating to Flying Machines.**

17894. F. W. THOMAS. **Improvements in aeroplanes and flying machines applicable also to man-lifting kites.**

17967. C. CRASTEN. **Improvements in helicopters or screw winged flying machines.**

7974. April 17th. A. E. GAUDRON. **New mechanical ballast discharger for balloons and the like.**

8116. R. SHAPLAND. **Improvements in aeroplanes, kites and similar apparatus for use in aerial flight.**

8435. J. SAWARD. **Air ship.**

8716. April 24th. E. P. FROST AND F. W. HUTCHINSON. **Improvements in artificial feathers or wings for flying machines.**

8818. C. G. UNDERWOOD. **Apparatus for balancing aeroplanes and the like.**

8966. W. A. MCCURD. **Improvements in flying machines.**

9101. M. J. SCHULTE. **Improvements in or relating to flying machines.**

9119. W. V. REDEN. **Improvements in flying machines.**

9114. C. HEIN. **New or improved appliance for showroom windows.**

MAY.

9299. FR. BARNES AND D. GRAHAM. **Improvements in and relating to aerial vessels.**

9413. F. W. LANCASTER. **Improvements in aerodromes applicable to balloons and submarine vessels.**

9433. S. T. WILLIAMS. **Improvements in apparatus for aerial photography.**

9445. J. E. CAPPER AND G. BREWER. **Apparatus for obtaining photographs from balloons and kites.**

9469. J. H. LEE. **Improvements in and connected with the propulsion of aeroplanes over water.**

9594. J. L. GARSED. **Improvements in the method and means employed for propelling and steering aerial machines.**

9691. B. F. S. BADEN-POWELL. **Aerial machine.**

9847. J. B. Passat. **Improvements in apparatus for aerial navigation.**

9940. P. A. Kenna. **Improvements in and relating to propellers for aerial navigation.**

10,004. E. Bode. **Aeroplane.**

10,361. A. H. Edwards. **New or improved construction of apparatus or appliance for use in marine navigation.**

10,603. May 15th. L. Kingsley. **Parachute gun and parachute.**

10,961. J. Schulke. **Improvements in flying apparatus.**

11,106. May 23rd. R. M. Jones. **Device to improve aeroplanes and airships of any description in reference to their stability.**

111,317. A. Hoffman and F. Frohlich. **Improved flying machine.**

11,188. M. Buch. **Improvements in flying machines.**

11,418. H. B. Webb. **Improvements in aeroplanes or flying machines and the like models thereof.**

11,863. May 29th. G. Castagneris. **Suspension of the balloon car to the inner walls of the gas bag.**

JUNE.

12,156. June 5th. T. M. Hewitson. **Improvements in air ships.**

12,509 L. F. Gowans. **Improved air ship or air navigator.**

12,650. E. Jones. **Improvements in or connected with flying machines.**

12,718. W. Brooks. **Improvements in and relating to captive balloons.**

12,848. June 12th. A. Pengeot, T. Huber, and H. de Lostalot. **Improvemnnts in or relating to apparatus for aerial navigation.**

13,905. E. Tezka. **Improvements in or relating to flying machines.**

14,042. H. Ruthenberg. **Improvements in wings for aerial apparatus.**

14,205. F. E. Jackson. **Improvements in kite parachutes and the like.**

14,216. J. Garsed. **Improvements in or connected with aerostats or aerial machines.**

14,334. J. Macinayte. **Flying machines.**

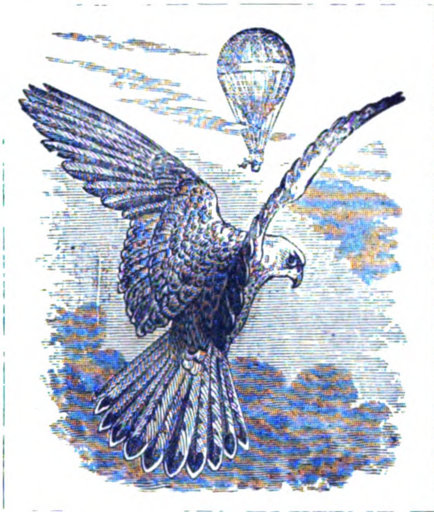
Notice.

"Researches on the Forms and Stability of Aëroplanes," by W. R. Turnbull. Members of the Aëronautical Society of Great Britain who may wish for copies of this pamphlet can obtain the same by applying to

W. R. Turnbull, M.A.,
Laboratory,
Rothesay, N.B., Canada.

ENTERED AT STATIONERS' HALL.] PRICE 1s.

THE AËRONAUTICAL JOURNAL



Edited for the Council of the Aëronautical Society of Great Britain

By ERIC STUART BRUCE, M.A. Oxon, Fellow of the Royal Meteorological Society.

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THE AËRONAUTICAL JOURNAL

BACK NUMBERS.

BACK NUMBERS. **Back Numbers may be obtained from the Publishers: Messrs. KING, SELL & OLDING, LTD., 27, Chancery Lane, W.C.**

The following are some articles of special interest which have appeared during the last few years:

Lord Rayleigh on Flight. April, 1900.
The Balloon Work of the late Mr. Coxwell. April, 1900.
A Theory of Flight. By D. M. BOYER SMITH. April, 1900.
On Forms of Surfaces Impelled Through the Air and their Effects in Sustaining Weights. By F. H. WENHAM. July, 1900.
The Lifting Power of Air Propellers. By WILLIAM GEORGE WALKER. October, 1900.
The Paris International Aëronautical Congress. January, 1901.
The Experiments with the Zeppelin Airship. April, 1901.
Aëronautics in France. By WILFRED DE FONVIELLE. July, 1901.
The Chief Scientific Uses of Kites. By A. LAWRENCE ROTCH. October, 1901.
Aërial Navigation by Means of Bodies heavier than Air. By Sir HIRAM MAXIM.
Atmospheric Currents. By WILLIAM MARRIOTT. January, 1902.
The Berlin Congress of the International Aëronautical Commission. July, 1902.
The "Peace" Balloon of the late Senhor Augusto Severo. By Dr. CARLOS SAMPAIO. October, 1902.
Recent Aëronautical Progress. By Major B. BADEN-POWELL. January, 1903.
Contributions of Balloon Investigations to Meteorology. By Dr. W. N. SHAW, F.R.S.
Photographs of the Paths of Aërial Gliders. By Professor G. H. BRYAN, F.R.S., and W. E. WILLIAMS. July, 1904.
Scientific Balloon Ascents. By CHARLES HARDING. October, 1904.
Automatic Stability. By E. C. HAWKINS, J.P. April, 1905
Notes on a Bird-Like Flying Machine. By Dr. F. W. H. HUTCHINSON, M.A. July, 1905.
The Santos Dumont, No. xiv. October, 1905.
The Acoustical Experiments Carried Out in Balloons by the late Rev. J. M. Bacon. By GERTRUDE BACON. January, 1906.
The late Prof. S. P. Langley. April, 1906.
The Use of the Balloon in the Recent British Antarctic Expedition. By Captain ROBERT FALCON SCOTT, R.N. July, 1906.
The Experiments of the Brothers Wright. By Sir HIRAM MAXIM. July, 1906.
The Relative Weight and Span of Birds. July, 1906.
Wings v. Screws. By Colonel J. D. FULLERTON, R.E. April, 1907.
The Free Lever of the Flying Machine. By CHARLES MILLER. April, 1907.
The Principle of Sailing Flight and Longitudinal Balance. By JOSÉ WEISS. April, 1907.

Special Illustrated Number of the Aëronautical Journal, January, 1904, containing Report of the International Kite Competition and the Longitudinal Stability of Aëroplane Gliders, by Professor G. H. Bryan, F.R.S., and W. E. Williams, B.Sc.

There are only a few copies left of this number, which will be sold at 3/- each.

Special Number of the Aëronautical Journal, January, 1907. There are a limited number of copies left of this number, con aining Dr. William Napier Shaw's paper on "The Use of Kites in Meteorological Research," with specially prepared diagrams. Price 2/-.

TO LET.

THE AËRONAUTICAL JOURNAL.

OCTOBER, 1907.

The Aëronautical Journal.

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27, Chancery Lane, W.C.

Editorial communications should be addressed to the Editor,

53, Victoria Street,
Westminster, London, S.W.

NOTICES

OF

The Aëronautical Society of Great Britain.

At a Council Meeting of the Aëronautical Society of Great Britain, held at 53, Victoria Street, Westminster, on Monday, October 7th, 1907,

Lt.-Colonel F. C. TROLLOPE (late Grenadier Guards)

was elected Vice-President of the Aëronautical Society of Great Britain.

The following gentlemen were elected Members of the Society:—

Mr. ADOLFE GUSTAV HEINZE,
Mr. WALLACE RUPERT TURNBULL,
Mr. BASIL WALCOT, R.E.

The opening meeting of the Forty-third Session of the Aëronautical Society of Great Britain will be held at the Society of Arts, John Street, Adelphi, in December next, the date of which will be duly announced.

Amongst the papers read at this meeting will be "The Starting Methods of Aëroplanes," by Mr. José Weiss, M. Aër. Soc.; "Mechanical Aërial Navigation," by Mr. Rankin Kennedy; and "A Study of Model Gliders," by Mr. A. V. Roe.

THE LIBRARY.

The following books and publications have been presented to the Library:—

By the Meteorological Office, "Publications of the International Commission for Scientific Aëronautics."

By the Smithsonian Institution, "Samuel Pierpoint Langley" (Doctor White, Professor Pickering, and Mr. Chanute).

By A. Lawrence Rotch, "The International Aëronautical Conference of October, 1906, at Milan" (A. Lawrence Rotch).

RESEARCH FUND.

A contribution of a sum of £105 towards the Research Fund of the Aëronautical Society of Great Britain has been received from the Mercers' Company.

THE TRAVEL EXHIBITION, 1907.

A Diploma of Honour has been awarded the Aëronautical Society of Great Britain for its loan exhibit in the Aëronautical Section of the Travel Exhibition held at the Horticultural Hall, Westminster, in May last.

ERIC STUART BRUCE
(*Honorary Secretary*).

Three Airships of Three Nations.

I.—THE FIRST BRITISH MILITARY AIRSHIP.

The successful launching of the first British navigable balloon into the unstable ocean of the air at Farnborough on September 10 was an event which has met with universal approbation. The fact that both France and Germany had added airships to their implements of war had been lately causing a certain amount of public uneasiness that this nation was behindhand in the application of aëronautics to warfare.

The war uses of the navigable balloon as at present developed, have no doubt been exaggerated. Therefore the absence of a British airship did not mean such imminent danger as some have supposed. But it is now being recognised that an aërial vessel which can be steered will be of service in scouting operations, and by its mobility exceed the powers of the ordinary captive balloon, whilst its utility as a destructive agency cannot be entirely ignored.

As might be expected in the case of a military airship, the details of its construction have not been communicated by the authorities. The balloon was, however, seen by many on the day of its first manœuvres, and although it is not possible to vouch for accuracy in the reports concerning detail that have been published, still much concerning the construction of the airship has been obviously manifest.

The "Broad Arrow" of September 14th thus describes the new airship and its manœuvres:—

"The shape of the balloon is that of a sausage, with rounded ends, where the skin of which it is made is gathered and tied. Its length is about 90 ft., and in circumference the same. From end to end it is covered in a network of cordage, which meets about 10 ft. below and is fixed to a light steel framework. Below the latter, some 8 ft., is fixed the car of light steel framework covered with canvas. Of the shape of a boat, it is about 16 ft. long, one-third of it being taken up with the engines fixed in the forepart. These are worked by petrol, the supply tanks being placed in the rigging above. On either side are the propellers, a light wooden framework keeping these clear of the car, to which they work at right angles. A square of sail-cloth stretched on a frame of wood is placed at the rear of the car and is carried up almost to the balloon above. This is fixed like the rudder of a ship, and acts in exactly the same manner, being worked by an arrangement of ropes and pulleys so as to be set at any angle to the car. Two huge wings are laid out flat on the air from either side of the car, and by altering the plane of these the balloon is assisted to ascend or descend while the engines are working. The weight of the car and engines and three occupants is stated to be just over a ton. Mr. F. S. Cody, who has been attached to the Balloon Department for experimental purposes, was in charge of the engines; Colonel Capper steered, and Captain King, of the Balloon Department, completed the crew. The airship rose to about 1,000 ft., with its head to the wind, which was blowing about four miles an hour. On the engines being started, the airship at once moved forward against the wind, rising and descending as the wings at the sides were altered. The steering apparatus was subsequently brought into play and three parts of a circle was made, the arc described being about two miles in extent. The balloon descended on Jersey Brow. Some adjustments having been effected, the airship was again brought out of the shed, and the trial of the earlier part of the day was repeated, but this time a circle of about three miles was accomplished while at a height of nearly half a mile."

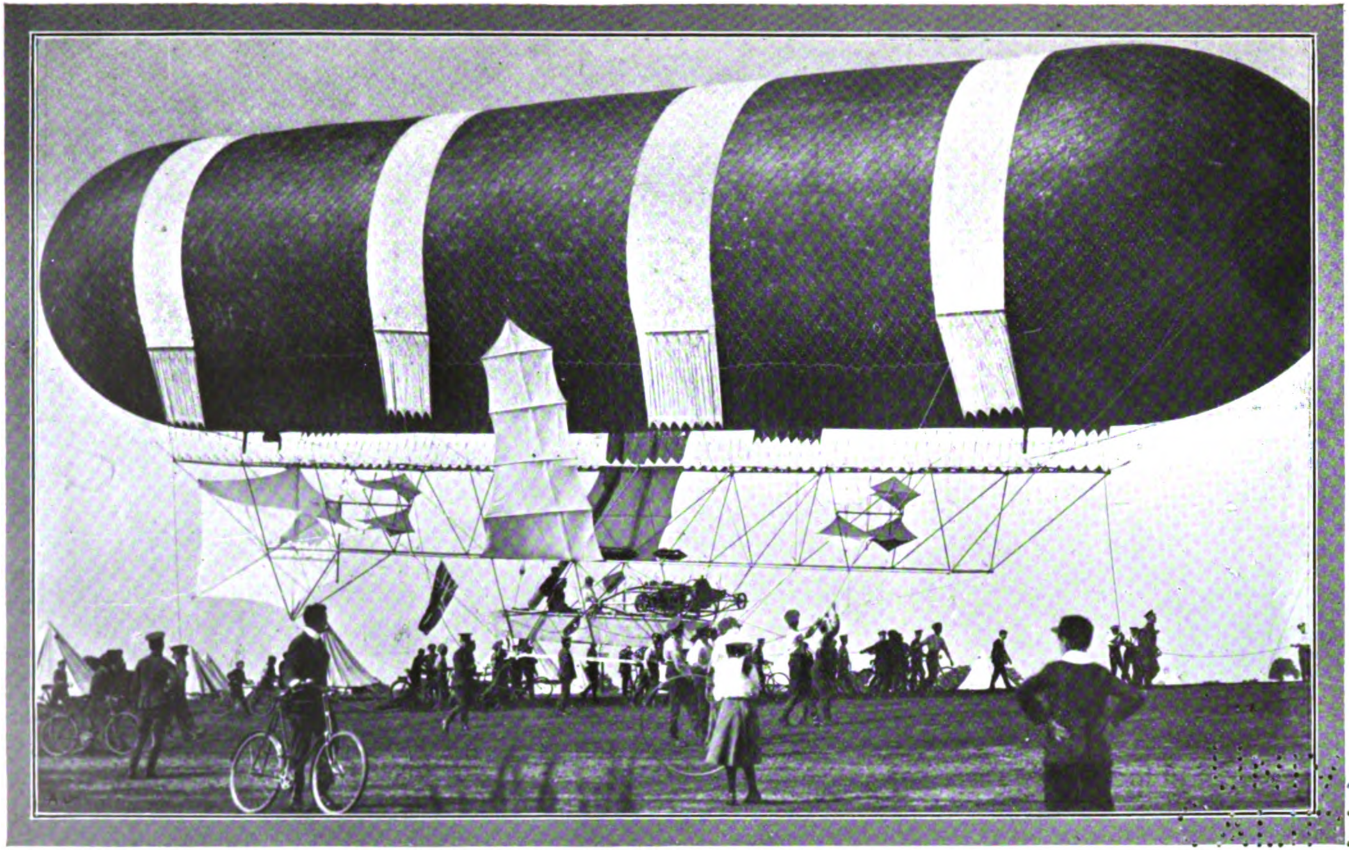
One of the most noteworthy features of the airship is the material of which its envelope is made.

This is the first instance of a navigable balloon envelope having been made of gold-beater's skin. The excellent qualities of this substance for the purpose have been well proved by its long use in the manufacture of the ordinary observation balloons. Foremost amongst those qualities is its power of retaining the hydrogen gas. Capability of long retention is certainly one of the first requirements of a navigable balloon.

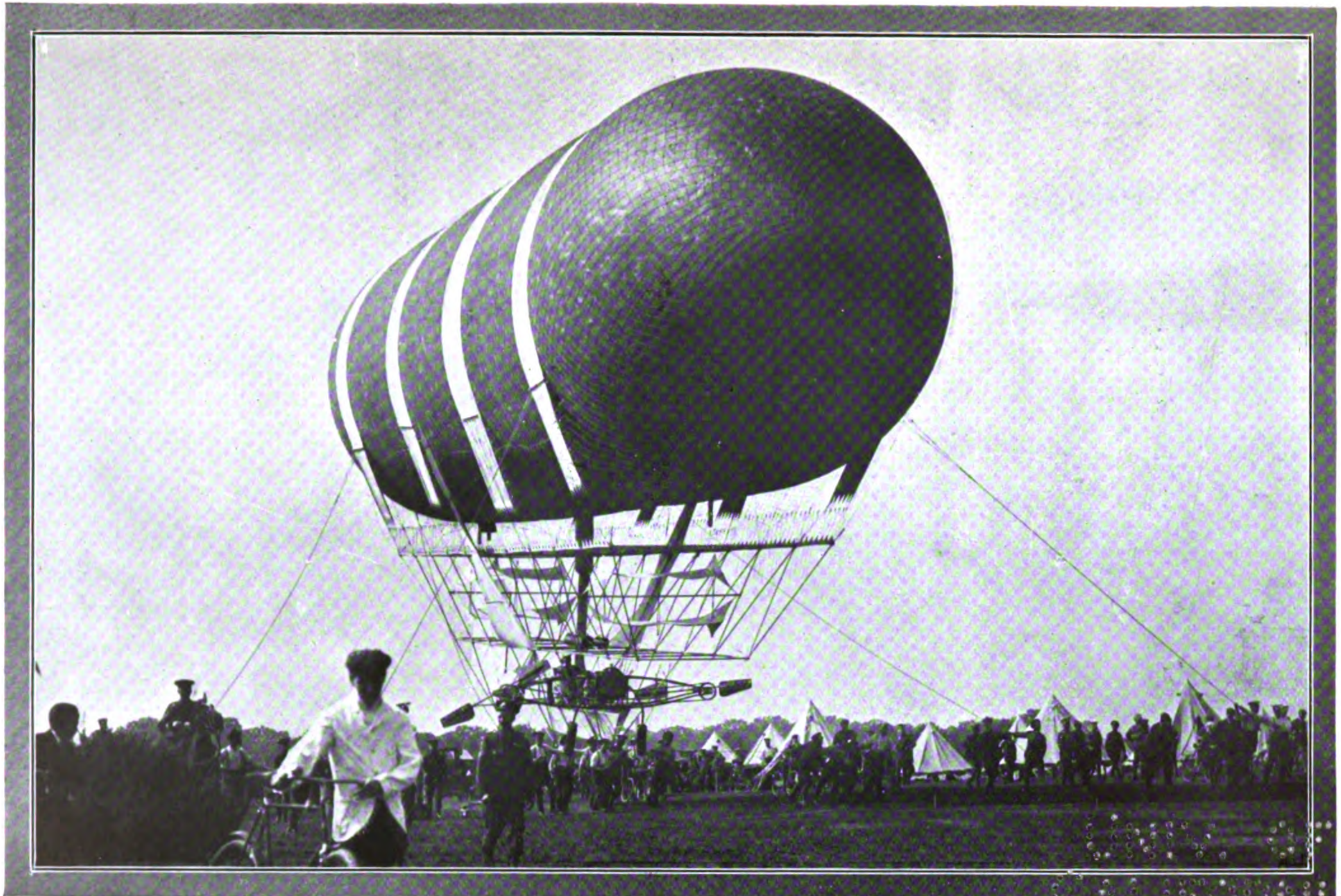
Just as the first proofs of these remarks were being corrected by the editor of this journal a new opportunity was afforded of adding some additional remarks on the practical success of the British airship.

About 11.20 on October 5th there was a sound as of a motor car in the air above the grounds of the residence of the Honorary Secretary of the Aëronautical Society of Great Britain, at Sunningdale, and this was followed by the appearance of Dirigible No. 1, travelling at splendid speed on its way from Aldershot to London.

As has already been made generally known by the daily press, the airship exhibited a remarkably fine performance and one reflecting the highest possible credit on those responsible. The airship remained in the air 3½ hours, and but for the



By kind permission of] **THE BRITISH MILITARY AIRSHIP.** [*" The Autocar" and ' The Daily Mirror."*



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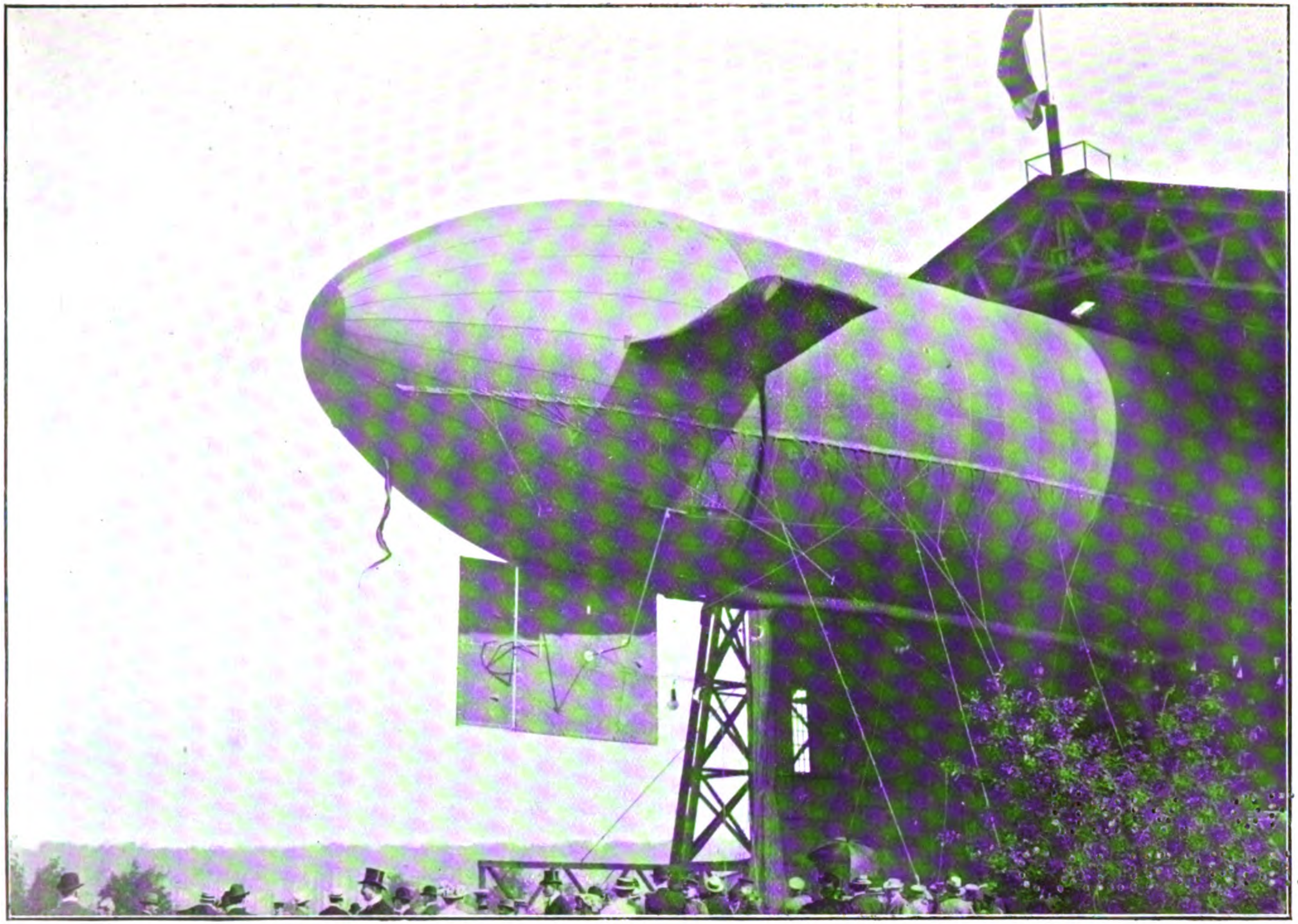
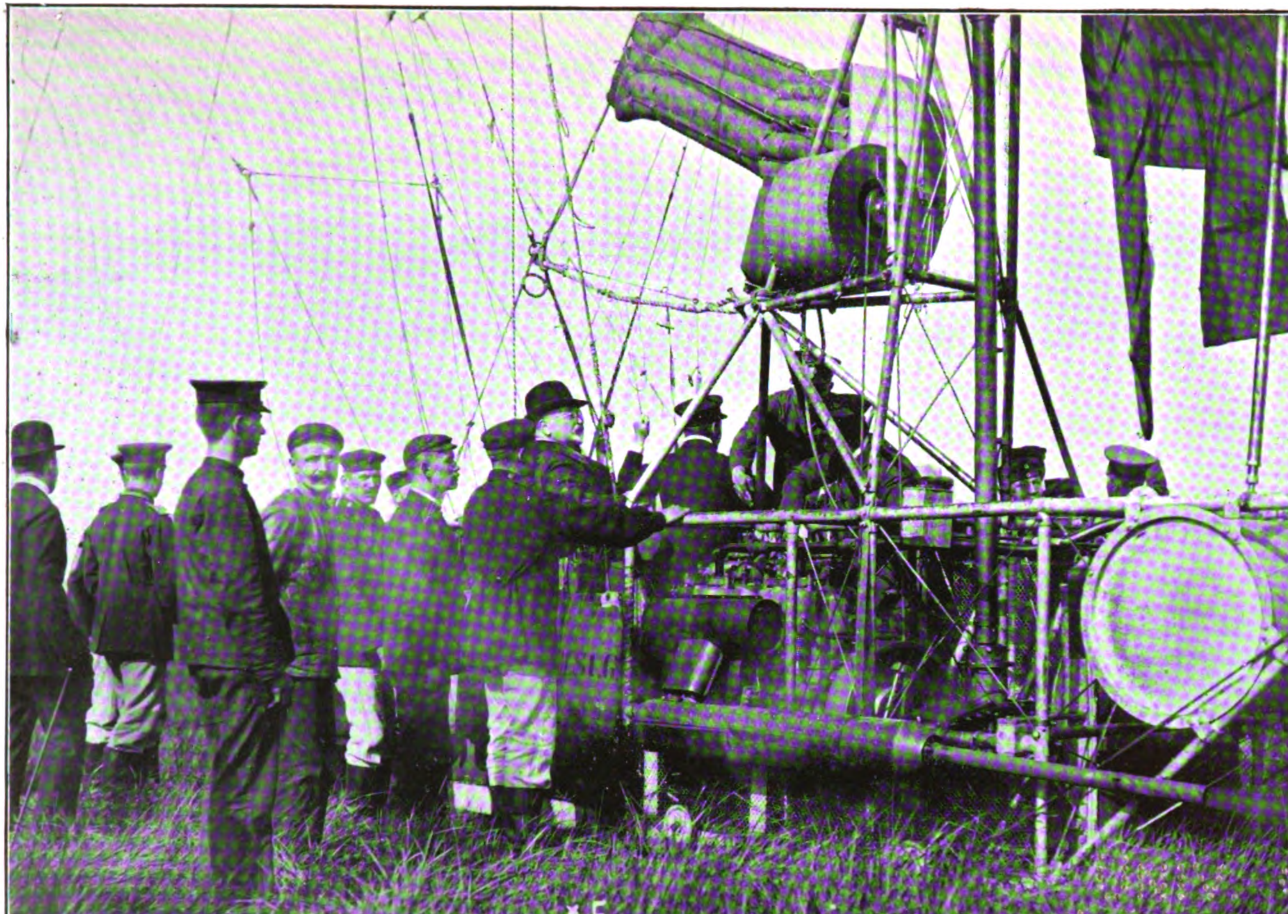
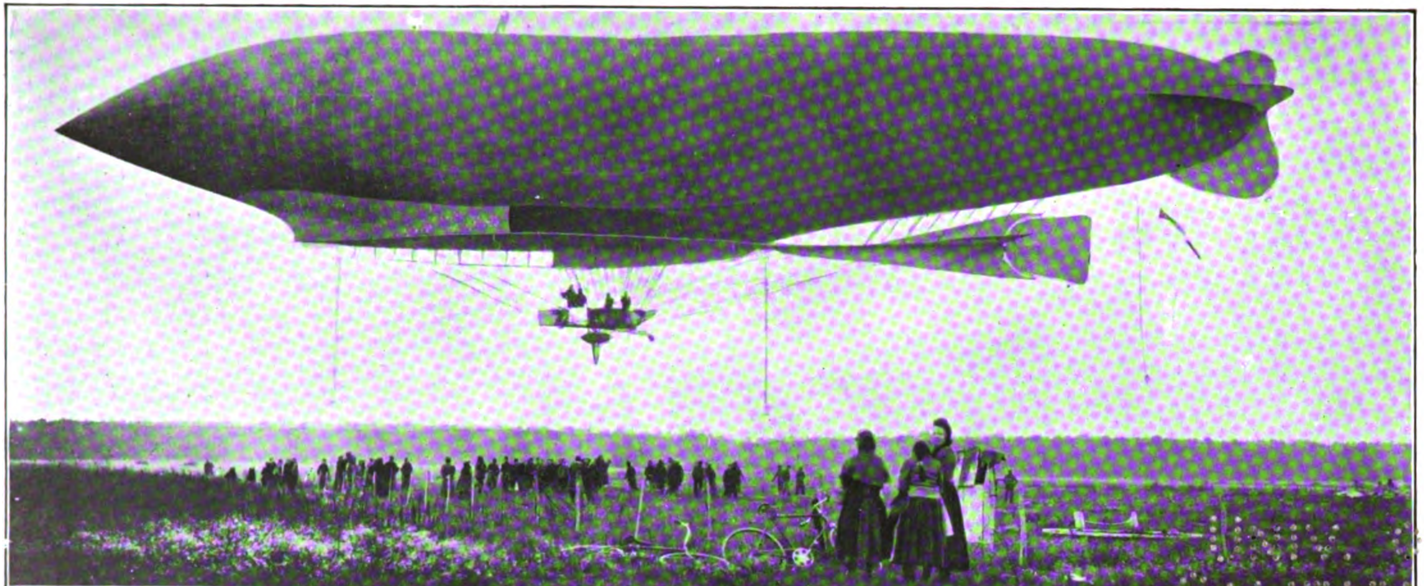


THE PARSEVAL AIRSHIP.



THE PARSEVAL AIRSHIP.



By kind permission of] "LA PATRIE." [*"The Car," and Messrs. Bolak.*

necessity of running for a safe anchorage before an increasing wind, could have remained up 5 or 6 hours longer. The distance travelled was 50 miles and the speed through the air was about 14 miles an hour. The only disappointing feature of the journey was that owing to the wind increasing a return journey was not possible, and thus the present limitations of navigable balloons were exemplified.

The *Times* of October 7th, in an article on the voyage of the airship over London, thus describes the journey :—

" When released, at about 11 o'clock on Saturday morning, it rose steadily on an even keel, and, after making a few curves to test the steering apparatus, settled into a north-easterly course. At Aldershot it was an open secret that London was the objective, and it was anticipated that the airship would reach London at about 1 o'clock. Pursuing a practically straight course, however, the distance was covered in less time, and before half-past 12 o'clock the airship was circling round St. Paul's Cathedral, having previously passed over the War Office. In Whitehall the manœuvres of Nulli Secundus were watched by several members of the Army Council, including Colonel Sir Edward Ward, General Sir William Nicholson, Major-General Hadden, and Lieutenant-General Charles Douglas. The streets were speedily crowded with people watching the progress of the airship, which at many points came so low that it was possible to see something of the working of the mechanism and the movements of the occupants, Colonel Capper, Mr. Cody, and Lieutenant Waterlow. Nulli Secundus also passed over Buckingham Palace and its grounds, and manœuvred above the lawn on which the King occasionally holds reviews. This, it is stated, was a rehearsal of the visit to be paid on October 14th, when His Majesty will inspect the airship. Travelling eastwards, the airship made a wide circuit of St. Paul's Cathedral, afterwards heading against the wind on the return journey. Nulli Secundus was under complete control, but the wind was rather strong, and when over Clapham Common the course was altered for Sydenham. Over the grounds of the Crystal Palace the airship was put through a series of manœuvres, these extending over a period of about a quarter of an hour. Then the airship was lowered to the ground, its final position being in the centre of the cycle track."

The successful journey of the airship over the metropolis points to the advisability of larger national funds being applied to the service of the air, and suggests that if the powers that be can see their way to bestow a materially increased annual grant to the Balloon Department of the British Army, we need not fear being behind other nations in military aëronautics. It is a matter, however, of serious consideration that whilst other Powers have already several of these engines of destruction, each one of which is capable of nearly or quite twice the speed of the British airship, and able to carry a suitable armament for offensive warfare, our solitary representative is but small and of feeble pace, and can carry but little beyond her complement of two hands.

That our designers and aëronauts are now sufficiently skilled to produce more powerful and speedy machines than any now existent may be accepted, but funds in ample though not extravagant amount are absolutely necessary for the purpose.

2.—"LA PATRIE."

The Lebaudy airship was not long in the possession of the French Government before the manufacture of a second balloon of the same type was in progress. The accompanying illustration represents "La Patrie," which made its first journey in November last. In its principal features this balloon resembles its predecessor, though advantage has been taken of experience with the former to effect some details of improvement in the latter, and especially in those minutiæ which will enable it to play its part as an instrument of war.

The envelope is of the fusiform dissymmetrical shape which characterised the former balloon. It is made of cotton covered with indiarubber. Its length is 60 metres instead of 58 metres as was the case in the older balloon. The master diameter 10 metres 30. The volume 3,150 metres instead of 2,960.

The steel tubes which have formed a feature of the Lebaudy type and which convey the thrust of the screws to the oval platform in the centre of the balloon have been retained, but it has been arranged in the improved airship that these tubes can be unfixed so as to enable the balloon to be conveyed over railway telegraphic wires when dismantled it is being transported from place to place.

The ballonet in the new balloon has been enlarged. It is now 650 metres instead of 500 metres.

A successful feature of the Lebaudy system has been the devices attached to the airship to minimise rolling and pitching. The planes for producing stability in the newer airship have been somewhat modified and further developed. The cross tail at the back of the balloon, especially designed to obviate the rolling and pitching, is longer than the former one, and it has been rounded more at the edges so as to closer resemble a bird's tail. The butterfly arrangement at the back for preserving stability has been retained.

The motor is a Panhard-Levassor of 70 horse-power, the motor in the former airship being only 50 horse-power. The screws are similar to those used in the airship of 1905, and are again placed at the right and left of the car. The car is still made of steel tubes, but it is larger and more accommodating than it was in the older type.

Towards the close of 1906 "La Patrie" made some highly successful journeys, one of the most remarkable and one which determined its acceptance by the French Government being that of November 26th, when the airship several times made the tour of the peninsula of Moissan and came back to the place of departure. The speed attained was estimated at 93 kilometres in 2½ hours, the airship having travelled a good portion of the distance at 45 kilometres an hour.

Its steering capacities have been well tested in many other trials, notably on its first appearance above Paris on December 17th, and on the occasion of its further manœuvres over the Parisian capital on July 8th. Another striking manifestation of its powers was on July 14th on the occasion of the review at Longchamps. On this occasion the possibility of descending by means of the action of the lateral wings mounted on the front of the oval platform in the centre of the balloon was well demonstrated.

On July 22nd M. Clemenceau and General Picquart, the French Minister of War, both ascended in "La Patrie" and expressed their complete confidence in this new engine of war.

THE PARSEVAL AIRSHIP.

As "L'Aérophile" has pointed out, Germany, at the present time, may be said to possess three types of navigable balloons—(1) The "Zeppelin," of the rigid type; (2) the "Parseval," in which the use of rigid materials is reduced to a minimum; (3) the "Gross," which is intermediate between these extremes.

In the Parseval airship special effort has been made to abolish all rigid materials so as to produce simplicity of construction and to render the balloon when deflated easy of transport.

This object has certainly been attained, as one cart drawn by two horses can effect the transport.

Last year satisfactory results were obtained in the trials of the balloon. Those trials have suggested certain modifications and improvements. The point of the envelope has been sharpened, the length has been increased from 48 to 52 metres, the master diameter from 8 metres 57 to 8 metres 70, and the capacity from 2,500 metres to 2,800 metres.

Two ballonets are used to give permanence of form; one of these is placed at the back of the balloon, the other at the front. These are supplied with air by a unique blower, so that the amount of air in them is easily regulated for the facilitation of ascent or descent.

The car is placed 9 metres below the balloon, and accommodates three persons. There is a Mercédès motor of 50 horse-power.

The propeller is four-bladed, being 4 metres in diameter. The blades are of thin steel tubing covered with shirting. The suspension of the car is novel, gliding corels being provided to enable the car to be moved about freely without interference with its parallel position.

The trials with the improved airship have been lately renewed.

The Franco-American Expedition to Explore the Atmosphere in the Tropics.

Mr. A. Lawrence Rotch's paper on the Results of the Franco-American Expedition to Explore the Atmosphere in the Tropics, recently published by the American Academy of Arts and Sciences, is still another testimony to the indefatigable energy of the Director of the Blue Hill Observatory.

Not only was he the pioneer in the systematic exploration of the atmosphere, but he continues steadfastly to extend our knowledge of the upper air. In the History of Science his name will be closely associated with the advent of the new meteorology.

In the important publication to which reference has been made, Mr. Rotch states that it has long been believed that the ascending currents above the thermal equator proceed immediately over the north-east and south-east trade winds as south-west and north-west anti-trades. It is possible that part of the anti-trade sinks down over the high barometric pressure in the north and south Atlantic oceans, and returns with the trade winds, but the greater portion descends north and south of the origin of the trades and continues to the poles as the prevailing south-west or north-west winds of the north and temperate zones respectively.

This theory is based on observations taken throughout the whole year on the Peak of Teneriffe. Although the south-west wind is at a lower level in winter than in summer, there appears to be no evidence to prove that the anti-trade ever reaches the surface of the ocean.

In 1901, at the Glasgow meeting of the British Association, and again in 1901, at the Berlin Congress for Scientific Aëronautics, Mr. Rotch suggested the application of flying kites on steamers to the exploration of the atmosphere in the trade wind region. By the method of utilising steam vessels the kites could be flown independently of wind.

In order to organise the expedition applications for aid were addressed to the Prince of Monaco, and in 1905 to the Carnegie Institution, but without effect.

Professor Hergesell, however, was successful in interesting the Prince of Monaco in the scheme, and upon his yacht, the "Princess Alice," during the summer of 1904 kite flights were made in the region bounded by Spain, the Azores and the Canaries.

Though the heights attained by the kites on several occasions exceeded that of the Peak of Teneriffe, we are told that the south-west current which had been reported on that mountain was not found.

This experience led Professor Hergesell to state at the St. Petersburg Congress of the International Commission for Scientific Aëronautics that he thought this current was due to the disturbing influence of the island, and in the explored region to the interchange of air taking place through the north-west current.

As the existence of the upper return trade seemed to demand further investigation, in 1905 Mr. Rotch, in conjunction with M. Teisserenc de Bort, undertook the task. Each entrusted the research to one of their assistants. Mr. Maurice, of the Trappes Observatory, undertook the work for M. Teisserenc de Bort, and Mr. Clayton, of Blue Hill, for Mr. Rotch.

In June, 1905, Mr. Clayton made the voyage from Boston to Gibraltar *viâ* the Azores on the White Star steamer "Romanie," and raised kites six times to an average height of about 1,000 metres.

During July and August in the same year Messrs. Clayton and Maurice experimented on M. Teisserenc's yatch "Ontaria," at the mutual expense of M. Teisserenc de Bort and Mr. Rotch. The journey was made from the Mediterranean, *viâ* Madeira, the Canary and Cape Verde Islands, to latitude 10° north, longitude 30° west, returning *viâ* the Azores and Corunna (Spain) to Havre.

No less than 17 kite flights were made over the ocean, as well as two in the Harbour of Santa Cruz (Teneriffe) to study the sea breeze, and another off Corunna (Spain) during the total eclipse of the sun of August 30th.

Continuous records of barometric pressure and air temperature were obtained from the sea-level to a height of 2,200 metres. Wind velocity was recorded up to 3,100 metres.

The direction of the wind was obtained by measuring the azimuth of the kites.

Mr. Clayton made direct observations upon the Peak of Tryde (Teneriffe) to a height of 3,700 metres; also upon the Peak of Togo to 2,200 metres.

In addition to the observations with kites, large paper balloons were sent up from the "Ontaria." Eleven of these were dispatched from the islands of St. Michael's (Azores), Madeira, Teneriffe, Canada and St. Vincent (Cape Verde). These balloons did not carry self-recording instruments, and their direction and velocity at increasing heights were determined from angular measurements at the ends of a base line laid off on the lee shore of the islands.

One ballon-sonde, however, with self-recording instrument, was sent from the yatch off the Island of Palma, but it shared the lot of so many ballons-sonde, and was not recovered.

"West of the Azores, on the westerly slope of the permanent area of high barometric pressure, the observations between longitudes 69° and 39° show a slow decrease of temperature with increase of height, amounting to 4.5° per 1,000 metres. In the lower 500 metres the decrease is only 0.24° per 100 metres, owing to inversions of temperature within the first few hundred metres in half the flights. In the next 500 metres there is the more rapid decrease of 0.66° per 100 metres. Upon the easterly and south-easterly slopes of the high pressure, between longitudes 25° and 19°, latitudes 38° and 33° north, the temperature falls at the adiabatic rate of one degree per 100 metres in the lower 500 metres, and then declines more slowly, namely, 0.20° per 100 metres. The adiabatic rate appears to prevail over the ocean at night as well as in the daytime, and the bases of the cumulus clouds generally are not higher than 500 metres. The relative humidity decreases with height on the west of the high pressure, and increases to above 500 metres on the south-east side. In the former region south-west winds prevail, and in the latter locality north-east winds, the south-west winds turning to the left when facing them up to 500 metres, with increasing velocity up to 1,000 metres, and the north-east winds turning to the left and increasing slightly in velocity up to 500 metres, but diminishing above that level."

The observations on the northern edge of the north-east trade, that is, between latitudes 36° and 34° north, are marked by a rapid fall of temperature with height (7.8° per 1,000 metres), which is fastest (0.92° per 100 metres) within the first 500 metres. The relative humidity rises nearly to saturation within the first 500 metres.

The direction of the wind, which is generally north-east, varies but little with altitude, but its velocity increases at about 500 metres. Two observations taken south of the north-east trade in about latitude 10° north show the same features. Within the trade wind region, between latitudes 31° and 15°, the vertical distribution of temperature and moisture is quite different. "Near its origin the trade has the character of a descending current, that is, small vapour contents and little cloud, which is the flat cumulus typical in northern regions of high pressure and descending air. In approaching the equator, that is, south of latitude 24° north, the trade presents characteristics of an ascending current, the relative humidity increases much with height, the sky is cloudy, and there are frequent rains, often accompanied by thunderstorms. The decrease of temperature within the trade region is less than 1° C. in 1,000 metres, there being a fall of 0.58° in the first 500 metres and a rise of 0.56° per 100 in the next 500 on account of the temperature gradients which occur near 1,000 metres at the upper limit of the trade wind. Its depth varies from day to day between 300 and 1,500 metres, and appears to be greatest in the afternoon and least at night. The upper portion is damp with cumulus and strata-cumulus cloud, above which the wind falls light and the relative humidity sinks nearly to zero, coinciding with the rise in temperature, which frequently carries it much above that at sea-level. With increasing altitude there is a gradual shifting of the wind, when facing it, to the right, accompanied by an accelerated velocity up to at least 1,000 metres."

It would appear that above the surface trade there is a warm and dry current about 2,000 metres in depth varying in direction between north-east and north-west, but coming invariably from a direction to the left of the lower wind when facing it. It usually has a velocity much exceeding that of the lower wind.

The third stratum, which begins at 3,000 metres, moves from east, south, or south-west, very generally from the west in equatorial regions and from the south between latitudes 15° and 30° north.

Mr. Clayton's observations on the Peak of Teneriffe indicated that this stratum was dry in its lower portion, but had a larger vapour contents than the air immediately below.

In the portion of the Atlantic investigated by the Franco-American Expedition, the atmospherical circulation was as follows:—

"(1) North of Madeira and near the Azores, the upper winds, as was already known by observations of clouds, are chiefly from west and north-west, this region being generally to the north of the barometric maximum over the ocean and beyond the zone of the trades. (2) The winds blowing towards the equator are from north-east to east in the lower region, and generally from north-west to north-east above 1,000 metres. (3) The return currents from the equator, or anti-trades, are formed by winds having a southerly component, being generally south-west in the latitude of the Canaries, and south-east near the Cape Verdes, thus showing the influence of the earth's rotation. The law of the vertical succession of winds, as formulated by Abercromby, namely, a shifting in the northern hemisphere of the upper winds to the left-hand, when one's back is turned towards the wind, is found not to hold true always, the right or left-handed rotation depending upon the origin of the wind, and, presumably, upon the distribution of the pressure at high levels."

Mr. Rotch states that the vertical distribution of temperature and relative humidity recorded by these observations up to 4,000 metres nearly correspond with those taken by Professor Hergesell during the cruises of the "Princess Alice" in 1904 and 1905.

"Most of his observations of direction of the upper currents differ radically, however, in showing no southerly component, although one balloon, launched west of the Canaries, gave the same direction as that obtained near these islands, meeting interlaced currents from the south-east to south-west, above the north-east trade. From the distribution of pressure on the earth's surface it would be supposed that the upper anti-trade ought to be especially regular in the region between Cape Verde and the Canaries, but this idea is contrary to the belief of Professor Hergesell that the upper south-east and south-west winds observed near these islands, and long considered to furnish a demonstration of the return-trade, are due to local disturbing causes."

It was to settle this point that Mr. Rotch and M. Teisserenc de Bort again dispatched the "Ontaria" during the winter of 1906 to the south and west of the region where their observations had been taken the previous summer.

In this expedition Messrs. Maurice and Nilsson constituted the scientific staff. Their observations both by balloons and the drift of clouds show the existence of the upper anti-trade, the stratified condition giving place to the southerly wind between 3,000 and 4,000 metres.

Mr. Rotch, therefore, concludes that "The classic observations of the return-trade, which were long ago made on the Peak of Teneriffe, indicate a general phenomenon and agree with those obtained over the open ocean by the recent expedition."

There could be no greater evidence of the value of aëronautical science to meteorology than the results of these researches. On the progress of the former will depend the future of the latter. But the benefit will ever be a mutual one, for when by the use of new aëronautical implements the meteorologist has gained new knowledge, that knowledge will re-act on the science which lent its services and extend its usefulness still further.

The Recent International Aëronautical Conference at Brussels.

By A Member of the Paris Aëro Club.

The International Aëronautical Conference, opened at Brussels on September 12th, commenced by a meeting of the Permanent Aëronautical Commission at the Conference Chamber of the Hôtel des Finances, under the presidency of Prince Roland Bonaparte. M. Guillaume, a Swiss delegate, director of the International Office of Weights and Measures at Sièvres, read a paper in praise of the metric system, and advocating its world-wide adoption by aëronauts. Other addresses which followed treated of air currents, atmospheric dynamics, the speed of winds, the varying temperatures at great altitudes, and the necessity of establishing aëronautical observatories for practical meteorology. Captain Voyer contributed a paper on the evolution of dirigible balloons in the horizontal plane, and the measurement of their speeds. M. Georges Claude described experiments which have been in progress for the economical manufacture of hydrogen by a liquid air process.

On the following day the International Aëronautical Federation opened its annual conference and discussed several matters of business relating to the federation of various clubs. The afternoon was devoted to a joint assembly of the Permanent Commission and Federation in the Palais des Academies. Amongst the distinguished aëronauts present were M. A. de la Vaulx, Comte de Castillon de St. Victor, Captain Ferber, M. René Gasnier, M. Maurice Mallet (the greatest French balloon builder), M. E. Boulenger, Commandant Renard, M. F. Jacobs, Chevalier Le Clement de St.-Marcq, Colonel Van den Borren, M. A. Flamache (Professor at the Gand University), Drs.

Bamler, Stade, and Wegener, Captain von Abercron, Captain Voyer, M. Hiedemann, Captain Hildebrandt, Messrs. Roger W. Wallace, K.C., and F. H. Butler, Captain Castagneris Guido, Signor G. L. Pesce (the great Italian engineer), Professor Paul Koffmann, Colonel Schaeck, Mr. Patrick Alexander, Colonel Templer, Lieutenant-Colonel Trollope, Captain A. Hildebrandt (a commander in the Swedish Navy), and M. Paul Tissandier.

On this occasion Commandant Renard read a paper on the History of Navigable Balloons, Captain Voyer on Recent Experiences in Airships, and Captain Ferber gave a discourse on Flight. The joint Conference was continued on the Saturday morning.

In most International Congresses excursions play a prominent part. The principal excursion on this occasion was to the Park of Military Aëronautics, two miles out of Antwerp. Here the aëronautical party were shown over the works by Captain Ferber. In the evening the aëronauts were entertained at a banquet by the Belgian Aëro Club.

On September 15th the balloon race for the 2,000 F. Cup took place from the Parc Cinquantenaire, when the novel sight of 32 balloons massed together and ready filled was witnessed. The following table gives the results of the race :—

INTERNATIONAL BALLOON RACE FROM BRUSSELS.

Order.	Name of Balloon.	Cubic Capacity, mètres.	Aëronaut.	Nationality.	Hour of Ascent.	Hour of Descent	Place of Descent.	Distance Travelled. Kilomètres
			MM.		Sunday.	Monday.		
1	Pommern ..	2,200	O. Erbslöh	Germany ..	17 48	22 30	Seignosse (Cap Breton)	935
2	Le Cognac ..	1,700	V. de Beauclair ..	Switzerland	18 02	18 03	Mimizan (Landes) ..	870
3	Zéphir ..	2,200	Prof. Huntington ..	Gt. Britain	17 09	17 30	Cazaubon (Gers) .	860
4	Britannia ..	2,200	Hon. C. S. Rolls ..	Gt. Britain	17 43	18 06	Sanguinet	840
5	Bamler ..	1,437	E. Mensing	Germany ..	18 37	18 30	Cabanac (Gironde) ..	830
6	Milano ..	2,000	Usuelli	Italy ..	17 07	14 30	St. Amand (Agen) ..	810
7	Ville de Bruxelles	2,200	L. de Brouckère ..	Belgium ..	19 10	18 45	Audenge	800
	Tschudi .	1,300	Dr. V. Niemeyer ..	Germany ..	20 16	19 20	Andernos (Bordeaux)	800
9	Eden ..	800	E. Boulenger ..	France ..	17 43	16 0	Tonneins (Lot et Garonne)	780
10	Aéro-Gand	1,250	F. Hansen	Belgium ..	18 35	16 0	Pessard (Bordeaux)	770
	Equateur	900	Leprince	France ..	19 55	16 45	Cubnezais (*id.*) ..	770
12	Bezold ..	1,380	A. Cassirer	Germany ..	18 15	17 19	Arcins	740
13	Abercron ..	1,437	Capt. von Abercron	Germany ..	19 58	19 30	Carcans	730
14	Sylphe ..	1,600	P. Tissandier ..	France ..	17 30	12 45	Ste. Croix de Mareuil	660
	Le Charles	1,437	Léon Gheude ..	Belgium ..	17 34	14 05	Marthon	660
16	Quo Vadis ..	1,200	Schelcher	France ..	18 50	12 40	*Près* Limoges (Hte. Vienne)	610
17	Mouche ..	1,600	R. Gasnier	France ..	18 23	12 30	Dompierre (*id.*) ..	575
18	La Perle ..	800	G. Cormier	France ..	18 16	10 0	Saint Bautel	475
19	Elberfeld ..	1,437	Prof. Milarch ..	Germany ..	18 38	13 07	Mehun s/Yères ..	400
20	Luciole ..	900	Ribeyre	France ..	20 03	2 30	Menneville (Aisne)	160
						Sunday.		
21	Köln ..	1,437	Hiedemann	Germany ..	17 16	23 20	*Près* Charleville ..	125
22	Aéro IV. ..	850	H. Demoor	Belgium ..	17 50	19 12	Sart Dames Avelines	20

Franco-British Exhibtion, 1908.

There will be an aëronautical section in the transportation group of the Franco-British Exhibition to be held at Shepherd's Bush next year.

The following are the sub-classes under which objects will be exhibited :—

Balloon construction : Fabric, varnish, cars, nets, valves, cordage, appliances for stopping balloons, anchors, and grapnels, production of hydrogen and other light gases, captive balloons.

Aërial voyages : Employment of balloons for meteorological observations, air currents, clouds, temperature at high altitudes, optical phenomena, etc., drawings, maps of journeys, diagrams, photographs.

Military ballooning: Military captive balloons, and their accessories; winding drums for captive balloons; transport waggons, appliances for inflating balloons.

Aërial navigation: Dirigible balloons and apparatus for steering; apparatus for mechanical sails; screw propellers; aëroplanes and parachutes.

Flying machines.

Applications for space should be made to the Hon. Secretary, Franco-British Exhibition (Incorporated), 56, Victoria Street, London, S.W.

NOTES.

The British Government Aeroplane Experiments in the Scottish Highlands.—It appears that those who are conducting the aëroplane experiments in the Highlands of Scotland on behalf of the British Government have so far been successful in preserving essential secrecy, though glimpses of the machine have been obtained from a distance. The scene of operations is in one of the most inaccessible regions of the Grampian Hills, and the site has been placed at the disposal of the engineers by the Marquis of Tullibardine, the eldest son of the Duke of Atholl. A correspondent of the *Daily Express* appears to have got a sight of the aëroplane through field-glasses, and his impressions are related in the *Daily Express*.

The machine, a lightly built, delicately framed structure, was brought out from its shed shortly before midday. In general appearance, as seen through a pair of powerful field-glasses, it is like a large butterfly, with wings always extended, and an airiness that would seem unequal to the results it is expected to achieve. It is not unlike those of M. Santos Dumont, but the Cody kites are extensively used in the construction.

The engineers who are in charge of the station ran the machine for some distance on attached wheels, when the motors responded to the touch of the man on deck, who sits immediately behind the whirling screws. But before the aëroplane rose into the air a gust of wind blowing heavily down the valley from the east swept by, and the ropes by which the machine was held were not released.

The machinery was stopped awhile, but a few minutes later the pulsating of the motor again broke upon the stillness of the mountain air. The screws revolved once more at so rapid a pace that in the sunlight they looked like catherine wheels, but the wind rose into a gale that stormed down the gap, and realising the impossibility of further experiments the aëronauts stopped the motor and carried the machine back to its resting place.

Recent Manœuvres of the Zeppelin Airship.—On September 25th, Count Zeppelin made a very successful ascent of his new airship, and proved that the great increase of horse-power has not been applied without effect.

A fair wind seems to have been blowing when the ascent was made to a height of some 1,000 ft., but the balloon answered to its rudder, made a half turn towards the land, sailed a short distance northwards, then made a quarter turn and faced the wind. The screws were then worked more vigorously, and the balloon followed the required course.

It was directed all round the lake, and several manœuvres were executed without any hitch, and in the teeth of the wind, one of the manœuvres being that the balloon turned a complete circle several times in an extremely small space. The balloon was in the air 4 hours 17 minutes. The speed is stated to have been 50 feet per second.

M. Santos Dumont's Hydroplane.—Variety certainly characterises M. Santos Dumont's more recent experiments. His latest departure is called an hydroplane, and with this he hopes to skim the surface of the water. The apparatus consists of three cigar-shaped reservoirs filled with compressed air. On the centre one is fixed the screw propeller.

The centre one is ten metres long and those on either side of it a metre in length. Over the air reservoirs is built a small platform where the chauffeur takes his seat before the steering wheel.

The Accident to M. Bleriot's Aëroplane.—M. Bleriot had a very narrow escape when experimenting with his aëroplane on September 18th. It appears that he made an excellent start and rose to a considerable height. After having sailed through the air for about 150 yards the motor stopped and the aëroplane fell to the ground, being dashed to pieces. M. Bleriot escaped with only a cut face.

The accident is ascribed to a flaw in the motor, and not to any defects in the aëroplane.

As the *Daily Telegraph* points out, this accident shows the danger of trying to steer too high with the machine during the preliminary trials.

"The Giroplane."—The *Daily Telegraph* recently gave an account of a new flying machine called "The Giroplane," and invented by M. Brequet and M. Michet. The apparatus consists of four large horizontal propellers, each composed of thirty-two winglets, and forming all together a superficies of twenty-six square yards. The motive power is supplied by a 40 h.p. motor. The four propellers are slightly inclined forwards for the purpose of propulsion, the main power being reserved for lifting. As the machine is not yet complete, having no car or basket attached, an armchair was suspended under it, in which one of the inventors took his seat. The motor was then set going, and the machine rose with ease from the ground and appeared to be in perfect equilibrium. Four men did all they could do to hold it down, as the inventors had no intention as yet to attempt a free flight, the apparatus still needing among other accessories a steering device. They are, however, sanguine after this trial that their machine will be a practical one, and will have the advantage of rising at once in the air without any previous horizontal start. The total weight which it lifted was more than half a ton.

Hydrolith.—Hydrolith would appear to have a future before it as a means of providing hydrogen for filling balloons. A comparatively small quantity of this substance produces a large amount of hydrogen, one pound weight supplying 16 cubic feet of the gas. Hydrolith is known to the chemist as calcium hydride. Oxylith gives 2·4 cubic feet of oxygen per pound, while calcium carbide gives about double that amount. But pure hydrolith gives over 18 cubic feet to the pound. The commercial hydrolith contains about 10 per cent. of impurities, mainly oxide and nitride of calcium. Metallic calcium is exposed to a current of hydrogen in horizontal retorts, heated to a high temperature.

The gas is gradually absorbed by the calcium, which is thus converted into hydrolith. The pure substance forms a white crystalline mass, which has no known solvent. Commercial hydrolith occurs in irregular, slate-grey lumps.

The Uses of Airships in War.—The opinions of Major Von Parseval, quoted in the *Morning Post* of September 25th, support views as to the scouting uses of military airships expressed in another part of this Journal. He is, however, somewhat sceptical concerning the use of the navigable balloon as a weapon of war. It will, he thinks, in its improved condition, serve as a better reconnoitrer in times of war, and will, with the aid of wireless telegraphy, be the means of enabling news of an enemy's movements to be more quickly obtained. The carrying capacity of the balloon is still relatively very small, and it would require a vast flotilla of airships to carry guns of even small calibre and projectiles in sufficient quantities to inflict serious damage on an enemy. He points out that such great bodies as the present balloon offer an easy aim to an enemy's sharpshooters, and a navigable balloon must for the present remain fairly near the surface of the earth, as they cannot yet contend with the currents, etc., of the higher regions of the air.

Foreign Aëronautical Publications.

(In this list a selection of some of the more notable articles is only given.)

L'AÉRONAUTE (Paris).

July.—Note sur les Aéroplane (M. A. Elévé). — Suspension pour Photographie par cerfs-volants (J. Lecornu).—L'Aérostation au Japon. —Sur le Congrès des Etudes Solaires tenu à Meudon (W. de Fonvielle).

L'AÉROPHILE (Paris).

Portraits d'Aéronautes Contemporains: Commandant Bouttieaux (G. Besançon).—Equilibre Longitudinal Automatique des Aéroplanes (José Weiss).—Les Frères Wright à Paris.—L'aviation à l'Académie des Sciences: Mode de construction des Aéroplanes augmentant leur valeur sustentatrice et leur stabilité de route: Importance des réactions sur un plan mince et principe du movement relatif (A. Goupil).—Note sur le coefficient d'utilisation des hydroplane à hélice aérienne (Lieutenant Crocco).—Une femme Artiste: Mme. Marie Anne Lafaurie (François Peyrey).—Essais heureux de nouvel Aèroplane Blériot (Ancelle).—Le dirigéable militaire " Patrie " (L. Lagrange).

August.—Portraits d'Aéronautes Contemporains: Capitaine Voyer (Georges Besançon).—Le Grand-Prix de l'Aéroclub de France 1907 Réglement.—Les grandes journées Aéronautiques de Bruxelles.—Le dirigéable militaire, " Patrie."—Nouvelles expériences de dirigéables en Allemagne.—Aéroplanes d'hier et de demain. —Les essais de l'aéronat " La Ville de Paris " (Philos).

ILLUSTRIERTE AERONAUTISCHE MITTEILUNGEN (Strassburg).

July.—Karl J. Trübner.—Friedrich Ritter Von Lössl. — Capitano Ulivelli. — Kritische Betrachtungen über die Neuen Drachenflieger (Professor G. Wellner).—Entlastete Flugmaschinen.—Flugtechnische Übersicht.

August. — Die Erforschung der höheren Schichten der Atmosphäre auf der Reise S.M.S. " Planet " von Januar bis October, 1906. —Aus dem Kgl. Aëronautischen observatorium Lindenberg (R. Assmann).

September.—Die Erforschung der höheren Schichten der Atmosphäre auf der Reise S.M.S. " Planet " von Januar bis October, 1906 (Schluss).—Das Zweite französische Militärluftschiff " Patrie " (R. Clouth).—Der Lenkbare " La Ville de Paris " (G. Espitallier).

WIENER LUFTSCHIFFER-ZEITUNG (Vienna).

July.—Vermisste Luftschiffer.—Ein Ballon vom Blitz Getroffen Die Fahrt Leipzig-Leicester.—Ein entflohener Ballon.—Die Düsseldorfer Wettfahrten—Ein Motorboot mit Luftschaube.—Vom Sonnen-kongress in Meudon.

— Wellman's Expedition.— Santos Dumont No. XVI.—Vcm Kongress in Jamestown.

August.—Andrée, 1897-1907.—Von Mailand nach Bozen.— Wettfahrt in Lüttich. — Ein deutsches Militärluftschiff.—Vom Perseval Ballon—" La Patrie."—Einfluss der Sonne Aufs Wetter.

BOLLETINO DELLA SOCIETÀ AÉRONAUTICA ITALIANA (Rome).

Il dirigibile in mare sul cono d'ancora (G. A. Crocco).—Il prezzo del gas illuminante in Italia.—Il nuovo aëroplano C.R.—Da Lipsia a Leicester in ballone.—Sulla frequenza dei venti a delle calme a Pavia.—Osservazioni dell'alta atmosfera con cervi-volenti. All'Osservatorio di Pavia, dott P. Gamba.

BULLETIN, SCHWEIZER, AERO CLUB (Berne).

July.—Fahrtenberichte des Jahres 1906 (C. Deutsch).—L'origine des ballons à air chaud (A. Bernoud).—Unsere Ballon Kompagnie (mit Vier Bildern) (O. Bochsler.)

Applications for Patents.

(*Made in July, August, and September.*)

The following list of Applications for Patents connected with Aëronautics has been specially compiled for the AËRONAUTICAL JOURNAL by Messrs. BROMHEAD & Co., Patent Agents, 33, Cannon Street, London, E.C.

JULY.

15248. July 2nd. G. B. BOTLEY and J. ROSS. **New Device to Minimise Atmospheric Pressure on Locomotives, Motor Cars, Vehicles of all Kinds, Ships, Boats, and other Vessels Travelling Through the Air.**

15438. July 4th. C. L. BUCKWALTER. **Improvements in Airships.**

15457. July 4th. B. H. WALLIN. **Improvements in Mechanisms for Transmitting Motion to the Wings of Flying Machines.**

15590. July 6th. J. R. PORTER. **Improvements in Airships and in Apparatus for Propelling the same.**

15654. July 8th. H. L. GODDEN. **Improvements in Aerial Tracks for Popular Amusement, Toys, and Other Purposes.**

15796. July 9th. F. R. SIMMS. **Improvements in Flying Machines.**

15890. July 10th. T. H. ADDIS. **Improved Flying Machine.**

15938. July 11th. L. T. QUEREDO. **Improvements in Fusiform Aerostats.**

16063. July 12th. A. MITCHELL. **Improvements in Aerial Navigation.**

16121. July 13th, F. BOLLHORN. **Aerial Ship.**

16176. July 15th. F. E. JACKSON. **Improvements in Kites.**

16297. July 16th. H. EXHINGER. **Improvements in Dirigible Airships.**

16484. July 18th. E. E. LINDKVIST. **Driving Device for Boats, Airships, and the like.**

16967. July 24th. M. SCHIAVONE. **Improvements in Dirigible Aerostatic Devices.**

17011. July 25th. F. H. PAGE. **Improvements in Aerial Machines, such as Aeroplanes, Aerostats, and the like.**

17152. July 26th. J. H. LEE. **New or Improved Means and Apparatus for Raising and Propelling Aerial Cars over or on Water or Land.**

17366. July 29th. J. A. COLQUHOUN. **Improvements in Apparatus for Automatically Preserving the Equilibrium of Aerial Machines.**

AUGUST.

17048. August 2nd. T. A. GOSKAR. **Improvements in Flying Machines of the Heavier than Air Type.**

17725. August 2nd. H. B. WEBB. **Working Aeroplane or Flying Machine, Toy Model. Some of the Principles of Which are Applicable to Larger Machines.**

17999. August 8th. H. BLACKBURN. **Dirigible Balloon.**

18158. August 10th. J. FROSSARD. **Improvements in or Relating to Flying Machines.**

18246. August 12th. H. KOST AND A. J. MAYER. **Improvements in or connected with Airships.**

18559. August 16th. L. GATHMANN. **Improvements in Dirigible Airships.**

18765. August 20th. S. PERON. **New System of Miners' Parachute.**

18993. August 23rd. H. M. ROGERS. **Improvements in Aerial Vessels.**

19087. August 24th. H. E. HUGHES. **Improved Kite.**

19161. August 26th. H. L. TODD and C. B. PHELPS. **Improvements in Aerial Navigation.**

SEPTEMBER.

19586. September 5th. SIEMENS BROS. **Improved Means for Connecting Alternating Current Generators to their Prime Movers.**

19822. September 4th. R. A. POMIANOWSKI. **New or Improved Means for Balloons and Vessels.**

20313. September 12th. A. G. W. DE TIVOLI. **Flying Machine Regulator.**

20554. September 16th. H. L. ROBINSON. **Improved Flying Machine.**

20601. September 19th. W. C. JOHNSON. **Improvements in Flying Machines.**

20811. September 19th. L. BILTCLIFFE. **Improvements in Kites.**

20823. September 19th. C. W. KING. **Flying Machine.**

20917. September 20th. A. P. FILIPPI. **Improvements in Surfaces of Ascension or Aeroplanes for Flying Machines.**

21002. September 21st. A. MICHAEL. **Flying Machine.**

21030. September 21st. M. M. L. STUCKENHOLTZ. **Improvements in Mrgnets for Lifting.**

NOTE ON GOING TO PRESS:—

The Injury to the British Military Airship in the Recent Gale.

Just on going to press a report was circulated in London that the British Military Airship had been wrecked in a gale of wind at the Crystal Palace. The report, however, was a much exaggerated one. The incident which occurred to the Government Balloon on October 10th was one very likely to happen to a navigable balloon anchored in our uncertain climate.

It appears that the airship was caught by a squall between 8 and 9 in the morning, and a number of the stakes to which she was attached were pulled out, with the result that the contrivance heeled over.

The most fitting comment to make on the accident would seem to be a commendation of the efficiency of the Sappers in charge of the airship, who speedily accomplished the necessary deflation, and thus saved the envelope and motors from threatened damage.

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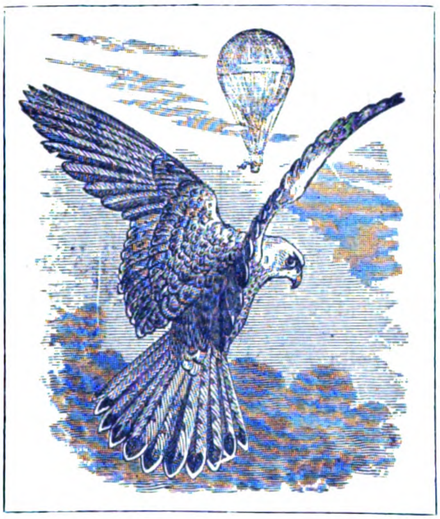

Edited for the Council of the Aëronautical Society of Great Britain

By COL. J. D. FULLERTON, R.E. (RET.), F.R.G.S., F.Z.S.

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Contents.

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NOTICES

OF

The Aëronautical Society of Great Britain.

At a Council Meeting of the Aëronautical Society of Great Britain, held at 53, Victoria Street, Westminster, on Monday, February 17th, 1908,

1.—The following gentlemen were elected Members of the Society:—

MR. G. M. HERRMANN.
MR. W. V. GILBERT.
LT. J. W. M. MCCOWEN, R.N.
MR. R. MORCOM.
MR. R. B. WOOSNAM.
MR. J. H. LEDEBOER.

To date February 17th, 1908.

2.—It was decided to send a vote of thanks to Major B. Baden-Powell, late Scots Guards, on his retirement from the Presidency of the Society.

53, Victoria Street,
Westminster,
February 17th, 1908.

MY DEAR BADEN-POWELL,

I am requested by the Council of the Aëronautical Society of Great Britain to convey to you the thanks of the Society for the valuable services you have rendered during your seven years' term of office as President.

On behalf of the Society allow me to give you our thanks for the work you have done, and to express our pleasure that, as a Member of the Council, we shall still have the benefit of your advice in matters affecting the welfare of the Society.

Believe me,
Yours very truly,
(Sd.) FRANCIS TROLLOPE, LT.-COL.,
Vice-President.

3.—It was decided to send a vote of thanks to Mr. Eric Stuart Bruce, M.A., on his resignation from the post of Hon. Secretary of the Society.

53, Victoria Street,
Westminster,
S.W.,
February 17th, 1908.

MY DEAR BRUCE,

I am desired by the Council of the Aëronautical Society of Great Britain to express their most sincere and deep regret that you have decided in view of your increasing private affairs to resign the office of Hon. Secretary to this Society, for you have during your term of office, which practically covers seven years, brought the Society from a comparative state of penury to that of comparative affluence. On behalf of this Society allow me to express our most grateful thanks for your great past services, and to express a hope that you will still continue to aid our work by continuing on the Committee of the Society.

The Council beg me to thank you for your generous gift of furniture to the office.

Believe me,
Yours very truly,
(Sd.) FRANCIS TROLLOPE, LT.-COL.,
Vice-President.

4.—It was decided that in future the financial year should date from January 1st to December 31st of each year, and that the accounts of the Society should be made up to December 31st.

5.—It was decided to form a Committee to consider the disposal of the grant given by the Mercers' Company "towards experiments." The composition of the Committee to be as follows:—

Mr. Dines, F.R.S.
Dr. Shaw, F.R.S.
Col. J. Capper, R.E., C.B.

The Vice-President to act as Final Adjudicator.

6.—The following awards for the Milan Exhibition were made:—

Bronze Medals.

Mr. Eric Stuart Bruce, for his services in connection with the Exhibition.

Mr. S. H. Salmon, for his exhibit at the Exhibition.

At the Council Meeting of the Aëronautical Society of Great Britain, held at the Royal Society of Arts, John Street, Adelphi, on March 27th, 1908,

1.—The following gentlemen were elected Members of the Society:—

Mr. G. F. Leake.
Capt. H. J. Coningham.
Mr. C. Parker.
Mr. J. D. M. Tinline.

To date March 27th, 1908.

2.—The Committee appointed to consider the disposal of the Mercers' grant reported the following awards:—

Major B. Baden-Powell ...	£30
Mr. J. Weiss ... ... (loan for motor, the property of the Society.)	£30
Major Moore, R.E., President of the Committee on "Wings"	£30
Mr. G. P. Saul	£10
Mr. R. Draper	£5
Total	£105

The Council decided that the following instructions should be sent to each of the above-mentioned Members.

1st.—A preliminary report to be sent in by them giving an account of the work done, not later than June 1st, 1908.

2nd.—A final report giving a full account of their work, to be forwarded by them not later than December 15th, 1908.

The Council also suggested that it would be a great advantage if the reports were accompanied by photos, sketches, etc.

MISCELLANEOUS NOTICES.

1.—The second meeting of the 43rd session of the Aëronautical Society of Great Britain will be held at the Royal United Service Institution, Whitehall, on May 27th, 1908, at 8 p.m.

Representatives of the principal foreign Aëronautical Societies have been invited to attend this Meeting, as also the Members of the F.A.I. Congress, then visiting this country.

2.—The Royal Aëro Club of Spain is organising a balloon race for the Municipality of Barcelona, to take place on May 17th, 1908. Entries to be made not later than midnight on May 1st, 1908, to the Secretary of the Royal Aëro Club of Spain, Madrid.

Entrance fee 300 francs.

Intending competitors can obtain further particulars from the Hon. Secretary of the Aëronautical Society of Great Britain.

3.—The following books and publications have been presented to the Library:—

By the Meteorological Office.

Publications of the International Commission for Scientific Aëronautics.

By Capt. Ley, R.E.

"The Possibility of a Topography of the Air, Based on Balloon Observations with Special Theodolites."

By Col. F. Trollope (*Vice-President*).

Miscellaneous Publications.

By Messrs. Constable.

"Aërodynamics," by Lanchester.

4.—The following is a list of the prizes now offered for flying machines, etc., from "La Conquete de l'Air," March 15th, 1908.:—

A.—FLYING MACHINES.

Belgium.—At Spa, on July 5th, 12th, and 19th, 1908, 75,000 francs in prizes, etc. (Aëro Club of Belgium).

France.—Armengaud Prize, 10,000 francs, for the first aviator who succeeds in remaining in the air for 15 minutes.

Pepin Prize of 1,000 francs to first aviator who crosses the River Garonne. Aëro Club of France Prize of 500 francs for the best level suitable for aëronautical work.

Aëro Club of France: Three prizes of 200 francs, and 3 silver medals, for flights of 200 metres.

Archdeacon Cup, at present held by Mr. Henry Farman.

Ruinart Prize: 12,500 francs, for first aviator who flies from France to England, or *vice versâ.*

Aëro Club of France, 5,000-metre flight. Prize of 5,000 francs.

Michelin Prize No. 1: An "objet d'art," valued at 10,000 francs, to be competed for under rules laid down by the Aëro Club of France. In addition 15,000 francs go to the driver of the machine, and this will be continued for 10 years.

Michelin Prize No. 2: 100,000 francs for a flight (two persons in the machine), from any point in the Departments of the Seine, or Seine-et-Oise, to the summit of the Puy de Dome, the Arc de Triomphe, and the cathedral at Clermont Ferraud to be circled en route.

Great Britain.—"Daily Graphic" Prize of £1,000 for a flight of one mile.

"Daily Mail" Prize of £10,000 for a flight from London to Manchester. In connection with this there is a special prize of £2,200, given by Adams Manufacturing Co., and a gold medal offered by Mr. Santos Dumont.

Germany.—Dr. Gau's Prize at the Munich Exhibition, £500, for a flight in the air lasting 10 minutes.

B.—FOR PILOTS OF DIRIGIBLES OR FLYING MACHINES.

Deutsch Prize: A Cup valued at 10,000 francs, and three prizes of 20,000 francs each. Rules for this competition are laid down by the F.A.I.

C.—FOR PILOTS OF SPHERICAL BALLOONS.

Belgium.—Aëro Club of Belgium: The Paris-Brussels Cup.

Aëro Club of Belgium Cup, given by l'Etoile Belge (at present held by Mons. de Bronckère).

France.—Gordon-Bennett Cup, valued at 12,500 francs, and prize of same value (at present held by Captain Erbslöh).

Santos Dumont Prize of 4,000 francs for the aëronaut who remains 48 hours in the air without descending. Cup given by le Gaulois (at present held by Mons. Leblanc).

America.—Lahm Cup (at present held by Mr. Mac-Coy).

Italy.—The Margaret of Savoy Cup (at present held by M. Uselli).

5.—Mr. P. Y. Alexander has presented his Aëronautical Library (which includes among other works 70 volumes of Press cuttings) to the Victoria and Albert Museum. Members desirous of inspecting the books should apply to Mr. Fulcher at the Museum.

6.—The Press cuttings supplied to the Society during March Quarter, 1908, are now available for issue to Members. Any Member who wishes to have them should apply to the Hon. Secretary on April 30th, 1908. They will be given to the first applicant.

GENERAL MEETING.

The opening Meeting of the 43rd Session of the Aëronautical Society of Great Britain, was held at the Royal Society of Arts, John Street, Adelphi, on March 27th, 1908. The chair was taken by Major B. Baden-Powell (late Scots Guards).

The Chairman: The first paper this evening will be by Mr. Parsons. I have much pleasure in calling upon him to give us his paper.

Mr. W. B. Parsons, M.R.C.S., then read a paper entitled "Some Circumstances Attending the Rotation of Planes in Air, with Special Reference to Aërial Screws."

Deductions from Experiments

SOME CIRCUMSTANCES ATTENDING THE ROTATION OF PLANES IN AIR, WITH ESPECIAL REFERENCE TO AËRIAL SCREWS AND PROPELLERS.

A Paper read before the Aëronautical Society of Great Britain on March 27th, 1908.

By W. B. PARSONS, M.R.C.S., &c.

Mr. President, Ladies and Gentlemen,—In bringing before you the results of my experiments on the rotation of planes in air, it is but fair to say that they were undertaken two or three years ago, at a time when I was ignorant of the conclusions of other investigators and of the opinions prevailing amongst those who have the best right to speak authoritatively on the subject.

My experiments were undertaken more as a pastime than in any spirit of earnest aërodynamical investigation, and, as is to be expected under such circumstances, I spent a great deal of unnecessary time and trouble in investigating questions already definitely set at rest by the work of more accomplished observers. In so far as certain of such questions are capable of being completely answered by direct experiment, the information in regard to them is already in our possession, and where I find my results in agreement with accepted facts I will not trouble you with them. There are, however, certain questions in which I find myself unable to agree altogether with accepted authority, my own conclusions being in conflict therewith, and, also, there is a curious coincidence in the relation between the angle of inclination of a rotating plane and the velocity acquired under a constant force, which I can claim to have noticed, and which if it be found to obtain in the motion of larger planes impelled by greater powers than I have worked with, would form at once a simple and direct means of corelating angle and velocity.

Present endeavour to compass aërial sustentation and flight is directed towards the aëroplane as against the aërial screw. There is no doubt that the writings and experiments of Dines and Langley are largely responsible for the tendency, together, of course, with the practical results achieved and reported to have been achieved with the aëroplane. There are, however, signs that indicate that the aërial screw is beginning to receive its meed of attention, and our notice has been drawn to an important paper communicated to the French Academy of Sciences by Lieut. Vlahavos, of the Greek Artillery, which is a comparative study of aëroplanes and bladed air propellers. The conclusion is that the aëroplane has no advantage over the screw.

I think it may fairly be stated that everybody is agreed that we have in the aërial screw, driven by present-day engines, all that is necessary to accomplish aërial sustentation, and that the difficulties in the way of aërial navigation by means of screws to lift and propel are chiefly mechanical. But experiments in this field have been deplorably few. Our information is meagre and in some instances misleading, and much remains to be learned concerning the best form to be given to aërial screws, the proper area, velocity, and pitch, as well as the power required for sustaining or propelling a given weight in the air with a screw.

It has been my object to obtain some reliable information on each of the points referred to.

(After a brief account of aërodynamical principles connected with the subject, in the course of which Mr. Parsons referred to Duchemin's formula which reaches its maximum at 36°, and De Louvrié's rational formula with its maximum at 39°, Mr. Parsons continued:)

I will without further introduction proceed to describe the nature and scope of my experiments.

The photograph which I exhibit will serve to make clear the arrangement of my apparatus.

It consisted of an electro-motor, connected through lamps with a source of electricity.

The motion of the motor is communicated to a vertical spindle in ball bearings, upon the summit of which is a bed to accommodate the screw.

The screw is constructed of a shallow cup-shaped boss made of brass, to opposite sides of which are fastened holders for taking the blades used in each experiment.

The cup is intended to receive flat circles of brass, so that the weight of the screw could be increased when desired without adding to the surface of the blades. The blades are made of a framework of stiff wire covered with silk and, in form, are sectors of a circle.

Of these I had five pairs of different size carefully weighed and equalised. They could be firmly fixed to the boss at any desired inclination.

A spirit level mounted on the board carrying the motor and spindle ensured horizontality in working.

A circular scale of angles, situated in a convenient position and carefully adjusted so as to be level and vertical, enabled me to set the blades.

Within the uprights supporting the spindle can be seen a clockwork instrument which carries a running strip of paper about $\frac{1}{2}$-inch in width, and in a corresponding position on the other side a holder carrying a compressed tabloid of fuchsin. Attached to the spindle, but not seen in the photograph, is a pointed quill, which revolves with the spindle and, striking alternately the fuchsin and the running paper, records the revolutions of the spindle and so of the screw. The markings when made are so faint as to be hardly discernible, but upon wetting the paper they come up with surprising clearness and sharpness.

This recording arrangement is the outcome of many hours of fruitless labour. I had tried writing arrangements actuated by springs, by levers, electro-magnetically, and in other ways, only to find that whilst making very beautiful records of low velocities they were quite useless for higher velocities, owing to delay in the writing due to mechanical inertia and vibration.

Time was measured by means of a stop watch, and in some experiments by means of a writing metronome carefully corrected. In the case of a stop watch there is the disadvantage of the personal element, but a little practice in working and the repetition of a doubtful experiment were sufficient to neutralise any error on this score.

There is also to be seen in the diagram a stand bearing two pith balls depending by threads from arms movable along a scale, the use of which I will point out later.

Everything being in readiness, I set the motor in motion with the screw blades at right angles to the direction of motion, using for blades, sectors of 45° included angle, and I obtained a record of revolutions for that particular power of motor for 10 seconds.

I took similar records with the blades inclined at angles 80°, 70°, 60°, 50°, 40°, 30°, 20°, 10°, and 0° respectively, with the motor running under the same power and all connections undisturbed. I thus obtained a series.

The angle of inclination was confirmed after each experiment, and for one reason or another many experiments had to be repeated several times in order to obtain a complete series.

I took many score of series at different powers of the motor, but any series complicated by a necessary re-adjustment of machine was left incomplete or rejected altogether.

I was thus enabled to note the behaviour of the screw at different inclinations of blade, but under the same conditions of motive force and friction.

It is obvious that for any given power the only variable factor present is the inclination of the blades. The consequent variation in velocity is the expression of the air resistance for that inclination and velocity.

Desiring to maintain a mind free from preconceived ideas I studiously avoided consulting any authority on the value of air resistances, nor did I do so until the moment of preparing this paper.

As the most clear and simple method of exhibiting the variation is by means of a graph I have plotted the curve of a set of revolutions.

(These are reduced to angular velocities in feet per second for comparison with Wolff's table of wind pressures.)

Rev. ...	30	33	33	43	44	55	67	84	113	165

It is simple to at once detect and exclude any value which, by its position in the graph, is obviously incorrect.

Having obtained a curve which, upon a cursory glance, seems to belong to the conic sections, a figure one is naturally led to expect, I endeavoured to find a mathematical expression for it, but the finding of a curve which shall pass through a finite number of isolated points has an infinite number of solutions, because there is no restriction whatever on the form of the curve between those points.

The curve of lowest degree which can be drawn through the nine points is evidently one containing 27 constants and is of the 26th degree. To find it would involve an immense amount of useless labour, and as it is not calculated to advance the problem which I had set myself to solve I will neither attempt nor will I ask you to follow me in any solution of it.

I determined to resign a wearisome task, and turned my attention to the estimation of the best angle of inclination for the blades.

You will recollect that other things being equal, and consideration for the moment being withheld from any other factor, the resistance depends on the sine of the angle of inclination. I do not mean to say that it depends simply upon the sine, but it is certain that this is a factor of importance, and the inverted curve of the natural sines of the angles is the form that the graph should assume if this factor were free to act alone. I would like to make it quite clear that as yet I postulate nothing for the experimental curve of velocities. I merely refer it to quite arbitrary axes. This is, indeed, necessary in view of what I shall have to say later.

Plotting the curve of sines to correspond with the experimental curve it is easy to see the divergence between them, and by subtraction to find where the difference is greatest. It is obviously here that the product of the other disturbing factors is most in evidence.

It is here that the experimental curve is most forced away from the path which it would take if the only factor present were the effective surface of the plane, varying as the sine of the angle of inclination.

It is here that in proportion to surface the air pressure is greatest.

The greatest difference is seen to lie at about 22° of inclination.

This is, without any doubt, an unscientific, unmathematical, and altogether inexcusable process. It is nothing more nor less than a juggle.

I feel that an apology and an explanation is necessary. I have preferred to invert the curve of the sines in actuality on the graph and so preserve the reality of circumstance.

Without the statement that I have made it would be difficult to explain how I was led to choose this angle of 22°, for it was neither the result of chance nor of a direct examination of each inclination through 90 degrees.

It is, moreover, a deduction from a particular case, and cannot be made of general application.

Nevertheless, it is amply confirmed experimentally.

I fitted my motor with a brake upon the driving wheel, actuated by a micrometer screw, by which I was able to obtain the utmost nicety of adjustment of the power exerted by it.

I inclined the screw blades to about 22° and obtained the motive power which was just sufficient to raise the screw. I found this to be insufficient at 30° of inclination, or any higher angle, and insufficient at 20°, and by many repeated experiments I confirmed the conclusion.

I then substituted for the motor an arrangement of weights and pulleys by which to drive the screw. It was necessary to interpose at least six pulleys, and I did not find the method nearly so delicate as the former.

I found, however, that a weight which was just sufficient to cause the screw to rise with blades inclined at 22° was insufficient to lift it with blades inclined at 30° or at 20°.

Angle.	Current to Motor.	Braked.	Revols.	Position of Screw.
22°	32 c.p.	Yes	160	Mid-elevation.
30°	32 ,,	Free	—	Did not rise.
30°	37 ,,	Yes	117	Mid-elevation.
45°	37 ,,	Free	—	Did not rise.
45°	48 ,,	Free	123	Mid-elevation.

There is a circumstance particularly striking in the rising of the screw with the blades inclined at the various angles.

Much below 20° I was unable to get the screw to rise at all. At inclinations between 20° and 30° the rising of the screw was free, perpendicular, and even. Above 30° rising was irregular with much side to side rocking, and this irregularity increased with increase of inclination.

Whereas below 30° the screw rose smoothly and gradually, above that angle the rise was sudden and jerky.

At this stage of my experiments I substituted a hand-driven machine for the motor, and by its means I was able to obtain a much greater power. The screw in these experiments was free to rise to any height, and it was simple to throw it up in a vertical direction to the ceiling, with blades inclined between 20° and 30°, but when the inclination was greater the screw took an oblique path, the direction of which it was impossible to foretell. I did not continue these experiments as my screw had some narrow escapes from being damaged.

Circumstances now arose which led me to abandon my experiments for a time, satisfied that I had found nearly enough for practical purposes the best angle of inclination for the screw blades.

On resuming the investigation a year later in June, 1907, a careful scrutiny of the values between 20° and 30° led me to believe that an inclination of 21° was probably the point of maximum utility for lifting, and to form certain conclusions in regard to the curve of velocities the consideration of which I will defer for a while.

The next point to decide was whether or not the inclination should be varied from periphery to centre as is usual with propellers and fans of all kinds.

It is authoritatively stated that there should be a uniform total pitch for all parts of the screw, *i.e.*, a decreasing rate of pitch from the centre towards the outside.

The late Mr. Hastings, in a paper published in the Proceedings of the International Conference on Aërial Navigation, held in Chicago in 1893, suggests that if this principle be carried out that portion of the surface of the screw which is set at a greater angle than 35° (the maximum by Duchemin's formula) is peculiarly inefficient, and that the exposure of this portion of the surface should be avoided, and the central portion so shielded that no portion of the blades the angle of which is greater than that of maximum thrust should be exposed.

A large available surface is thereby sacrificed.

In the case of windmills the inclination of the sails is varied in order to allow of the more slow escape sideways of that part of the sail which is travelling slower than another, the impulse and velocity of the wind being the same at all parts.

There is no reason for supposing that in the case of screws the same considerations apply. Just as the angular velocity of a screw varies from a maximum at the periphery to zero at the centre, so does the wind produced by it vary in the same proportion from periphery to centre, and there is no *prima facie* reason for supposing that an inclination which is best at a particular velocity is not best at any other velocity.

My experiment to decide this question was as follows: —

I procured a pith ball and suspended it by a strand of silk from an arm attached to an upright, in such a position that I could successively bring the ball over any desired portion of the blade while in revolution, and by means of a scale along which the arm moved freely I could read its position in regard to the moving blade at any moment.

The arm also carried a vertical scale of angles by means of which the deflection of the pith ball occasioned by the draught could be measured.

I found the point of maximum pressure to lie over a section of the blade $\frac{5}{8}$ of the distance from the centre. This was to be expected, seeing that at this spot the blade was widest, but what I did not expect to find was that, whereas the pressure on the pith ball seemed to decline gradually as the ball was moved nearer to the centre, it fell very suddenly as the ball was moved further out from the maximum point, and became lost opposite the extremity of the blade. There is, therefore, an area in the blade of a revolving screw, which, compared with the centre of pressure and the rest of the surface, is a very ineffectual area, an area that might be sacrificed without much loss to the effective power of the screw.

The inclination of a blade at this point could be reduced as low as possible without sacrifice of power. The gain of a smaller inclination at the extremity is incalculable seeing it is here that the velocity is greatest and the effective surface least.

I will refer to an accident which befell at an earlier stage in my experiments, which, indeed, led me to make the experiment just described.

In attempting to affix with sealing-wax a writing point to the extremity of one of my screw blades (a method of recording velocities which I subsequently discarded in favour of the plan described above), I brought the flame of the spirit lamp too near the silk covering, with the result that the sealing-wax, catching fire, a hole was burned in the extremity of one blade.

It was inconvenient to replace the covering that day, and as I was about to record the number of revolutions necessary to lift the screw, I proceeded with the trial, making several records.

I obtained as a result from 90 to 100 revolutions per 10 seconds. After the repair of the blades I was never able to raise the screw under 120 revolutions in 10 seconds.

I should refer in this place to Professor Langley's observation, of which I was then unaware, viz., that holes may be cut in the planes without reducing the aggregate pressure in proportion to the surface cut away.

The conclusion, then, is that although there seems no reason for altering the inclination of the srcew blades from the point of maximal pressure towards the centre, the advantage of lessening the inclination from the maximal point peripherally is incalculably great, and that this should be done as sharply as mechanical possibilities will allow.

The next question has regard to the area of the blades. In a very instructive article on fundamental principles, by Rankin Kennedy, contained in the "Aëronautical Journal" for January of this year, it is pointed out that the energy required to lift a pound weight in air by means of a screw is not a fixed quantity, but depends on the speed of revolution and the weight of fluid acted upon. There is no limit to the variation of these terms in theory, but in practice the area of the propeller blade soon becomes unmanageably large when the speed of revolution is kept low, and with much increased speeds the waste of energy becomes prohibitive. There is a middle course and a best area for a given power.

For a decision on this point I had constructed five pairs of blades.

A pair of semi-circles.
A pair of sectors of included angle 120°
A pair ,, ,, ,, 90°
A pair ,, ,, ,, 60°
A pair ,, ,, ,, 45°
all having the same radius.

The semi-circular pair were useless. They tended to make the screw behave as if it were two attached planes to tilt up one side immediately it commenced to revolve, after which the screw would not regain a horizontal position, but remained in a condition of great instability.

Results obtained with the other surfaces are as follows: —

Sector.	Area (inch²).	Weight (Grns.)	Added Weight.		Power	Proportion of Circle of Revolution.		
120°	38·72	576	Nil.	Total Weight Carried, 576.	Constant, 56 C.P.	—	Circle of Revolution, 82·46.	1
90°	21·66	518	28			·38		2
60°	18·90	548	28			—		3
45	11·20	448	100			—		4
45°	11·20	448	28	476		—		5

Remarks: —

1.—Does not rise.
2.—Remains suspended.
3.—Does not rise.
4.—Does not rise.
5.—Just rises and remains suspended.

So that it will be seen that of these areas the most effective is one which fills a little more than one-third of the area of the circle of the screw, which agrees well with Wenham's estimate. It will also be noted that the use of a sector of 45° included angle required the same power to lift and keep suspended a screw 100 grains lighter than that provided with blades of area $\frac{1}{3}$ of the circle, the area in the former case being about $\frac{1}{7}$ of the circle of revolution.

(It should be explained that the sector whose included angle is given has reference only to the blade and not to the circle of revolution, whose diameter is considerably greater.)

The next question for decision is the number of blades over which the most effectual surface should be distributed. To make direct experiments would have entailed a complete re-construction of my screw and spindle, an undertaking that I did not consider worth while, as I have from other data concluded that a two-bladed screw is the most effectual. I am well aware that a three-bladed screw has been recommended, but I have not heard a satisfactory reason given for its use. On the other hand, it has been found that multiplicity of blades tends to inefficiency of action.

In Sir Hiram Maxim's experiments in the propulsion of inclined planes it was found that a two-bladed screw gave the best results.

In the Copenhagen experiments it was shown that not only would the aërial propeller develop as great a thrust as the water propeller in proportion to the energy consumed, but that under certain conditions it would do slightly more, and greater thrusts per horse-power were obtained than in any previous experiments. A two-bladed screw was used which was calculated to do work equal to 63 per cent. of the energy imparted to it, and it was further noted that the power was augmented in 75 per cent. of the directions from which the wind could blow.

Professor Langley, in some experiments for arriving at the power available for moving his planes, used a six-bladed propeller with blades set at 45°, and also tried propellers of four and eight blades, but discarded them in favour of an aluminium propeller of two blades set at an angle of 75° with the axis.

It is reported, with how much truth I am, however, unable to say, that the battleship "Cæsar," when examined in dock at Devonport, was found to have lost one of the blades of the starboard twin screw. The mishap was by no means recent, the main engines had been run since the breakage happened, yet nothing in the action of the machinery gave any indication of it. An incident is recalled of the battleship "Renown," which made a record passage from Bermuda to Devonport at an average speed of more than 15 knots. When docked on arrival it was found that she had performed this feat with one propeller blade knocked away, yet there was no loss of driving power or increase in the mean slip of the screws.

When in my experiments it became necessary to allow the screw to rise off its bed, and I was registering revolutions directly from the screw blade, I was compelled to seek a means which would be uninterfered with by the rising screw.

I adopted the plan of fixing a light wooden pointer to the bed of the screw, the pointer projecting beyond the blades and at right angles to them and nearly in the same horizontal plane.

When everything was ready, and my motor working braked down to the previously ascertained lifting point, the screw did not rise.

In seeking for the cause I inadvertently brought my hand into the path of the revolving pointer, with the result that the pointer broke off short, and the screw immediately rose.

Thinking that the weight of the pointer might have reduced the motive power below the lifting point, I substituted for it a short file many times heavier than the pointer when on setting the motor in motion the screw rose despite the additional weight.

I then fashioned and fixed another pointer, and again found the interference present.

I repeated this experiment many times with the same result, but on the following day I failed to produce it several times, and several other times I succeeded in reproducing it.

It seems that the presence of the pointer in the path of the blades and at right angles to them in some way seriously interferes with their effectiveness, the interference occurring in a space of very limited vertical dimension.

I have devised some experiments for investigating this most curious circumstance, but I have not yet had an opportunity of carrying them out.

It is, however, sufficient to indicate, and I think the conclusion may fairly be drawn that a third or fourth blade, occupying as it would be certain to do, this critical position in the path of revolution, would insomuch detract from the effectiveness of the propeller.

The next question for investigation was the nature of the surface. I remember having heard, although I cannot recall from whom or when, an observation that seems full of significance. A bird that had just passed through a thick column of smoke was brought down and an examination of its wings revealed particles of soot between contiguous feathers. It was clear that during flight the air had passed through the spaces between the feathers.

The consideration of this fact led me to try an imbricated surface for the blades of the screw with the following result:—

A plane surface required 120 revolutions per 10 seconds, whereas an imbricated surface required a much greater speed to lift the same weight and size of screw.

A reference should find a place here to Professor Langley's experiment in which he found that inclined planes may be superposed without diminishing the sum of their separate individual pressures, provided they be not too close, but even in this case the amount of interference will vary with the speed.

With a hole cut in the covering of each blade just outside the point of maximum pressure I obtained a distinctly better result in the power required to lift the screw, and there was little if any difference between the power necessary at 22° of inclination and that necessary at 30°, but on enlarging the holes there was a distinct falling off, and I was led to conclude that there is no superiority in a screw with holes in the blade over one with the inclination beyond the point of maximum pressure lowered, as I have already explained.

This leads me to an observation on the occurrence of "bulging."

Although there is little that is common in the action of windmills and aërial screws, there is this in which they agree. They both depend for their action on the pressure of the air upon surfaces inclined obliquely, and the circumstances which are in operation in the one case to produce a point of maximum effect are the same in the other case.

The best angle of inclination in both cases should, therefore, be the same if what I hope to show in regard to the law of air resistance be true.

That the best angle of inclination for the setting of windmill sails is not 22°, but a much lower one, 18°, is amply proved by the experiments of Smeaton and all who have followed him.

I attribute this apparent discrepancy to the occurrence of bulging in the windmill sail, and I have confirmed my opinion experimentally.

With the silk covering of one blade slack and of the other taut, I found it necessary to incline the slack blade at about 15° whilst the other remained at 22° in order to obtain an even rise of the screw, and to compensate for the bulging.

With both frames at 22° there was considerable side to side rocking, which always occurs with unequal inclination of the blades, particularly at the higher angles.

I next tried the effect of a porous surface, thinking that the resistance to the passage of air through numerous small holes might be enough to compensate for the loss of area incurred, whilst at the same time there would be a gain in lightness of the blade, but my supposition was not borne out as I found these blades much inferior to any I had previously used.

Corrugation of the surface is a means for increasing the area without increasing the radius of the screw, and is supposed to be of use in reducing skin-friction.

Professor Langley has pointed out that skin friction as an accompaniment of the movement of planes in air is largely imaginary, and Sir Hiram Maxim found it to be a quite negligible quantity. I have, therefore, no reason for supposing that a corrugated surface is likely to prove superior to a plane surface of the same extent, but I did not experiment with it.

In a work recently published Mr. Lanchester has called in question Professor Langley's statements in regard to skin friction, and states that an allowance of 2 per cent. should be made on account of it.

To decide the velocity with which the screw must be revolved and the power required to lift it, it was only necessary to make an estimation of the force expended in terms of H.P. whilst the screw was at what I may call the middle elevation, *i.e.*, neither rising nor falling.

It was easy to obtain any desired rise within the limits of my safety catch and maintain the screw indefinitely at that height by regulating the speed of the motor to a corresponding degree.

For velocity, the results with stop watch and with metronome are subjoined in the table, the blades being inclined at 22°, the best angle.

Weight of Screw.	Time.	Revolutions.	Power.	Remarks.
448 grs.	20·5 200m	80 13 per sec.	8 lbs. 10 ozs. Over 6 pulleys	— —
—	20 sec.	240 12 per sec.	Motor	Just lifted.
—	20 sec.	360 18 per sec.	Motor	Well up at top.
—	20 sec.	304 15·2 per sec.	Motor	Well sustained.
548 grs.	10 sec.	137 13·7 per sec.	Motor	Mid-elevation.

Wenham found a force of 60-foot pounds per minute requisite to raise 396 grains, or in the ratio of 3-H.P. for every 100 lbs. Experiments on a larger scale have demonstrated that one H.P. can sustain a weight of 33 lbs., which agrees very well with Wenham's estimate. I am not acquainted with the details of these experiments, nor can I say what was the inclination of the screw blades or the pattern of screw used.

It is well known that the calculation of forces expended upon models of the dimensions of my screw are likely to be inaccurate however carefully done, but the error is usually in excess of power. Practical engineers state that a model of a machine which will yield but 20 per cent. of the power expended upon it will usually yield 70 per cent. when made up in full dimensions.

I put forward my estimation with some hesitancy on account of the large probable error, but in view of the fact just stated, with less concern than otherwise.

Comparing it with Wenham's estimate it shows a marked advantage.

Having obtained the power necessary to lift and maintain the screw at middle elevation, by braking down the motor to the proper degree, I removed the screw from its bed, leaving all other connections undisturbed, and made an estimation of the power by means of weights hanging over a pulley on the driving wheel.

The figures are as follows:—

Power Estimation.—Blades .38 of area of circle of revolution, inclined at 22°.

Revolutions of screw at mid-elevation	No.	137
„ „ Motor weighted	No.	178
Diameter of pulley	ins.	0.9
Time	secs.	10
Area of blades	s. ins.	21.66
Load on spindle (diff. of weights) ...	grains	1620
Weight of screw	grains	543

Space travelled over = 17·8 × 9 II ins. per sec.

Work = 17·8 × 9 II × 1620 × $\frac{60}{12}$ gr. ft. min

$$\frac{548 \times 33000}{17{\cdot}8 \times {\cdot}9\,\text{II} \times 1620 \times 5} = 46.45 \text{ lbs. per H.P.}$$

Log.

		.497,149
2.738,781		1.250.420
4.518.514		1.954,243
7.277,295		3.209,515
5.610.297		.698,970
1.666,998	Log. 46.45	5.610.297

I also undertook several experiments to determine the condition of the superincumbent and underlying air, and the direction of air currents, during the revolution of the screw both when held down and when free to rise.

Experiments with a pith ball suspended vertically above the centre of the screw showed that the air above the reversed screw was twisted into a cone the base of which occupied the path of the screw, and the apex varied with the inclination of the blades.

At 90° and 80° the pith ball suspended a radius' distance above the screw was unaffected, at 70° it began to oscillate slightly, at 60° the ball described a circle of $\frac{2}{10}$ inch diameter, at 50° this reached $\frac{4}{10}$ inch, at 40° $\frac{5}{10}$, at 30° 2 inches, at 20° $\frac{14}{10}$, and at 10° it fell again to $\frac{4}{10}$.

The screw is apparently lifted up in a veritable whirlwind. I would draw your attention to the fact of the maximum effect between 20° and 30° of inclination, the force of the draught bearing a similar relation to the angle of the blade as in lifting, a further confirmation of the superiority of this angle.

It has been pointed out by writers of authority that there is much confusion of mind prevalent in regard to screws when used as fans and when used as propellers, the most effective propeller being that which produces the least disturbance in the fluid in which it operates and the most effective fan that which produces the greatest.

If a screw were free to move in a resisting fluid without slip the effect of revolving it would be a motion through the fluid of the screw, but if the screw be restrained from advancing the result is a motion of the fluid and total slip of the screw.

If the screw have any work to perform it is to that extent fixed, and in that proportion will it slip.

It does not follow that the slip at every inclination of blade will be the same. If the screw revolve at such a velocity that the time of one revolution is equal to the time of one slip, it is clear that the screw will not advance at all, but if the screw be made to bite faster than it can slip it must progress. It does not follow that the biggest bite is the best. At a given power there is a very definite relation between the bigness of the bite and the quickness of it. It is inverse, but not in simple proportion, there is a maximum and a minimum point, the maximum lying as is shown at about 22° of inclination. The nature of the relation I hope to deal with presently.

In the Copenhagen experiments a very curious circumstance occurred in which what is called negative slip was demonstrated.

At a speed of 70 revolutions per second the screw rose between 30 and 100 feet in height in the air in less than a second, when, according to pitch (which was 1 foot), it should have required one second to reach this height if there had been no slip at all.

It is clear that the screw was lifted up by some force in addition to that obtained by its revolution and reaction against the air. It may be, and possibly is, that at such velocities as 70 revolutions per second other factors come into account which have no place at a more economical speed.

There is a prevalent notion that when a screw rises in air it, as it were, compresses the air below it and sucks in the air above, the diminution of pressure above and the increase of pressure below combining to lift it. This view is, indeed, strengthened by the Copenhagen experiments, H. C. Vogt stating that "propellers both in air and water do their work by causing a rarefaction, *i.e.*, by diminution of pressure or partial vacuum on the drag or rear side of their blades," nearly the whole thrust resulting from this rarefaction, which amounts to a difference of pressure of several *inches* of water.

Again also it may be that these occurrences take place at such high velocities as 70 revolutions per second, but at the velocities at which I have worked this does not obtain.

I introduced one end of a mercurial manometer into the air space both above and below the revolving screw (velocity of about 20 revolutions per second) whilst the other end was sufficiently far removed to be outside the area of influence. I was not able to detect the slightest difference in pressure. Seeing that by simple suction with the mouth I could cause a very considerable inequality in the heights of the mercury limbs, I am forced to conclude that there is no actual inequality in these pressures at velocities somewhat in excess of those sufficient to lift the screw.

We know that cavitation occurs in water propellers, and it is not permissible to deny cavitation in air propellers, but the statement that an air screw is lifted up by cavitation and suction due to centrifugal force as concluded from the Copenhagen experiments I am in a position to oppose.

My next experiment was to revolve the screw completely enclosed in a large bell-glass. Within the glass were a number of very small feathers which, being caught in the current of air, indicated its form and behaviour.

With the screw inverted the feathers swept round the walls of the bell-glass, but a few of the heavier were not immediately caught up, but, gaining a position beneath the blades, were rapidly drawn towards the centre and, being then entangled in the current, were whirled round with the rest.

The experiment was complicated by the fact that the air, being confined, was reflected from the floor and walls of the chamber, and although it clearly showed the form of the whirlwind created by the screw, I am not prepared to draw any useful conclusion.

I now ask your attention to the "curve of velocities."

Being tempted during the long evenings of the winter of 1906 to re-examine the curve and seek a solution of it, I tried at random many formulæ, and in despair sought to see how it would agree with a simple Harmonical Progression (*i.e.*, a progression of reciprocals).

I took the series beginning at 30 revolutions and ending at 165, and inserted eight harmonical means between them. I found the progression approximate closely with the figures obtained by experiment (as you see).

Considering the many sources of possible error, remarkable as this approximation was, I could only set it down as a coincidence.

I examined several other series of revolutions, and determined suitable harmonical progressions, being limited in my first and last terms to those obtained on the machine. I was surprised to find the closeness of agreement between the figures calculated and those obtained by experiment. The plotted harmonical curve seems to hug the curve of velocities.

I then obtained a record of revolutions at 90° of 40 in 10 seconds and one at 30° of inclination of 90 revolutions and constructed the following H.P. neglecting fractions:—

40, 44, 49, 55, 63, 70, 90.

I set the blades of the screw at 60° and took a record, using the same power of motor and preserving as far as possible every condition unaltered. Judge of my satisfaction to find the count number 55 revolutions in 10 seconds, as foreshadowed in the progression.

To further confirm this most singular coincidence, for such I must continue to call it, I set up an arrangement of weights and pulleys wherewith to actuate the screw, and obtained the following records:—

36	x	43	46	x	58	72	84	x	x
90°	80°	70°	60°	50°	40°	30°	20°	10°	0°

My writing arrangement was not working well, for the new setting up of the apparatus led to a great many annoying complications and necessary adjustments. The records for 80° and 50° were unreadable, and those for 10° and 0° had to be rejected as untrustworthy, owing to limitation of space in the room, which was too small to permit of the use of enough string at the higher speeds, and if a shorter string were used the fall of the weight was noticeably accelerated, which, of course, could not be allowed.

Taking 84 and 36 as fixed points in my H.P., I obtained a series

36, 39.19, 43.01, 47.66, 53.44, 60.81, 70.54, 84,

which agrees very well, despite the many difficulties encountered.

I therefore felt justified in assuming that the velocities of revolving inclined planes bear a harmonical relation, when the angles of inclination are in arithmetical progression.

It was necessary to find a curve such that this relation will hold true whatever may be the common difference and for all magnitudes of the first term.

If the expression for the curve be

$$y = \frac{1}{f(x)}$$

and y_1, y_2, y_3 be the ordinates corresponding to the abscissæ $(x-h)$, x, $(x+h)$, then since the ordinates are in H.P.

$$\frac{1}{y_1} + \frac{1}{y_3} = \frac{2}{y_2}$$

$$\text{or } f(x-h) + f(x+h) = 2f(x),$$

and this relation must hold good for all values of x and h.

By Taylor's theorem this is equivalent to

$$2\left[f(x) + \frac{h^2}{\underline{|2}} f''(x) + \frac{h^4}{\underline{|4}} f''''(x) + \text{etc....}\right] = 2f(x)$$

giving

$$f''(x) = f''''(x) = \text{etc.} = 0$$

These are all satisfied if $f''(x) = 0$ and this condition is necessary since the above relation is to hold for *all* values of h.

Now if

$$\frac{d^2f}{dx^2} = 0$$

$$f(x) = ax + b$$

and this is the only possible form for f(x).

Consequently,

$$y = \frac{1}{ax + b}$$

is the only expression for the curve defined as above (where a and b are arbitrary constants.)

The form of the curve could have been easily seen to begin with, but without the functional investigation it would not have been so easy to see that it is the only possible relation between x and y satisfying the given conditions.

It is unfortunate that this does not involve a trigonometrical function.

The figure is obviously a rectangular hyperbola, and it is interesting in relation to Marriott's law of gaseous pressure and density.

The expression found is based upon the assumption of the relations in Harmonical Progression which the velocities assume when the angle of inclination of the planes varies in Arithmetical Sequence.

The variation is seen to prevail in direct experiment, and if the values be not exact they, nevertheless, approach the truth so closely as to make the difference of no practical moment.

It now becomes of interest to enquire if the angle of maximum effectiveness can be found mathematically.

Consider the cases

$$y = \frac{1}{ax + b}$$

$$y = \frac{1}{\sin x}$$

and find the stationary value of the expression.

$$\frac{1}{\sin x} - \frac{1}{ax+b}$$

$$\therefore \frac{\cos x}{\sin^2 x} = \frac{a}{(ax+b)^2}$$

$$\text{or } (ax + b)^2 \cos x = a \sin^2 x$$

$$\text{or } \left(x + \frac{b}{a}\right)^2 \cos x = \frac{\sin^2 x}{a}$$

In the progression 30 to 165

$$\frac{b}{a} = 20 \qquad \frac{1}{a} = 3300$$

$$(x + 20)^2 \cos x = 3300 \sin^2 x$$

If these curves be plotted they will be seen to intersect between 68° and 70°.

By means of tables it will be found

when $x = 68^\circ$ $(x+20)^2 \cos x > 3300 \sin^2 x$
when $x = 69^\circ$ $(x+20)^2 \cos x < 3300 \sin^2 x$

showing that the root of the equation lies between these values.

In several other cases examined, the root is not far from the same value.

It seems to be probable, therefore, that the angle of maximum efficiency is not a fixed and definite inclination, but that it varies between very narrow limits, the variation depending upon the value of the constants *a* and *b* in the expression

$$y = \frac{1}{ax + b}$$

There can be no doubt that there is a relation between *a* and *b*, but the particular values examined have as yet afforded me no clue to it, and it is also probable that the angle of maximum efficiency and the relative value of the two constants are dependent and continuous variables.

I hope on a future occasion to be able to communicate a statement on the point if my conjecture be correct.

The conclusions at which I have arrived may be briefly summarised as follows: —

I.—The power remaining constant the greatest effect is produced when the blades of a screw, which is to be used for propelling or lifting are inclined at an angle near about 22° to the direction of motion, provided the blades be constructed of a rigid plane substance.

II.—If the blades be shaped as small sectors of a circle the point of maximum pressure at any velocity and inclination lies close to a point $\frac{5}{8}$ of the distance from the centre. From this point the pressure gradually declines towards the centre, but falls very rapidly towards the circumference.

Consequently the inclination of the outer sixth of the screw blade should be rapidly reduced from 22°, the amount of reduction depending upon the strength and nature of the material.

III.—The amount of surface of the screw blades should be about one-third of the area of the whole circle of revolution, and preferably less than more.

IV.—When screws are to be used for purposes of lifting or propelling, the best effect is produced when they are two-bladed, but when the available power is large and the screw is to be used for propulsion of air, or if the screw be actuated by a wind, a larger number of blades is an advantage.

V.—Other conditions being equal a plane, smooth surface is better than a perforated or imbricated surface, but in regard to concavity of the blade I am not prepared to offer an opinion.

VI.—When the blade of the screw is subject to "bulging" the angle of inclination should be proportionately lessened in order to allow for it.

VII.—The power required to raise and keep suspended an aërial screw is at the rate of 46 lbs. per horse-power.

VIII.—The difference in pressure above and below a revolving screw is potential, and at economical velocities there is no actual existing difference which is detectable.

IX.—The resistance offered by the air to a revolving plane inclined obliquely to the direction of its motion varies with the angle of inclination in such a manner that the velocities attained are in Harmonical Progression when the angles of inclination are in Arithmetical Progression and the relation is expressed by the formula

$$y = \frac{1}{ax + b}$$

where x is the angle of inclination.
y is the velocity attained (in revolutions);
a and b are Arbitrary Constants depending upon the power used to produce the motion of rotation

What is it, gentlemen, that stands in the way of a large scale endeavour to compass artificial flight by means of screws to lift and propel?

It is difficult to believe that it is the want of money, so small a sum as would suffice. The uncertainty of a return for outlay is the much more likely reason. The want of precise knowledge as to the dimensions, shape, pitch, and other qualities of the screw which will give the greatest effect for the least expenditure of power.

So long ago as 1842 it is reported that Mr. Phillips succeeded in raising into the air an apparatus weighing in the aggregate 2 lbs., by means of revolving fans with blades inclined at an angle of 20° from the horizontal.

I would ask you to notice this degree of inclination which was no doubt fortuitous, as it is only incidentally noted in the report.

"All being arranged the steam was up in a few seconds, when the whole apparatus spun around like a top and mounted into the air faster than any bird." This is the description of an eye-witness. It is stated that the apparatus afterwards fell and was broken, and there is no record of a repetition of the experiment.

I cannot conclude without an acknowledgment of help from others, without expressing my thanks to Mr. George Thompson, of Campbell College, Belfast, for his mathematical assistance, to Mr. I. Smith Bunney, who has at various times made for me the apparatus I have required, and to you, sir, and gentlemen, for so patiently listening to me.

TABLE OF VELOCITIES AND INCLINATIONS.

	Date.	0°	10°	20°	30°	40	50°	60°	70°	80°	90°	
1	15 May, 1907	—	—	—	129	—	90	70	57	57	—	Revolutions per 10 seconds
2	14 ,, ,,	—	153	137	95	87	64	58	54	54	51	,,
3	15 ,, ,,	136	132	100	82	—	72	66	56	51	50	,,
4	14 ,, ,,	112	104	84	68	62	58	48	39	34	34	,,
5	26 ,, ,,	165	110	84	67	55	44	43	33	33	30	,,
6	30 ,, ,,	—	—	—	106	—	—	75	—	—	—	,,
7	30 ,, ,,	—	186	141	—	—	—	—	72	—	69	,,
8	May, 1906	167	120	89	—	56	—	43	—	33	30	,,
9	—	164	—	87	—	53	—	43	—	—	—	,,
10	—	160	—	86	6	—	—	—	—	—	—	,,
11	—	167	—	—	60	—	—	—	—	—	—	,,
12	15 May, 1906	172	120	74	54	48	35	33	33	32	29	,,
13	do.	—	125	77	58	47	40	33	33	32	29	,,
14	do.	142	110	81	59	51	43	38	—	—	—	,,
15	6 June, 1907	168	—	84	72	60	—	46	43	—	—	,,
16	do.	—	—	84	72	58	—	46	43	—	—	,,
17	17 June, 1907	—	—	121	80	59	—	37	32	29	—	,,
18	do.	—	—	134	—	84	72	64	53	46	—	,,
19	do.	210	142	135	92	84	72	64	53	42	40	,,
20	do.	35·35	26 71	21·36	17·89	14·68	11·74	11·48	8·81	8·81	8 27	feet per second at periphery
		35 35	26·18	20·46	16·90	14·39	12·54	10·82	9·96	9·04	8·29	Harmonical Progression

The CHAIRMAN: Would any gentleman like to ask any questions, or to make any remarks on this paper?

Colonel CAPPER: I should like to ask the lecturer whether he tested the area of the screws—the proportion of the area of the air blades to the total area of the whole screw circle; whether he also went into the question of the velocities. He gave us figures, I think, that showed that with area of blades 11 per cent. of that of whole circle you get a screw lifting itself, but the lift for a given power was greater when you had about 33 per cent.—I am not sure of the exact figures. I should like to know whether he also took the velocity of the screws—the larger area screw as compared with the smaller area screw, when each was lifting itself. I think that is a very interesting thing to note.

Mr. WOOSNAM: A point I should like to ask very much is with reference to the number of blades in a propeller. I take it that the maximum proficiency would be obtained if it were possible for each propeller blade to act upon virgin air. I should like to ask whether Mr. Parsons has taken into account the difference that the propeller blades would encounter when moving through the air, that is to say, were his experiments carried out with a propeller blade that was stationary? If the propeller is revolving and is at the same time moving forward, the air has a greater chance of being less disturbed, even if there were a greater number of blades. I do not know if I make my point clear. When a propeller is revolving at a high number of r.p.m. and is fixed in the same spot, although cavitation may not occur, yet there must be a tendency towards it, but if the propeller is also moving towards undisturbed air at a rate of 40 or 50 miles per hour, this tendency to cavitation must be reduced, for there is a greater inrush of virgin air to be handled by the blades. Therefore is it not possible that although a four or six bladed propeller is not so effective as a two-bladed one when stationary, yet the greater number of blades might become more effective as the velocity of the aërodrome increased.

Mr. CLARKE: The lecturer, in mentioning one formula, viz., that of Duchémin, gave the maximum lift as at 36 degrees. Should not this maximum be at 26 degrees? I happened to go into this matter a little while ago. I saw in one of Major Baden-Powell's papers that at a given speed the maximum lift for a plane was at 26 degrees. This also agreed with Langley's results. Working out the above formula it also gave its maximum lift at 26 degrees. This also, I think, works in very well with the lecturer's results, in which he said that between 22 and 30 degrees he got some of the best values of the inclination. In that case it looks rather that the lecturer has given us a new formula of the relations between the velocity and pressures which seems to agree for propellers even better than that of Duchémin.

Mr. Parsons: In response to Colonel Capper, I may say I did measure the difference. I took the area of the screw blades in regard to the whole circle of revolution, and 0.3 refers to that proportion; that is to say, that the most effective area to use is such as would occupy one-third of the whole circle of revolution, not merely of available blade area. In regard to the velocity of this larger-area screw, I have had to pass it over rapidly, but I intended to say that I got a velocity of about 13 revolutions per second at 22° of inclination, which, reduced to angular velocity, brings it to 29.30 feet per second, equal to a pressure of about 1.901853 lbs. per square foot.

80 revolutions in $\frac{20 \cdot 5}{200}$ minute (metronome) = 13.01 per second
= 29.30 ft. per sec., angular velocity at centre of pressure.
Pressure = 1.90 lbs. per sq. foot (Wolff's table)
on 0.6498 sq. ft., the area of the surfaces of my blades.

In response to Mr. Woosnam, Professor Langley makes a great point of that (propeller blades striking virgin air). He speaks of the plane encountering new fields of air which have not had their inertia disturbed.

A good deal is also made of that point by Mr. Lanchester in his theory of peripteral zones, but I have not had time to go into it, as this book has been so recently issued from the press. My experiments were made with the propeller fixed, except in so far as it was able to rise to the extent of three or four inches. (It was held down by safety catches, except in those experiments of throwing it up to the ceiling. I did not go on with them because they did not lead to any definite result.) In regard to the others it was a question of finding out the least power which could lift a given weight, of finding out the best area, of loading up the propeller to the greatest weight which a particular power was capable of lifting, and of inclining the planes at that angle which would cause the screw to be lifted up with the least power and greatest weight.

In answer to Mr. Clarke, I may say that I am not responsible for the statement that 36° is the angle of maximum efficiency in the Duchémin formula. It may be an error of transcription. I have not estimated it. On the other hand, the other formula that I gave you, that of De Louvriè, is stated to agree very well with this emperical formula, and it is stated to attain its maximum at 39°. I do not feel inclined to say it is not 26°, especially if the gentleman is speaking from the Smithsonian publication of Langley's work. In the book from which I have copied there are several misprints which I have noticed at one time and another. However, I am not prepared to contradict Mr. Clarke, sir.

The Chairman: I am sure that we have all been interested in this very valuable and technical paper. This subject of screw propellers and the really scientific explanation of their action is one which we badly need to have carefully considered and discussed, and I am sure that this paper is a most valuable contribution to our knowledge of the subject. I must make one remark after what Mr. Clarke said about my little experiments because in those trials I rather think—I am only speaking from memory—but I think I made 15 degrees as the most efficient pitch for lifting propellers. But at the same time I do not wish to lay any stress on that, because my trials were not very accurately carried out, and the means I had at my disposal were not sufficient to make very accurate tests, so that when I put 15 degrees down as being the most efficient angle for a propeller I couldn't say within a good many degrees whether it was really best or not—only somewhere about that. There is one other remark I should like to make about the number of blades in a screw propeller to lift. I rather think I showed in this very hall some years ago a little propeller that I made with only one blade. It seemed rather absurd to have only one blade to a propeller, but this little instrument with twisted india-rubber was able to rise to the ceiling, showing the efficiency of the arrangement. Of course, having only one blade it was badly balanced, and I have no doubt that if constructed on a large scale it would give an uneven and wobbling effect—but it was an interesting result. Well, I won't detain you any longer, but I am sure you will accord Mr. Parsons a vote of thanks for the very able and interesting paper he has given us to-night. (Applause.)

The Chairman: I will now ask Mr. José Weiss to read his paper on the "Aspects of Sailing Flight."

Mr. José Weiss read the paper.

Aspects of Sailing Flight.

By Jose Weiss.

In my paper about "Starting Methods," which appeared in the last issue of the "Aëronautical Journal," I pointed to the fact that one of the reasons why the aëroplane of the future is not likely to start unassisted from the ground is that the power required for starting is much in excess of that required for actual flight, and that, consequently, if we have to carry on board an engine strong enough to raise our machine by running it on the level ground, that machine has to be much stronger, heavier, and larger than is necessary for carrying any specified weight. We fall into a vicious circle. The high figures of the Farman aëroplane are a good illustration of this fact. To carry one single man we have here a machine reaching a total weight of 1,200 lbs. and a 50-h.p. engine.

The reason of this lies in the general principle of sailing or gliding flight, which, in a nutshell, is about this: In the sailing bird or in a properly made glider, the main portion of the motive power is derived from the weight, the trajectory produced by the weight in following the path of least resistance depending entirely on the perfection of the aggregate features of the bird or glider. If we assume, for instance, in a perfectly balanced glider, the resistance to horizontal penetration to be equal to O, and the lift, that is the resistance to vertical fall, to increase with the speed, the result must be perpetual motion in the horizontal direction. Now, these are the very conditions which obtain in the sailing bird; we have a form which offers no appreciable resistance to penetration; we have the lift increasing with the speed; and we have also the resulting virtual perpetual motion which we observe daily.

I have often seen my own roughly-made motorless gliders, when at their best, reach in calm air 3° and even 2° from the horizontal, and in ascending currents they frequently rise to a considerable height whilst travelling against, or circling in, the wind, exactly in the same manner as a bird. A snapshot, which you will see presently on the screen, shows one of these successful glides. What wonder, then, that the sailing bird, in which every feature is absolutely perfect, and which has a living balance, should reach, in "falling," a line of flight which is practically the horizontal. It is obvious that the power required to reach the horizontal absolutely becomes, in this case, infinitesimal. In nature, such additional power as may be wanted is easily supplied by the least ascending currents, of which the bird takes every advantage, and so it is that it sails indefinitely, without expending the least power, as the mere result of gravitation. The supposed mystery of the beautiful ascending orbs of the larger sailing birds is thus fully explained. Whenever these ascending orbs are observed it is on a more or less windy day, and invariably on the wind side of the hills, or above a group of trees or other large object capable of producing an ascending current. Never, during years of observation, have I witnessed these orbs over the lee side of the hills, and unless the wind and the nature of the ground below were such as to account for the existence of ascending trends. If, then, the falling rate of the bird or glider be less than the ascending rate of the wind, the result must be that apparently paradoxical, but, nevertheless, very natural, fact that the bird or glider is falling while actually rising; that is to say, it is falling in relation to the supporting and ascending air, but is rising in relation to the earth below.

Once we thoroughly understand this, we can well realise why it is that the larger birds have such difficulty in starting flight, and why also a one-man aëroplane, weighing 1,200 lbs., requires no less than 50-h.p. to start unassisted from the level ground. It is because the weight does not come into play as motive power until the bird or aëroplane is actually on the wing.

If we take as a base the "Issy" experiments we can say that, roughly speaknig, the power required to raise an aëroplane from the level ground is a thrust equal to about one-third of the total weight of the machine.

Whether the machine be of a good type or not would not materially change this proportion of thrust to weight for a start from the ground. Once, however, the machine is on the wing, the thrust required to keep it afloat depends no longer on the weight of the machine, but on its quality as a glider; it depends on the nearness to the horizontal of the line of flight which the machine gives by its own weight, unaided by power.

I believe myself, from results obtained with heavy models, that a pedal-driven machine, requiring no more effort than an ordinary bicycle, is perfectly feasible, on condition that suitable launching ways are available for a start. It can be done if the total weight of the machine, including the rider, does not go much above 250 lbs., and if that machine glides by its own weight within no more than 4° from the horizontal. For such a machine an average thrust of about 20 lbs. is ample, and this a man trained to the bicycle can easily develop with a suitable aërial propeller. Here man has the advantage over bird. The latter has to take things as it finds them. We men can make things to suit our requirements, that is, we can make launching ways such as those which I will show you presently on the screen, and which enable us to put on the wing a light and inexpensive machine unhampered by and not depending on a powerful motor carried on board.

One of the slides to be shown is a table of sailing birds. The main point of this table is the relation of weight to wing area. That a correct relation between weight and wing area is an important factor in sailing flight is very obvious from the fact that, since a glider can, from experience, be underloaded or overloaded, one particular intermediate relation of weight to surface must necessarily be the optima relation. You will observe from the table that in nature that relation is not one of direct proportion, the constant being

$$\text{not } \frac{\text{weight}}{\text{area}} \text{ but } \frac{\text{weight}}{\text{area}^{\frac{4}{3}}}$$

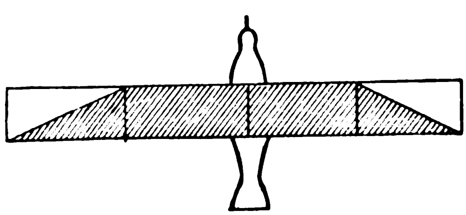
In all birds capable of real sailing the value of that $\frac{W}{a^{\frac{4}{3}}}$ remains at 1.6 or thereabouts. When below 1.6, as in the case of the peewit and of the heron, or above 1.6, as in the case of all fast flapping varieties, the bird is no longer a real sailer.

This seems to point to the existence of a law so far unknown. On the other hand, experiments with model gliders of graduated sizes show peremptorily that the relation is exactly the same in artificial gliders as it is in birds; that is to say, that two gliders of exactly the same type, but of different sizes, will glide at the same speed if, and only if, loaded in relation to the power $\frac{4}{3}$ of their surfaces. How this can be made to tally with the old classical formula KSv^2, which all mathematicians place at the base of their calculations, I cannot say. Huxley's famous saying, that what comes out of the mathematical mill depends on what is put into it, befits this case admirably. The data available at the present time are inadequate to arrive at anything definite from mathematical deductions, and we have, therefore, no option but to resort to empirical methods. There are at least three factors which, as far as I know, no mathematician has ever brought to bear on his equations. The first is the all-important action of the weight as motive power. The second is the beautiful horizontal component produced, under the action of the weight, by a rigid and bent-down front edge and a very flexible rear edge. The third and most important is the powerful vertical suction produced by a current of air striking a convex surface tangentially, and which, so far, is not only undefined, but completely ignored. I had hoped to have something more to say to-day about this mysterious reaction, but the experiments which Mr. H. Page and myself are carrying out, with a view to define its properties, are as yet incomplete, and the paper relating to them has to be left for a future occasion.

TABLE OF SAILING BIRDS.

Name.	Wing area in sq. feet.	Weight in lbs.	Lbs. per sq foot.	Weight / Area $\frac{4}{3}$.
Swallow	0·154	0·015	0·29	1·4
Black Swift	0·198	0'10	0·45	1·9
Tern	0·423	0·25	0·58	1·7
Small Gull	0·984	0·69	0·70	1·6
Another Gull	1·914	1·68	0·88	1·6
Another Gull	1·232	0·95	0·78	1·6
Black backed Gull *	3·834	5·00	1·15	1·6
Hawk	0·866	0·44	0·51	1·3
Rook	1·778	1·08	0·74	1·5
Albatross *	10·164	17·00	1·67	1·7
Vultore Gyp Fulvus *	11·440	17·50	1·53	1·6
Man-carrying machine, based on above	86		3·20	1·6

The table is compiled from personal observation except in the case of the birds marked*, when the information was obtained from the Natural History Museum. All the birds were measured by the following method for purpose of comparison:—



The wing area (shaded part) is deemed equal to three-quarters the span × greatest width, the span being taken when the rear of the wing makes a straight line, and no count being taken of either head or tail.

The CHAIRMAN: Has any gentleman any questions to ask or any remarks to make? If no one has anything to say, I think I cannot but ask you to accord your vote of thanks to Mr. Weiss, who has given us a very interesting paper. I am sure that we all know of his experiments, and how very interesting they are, with these gliding models that seem to act so very satisfactorily, and it is very interesting to hear about the launching ways that he has erected. I am sure some of us will be glad to see them. It rather reminds me of a certain structure that I put up once for launching gliding machines, and which I also found was hardly big enough. My appliance was just 50 feet long—a little bit longer than Mr. Weiss's, and I found that when we put a full-size machine on to it to run down on little wheels, that it did not get up enough speed to really do much good. We did get some glides, because in that case the machines were run off at the end of the track, which was at a considerable height, about 8 or 10 feet, above a sheet of water. But I expect it will be found necessary to make something a little larger to act satisfactorily. There is no objection to the general principle of making such a structure, and it is a specially good idea to make it so that it can revolve and face the wind in any desired direction. I can only ask you to accord your vote of thanks to Mr. Weiss. (Applause.)

Major BADEN-POWELL: I shall now crave your indulgence for a few moments to explain to you some little models that I have here. Major Baden-Powell then read his paper on "Experiments with Dipping Planes."

Experiments with "Dipping" Planes.

By MAJOR BADEN-POWELL.

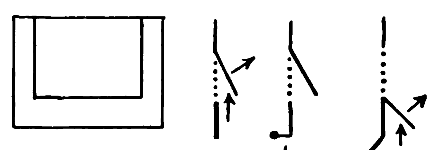
It has been usual, in considering the theory of aëroplanes, to assume a plane or combination of planes so fixed that they present an inclined under surface to be acted upon by the air. Yet it is generally found in practice that such surfaces do not satisfactorily fulfil their object. Curved or arched surfaces seem to do better, and several experimenters have gone further and arranged these aerocurves in such a manner that they do not present any under surface to the impinging air. Hargrave tried a curved surface the cord of which was set at a negative angle to the front. He found that an eddying current was set up in the concavity helping to sustain and propel the apparatus. Phillips arranged sustainers with a curved upper surface, but with a flat and horizontal under surface. He concluded that the air was driven upwards off the curve, forming a partial vacuum over the after part. But Langley, on the other hand, made out that a plane propelled horizontally without any inclination did not sink in the air.

I have found that if the front edge of a plane be inclined downwards it may still derive support from the air against which it is driven.

It is not my intention to-night to describe what I consider to be the best form for a practical machine, but merely to put forward a problem in aërodynamics which calls for explanation.

I will now show some simple little paper models.

Here are several sheets of stiff paper each having panels cut round three sides and bent back; thus—



No. 1. No. 2. No. 3.

These are slightly weighted at the bottom, and I drop them edge on. Now, taking No. 1 we can easily imagine what will happen. The air pressing normally against the under side of the flap will drive the whole away towards that side; it will also cause the whole to tilt so that the flap is upwards. But now on dropping it, you see that that is just what does *not* happen! It turns the other way with the flap downwards. This result may be explained by the weight of the flap, making the centre of gravity lie towards the side of the flap. We will, therefore, place a clip sticking out towards the other side, and, dropping this, we see it still turns with the flap downwards. It has been suggested that this is due to a rudder-like action, the plane turning about its centre of gravity. So we will try the flap the other way, as No. 3. Now the action of the air in the "pocket" formed must act strongly on the flap and turn it. But it doesn't. Some think the action due to the border, so I have made up a couple of planes attached by a stick, but still they act the same.

The dropping of these planes vertically should be exactly equivalent to propelling them horizontally, except that gravity does not bias their action. If so, when propelled along with planes pointing downwards, the tendency would be for them to rise against gravity. I, therefore, produce a piece of apparatus consisting of a series of inclined planes one behind the other. If this be thrown dart-like when the planes are inclined upwards it goes but a short distance and generally tumbles over, but when turned upside down so that the planes "dip" or incline downwards in front you will see it glides very nicely.

Though I have been thinking a good deal over this matter, I have not arrived at any entirely satisfactory solution of the action. It may be that each result is due to some different cause, but I hope some of you may be able to offer some explanation.

There is one other little experiment that I can show which might throw some light on the matter. Here I have a plain piece of cardboard with a number of little tabs of tissue paper gummed on to it at one end, and, of course, these show the direction in which the current is blowing. Now what I want to show you—I don't know to what extent you can see it—is that when held nearly edge on to the blast from the electric fan, so that the current is running along the surface of the plane, of course the little tabs are blown straight back. As the angle of inclination increases you will notice that a good many of those little tabs on the back of the plane are facing the opposite direction. That proves that the air circles round on the back side of the plane, and is going in the opposite direction to what it is on the other side. Some very careful experiments might well be made with this in order to ascertain exactly the angle at which the current begins to go backward. I have not been able so far to get at it exactly, because there is a lot of eddying wind so that the tabs flap about a good deal before they take any really decided forward action. (Applause.)

Mr. SENECAL: I should like to ask the lecturer whether he took a very great distance between the two planes? The distance, I should say, was twice the width of the planes.

Mr. WEISS: I think I can give a simple explanation of the behaviour of these models when dropped to act under their weight. Whatever they do they follow the path of least resistance. The direction in which the flap offers the least resistance is edgewise, and it falls edgewise the whole time. There would be resistance if it was to go in any other way. In the same way in the double model it must go better if the planes are pointing downwards, because that is the direction in which it tends to fall. You must bear in mind that as soon as the thing begins to glide, the centre of pressure moves forward and raises the head. There is no mistake that this is the principle of sailing flight. I do not know whether I told you before about some experiments I made three or four years ago with a dead bird. I fixed the bird in the attitude of flight in an open cage made of battens, and inside the bird was fixed in such a way that it could not move its position, although it could go backwards and forwards about a couple of inches. Whenever this was exposed to strong wind the wind had no effect on it, the resistance could not be appreciated; in fact, a gust of wind seemed to throw the bird forward. I know well from experience with my own models that whatever the strength of the wind, if they are held exactly with their nose to the wind one cannot detect the least pressure on the model.

Mr. REID: If I may be allowed I should like to repeat a remark of Mr. Weiss about the mathematical mill. I am glad to find that you have not put that mathematical mill into operation, for although one does not wish to depreciate in any way the value of mathematics, yet if there is time wasted in connection with aëronautics it is over the mathematical part of it. There are few accurate data, and they are made the foundation for a great deal of figuring. I think you have just now given us a very good object-lesson indeed; that things which are supposed to be well known and data upon which most of our aëroplanes are being built at present are not all what they seem. It shows us the very great importance indeed of actual practical experiment. I did not say anything after Mr. Weiss's paper, but I did feel that he was advancing our knowledge of aëronautics to a very great extent by these launching experiments. It is a defect we shall meet with, and there is only one form of aëroplane that can be raised direct from the ground, and that is one with lifting fans, but whether that will be practical or not we do not yet know. I thank you very much personally as we shall all do collectively directly for showing us these very ingenious experiments you have shown us. I have seen a great many others that you have carried out also, but I think this is one of the most instructive I have ever seen. (Applause.)

Mr. Senecal: About 32 years ago in this very hall I made experiments with similar models; also with aëroplanes of various forms and sizes, such as square, round, triangular, etc., both in aërial lines and in rotation, and as these planes falling under the action of gravity, I found that their own weight and resistance was a sufficient explanation of their seemingly paradoxical motions, so long as they are perfectly flat, of the same thickness and material, and gravity being the only acting force. (The explanation will be found in the Aëronautical Society's Report of about 1875.) If an additional force is used in the form of weights or a series of weights, the planes will travel faster and their motions will be altered under the compelling direction of the weight. That is, the position of the weight on the plane, figuratively speaking, will compel the plane to follow the weight. I noted the following law, that the position of the weight or series of weights dominates and determines the direction of the translation of bodies, or of planes, or systems of planes, etc., however complex and whatever may be their relative forms. A plane will travel forward if the weight is placed in advance of the centre of gravity of the plane; the plane will travel faster as the weight slides away from the centre of gravity and pressure, so that theoretically the weight should slide forward continually. In practise this cannot be done. The weight can only be moved within the limits of speed and margin of safety. The weights that keep the vertical balance should be raised more in the line or axis of motion as the rate of speed increases. That is one of the true theories of balancing. When you start a machine have your weight low and raise it upwards and forwards as the rate of translation increases, and do the reverse as the rate of translation decreases. By practise you will control your machine in an effective manner. Active surfaces can be used with nearly the same results. I find in the triangular planes that the faster they are rotating the weight drifts more to the base of the plane, and as the velocity and rotation decreases the weight flies backwards. The law of centrifugal force explains the behaviour of the triangular planes. There was also a folded edge mentioned. A folded edge increases the weight as well as the resistance. There is also a decrease of pressure behind the folded edge. The explanation of flight of all flying beings, models, planes, etc., is found in the true co-relation of power, weight, and resistance. This explanation is quite sufficient for all practical purposes.

Major Baden-Powell: I may say that as regards that I have not tried them wider apart than you see them there, but I have tried them very much closer together. I made one which had a whole series of these planes close together, about four actually overlapping a little bit, and that went very well, but, unfortunately, I broke the stick of it, so I have not brought it here to-night. But I do not think the distance apart has much to do with the results. I think what Mr. Weiss said is very true. When the appliance begins to fall it has its edge on so that there is no resistance and, therefore, it gathers speed. But there is no doubt about it, as you can see—you can try them again later on—that these planes have a wonderful way of recovering elevation. If you give them a launch they sometimes give a little dip down, but they always rise again and seem to go so very stably that it seems to me it requires a little more explanation than merely to say that the plane follows the line of least resistance.

Mr. Senecal: I may say I made experiments on that principle, and I found that an aëroplane piled one way would come forward; bodies with bristles, feathers, etc., are affective examples of the same principle —a sheet of velvet with a pile laid flat will come forward, but it will travel the other way only if you place a weight on the opposite edge. I may say that I will undertake to make any machine travel either backwards, forwards, sideways, or any other way, simply by altering the position of the weight.

NOTE.

[N.B.—With reference to Mr. Weiss' suggestions, I have since tried a device in which the area of the border is far greater than that of the panel. One would then expect that the former would offer greater resistance to the air, but still we get the same result as before, indeed, the "dipping" action is more pronounced.—B. B-P.]

The CHAIRMAN: I will now ask Colonel Fullerton to read his paper.

The Farman Flying Machine.

By COLONEL FULLERTON.

So much interest has been aroused by Mr. Farman's successful flights that an account of his machine may, perhaps, be found useful. It is difficult to get accurate details of the apparatus, but it is hoped that the description given below may be found of some assistance to those who wish to design similar machines.

I.—GENERAL DESCRIPTION.

Speaking generally, the machine consisted of the following parts:—

(*a*) A double-decked aërosurface; the main sustaining surface.

(*b*) A body for carrying passenger, motor, etc.

(*c*) Small balancing planes, in front of the main aërosurface, for steering in the vertical plane.

(*d*) A box-shaped rudder, in rear of the main aërosurface, for steering in the horizontal plane.

(*e*) Motor.

(*f*) A propeller fixed in rear of the motor, working like the propeller of a marine ship.

(*g*) A chassis fitted with wheels, to facilitate starting and alighting.

(*h*) Seat for passenger.

As regards the general construction of the machine, etc.:—

(1) The framework of body, sustainers, etc., was made of steel tubing, the covering of aërosurfaces, etc., being of canvas.

(2) The total weight, in order of march, was 530 kilog. (1,168 lbs.).

(3) The total sustaining surface was 52 sq. m. = 560 sq. ft. The area of the balancer (*c*) is not counted as a sustaining surface.

(4) The sustaining velocity does not seem to have been accurately measured, but apparently the machine moved on a level course, when its speed was from 14m. (45.9 ft.) to 17m. (55.8 ft.) per sec., the inclination of the sustaining surfaces being about 12° in the former case and about $6\frac{1}{2}$° in the latter.

(5) The main aërosurface consisted of two superposed surfaces each 10m. (32.8 ft.) wide by 2m. (6.56 ft.) in length, the total surface being equal to 40 sq. m. (430.5 sq. ft.). The surfaces were arched, the arching being about $\frac{1}{14}$. When the machine was in full flight the angle of inclination of the chord of the arch varied between 12° and $6\frac{1}{2}$°. The vertical distance between the two surfaces was 1.5m. (4.92 ft.), and the connecting posts were stayed and kept in position by suitable wire guys.

The surfaces were fixed at a dihedral angle of about 140°.

(6) The body consisted of a tubular framework covered with canvas, fair-shaped in front, but with a vertical stern. The extreme width (transverse direction) was .75m. (2.46 ft.); length 4m. (13.12 ft.). The passenger's seat was in such a position that his centre of gravity when seated was in the vertical line passing through a point .25m. (.81 ft.) in rear of the front edge of the main aërosurface.

(7) The balancing planes consisted of two wooden surfaces each 2m. (6.56 ft.) by 1m. (3.28 ft.). In section the planes were arched above, but had very nearly flat undersurfaces. They swung on a pivot fixed at .25m (.81 ft.) from their front edges, and could be moved up and down by a suitable gearing worked by the passenger.

(8) The box-shaped rudder was 2m. (6.56 ft.) wide, and 3m. (9.84 ft.) long. The upper and lower surfaces were arched $\frac{1}{14}$, and the angle of inclination of these surfaces in full flight was about 12°. The stays, guys, etc., were similar to those used on the main aërosurfaces. The area of the upper and lower surfaces, which both helped to sustain the machine, was 12 sq. m. (129.17 sq. ft.). The front edge of the box was 6m. (19.68 ft.) in rear of the front edge of the main aërosurfaces.

(9) The motor was an 8-cylinder petrol Antoinette, giving 50 Fr. H.P. as a maximum. Its weight was 80 kilog. (176 lbs.); there were no cooling appliances. The centre of gravity of the motor was in the vertical line, passing through a point about .7m. (2.3 ft.) in advance of the rear edge of the main aërosurfaces.

(10) Propeller. This was of the driving type used in marine ships; it had a steel frame and was covered with canvas. The diameter was 2.3m. (7.54 ft.); pitch 1.4m. (4.6 ft.). It was mounted directly on the motor shaft, and at 1,050 revolutions per minute required 38 Fr. H.P. to drive it.

(11) The chassis was constructed of steel tubing. The wheels were of the usual bicycle type, the front one being .25m. (.81 ft.) in diameter, the rear ones .13m. (.425 ft.).

(12) Starting. To start, the machine was simply run along the ground under its own power until it rose in the air, movements in a vertical plane being controlled by the balancing planes.

(13) Alighting. To alight, the power was shut off, and the machine glided down to the ground on a gentle slope.

II.—TRIALS.

The trials of this machine were carried out in a very methodical manner, Mr. Farman's great object being to get a thorough knowledge of the working of the apparatus before attempting to leave the ground.

The earlier experiments were made in September, 1907, and were not very successful, as the best flights only reached 30 or 40 yards in length. Improvements were, however, made from time to time, and the distances increased to 100 yards, 120 yards, etc., until rather unexpectedly on October 26th, 1907, a flight of 770 yards was accomplished. Circular flights were next tried, and at first great difficulty was experienced in taking a curved path, as the machine always dropped to a lower level when the rudder was put over.

On January 11th, 1908, however, a circuit including two curved paths was made in 1 min. 45 secs., the total distance traversed being 1,800m. (about 2,000 yards).

Mr. Farman then decided to try for the Deutsch-Archdeacon prize, and on January 13th, 1908, succeeded in winning it.

He is reported to have covered a distance of 1,500m., including a curve of 220m. radius, in 1 min. 28 secs. This would make the velocity about 17m. per sec., but as the inclination of the sustainers was apparently from 10° to 12°, it is doubtful whether the real velocity ever exceeded 14m. per sec.

On January 11th, 1908, some further trials were made, chiefly to test the amount of extra weight which could be carried. (Boxes of water were used to represent these weights.) In the first trial without extra load, 1,500m. was covered in 1 min. 33 secs. (one turn); subsequent trials gave the following results.

Load of	15 kilg. ...	400m.	(one turn)
,,	20 kilg. ...	100m.	(straight)
,,	25 kilg. ...	30m.	(straight)
,,	30 kilg. ...	*nil*	

The H.P. used has not been recorded, and no details have been published as to the position of the extra weights.

III.—REMARKS.

Before criticising this machine it is necessary to clearly understand that it was constructed for a special purpose, viz., to cover a distance of at least one kilometre on a circular course. To this end everything was subordinated, and the question of providing a machine capable of carrying more than a very limited amount of effective load (viz., passengers and stores) was not considered.

This should be recollected when examining the design, and full allowance must be made for the peculiar conditions under which the trial was carried out.

(1) *General Type.*—Mr. Farman selected this type of machine chiefly because of its stability, but also on account of the simplicity of its constructional details. On the whole it worked well, and would seem to be a good class of machine for elementary attempts at flight.

(2) *The great weight and size* of the machine is very noticeable, especially when it is remembered that it only carried one man for a very short distance. A weight of half a ton and a space occupied of 1,200 sq. ft. appear to be much too great for such a small effective load.

(3) *Power Expended.*—This also was very large, no less than 38 Fr. H.P. being used.

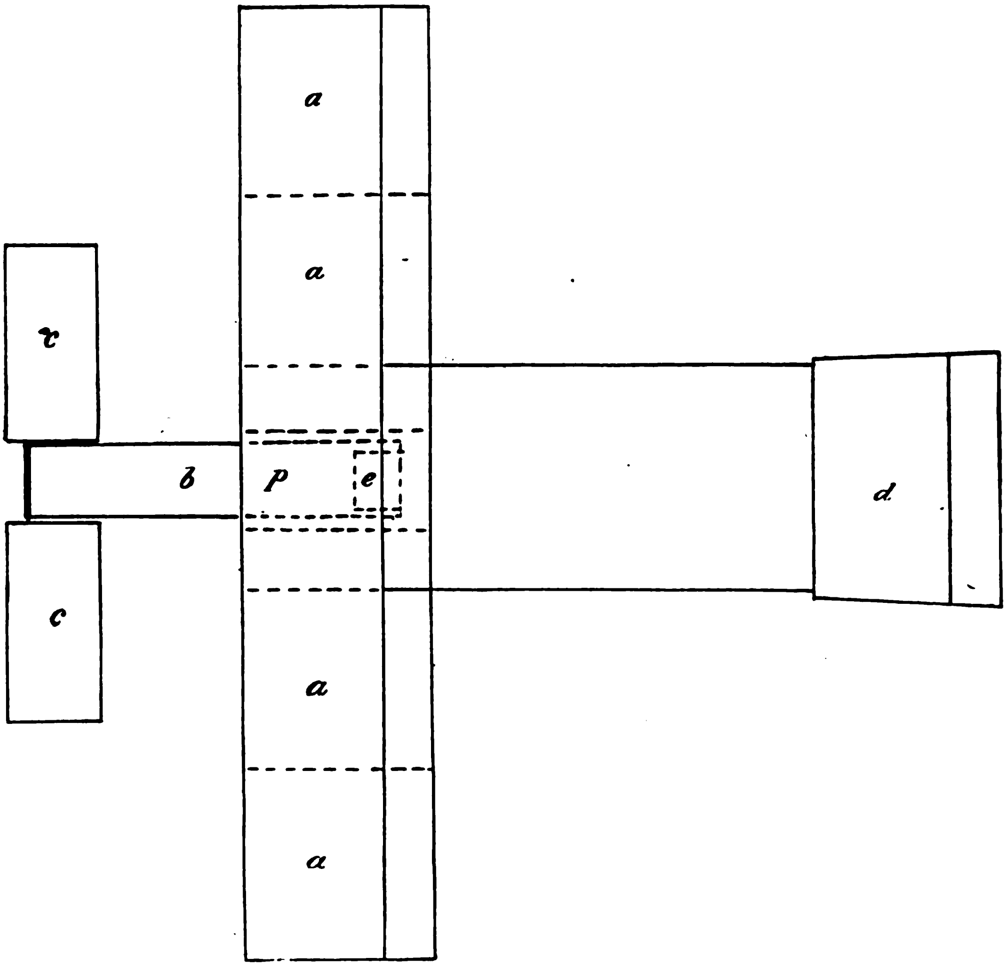
The lift was

$$\frac{530 \text{ Kilg.}}{38 \text{ H.P.}} = 14 \text{ kilg. per Fr. H.P.},$$

or about 30.8 per B.H.P.

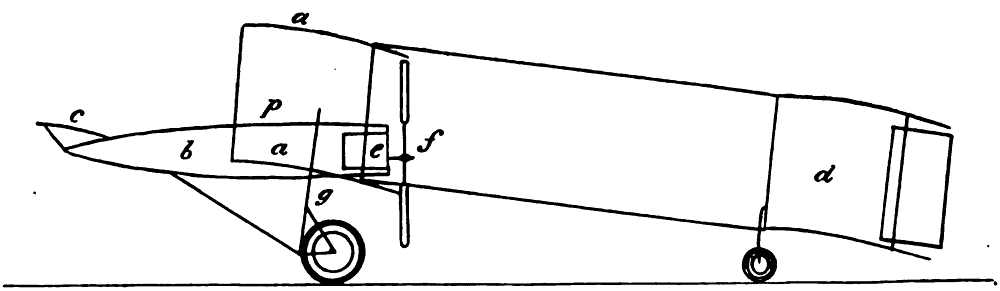
(4) *There are not* sufficient details to calculate the thrust from the propeller dimensions, but the actual thrust was at 16.67m. per sec.

$$\frac{38 \times 75}{16.67} = 170.6 \text{ kilg.};$$



The Farman Flying Machine. Fig. 4.—Plan. Scale 1/80.

(By special permission of the Motor Supply Co., 111, Piccadilly, W.)



The Farman Flying Machine. Fig. 5.—Section on Centre. Scale 1/80.

(By special permission of the Motor Supply Co., 111, Piccadilly, W.)

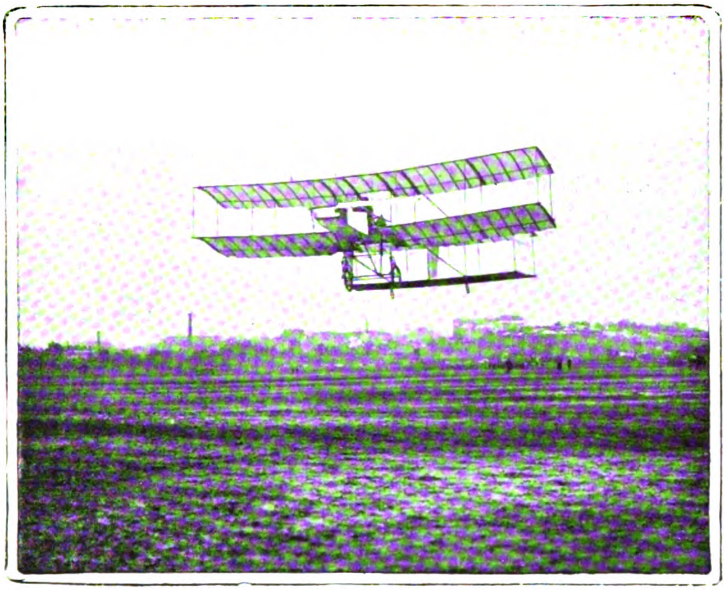
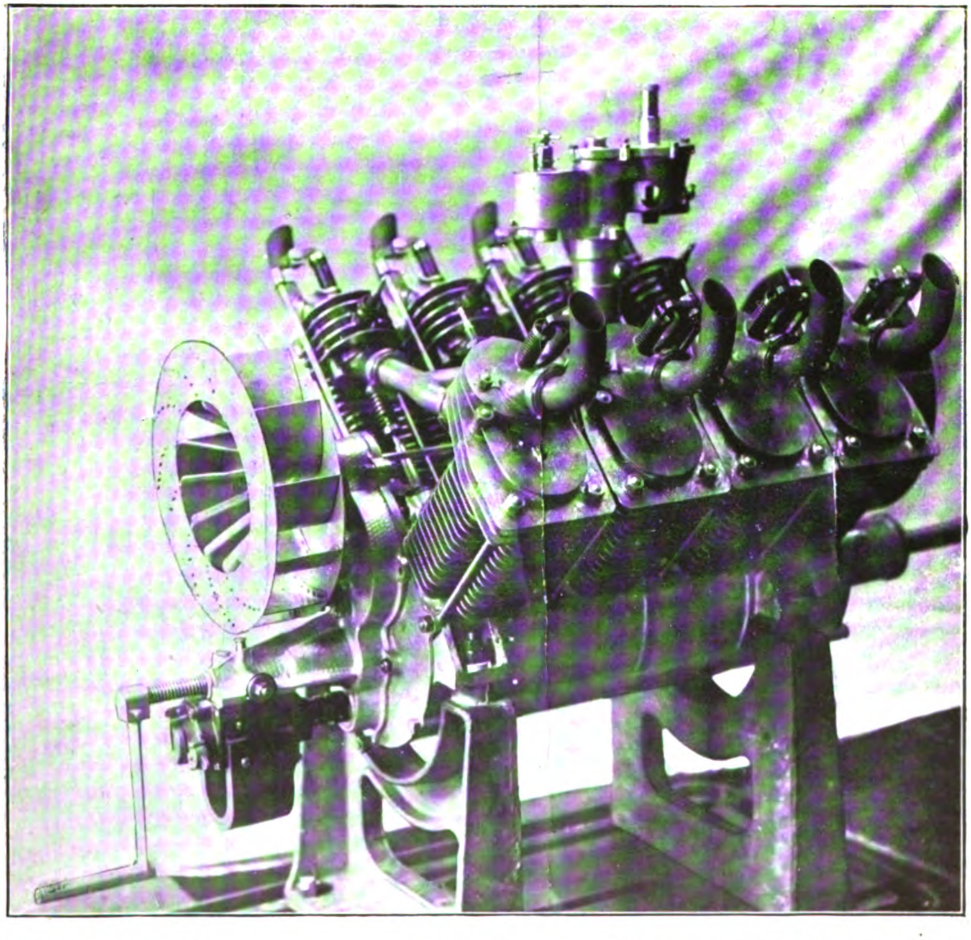


Fig. 6.

THE FARMAN FLYING MACHINE.

By special permission of the Motor Supply Company, 111, Piccadilly, W.



By special permission of the] **Fig. 7.** [*Motor Supply Company, 111, Piccadilly, W.*

THE FARMAN FLYING MACHINE.

hence

$$\frac{\text{drift}}{\text{lift}} = \frac{170{\cdot}6}{530} = \frac{1}{3{\cdot}1}$$

At 14m. per sec.

$$\frac{38 \times 75}{14} = 204 \text{ kilg.};$$

hence

$$\frac{\text{drift}}{\text{lift}} = \frac{204}{530} = \frac{1}{2{\cdot}6}$$

which results do not compare very favourably with the Maxim or Phillips machines.

(5) *Calculation of Lift, etc.*—Owing to the doubt as to the real speed, it is difficult to check the results with well-known formulæ, but it is worth while noticing that the lift and drift check fairly well with the diagrams given in Table IV. of "Der Vogelflug" by the late Herr Lilienthal. Thus with $V = 14$m. and $\alpha = 12^\circ$

$\text{Lift} = .612 \times .09 \times 52 \times 14^2 \times \cos 12^\circ$
$= 549.6$ kilg.

$\text{Drift} = .612 \times .09 \times 52 \times 14^2 \times \sin 12^\circ$
$= 116.412$ kilg.

Since the total thrust at this velocity was
$= 204$ kilg.,

the body resistance was
$= 87.6$ kilg.,

a very considerable amount.

Similarly, when $V = 16.67$ $\alpha = 6\frac{1}{2}^\circ$, the body resistance was
$= 109.5$ kilg.

It is clear from the above calculations that the large amount of power required to drive the machine was due to the body resistance, which, on the average, was equal to the resistance of the sustaining surfaces. No doubt this will be altered in future machines.

(6) *The Body.*—It is not quite clear why the square-shaped stern was adopted. This shape adds considerably to the forward resistance, and a fair-shaped body might be used with advantage.

(7) *The Balancing Planes* seem to have worked very well. Their shape is noticeable, as the section is very similar to that of one of the sections used by Mr. Horatio Phillips in his earlier experiments.

(8) Owing to the conditions of the trials the design of the rudder was of special importance. It seems to have acted well, but it is doubtful whether such a large surface is desirable. Again the great distance between the rudder and the main aërosurfaces was decidedly disadvantageous from the constructional point of view.

(9) *The Motor.*—This was of the Antoinette type, and worked well. The absence of cooling arrangements, however, made a long flight out of the question.

(10) *The Propeller.*—Very little information is available about the propeller. At 16.67m. velocity the slip

$$\frac{16{\cdot}67}{1{\cdot}40 \times 17{\cdot}5} = .68,$$

and slip $= 32$ per cent.

At 14m. velocity

the slip $= 43$ per cent.,

on the supposition that the revolutions were 17.5 per sec. in both cases.

(11) *The arrangements* for starting and alighting worked very satisfactorily, and there does not seem to have been any trouble in executing either of these manœuvres.

(12) *As regards the trials*, they seem to have been well and carefully carried out, special attention having been paid to familiarising the passenger with the working of the machine, *before leaving the ground*, an important detail which should be copied by all aëronauts when testing their apparatus.

NOTE.

Since the above was written Mr. Farman has made a number of very successful flights, notably one on March 21st, 1908, in which he covered about $3\frac{1}{2}$ kilm. in 3 mins. 47 secs. (Velocity $= 51$ kilm. or 31.7 miles per hour approximately.)

Members of the Society will be glad to hear that his accident on March 27th was not so serious as at first reported. The latest accounts state that he is doing well and hopes soon to go on with his experiments.

The CHAIRMAN: Does any gentleman wish to make any remarks?

Mr. WEISS: I should like to ask what was the actual thrust of the Farman motor when tried. I have not been able to get the record.

Colonel FULLERTON: The details of the propeller are not sufficiently well known to work out the thrust. Approximately from other information I make it 170 kilg. at 16.67m. per sec., and 204 kilg. at 14m. per sec.

A GENTLEMAN: Could you tell us the position of the propeller?

Colonel FULLERTON: It was fixed upon the motor shaft immediately in rear of the boat-shaped body.

A GENTLEMAN: I understand that at one time there was a helm or rudder at the back of the machine. I do not know whether this was the case in his last flight.

Colonel FULLERTON: Yes, that box at the back is the rudder.

A GENTLEMAN: There was not an actual rudder to move.

Colonel FULLERTON: He could move the box at the back a little, as far as I can make out, but I cannot give you the details.

Mr. SPENCER: Would you allow me to correct you? The box at the back has a rudder about half its length inside. You are incorrect in saying that the whole box moves; it does not, it is fixed absolutely at right angles. The rudder itself is moved by cords held by Mr. Farman.

Major BADEN-POWELL: When I first heard of this mishap to Mr. Farman to-night I thought he was probably trying his new machine, because I cannot help thinking—I daresay it has occurred to many of you, too; I know it has to those I have spoken to—that from the published designs it certainly does not look to me very serviceable. I suppose he knows better than we do what it is likely to do, but if that new machine succeeds, and if it is made as the public designs show, it will certainly give us some rather curious and unexpected effects, as the whole balance of the machine is so different from what has been tried before. I ask you to accord your thanks to Colonel Fullerton for his paper. (Applause.)

Mr. FROST: Ladies and gentlemen, we are all very pleased to see Major Baden-Powell in the chair, and I am sure we not only thank him for taking the chair, but we also thank him for the interesting experiments that he has showed us. (Applause.)

This concluded the Meeting.

REVIEW.

"AERODYNAMICS," Vol. I. By F. W. Lanchester. Constable and Co: pp. 442, with many illustrations.

This is a very interesting book, and should be read by all who wish to get a good general idea of the principles of aviation. It must, however, be understood that the book is of a somewhat advanced type; much of the matter contained in it is only likely to be appreciated by those who have made a scientific study of the subject, and the student who takes it up must prepare for some rather tough reading.

The present volume deals only with the theory of aërodynamic support, and the resistance of bodies in motion in a fluid; the questions of equilibrium, stability, etc., being left for discussion in a volume to be published later.

Generally speaking, the first three chapters of the volume now under consideration are devoted to the more elementary principles of fluid dynamics. Chapter IV. deals with certain investigations made by the author on peripteral motion, while chapters V. and VI. give a *résumé* of what is known about aëroplanes. Chapters VII. and VIII. discuss the economics of flight; chapter IX. gives a theory of screw propulsion propounded by the author, and remarks on the power required for flight; while chapter X. concludes the volume with an account of the experiments carried out by Dines, Langley, etc., and also describes certain investigations conducted by the author.

Taking the chapters *seriatim*:—

CHAPTER I. discusses fluid resistance. The Newtonian method of computing it is explained, and the reason why this system, though true enough in itself, fails to be always applicable. The stream-line theory of Rankine and Froude is then considered, and the principles of the transference of energy by the different parts of a stream-line body outlined. The chapter concludes with a brief account of the doctrine of continuity, and notes on stream-line flow in general.

CHAPTER II., on Viscosity and Skin Friction, is a very important one, as the author, like Zahm, maintains strongly that viscosity is the main source of the resistance to which bodies passing through a fluid are subjected. Commencing with Maxwell's definition of viscosity, he explains that skin friction is rather a misleading term, as when a fluid passes the surface of a body a thin film adheres to the surface, and the resistance or drag is more due to the fluid particles rubbing against the particles of the film than to anything in the nature of friction between solids. Various theoretical considerations regarding viscosity follow, and finally the experimental results obtained by Beaufoy, Froude, Dines, and Allen are discussed. It is somewhat surprising that no reference is here made to the work of Zahm, who, curiously enough, is one of the few experimenters in agreement with the author. Zahm's experiments were conducted in air, on lines similar to those of Froude in water, and are certainly deserving of most careful study by all aëronauts.

CHAPTER III.—The Hydrodynamics of Analytical Theory—is a carefully worked out explanation of the theory under consideration. Commencing with the equations of motion for steady flow, the velocity potential, flux function, etc., are commented upon. Rankine's sink and source system is fully described, and some excellent diagrams show the water lines generated by sphere, cylinder, etc. No mention, however, is made of the very ingenious extension of Rankine's theory put forward by Taylor. This experimenter substituted a number of infinitely small sources and sinks for the two or three used by Rankine, and thus got a far greater approximation to ship-shaped forms than any of the earlier workers in this field. The idea is a very good one, especially as by suitably arranging the sources and sinks it seems possible to adapt it to experimental work, and thus ascertain, in a comparatively simple manner, what the real pressures on different parts of bodies and surfaces are.

Some account of Hele-Shaw's experiments might have been given with advantage, as they show the formation of the stream-lines round bodies in a very clear way.

The chapter concludes with a summary of the author's views on discontinuity.

Chapter IV. deals with wing forms, and peripteral motion, viz.: the motion of a fluid in the immediate vicinity of a wing. The author rightly notices the great importance of the arched sections and dipping front edges of wings, and points out that these essential features of wing construction seem to have been rather overlooked by most aviators. He gives the credit of their discovery to H. Phillips (1884), who certainly seems to have been the first to point out the rarefaction of the air, *above* certain types of curved surfaces. Lilienthal, of course, described and used curved surfaces, but he did not explain the action of the air in connection with them. The author seems to have formulated a theory of this kind in 1894, but his views were not acceptable to the scientists of the period, and his interesting experiments remained unpublished. The question of aërial support is next considered, and peripteral motion in imaginary and real fluids discussed.

Chapter V.—The "Aëroplane"—describes at considerable length the pressures upon normal planes of different types. The results obtained by Hutton, Dines, Langley, etc., are discussed, and the importance of the shape of the planes pointed out. The general normal plane theory is examined, and the chapter closes with a consideration of the question of perforated surfaces.

Chapter VI.—The "Inclined Aëroplane"—deals with planes of different sizes and shapes, fixed at an angle of inclination to their line of motion. Formulæ for the pressure on them are discussed, especially those of Dines and Langley. No mention, however, is made of Stanton's experiments at the National Physical Laboratory, which is unfortunate, as these experiments are the only ones carried out in this country in which the pressures above and below the atmosphere at different points on plane surfaces have been actually measured.

The very important question of the centre of pressure is only briefly touched upon, but this no doubt will be dealt with in Vol. II.

The chapter ends with a brief account of the author's "Ballasted Aëroplane," and as he uses this apparatus in his skin friction experiments described in Chapter X., it should be carefully studied.

Chapter VII. is a theoretical discussion on the "Economics of Flight." The equation of least resistance is examined and the influence of viscosity considered. The practical application of the theory is, however, left for a subsequent chapter.

Chapter VIII.—The "Aërofoil," or sustaining part of a flying body. The chapter commences with certain formulæ for finding the best angle of inclination, gliding angle, etc., of sustainers having a wing-like form. As these formulæ contain constants, an effort is made to obtain the approximate value of these latter from experimental results; but it is very sensibly pointed out that the values obtained are "plausible" only, as the present state of our knowledge is not sufficient to enable really accurate results to be obtained.

Various other interesting matters are discussed, such as the best sectional form, etc. What is called by the author "the standard form," viz.: the one used by him in his experiments, is described, and the chapter concludes with a numerical example worked out in detail.

Chapter IX.—The Screw Propeller and the power expended in flight. Rankine's well-known formulæ are first examined, and then propulsion in its relation to the body propelled. The various kinds of propelling instruments are mentioned, but the screw propeller is the only one dealt with in this volume. This latter is considered in great detail, efficiency, pressure, distribution on the blades being all discussed. A good many data regarding the marine propeller are given, and there are some rules deduced therefrom for the design of an aërial propeller. Finally, the power required for the flight is examined, and making certain suppositions regarding weight of motor, etc., the author shows that in dynamic flight, speeds exceeding 70 miles an hour are very improbable. In the present state of our knowledge the question of power is a difficult one, but probably when the importance of good shapes of bodies and sustainers is more fully realised the speed of really well designed flying machines will considerably exceed the limits laid down by the author.

CHAPTER X.—"Experimental Aërodynamics"—is a very interesting one, as it deals very fully with the methods employed by various experimenters. Commencing with Hutton and the older workers in this field, the author gives details of the whirling tables, etc., used by them. Dines' method is next described and his results considered, and a remarkable innovation, the triangular (in section) surfaces used by him commented upon. The author thinks (see page 347) that this peculiar shape would not invalidate the results obtained at the higher angles of inclination, but he is doubtful as to the effect at the lower inclinations. It would certainly seem that Dines' results for small angles require carefully checking with the work of other experimenters, as there is no doubt that at small angles of inclination the form of the surface under test has a very great influence on the air pressure.

A very detailed account of Langley's experiments is given, and the author does not, generally speaking, admit them to be satisfactory. He points out various defects in the manner of drawing the smooth curve, of the resultant pressure recorder, the doubtful error, said by Langley to be due to the bending of the arm of the whirling table, etc., and especially objects to the conclusion drawn, that skin friction is a negligible quantity.

Before proceeding to describe his own experiments, the author makes one very important statement, viz.: that the equilibrium of a bird in flight is *not* dependent upon the intervention of the brain and nerve centres, and that it is *not* necessary to supply some "brain equivalent" to be directed by the aëronaut. There is no doubt that this view is correct, and that, as stated by the author, "a properly-designed rigid structure is capable of maintaining its own equilibrium, and possesses complete stability within pre-arranged limits.

A short account of the author's own experiments on the value of the skin friction co-efficient follows, but it must be confessed that they are not very convincing. He used three different systems for his tests, viz.: the "added surface," the "total surface," and the "ballasted aëroplane" device described above. A good account of the method of carrying out the tests is given, and the tables and calculations furnish a certain amount of useful information. The great objections, however, to all the methods are the defective arrangements for starting the models and the want of accurate instruments for automatically recording the time of flight, path, etc. It is impossible to get satisfactory results by throwing the aëroplanes, and the taking of times by a stop watch is not nearly accurate enough for scientific work, particularly as such very small models were used.

The experiments were, however, interesting, and would at all events throw some light on the equilibrium question, a matter of very great importance.

The work concludes with some appendices and a very good index. The excellent illustrations are an important feature of the book.

NOTES.

Retirement of Col. J. L. Templer, late Superintendent Royal Engineers' Balloon Factory, Aldershot, Member of Council of the Aëronautical Society of Great Britain.—The following extract from the "Daily Telegraph," will no doubt be read with interest by the Members of the Society:—

To-day Colonel James L. Templer, formerly of the King's Royal Rifles, retires from the distinguished official position he has so long and so admirably filled under the War Office in connection with the Royal Engineers' balloon establishment at Aldershot. Somewhere about April 1 seems to be a chosen time for important military manœuvres. It will be recalled that some little time ago Colonel Templer was superintendent of the balloon factory, the work of which also included the construction of steam road-transport engines, as well as everything in connection with Army aëronautics, and that he held the post for many years. Latterly he has been the official technical adviser to that highly-specialised department, a duty no one was better qualified to fill than the gallant Colonel, who has seen service at home and abroad, in peace and in war. The "age clause" brought about his first severance, and now he ceases altogether the official connection. It will not be easy, if it is even possible, to replace the gentleman who through weary years has untiringly wrought to keep the War Office interested in aëronautics, and done so much to secure for the Army the best and most complete balloon and signalling equipment of any service in any country.

Colonel Templer, although of tall, athletic build, took in the first instance to ballooning as a pastime and sport. He made many ascents with Mr. T. Wright, a pupil of Mr. Coxwell's, as did the late Colonel Fred Burnaby and other well-known personages. Impressed with the possibilities of aërial navigation, the Colonel determined to make a scientific study of the whole subject.

AN AËRIAL ENTHUSIAST.

He saw at once that it could be made of great use in many ways in military operations. So, in 1877, he put forward his plans to the War Department, and was appointed as an assistant to Sir Charles Watson, K.C.M.G. From that time forward he has been in the Service, and become famous everywhere, and is perhaps the best-known aëronaut, at least among experts, in any country. He initiated and perfected the manufacture of goldbeaters' skin balloons, the best receptacles for holding hydrogen gas. And in this direction the public owe to him new methods for making, compressing, and storing the gas for military ballooning. Colonel Templer made endless experiments in these and other branches bearing upon aëronautics, and he devised various apparatus for gauging wind-pressures, currents, as well as types for captive, free, and dirigible balloons. Even aëroplanes were not neglected, and years ago, before and after Sir Hiram Maxim's experiments to solve flight, Colonel Templer laboured in the same direction. Upon the Continent to-day, his tables and methods are the accepted standards by which officials and private persons conduct their operations in the domain of aëronautics. The British public will remember him best as the official who six years ago believed in the dirigible balloon, and obtained the consent of none too willing authorities to build "Dirigible No. 1" and No. 2. It was the first in which, last year, Colonel Capper and Mr. Cody came screwing up from Aldershot to London, and alighted within the Crystal Palace grounds.

BALLOONS AND AËROPLANES.

Very early in the pursuit of his favourite study the enthusiastic aëronaut decided that coal gas was only a little less bulky and out of date for balloons than the hot air used by the Montgolfiers. So he set about manufacturing skin balloons and using hydrogen for their inflation. And this is an instance in which figures speak volumes. The weight, say, in vacua of 1,000 cubic feet of ordinary air is at a barometer pressure of 30 in. and 50 deg. Fahrenheit temperature about 75 lb. Now 1,000 cubic feet of coal gas weighs from 35 lbs. to 40 lbs., whereas the same quantity of ordinary hydrogen weighs not more than 5 lb. Were the hydrogen absolutely pure it might weigh but a matter of 2 lb. per 1,000 cubic feet. The difference between the 75 lb. and the weight of coal gas or hydrogen, plus the material for the balloon, gives the lifting power exerted. Colonel Templer made in 1884 a skin balloon with a capacity of 4,500 cubic feet. It has been used since then in making hundreds of ascents, and is still in good condition, able, when filled with hydrogen, to lift a man of medium weight. Since his entry into official life Colonel Templer has had built nearly 1,000 balloons of various kinds for the Army. He has built the first dirigible military balloon, has seen the birth and growth of kite flying for war purposes, and has with his own hands devised and schemed to construct practical aëroplanes. From the beginning he has maintained the practical utility of the dirigible balloon, even with existing means, and he has said that the aëroplane only awaits the coming of the suitable engine, or turbine, to make it a success. He has only held his hand of late with the aëroplane whilst he was seeking to perfect a suitable engine. We are, he declares, at the dawn of the era when aërial navigation will compete with the road motors. And Colonel Templer does not mean to discontinue his study and services to the cause of aërial navigation.

Lecture on Aërial Navigation, by Mr. H. Chatley, B.Sc.—An interesting lecture on the subject of aërial navigation was given by Mr. Chatley, at a meeting of the Junior Institution of Engineers, on February 7, 1908. The lecturer described the various types of aërial machines, but dealt more especially with aëroplanes, partly, as he stated, because a thorough understanding of their principles is necessary before other types can be rightly considered, and also because the most interesting results have so far been obtained from machines of this class.

The lecture was attended by many aëronauts, and in the discussion which took place afterwards, some very interesting information was given by Mons. Julliot about the French dirigible balloons, and by Capt. Ferber about his own aëroplane experiments. The lecture is published in the "Automotor" of February 15, 1908.

Cost of British Military Airships.—According to the Army Appropriation Accounts for 1906-7, the expenditure on "Nulli Secundus" up to March 31, 1907, amounted to £6,679 4s. 9d. Other interesting figures given are the sum of £9,091 9s. 6d., representing the value of articles manufactured and services performed at the balloon factory, which compares with the sum of £8,810 6s. 2d. for the year 1905-6.—"Automotor."

The Cordingley Motor Exhibition (Aëronautical Section).—This exhibition was held at the Agricultural Hall from March 21 to 28, and although the aëronautical exhibits were unfortunately by no means numerous, some interesting machines were on view. Messrs. Spencer Bros. showed various types of spherical balloons, and two full-sized cars, with motor and propellers complete, for use with dirigibles. They also had a very interesting collection of photographs, prints, etc. T. W. Clarke and Co. had a number of models of the Langley type on view, and the demonstration of the flying capabilities of the smaller ones was quite one of the features of the exhibition. One of the larger ones, which weighed 1.4 lbs., with an area of 3.1 sq. ft., had flown 400 feet in the open air, the motor used with it being 14 ozs. of twisted rubber.

Mr. Stanger's aëroplane was also an interesting one. Its sustainer consisted of one top and two bottom surfaces, the average spread being 7½ ft., while the average width was 3 ft. Total weight in order of march, 20 lbs. The motor weighed 8 lbs., and gave 1½-h.p. There were 4 cylinders, 1¼-in. bore, 1½-in. stroke, with 50 lbs. on the sq. in. compression. At 15 miles per hour the revolutions were 1,300 per minute. The best flight made was 200 yards (stopped by a tree), and the machine on that occasion rose from the ground between 40 and 50 yards from the starting point.

Of *light motors*, some interesting specimens were shown. That of Mr. Lambert weighed 15 lbs., and gave off 3.2-h.p, by R.A.C. rating, while two J.A.P. motors, weighing 53 lbs. for 8-h.p. and 130 lbs. for 16-h.p., showed that the question of providing motors suitable for aërial work is now attracting the attention of engineers in this country.

The aëronautical section was in charge of Messrs. Spencer Bros., who must be congratulated on the success of their efforts to make it interesting.

Mr. E. Wilson's Aëroplane.—Mr. Wilson has now nearly completed a full-sized machine, and hopes to be able to commence its trials very shortly. It is of the Farman-Delagrange type; main planes, 32 ft. by 6½ ft., spaced 6 ft. apart, arching hyperbolic, posterior margins, flexible. The box-kite front elevating planes are 10 ft. by 3 ft., while the tail in rear is of a similar type, 8 ft. by 5 ft. Total sustaining area = 528 sq. ft. The total weight in order of march is 600 lbs; which includes operator, a 16-h.p. engine, two hours' supply of fuel, and a pair of gyrostats (30 lbs. each), to facilitate lateral control. The propellers are twin screw, 6½ ft. in diameter, with variable pitch. Longitudinal stability is secured by the length of the machine (32 ft. all over), together with automatic adjustment of the front planes by operators' weight acting as a pendulum to counteract diving.

"La Patrie."—A very interesting detailed account of this dirigible is given by Chef de Bataillon Voyer, Corps du Génie, in the "Revue du Génie Militaire" for February, 1908. As is well known, the general design of this airship was the same as that of the "Lebaudy"; but in minor details there was really a good deal of difference. The author describes these differences very clearly, and also gives an account of the principal journeys made by "La Patrie," including the last one, when it was lost. He sums up the general results of the numerous trials as follows:—

1st.—The velocity of a dirigible of this type, though it has not been measured very exactly, is about 40 kilm. (24.8 miles) per hour, in still air.

2nd.—With an opposing wind of about 7 m. per sec. (15.5 miles per hour), one can count on a velocity of at least 30 kilm. (18.6 miles) per hour. In a 10 hours' run a distance of 300 kilm. (186 miles) might be traversed, the radius action being 150 kilm. (93 miles).

3rd.—The amount of ballast carried by this type and the capacity of its "ballonet," allow of an altitude of 1,500 m. (4921 ft.), with four aëronauts in the car.

The article is remarkably well illustrated, as there are twenty-three photographs showing the balloon in motion, entering and leaving its shed, etc.

Model Dirigible at the Surrey Masonic Hall.—Through the kindness of Mr. Whitby, members of the Society were able to see this model in action on January 24.

The envelope was 14 ft. long, 3½ ft. in maximum diameter, and held about 100 cubic feet of hydrogen. The inventor's description of his machine is as follows:—

"It is an entirely original, exceedingly simple, and very effective contrivance for aërial navigation. It has the power of raising an airship perpendicularly, or at any desired angle, without discharging ballast; lowering without releasing gas; propelling forwards or backwards with considerable speed; steering perfectly; coming to a standstill in mid-air; and turning in about its own length, without stopping or interfering with the motor for either of these manœuvres, which are all accomplished by a very quick and simple means. There are no "wings," gear-wheels, or any delicate attachments whatever, to require attention, add to the weight to be carried, or to get out of working order; and above all, *no rudder is required.*

The trials made before the visitors appeared to be satisfactory; the balloon moved from one side of the hall to the other, rose in a slanting direction and perpendicularly, and performed various manœuvres. The spectators were not allowed to examine the machine as the inventor desires to keep the arrangement for steering, etc., secret, so that it is difficult to give an opinion of its merits, but as far as could be seen the model did what was claimed for it.

Accident to the Gastambide-Mengin Aëroplane.—This machine is of great interest, as it is one of the very few that is almost an exact imitation of a bird. The "New York Herald" gives the following account of the accident:—

The Gastambide-Mengin aëroplane met with a serious accident at Bagatelle, in the Bois de Boulogne, yesterday morning, and, though M. Boyen, the driver, was not injured, the apparatus was considerably damaged. The machine has been out on several occasions of late, and, as is usual, the preparations and evolutions were watched by a crowd of interested spectators. A preliminary flight of fifty yards or so was made with success about eleven a.m., and as the motor was working regularly even better things were anticipated. The aëroplane was then taken to the Longchamps end of the field, and as soon as the propeller had been set in motion the apparatus dashed off towards Neuilly. After running along the ground for about a hundred mètres the plane lifted, and swaying considerably to right and left and varying its height every second, it rushed through the air for 150 mètres or thereabouts.

All at once the apparatus was seen to dive sideways and fall fast. The propeller and bow of the aëroplane cut into the earth, causing it to turn a somersault, and as it fell on its back there was a loud noise of rending timber. Spectators rushed up, expecting to find the driver crushed beneath the heavy frame and motor. Fortunately M. Boyen had seen the danger and had crouched into the well behind the motor. When the crash came he was sheltered from all harm and was able to crawl out between the ribs, to the amazement of the bystanders.

The machine was badly damaged, and will require considerable repairs. The wheels were twisted up and the propeller reduced to a tangled strip of iron. The tail was dislocated and the wing supports snapped.

The general impression concerning the Gastambide aëroplane is that similar accidents will happen regularly as long as the constructors refuse to fit a horizontal rudder or headpiece, whereby the height and angle of the machine may be controlled when in the air. With the aëroplane as it was yesterday, once the ground had been left, the only means possessed by the driver to control upward and downward movement was the motor.

Aëroplanes are hardly sufficiently advanced yet to rely upon the suppleness of a petrol motor for angle and height. The most skilful aëroplane driver finds he has enough to do in controlling the general direction of the apparatus by simple means, without having to trouble about the ignition and carburation of his motor.

It was further remarked that, however sound in theory the single plane aëroplane may be, every serious accident yet recorded has occurred with this type. M. Blériot, who was an interested spectator of yesterday's accident, has had three falls with his Langley flyer, M. Esnault-Pelterie, one or two, Comte Henry de La Vaulx, one at least, and now M. Boyen, with the Gastambide-Mengin aëroplane.

On the other hand, Mr. Henry Farman never had an accident of any importance with his cellular plane during the 250 flights accomplished. M. Delagrange also has escaped with one fall, due to the breaking of some wires. The movements in the air of all single plane machines appear to be too rapid for the beginner. This, at any rate, is the opinion of such authorities as Captain Ferber and Mr. Farman. To learn to fly, slow-moving types of aëroplane are essential. When the knack has been acquired, swifter and less stable systems may become possible.

The New French Army Dirigible.—According to the "Practical Engineer," the new airships that are to be built for the French Army, from the design of M. Julliot, are to be nearly twice the size of the "La Patrie," the balloon having a capacity of from 25,000 to 26,000 cubic feet of gas. Their length will be 328 ft., the greatest transverse diameter 37¾ ft., and, like all French airships, they will have an interior compensating air balloon to ensure rigidity of the outer envelope, which will be of double-lined guttapercha. There will be two 120-horse power motors, each driving two propellers, one pair being placed forward and one aft, and capable of producing a speed of thirty-five miles an hour, which, with the large lifting power of the balloon, and its ability for carrying a large quantity of provisions, petrol, etc., will enable the vessel to remain in the air for a prolonged period, and be a really formidable auxiliary of the army.

Mr. Horatio Phillips's New Machine.—This machine, which is now being experimented with, is described in "Engineering" for February 28, 1908. The sustainers are of the usual Phillips type, but in order to improve the stability, there are four of them instead of the single sustainer used in the earlier machines. The motor is an 8-cylinder air-cooled one of Mr. Phillips' own invention, and gives 20-22 brake h.p. at 1,200 revolutions per minute.

It is hoped to publish fuller details of this machine in a later issue of the Journal.

Foreign Aëronautical Publications.

(In this list a selection of some of the more notable articles is only given.)

L'AÉROPHILE.

January 1, 1908.—Bazin's Aëroplane, Beating Wings Type.—The Second Voyage of the "Ziegler" from Germany to England.

January 13, 1908. — Winning of the Deutsch-Archdeacon Prize by H. Farman.—The Journey of the "Ville de Paris" to Verdun.—From Rome to the Adriatic by Balloon.

February 1, 1908.—The Banquet to H. Farman.—Journeys Made by the "Ville de Paris," with Description of the Balloon.

February 15, 1908.—The Antoinette Motor.—H. Farman's Report to the Academy of Science.—The Efficiency of Screws in Air.—Capt. Ferber and Mons. Julliot at the Junior Institution of Engineers.

March 1, 1908.—The Elrich-Wels Flying Machine.—On the Pitching of Aëroplanes.—The Ellehammer Aëroplane.—The Gastambide-Mengin Aëroplane.

March 15, 1908.—Artillery Fire Against Dirigible Balloons.—The "Flying Fish."—Birds, Aëroplanes, and the Co-Efficient of Air Resistance.—The Aëronautical Meeting at Bordeaux.—The Gilbert Aëroplane.

L'AÉRONAUTE.

November, 1907.—Address by Mons. Armengaud.—Study of a Propeller.—The Farcot Motor.

THE AMERICAN AERONAUT.

January, 1908.—The Perfect Flying Machine; A Description of the Wright Bros'. Machine.—Zeppelin's Triumph.—The Government Flying Machine.

AERONAUTICS.

January, 1908.—The Government Dirigible and Dynamic Flyer.—The California Arrow.—Speed of American Dirigibles at St. Louis.

February, 1908.—Farman and the Grand Prix.—Experiments with Model Flying Machines, by E. W. Smith.

March, 1908.—The Value of the Motorless Glider.—"Curvature," a Relative Term, by G. A. Spratt.

February-March, 1908.—Motor Ballooning. Farman's Triumph.—The Use of Air Currents in Ballooning.—Airship Engines.

BOLLETTINO DELLA SOCIETÀ AERONAUTICA ITALIANA.

No. 1.—On Air Resistance.—Aërological Experiments in July, 1907.—Aviation, with Accounts of Various Flying Machines.—Dirigible Balloons.

No. 2.—Notes on the Autorotation of Symmetrical Plates in a Current of Air or Water.—The Winds in Italy.—Aviation.—Dirigible Balloons.—Scientific Chronicle.

No. 3.—Aërodynamics and Aviation (A Review of Mr. Lanchester's Work).—Visits to the Aërological Observatories of Lindenburg and Strasburg.—Aviation.—Dirigible Balloons.—Scientific Chronicle.—Sporting Supplement.

ILLUSTRIERTE AERONAUTISCHE MITTEILUNGEN.

January 3, 1908.—The Stability of Flying Machines.—Count Zeppelin.—The Jatho Flying Machine.

January 18, 1908.—The Loss of "La Patrie."—Miscellaneous Flying Machines.

February 3, 1908.—The Farman Success.—The "Wellin" Flying Machine.—Airship Motors: the "Antoinette."—Miscellaneous Notes.

February 18, 1908.—The Stability of Flying Apparatus.—The "Jatho" Flying Machine.—The First English Military Airship.

March 3, 1908.—The Stability of Flying Apparatus.—Miscellaneous Notes.

March 18, 1908.—The Stability of Flying Apparatus.—Miscellaneous Notes.

WIENER LUFTSCHIFFER-ZEITUNG.

January, 1908.—Airships in 1907.—Pierre Janssen.—The Loss of the "Patrie."—Aëronautical Maps.—Chanute and Etrich-Wels.

February, 1908.—Janssen.—The "Deutsch" Balloon; From Paris to Verdun.—Farman's Flight.

March, 1908.—About the "Zeppelin" Balloon.—A Visit to the Bros. Voisin.

Applications for Patents.

(*Made in January, February and March.*)

The following list of Applications for Patents connected with Aëronautics has been specially compiled for the AËRONAUTICAL JOURNAL by Messrs. BROMHEAD & Co., Patent Agents, 33, Cannon Street, London, E.C.

JANUARY.

84. January 1st. E. NEYEN. **Improvements in steerable aerodynamic airships.**

221. January 3rd. R. ESNAULT-PELTERIE. **Improvements in aeroplanes.**

528. January 9th. R. B. WOOSNAM. **Improvements in and relating to flying machines without aerostats.**

589. January 10th. J. Fozer and I. Foot. Improvements in airships.

1035. January 16th. J. L. Garsed. Improvements in or connected with aerial machines.

1258. January 18th. R. Esnault-Pelterie. Improvements in aeroplanes or flying machines.

1307. January 20th. A. Wunderlich. Improvements in or relating to motor flying machines.

1438. January 21st. A. Sainte-Beuve. Improvements in and relating to sheds and like structures for housing balloons and other purposes.

1449. January 21st. H. F. Phillips. Improvements in or relating to flying machines.

1569. January 22nd. W. I. Wilson. Apparatus or device for producing currents in fluids or acting inversely as a fluid current motor applicable for marine, submarine, and aerial propulsion and steering and for pumping, excavating, lifting, dredging and the like.

1593. January 23rd. M. Ferrero. Improvements in or relating to apparatus for aerial navigation.

1683. January 24th. O. Heeren. Improvement in aeroplanes.

FEBRUARY.

2493. February 4th. J. Wilson. Improvements in Airships.

2588. February 5th. L. Bleriot Improvements in or relating to balancing and steering apparatus.

2651. February 6th. W. P. Thompson. Improvements in flying machines.

2793. February 7th. D. F. Shearer. Improvements in or relating to flying machines.

2808. February 7th J. W. Dunne and A. K. Huntington. Improvements in and relating to aeroplanes.

2907. February 10th. W. F. Howard. Improvements in aeroplanes.

3029. February 11th. F. J. Alderson. Improved motive power for aeroplanes, balloons, and war projectiles.

3479. February 15th. N. Blood. Improvements in or relating to flying machines.

3538. February 17th. H. L. Todd. Improvements in airships.

3909. February 20th. H. Goodacre. Improvements in aeroplanes.

4054. February 22nd. H. H. Cooper. Improvements in or relating to the propelling apparatus of balloons, airships, and the like.

4055. February 22nd. J. G. H. Batchelor. Improvements in propellers and other bladed apparatus of balloons, airships, and the like.

4519. February 28th. A. H. Edwards. Improvements in or relating to aeroplanes or the like, or analogous machines or devices.

MARCH.

4677. March 2nd. J. Westaway. Improvements in or connected with aeronautical machines.

4769. March 3rd. S. H. Hollands. Improvements in aerial propellers and air-propelling screw fans.

4788. March 3rd. Motorluftschiff-Studienges. Improvements in a non-rigid air screw with fly weights.

4789. March 3rd. Motorluftschiff-Studienges. Improvements in a process and device for regulating the inclination of an oblong aerostat or airship by means of two air bags.

4813. March 3rd. C. Davis Improvements in means for use with balloons and other air vessels for indicating air currents.

4842. March 3rd. E. Von. Bernd. Improvements in wheels with rotary vanes suitable for airships, flying apparatus, and the like.

5193. March 7th. J. R. Porter. Improvements in propellers for use in air or water.

5220. March 7th. E. J. Lester and W. G. Beat. Improvements in and relating to airships and aeroplanes.

5310. March 9th. J. Chantraine. Improvements in flying machines.

5312. March 9th. S. Y. Beath and G. Whitehead. Improvements in aeroplanes.

5471. March 11th. G. Kerwat. Improvements in airships.

5508. March 11th. E. P. Alabaster. Improvements in aerial flotation.

5826. March 16th. G. Brewer. Improvements in grapnels, particularly applicable for use with aerostats.

5949. March 17th. A. Mutti and R. L. Mond. Improvements relating to apparatus for propelling vessels in air or water.

5977. March 17th. J. Cervelli, J. Molinari. and J. Bernasconi. Improved mechanism designed to be employed for the propulsion of ships, submarines, and aerostats as well as for the production of motive power by means of a current of air or water.

6159. March 19th. H. F. Phillips. Improvements in flying machines.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NOTICES OF The Aëronautical Society of Great Britain.

At a Council Meeting of the Aëronautical Society of Great Britain, held at 53, Victoria Street, Westminster, on May 11th, 1908.

1. The following gentleman was elected a member of the Council:

MR. W. F. REID, C.E.

To date April 28th, 1908.

2. The following gentleman was elected President of the Society, for a period of three years:

MR. E. P. FROST, D.L. (Cambs.).

To date May 2nd, 1908.

3. The following gentlemen were elected members of the Society:

MR. HERBERT CHATLEY.
MR. WILLIAM BENNETT.
MR. HERBERT EDWARD BROWN.
MR. THOMAS O'BRIEN HUBBARD.

To date May 11th, 1908.

4. It was decided to have an outdoor meeting of the Society during the month of July, 1908, if suitable arrangements can be made. The exact date when fixed, will be duly notified to members, by circular.

5. It was decided to award the Society's medal to:

(1) The author of the best paper published in the Journal during the year 1908, provided that the Council considers the paper suitable for such an award.

(2) Members doing useful research work for the benefit of the Society. (No special period was fixed for this award.)

MISCELLANEOUS NOTICES.

1. It is notified for the general information of members that a "London Balloon Company, Territorial Forces," is now in process of formation.

The general conditions of service are:

Term of enlistment, 4 years. Age limits, 17 to 35 years. Drills per annum, about an evening once a fortnight.

Annual training in camp, not less than 8 days, or more than 15 days.

Members requiring fuller information about the Company should apply to

H. E. HOLTORP, Esq.,
The London Balloon Company,
Drill Hall, Regency Street,
Westminster, S.W.

2. The following books and publications have been presented to the Library:

By COLONEL TROLLOPE (late Grenadier Guards).
"La Conquête de l'Air" (current numbers).

By M. J. ARMENGAUD (Jne.).
"La Problème de l'Aviation et sa solution par l'Aéroplane."

By HORATIO PHILLIPS, ESQ.
"Mechanical Flight, etc."

By H. F. LLOYD, ESQ.
Photo-Postcards of Flying Machines.

3. The Press cuttings supplied to the Society during June quarter are now available for issue. Any member who wishes to have them should apply to the Hon. Secretary on July 20th, 1908. They will be given to the first applicant.

4. Members and others contributing to the Journal are requested to kindly observe the following rules when drawing up their MSS.:

(*a*) Write on one side of the paper only.

(*b*) Leave a margin one inch wide on the left-hand side.

(*c*) Draw diagrams, etc., on very white paper with very black ink, as this greatly simplifies reproduction.

(*d*) Forward their communications to the Hon. Secretary at least 14 days previous to the date of the meeting at which the paper is to be read. Papers containing diagrams, sketches, etc., which it is required to show on lantern slides, should be sent in as early as possible.

GENERAL MEETING.

The second meeting of the 43rd session of the Aëronautical Society of Great Britain was held at the Royal United Service Institution on May 27th, 1908. The chair was taken by the President of the Society, Mr. E. P. Frost, D.L. (Cambs.).

The PRESIDENT: Ladies and Gentlemen, In the name of the Aëronautical Society of Great Britain—the oldest Aëronautical Society in the world—I beg to extend to our foreign visitors a very cordial welcome, and especially to those gentlemen who have come here this evening to assist us at this our 43rd Session. We rejoice to find that others of foreign lands are in the same line of thought and action as ourselves, and we hope that such joint and friendly action may bring about aërial navigation that may astonish the world. I do not mean, of course, such disasters that have recently happened in California, which we deeply regret, but I trust these failures may only lead later on to success. I am sure we all wish to offer to Mons. Farman and Mons. Delagrange and others our congratulations and our thanks for so courageously and so openly being pioneers of schemes towards the achievements we have at heart. I beg leave also to thank the engineers and motorists for the very powerful and light engines that they offer us now. Such equipment, such engines, that neither love nor any amount of money could have brought us twenty or thirty years ago, when I was busy on a big machine. Gentlemen, these friendly international gatherings should result in great things for the benefit of all. But, at the same time, we devise means of throwing explosives from above to annihilate each other's armies, and, I suppose, as long as there is any chance of any fighting we must do so. But I cannot let this opportunity pass without hoping that these international gatherings will not only lead to aërial navigation without the need of explosive throwing, but also to a scheme little talked about, but a great deal, perhaps, thought about, to bring about an international union that will do away with the necessity of fighting amongst civilised nations, and do away with the necessity of costly, ever increasing costly, armaments. But as we have many papers to go through this evening I must detain you no longer, and I will call upon the gentleman who will read the first paper.

In the absence of the author, the Hon. Secretary read the following paper:

The Art of Flying.

By V. SILBERER, President of the Vienna Aëro Club.

Seven years ago, when the first number of my "Wiener Luftschiffer-Zeitung" (Vienna Journal for Aëronauts) appeared, considerable surprise was evinced in some quarters by the sub-heading, "Special Journal for Aëronautics and the *Art* of Flying."

"The art of flying?"

Well, to-day there are but few who do not admit that the words were correctly chosen, though the title at that time may have been somewhat premature. To-day not one of those, perhaps, who, with an attentive eye, have followed the many recent attempts at aviation, will deny the fact that "Flying" is an art indeed.

It is, however, an art that is still in its very earliest infancy, an art whose greatest artists are but too well aware that they have yet everything to learn and that in spite of the jubilant cry of theoreticians about the problem being solved.

But the most remarkable point in the matter is that the great progress and success attained in so short a time in aviation and with dirigible balloons is not attributable to the conception of aëronautics or aviation at all, but to the manufacture of engines for motor cars. These modern light motors were originally constructed to meet the exigencies of automobilism, but are at present also employed for carrying out the ideas of aëronauts and aviators in the domain of dirigible balloons and flying machines.

If our poor old Kress here in Austria, at the time when he was in a position to spend the money needful for his "Kite-flyer," had been able to obtain one of the modern light motors, his labours and attempts would no doubt have been rewarded with greater success.

The admirably light motors with which aviators are at present provided may assuredly be regarded as the chief incentive to the construction of numerous flying machines which, whatever may be said against them, enable their inventors and constructors to effect real flights, though ever so short and uncertain, ever so perilous and unreliable.

In all these attempts and trials, however, it will be seen that a motor, whatever its weight may be, and a flying machine or aviator, however well constructed and furnished with such a motor, will not suffice to enable a mechanical contrivance to wing its flight successfully, but that there is a third and all-essential condition, and that is—*the art of flying*, which he who makes aviatic attempts of this kind will have to learn at the daily and hourly hazard of his sound limbs and life, even with the most promising machine.

This art, more than any other, will require active energy, courage, decision of purpose, a quick eye and clearness of judgment, utmost presence of mind; also an enormous amount of patience, assiduity and perseverance, and finally, efficient training and physical dexterity.

The practical aviator must be endowed with a portion of these qualities at the very outset of his experiments, namely, all the above-cited moral virtues, in addition to general manual skilfulness and bodily aptitude. Adroitness in managing the technical contrivances and an accurate knowledge of the working capacity of his machine in the air, the peculiarities of its movement, its reaction on all possible influences while flying, the influence exercised by the aviator's different operations upon the action of the machine, the manner of steering, the force needed for the different operations, the innumerable points to be taken into account; all these will, only by long-continued, indefatigable practice on the part of numerous incipient aviators, lead to such experience as can be embodied in general principles of aviation, and which will save much trouble and risk to future beginners.

These pioneers and truthfinders, however, who are now exploring this alluring "terra incognita," from which as yet no beacon of practical experience is sending forth its cheering light, have set themselves a sky-aspiring task as stupendous as it is difficult.

Even the trials and preliminary practice hitherto show to what extreme dangers to limbs and lives the disciples of the fascinating art of aviation must expose themselves. Even now, when—most reasonably—they are only trying to glide cautiously along on quite even ground, at a height of but a few metres, downfalls of the gravest and most formidable kind occur. More than one of the bold aspirants to the realms of thin air has encountered accidents in which his life was only saved as by a miracle. But how will it be when once they go beyond the first preliminary attempts? When they are placed before the task of passing from these incipient experiments made, so to say, in the workshop, on the even, unobstructed practising ground, to the infinitely graver and more difficult evolutions above the ordinary pathways of earth, at a height which enables us to rise above terrestrial obstacles, to soar above trees, forests, buildings, cities? What peril of life to the aviator if the motor should stop or any part of its propelling mechanism fail!

By far the majority of the apparatus now used for experiments, such as all those constructed with a cellular or box-like arrangement, all of which maintain themselves in air only so long as they are propelled with great velocity, do not sink slowly when the motor stops, but are precipitated to the ground like a lump of lead.

How many, then, will be the accidents, how great will be the loss of life, before sufficient experience has been acquired for producing an apparatus which does not capsize or lose its equilibrium under any circumstances?

And in the event of a sudden failing of the propelling force, of the steerage or other vital part of the mechanism, will it be possible in these trials with the present apparatus of small superficies, at some considerable height, to effect a smooth and safe landing and to preclude catastrophes through contingencies of any kind?

Let us, then, pay homage to the men who, with iron energy and at the constant risk of their lives, devote their services to the development of aviation and to the acquisition of this newest but most serious and perilous art—the art of flying!

The PRESIDENT: Is there any gentleman who wishes to say anything on the paper we have just heard? (No response.) We will pass on to the next paper. In the absence of the author, the Hon. Secretary read the following paper:

Recent Aëronautical Progress in the United States.

By O. CHANUTE.

The public attitude in the United States in 1906 and 1907 concerning aërial navigation has been one of expectancy and apathy. The announcements of the marvellous success achieved by Wright Brothers, which every investigation seemed to confirm, must have deterred many searchers from experimenting at all, until they knew how much remained to be accomplished in aviation.

In ballooning very little new work was undertaken. The United States Government having neglected aëronautics until quite lately, the only reward to be expected by inventors was from public exhibition, and for this only small sizes of dirigible balloon were within the means of promoters. Hence the speeds (depending as they do upon the power of the motor which it is possible to lift) have not been sufficiently great to overcome the wind upon all occasions. A number of dirigibles have, nevertheless, been shown in action; those of Mr. Stevens, Mr. Knabenshue, and Mr. Baldwin, mostly in connection with amusement parks, but fresh public interest in the subject was excited by the international balloon race from St. Louis on October 21st, 1907, of which full information has been published in many journals. This public interest, together with the reports of the great progress and activity of the European Governments, spurred the United States Signal Corps to issue invitations on December 17th, 1907, for proposals for dirigible balloons, to be opened January 15th, 1908.

Seven bids were received, but as they proved unacceptable, new proposals were called for, with some modifications, to be opened February 15th, 1908. Eleven proposals were then received, and an award was made to Thos. F. Baldwin for a dirigible balloon to be delivered in 150 days at a price of £1,350. This is now being built. It is to be 84 feet long by a diameter of 16 feet and a capacity of 17,000 cubic feet. The motor is to be of 30-horse power, 4 cycle, 4 cylinders of cast iron copper-jacketed, water cooled, and with magneto ignition, built by Curtiss. The probable weight is 200 pounds, and the speed required is 20 miles per hour. While this dirigible will be quite inferior in size and in speed to those now existing in Europe, it will be of value in training a corps of aëronauts for the management of larger vessels, perhaps to be built upon lines of less resistance, as indicated by some recent achievements in water navigation.

Meanwhile Aëro Clubs have sprung up like mushrooms all over the country. The leading one still is the Aëro Club of America in New York, which was organised in 1905. It has held several exhibitions, has promoted the publication of an interesting book, "Navigating the Air," the establishment of a correspondence School of Aëronautics by Mr. Triaca, and an effort is now being made in connection with the Club to raise a fund of £5,000 to be offered in prizes for Aviation.

In St. Louis and in Chicago local aëro

clubs propose to organise balloon races to be held in 1908. In these and other cities, members are encouraged to engage in the sport by owning and riding balloons themselves, and it remains to be seen how long the enthusiasm will last.

Two monthly Aëronautical Magazines have been started, one in New York and one in St. Louis, but it is yet to be ascertained how well they will be supported.

The Jamestown Exposition of 1907 organised an aëronautical exhibit which amounted to but little, as well as an Aëronautical Congress which brought out few papers, but searchers have been building apparatus upon various designs to be experimented with in the summer of 1908.

The most distinguished of these is Dr. Alexander Graham Bell, the inventor of the Telephone, who has been experimenting with his tetrahedral kite. He tested on December 6th, 1907, his gigantic man-lifting kite "Cygnet," consisting of 3,393 wing cells, presenting 1,966 square feet of oblique surfaces, and weighing with the floats and passenger an aggregate of 600 pounds. This was towed into the middle of a lake and raised against a wind of 21 miles an hour by a tug-boat. It exhibited that perfect stability which all previous experiments indicated, and upon the wind's dying away it descended gently from a height of 168 feet, but was broken on striking the water. It is to be tested again during the summer of 1908 with a view to eventually applying a motor. There is no question as to the automatic equilibrium of this form of apparatus, but it is possible that the inferior lifting power of the oblique surfaces and the resistance of so many front edges will make the design less favourable for a flying machine than other forms.

Dr. Bell then generously provided the means (he gives the credit to his wife) and organised the so-called "Aërial Experiment Association" with its headquarters at Hammondsport, New York, to give his assistants a chance to experiment their own ideas. The first result was the construction of the motor-driven aëroplane "Red Wing," chiefly designed by Lieutenant T. Selfridge, which made its trial trip on sleigh runners on the ice of Lake Leuka on March 9th, 1908. It is a double-decked apparatus 43 feet across, the surfaces being arched both fore and aft and from tip to tip; the upper aëroplane being bowed downward somewhat in the attitude of the gull and the lower aëroplane, which is 6 feet shorter, being bowed upward somewhat to the attitude of the vulture when soaring. The total surface is 386 square feet and the total weight, including the aviator, is 570 pounds. It is driven by a Curtiss motor of 40-horse power, actuating a screw propeller.

At the very first attempt the apparatus left the ice after travelling only 200 feet and flew a distance of 319 feet from the point where it left the ice to the point of descending. It alighted somewhat clumsily and broke one strut, this being the first public exhibition of the flight of a heavier-than-air machine in America. The melting of the ice prevented further experiments, but the machine was placed on wheels and a telegram announces that experiments were resumed on May 13th. The other assistants, Mr. F. W. Baldwin and Mr. I. A. D. McCurdy, are to have their innings later.

Mr. J. W. Roshon, of Harrisburg, Pennsylvania, has also built a motor-driven aëroplane, but only preliminary experiments have been made so far.

Mr. O. G. Luyties, of Baltimore, Mr. J. N. Williams, of Derby, Connecticut, and Mr. W. R. Kimball, of New York, are building helicopteres, while Mr. Israel Ludlow, Mr. G. A. Spratt, Mr. A. Q. Dufour, and Mr. L. J. Lesh are experimenting with gliding machines, the last-named being a 16-year-old lad of great promise, who has flown on a glider for 6 miles over the St. Laurence River towed by a motor boat.

The main interest, however, attaches to the pending United States Government tests of flying machines which are under contract for delivery next August. On December 23rd, 1907, the United States Signal Corps issued invitations for tenders, which produced much amazement. European and American journals have said that these specifications assume that flying machines are almost a usual method of transportation, and that the terms are so exacting as to seem unreasonable. The Signal Service officers answer that the specifications were drawn up after interviews with some of the inventors and merely cover what they said that they could perform, while some clauses were added to prevent the Government's being trifled with, and that the tests will be conducted with judicious reason and liberality. More especially does this apply to the granting but three trials each for the speed test and the endurance test of one hour, which might be defeated on each occasion by some fortuitous and trifling circumstance.

However, under these specifications, no less than 41 proposals were received, but only three were found to comply fully with the requirements. Awards were accordingly made on February 8th, 1908, to the following bidders:

J. F. Scott, Chicago, Ill., price £200, delivery in 185 days.

A. M. Herring, New York, price £4,000, delivery in 180 days.

Wright Brothers, Dayton, O., price £5,000, delivery in 200 days.

Mr. Scott has since withdrawn his proposal, and Mr. Hering and Wright Brothers are building machines.

For about 15 years Mr. Herring has been continuously working towards a solution of the problem of Aviation, and the present undertaking is to bring either the fruition of all his endeavours or the defeat of all his hopes. He was assistant to Professor Langley in the building of his first steam flying models, and to Mr. Chanute in carrying on gliding experiments. Since 1897 he has been operating for himself, finding this more congenial than to experiment under the direction of others. He is said to have now produced two gasolene motors of 22-horse power each, weighing somewhat less than 21 pounds, and a new mode of automatic regulator to neutralise all the turmoils of the wind. Also a working model which is said to have flown 22 consecutive circular miles. He expects to obtain a speed of about 50 miles per hour with the machine which he is building for the Government, and has notified it that he will be ready to make the tests in June. It is to be earnestly hoped that they will not be disappointing.

The performances of Wright Brothers have been viewed with incredulity because of the mystery with which they have been surrounded in the hope of a rich money reward, yet it is now generally conceded that they have accomplished all that they have claimed, *i.e.*, to have made a first dynamic flight in 1903, to have mastered circular courses in 1904, making 105 flights, the longest of which was three miles, and to have obtained thorough control over their apparatus in 1905, making 49 flights, the longest of which was of 24 miles, consisting of 30 sweeps over a circular course at an average speed of 38 miles an hour. Since then they have made no flights, having been engaged in negotiations with a view to marketing their invention.

Now they have made a contract with the United States Government to furnish a flying machine under those formidable specifications. They set to work at once. They have built parts of more than one machine, so as to guard against bad breakages, and have returned to their old experimental grounds near Kitty Hawk, North Carolina. This is situated on a long sand spit, two or three miles wide, between the waters of Pamlico Sound and the Atlantic Ocean. It is about as inaccessible a spot near civilisation as can well be, being almost a desert, occupied by a few fishermen and a Government life-saving station. Near the camp is "Kill Devil Hill," a cone of drifted sand about 100 feet high, on which former gliding experiments were made.

Here the Wrights have established themselves and begun their practice, for it is only by strenuous practice that the mastery of the air is to be obtained. They are said to be proceeding with great caution, testing every part and peculiarity of the machine, the longest flight yet reported (May 14th, 1908) being eight miles, followed, however, by a serious breakage on landing, said to be due to a false manœuvre, in consequence of some change in the location of the levers which control the rudders. It is stated that the wreck was so complete that the parts will be shipped back to Dayton, Ohio, where the craft will be rebuilt.

The Wrights are understood to have until August 27th to deliver their machine to the Signal Corps for testing, so that there will be sufficient time to resume practice after the machine is repaired. Whether this practice will take place on the same ground or elsewhere is not known. The spot is very secluded, but the ubiquitous reporter has found the camp and is sending "news," both true and untrue, to the great annoyance of Wright Brothers, from Manteo, a little town on Roanoke Island, the seat of Sir Walter Raleigh's first settlement in 1585. This is about six miles across from the camp.

An amusing struggle has resulted. The reporters are frantic for information, and the Wrights most determined that no description be given of their apparatus. It is probable that many contradictory cablegrams will have been received in Great Britain when the present paper reaches the Hon. Secretary.

Wright Brothers stand a fair chance of passing the tests and having their machine accepted. They may be defeated by some accident during the preliminary trials or the formal tests, but the present writer is sure that all the members of the Aëronautical Society of Great Britain will join him in the hope that the best of luck will attend the demonstration.

The PRESIDENT: The paper is open for discussion. Is there any gentleman who would like to say anything? (No response.) I will call upon Colonel Fullerton to read his paper.

Notes on the Phillips Flying Machine.

By COLONEL J. D. FULLERTON, R.E.

As Mr. Phillips is unable, through stress of work, to write an account of his machine, I have prepared a few notes about it, and he has kindly revised them.

The machine is of a quite unusual type, and the study of its design and general system of working will be found of great interest.

In order to understand the principles upon which it is based, it is desirable to first examine briefly the early experiments carried out by Mr. Phillips and the results obtained from them.

EARLY EXPERIMENTS.

In 1885 (see "Engineering," August 14th, 1885) he tested a number of surfaces of the types shown in Fig. I. by fixing them in a sort of wind trunk, through which air could be passed at any required velocity. Assuming a fixed lift, he then measured the drift and velocity when the surface was inclined at the most favourable angle, and from the data thus obtained the following table was drawn up:

TABLE I.

Description of Form.	Velocity of Air. Ft. per sec.	Dimensions Inches.	Lift. Ounces.	Drift. Ounces.	Angle.
Plane.. ..	39	16 × 5	9	2·00	15°
No. 1.. ..	60	16 × 1½	9	0·87	Small; not greater than 5°
„ 2.. ..	48	16 × 3	9	0·87	
„ 3.. ..	44	16 × 3	9	0·87	
„ 4.. ..	44	16 × 5	9	0·87	
„ 5.. ..	39	16 × 5	9	0·87	
„ 6.. ..	27	16 × 5	9	2·25	
Rook's wing	39	0·5 sq. ft.	8	1·00	

Mr. Phillips' explanation of the action of the air when passing over and underneath forms of the type above tested is as follows:

"The object of these blades (forms) is to deflect upward air that comes in con-

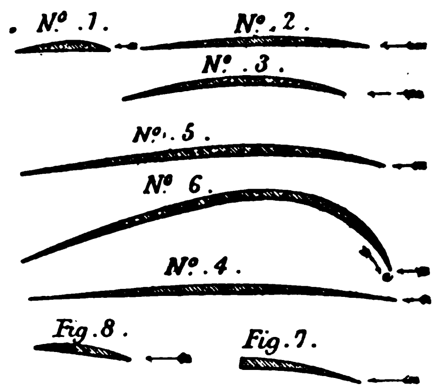


Fig. I.

tact with their forward edges or portions in such a way as to cause a partial vacuum to be created over a portion of the upper surface of the blade, thus aiding the air below to support the weight."—See Patent Specification, No. 13768 of 1884.

The general results of Mr. Phillips' experiments with a very large number of surfaces of different shapes may be summed up as follows:

1st. Slightly curved and arched surfaces of the types shown in the Figs. 1

and 8 have a far greater efficiency than flat ones.

2nd. Surfaces in which the width (perpendicular to the line of motion) is much greater than the length (in the line of motion) are much more efficient than surfaces in which these dimensions are reversed.

3rd. The maximum effect from any surface was obtained, when the amount of concavity of the lower side, and the corresponding convexity of the upper surface, bore a certain definite proportion to the velocity of the air current.

An inspection of Table I. shows that the best results were obtained with form No. 5 as with a velocity of only 39 ft. per sec.

$$\frac{\text{drift}}{\text{lift}} = \frac{1}{10{\cdot}84}$$

or, in other words, the lift was more than ten times the drift.

Mr. Phillips was not, however, satisfied with this, and continued his experiments. Eventually he designed some shapes, which gave a lift = 20 times the drift (see Fig. II.), and it is forms of this and similar types that he uses in his flying machines.

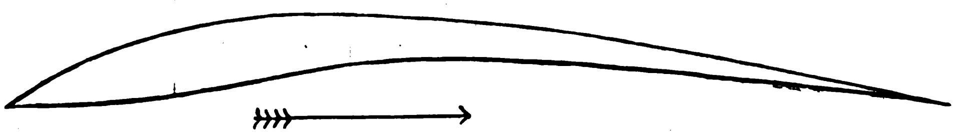


Fig. II

EXPERIMENTAL MACHINE.

TYPE 1893.

See Fig. III.

Patent No. 13768 of 1884.

Patent No. 20435 of 1890.

Patent No. 13311 of 1891.

The general construction of the machine was as follows:

General Dimensions.—Length, 25 feet; breadth, 22 feet; height, 11 feet; total weight, including 72-lb. load, 420 lbs. It was not intended to carry a passenger, but to show the principles of Mr. Phillips' invention. Lift per square foot, 3 lbs., and per B.H.P., 70 lbs.

Sustainers.—These consisted of 50 wood slats, something like the slats of a Venetian blind in shape, fixed in a steel frame, 22 feet long by 9½ feet in height. The slats themselves were 22 feet long, 1½ inches wide, curved in section to the peculiar shape advocated by Mr. Phillips. The area of the sustaining surface was 136 square feet, the slats being slightly inclined when the machine was in motion; total weight of the sustainers, 70 lbs.

Suspenders.—The sustainer was fixed to the car by wire guys, care being taken to have the frame truly vertical.

Car.—This was a sort of skeleton framework formed by two planks on edge. Just under the sustainer the planks were 3 feet apart; in rear the distance was 1½ feet, while in front the space between them allowed of the front wheel working easily in it. There were two other wheels, 1 foot in diameter, under the frame; weight, 60 lbs.

Motor.—An 8 to 9 I.H.P. compound steam engine, with coal fuel. The boiler was of phosphor-bronze, 1 foot in diameter and 1¼ feet in height. Steam pressure, 180 lbs.; revolutions, 400 per minute. Total weight, with fuel for about half an hour, 200 lbs.

Propulsion.—One 2-bladed screw, wing-shaped, in section; diameter, 6 feet; pitch, 8 feet; projected area, 4 square feet. The thrust, standing still, was 75 lbs., and was probably about 70 lbs. when in motion. The B.H.P. was about 6-H.P., and the efficiency of the whole very high.

Steering in a Vertical Plane.—There was no arrangement for this; see trials below.

Equilibrium Apparatus.—See trials below.

Rising and Landing.—See trials below.

Trials.—As it was not possible to put a passenger in the machine to control it, it was attached to a central post by wire guys and run round in a circle of 100 feet in diameter. The track consisted of wooden planking about 4 feet wide. The apparatus was started under its own steam. As the velocity increased, the pressure of air under the slats caused it

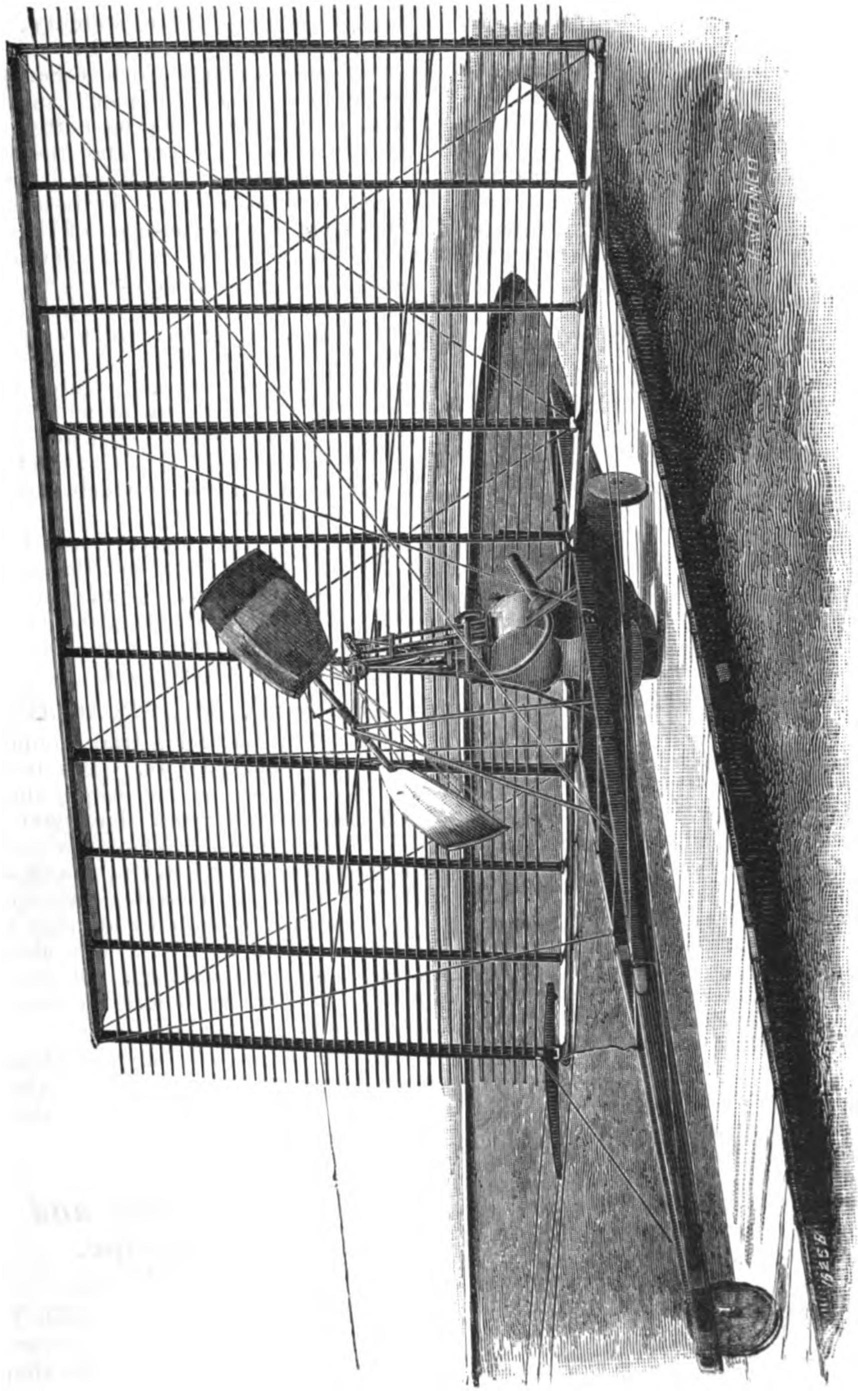


Fig. III.

to rise some 2 feet or 3 feet above the track, finally coming down again when the velocity fell off. The longitudinal equilibrium was found by trial, viz., shifting the weights until the front wheel barely touched the track. The best trial seems to have taken place on June 19th, 1893, when, with a speed of 40 miles an hour and load, 385 lbs., all the wheels were off the ground for about 2,000 feet of the distance traversed. The pitch of the propeller had been slightly reduced for this trial; it was noticed that when flying the slats appeared to be very nearly horizontal.

FULL-SIZED MACHINE.
Type 1904.

This machine is shown in Fig. IV It was very similar to the experimental machine of 1893, but was large enough to carry a passenger. The total weight was, with man, 600 lbs., and the machine lifted when a velocity of 50 ft. per sec. was attained; the brake H.P. was 22.

On trial, the longitudinal equilibrium was found to be defective; Mr. Phillips, therefore, prepared a new design.

FULL-SIZED MACHINE.
Type 1907.

This design is shown in Fig. V. It is similar to the 1904 type, but there are four sustainer frames instead of one.

The total weight is 500 lbs. (man 150 lbs. extra); the machine lifts at a velocity of about 30 miles per hour; brake H.P. of the motor varies from 20 to 22 H.P. at 1,200 revolutions. On trial the longitudinal stability was found to be very satisfactory.

The general dimensions can be judged from the propeller, which is 7 ft. in diameter.

REMARKS.

These experiments are very interesting. Like other aviators, Mr. Phillips has been much hampered by the want of a good experimental ground, but it is to be hoped that this difficulty will be overcome, and that he will be able to continue his meritorious work.

The President: We are very much obliged to these gentlemen for their papers. (Applause.) Is there any gentlemen who wishes to say anything on the paper just read?

Mr. W. F. Reid: I think it must be agreed by all of us that, although this type of aëroplane may offer certain advantages with regard to stability, such a form must undoubtedly be extremely heavy as compared with other planes which are used in most machines. Whether it would not be better if the slats were made wider and there were fewer of them is a question. I am inclined to think it would be better. We should get the advantages of the Venetian blind system with, perhaps, a diminution of weight. It seems to me that is the one difficulty with this form of machine. Of course, what we particularly do want nowadays is actual experiments. We are much indebted to Mr. Phillips for the results of what he has actually tried. We are glad to hear that he has succeeded in rising from the ground with a machine which appears to me to be rather heavy.

Major Baden-Powell: Could Colonel Fullerton tell us how far the machine flew through the air. I understood him to say it did rise over the ground.

Colonel Fullerton: I do not know exactly, but I will ascertain.

NOTE BY MR. PHILLIPS.

The field I had for a trial ground was about 400 yards across. The machine was started close to the hedge, and rose from the ground when about 200 yards had been covered. When the machine touched the ground again, about which there could be no mistake, owing to the terrific jolting, it did not run many yards. When it came to rest I was about 10 yards from the boundary. Of course, I stopped the engine before I commenced to descend.

The President: We shall be pleased to hear any other gentleman. (No response.) We will go on with the next paper.

Stable Progression and the Wedge Shape.

By R. Balston, Esq.

On the last occasion on which I had the honour of reading a paper before this Society I took as my subject the shape of stability, of bodies falling through the air. I endeavoured to show that if you wish

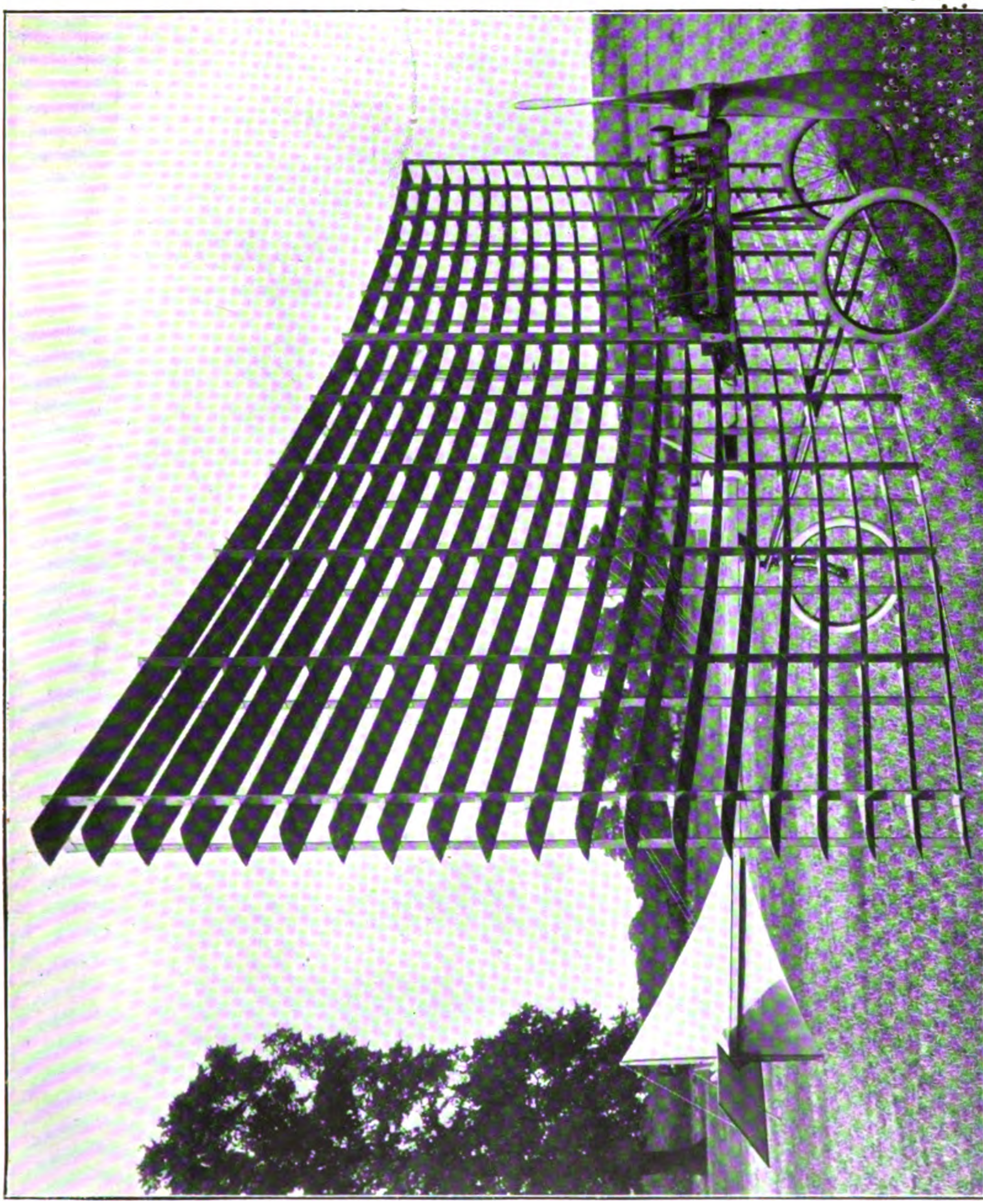


Fig. IV.

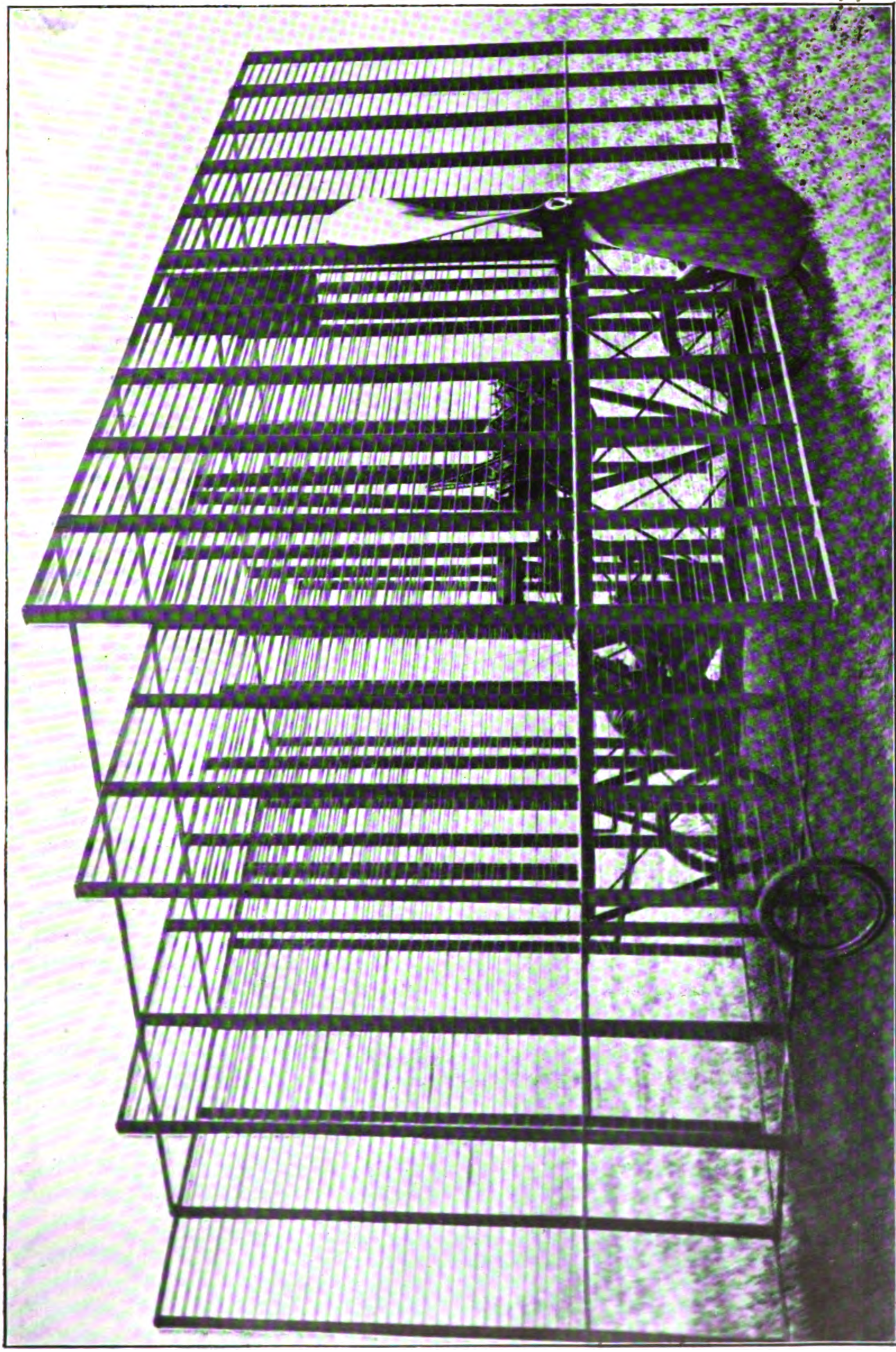


Fig. V.

to make an apparatus which will descend in perfect equilibrium you must do something more than give it lifting surfaces with the usual dihedral angle; that it is, in fact, necessary to extend this plan and form them with an upward angle in all directions from an approximately central point, thus making them take a form like the surface of an inverted cone.

To-night I want to ask you to look at stability from another point of view. A flying body, to be of practical value, must have, in addition to equilibrium of buoyancy, another equilibrium, viz., that of progression, *i.e.*, it must have a strong tendency to proceed with the same point of its framework always to the fore.

You will at once admit this necessity, I feel sure, for a moment's consideration of the subject will convince you that a machine which makes a practice of going on occasions broadside or stern first will never be satisfactory in the hands of anyone but an acrobat. Such a method of progression would closely resemble the behaviour of a heavy motor car on a greasy road, and no one who is familiar with the helpless feeling which a bad sideslip engenders will desire to repeat the experience in the air.

Inventors in the past have provided for this requirement which, for want of a better name, must be called stable progression, only in such a way as to produce very inadequate results; but there is a plan in existence whereby this equilibrium may be maintained economically as far as other factors of the problem of flight are concerned, which shows signs of coming into fashion, since it has appeared in one or two recent experiments.

Before explaining this new method let me first run over what has been done in this connection in the past. By this means you will be enabled to form a clear conception of the way in which the correct solution of the problem is being evolved. From the date of the first experiment down to some two or three years ago it is one long story of the development of the rudder or tail, *i.e.*, a tail of the type common to such birds as the blackbird, which trails this appendage, as it were, a long way behind its wings. It is a development which has been persevered in regardless of the fact that such birds are, without exception, flyers of a very second-rate order, and not to be compared to the swifts or to some of the gulls, whose tails are of so embryonic a nature that they can be of little or no account in flight.

In the earliest recorded experiments, of which the picture of M. Retif de la Brettonne is a good instance, the idea of stable progression never enters the minds of artists. No effort is made to keep the legs of the flying man behind him as he advances, and the only idea seems to have been to keep them below him, for, as you see in this particular instance, a basket is provided which was, no doubt, intended to be filled with stones.

Later on we come to the exploits of men like Oliver, of Malmesbury, who flourished in the 11th century. At first he placed very little importance upon the possession of a tail, as he attempted a flight from the top of a tower without one. At the same time the idea that something of the sort was necessary was beginning to dawn, for, on falling and injuring himself, he accounts for the accident by the fact that he had failed to attach a tail to his legs.

From that time forward no historical designer, whose drawings show a due consideration of the horizontal movement of his machine, ever fails to give the tail a prominent place, and though much else may be missing, in such sketches as, for instance, one of Leonardo da Vinci's drawn about the year 1500, the tail is always fully displayed.

Looking over the drawings of all early designers it becomes quite clear that they considered one particular form the right one in which to dispose their planes. They stretched out their wings in a straight line on either side and spread the tail behind, no doubt imagining that by this means they were copying Nature. In reality this plan is scarcely stable at all, and a close scrutiny of the position taken in actual flight by the wings and tail of a bird will reveal a fundamental difference from the imitations produced.

The most stable form for travelling forward is undoubtedly to be found in the dart which never attempts to proceed in any other position except point first. Butler and Edwardes, in 1867, no doubt perceived this when they patented an invention resembling one, and though this was doomed to failure owing to the inefficiency of such long planes when driven lengthways through the air, which makes them unable to carry anything so heavy as a motor, nevertheless, it shows that attention had been given to the fact that flying machines are intended to move forward. It is, in fact, this form which gives us the key to the real shape adopted by Nature, and probably we cannot do better than copy it into our machines in the modified form to be found in birds.

The two shapes of efficiency are—for lifting purposes a long, narrow plane driven with its long edge first, and for purposes of progression a wedge-shaped plane like the dart. Nature manages to combine these so as to get the advantages of both. She makes her planes in flight take the form of a broad wedge. A paper model on these lines at once justifies itself by its appearance in flight.

Following the subject historically, when we come to the 19th century we still find the same disposal of the aëroplanes adhered to as had existed throughout. A picture of Henson's machine designed in 1842 shows this to advantage. The front planes are placed in one long line, and a capacious tail juts out far behind. Le Bris' machine of 1857 shows a similar arrangement, only carried out rather more artistically, and the tail is not quite so large. His machine of 1867 is just the same.

In 1871 a notable exception to the general view came out. This was an apparatus invented by M. Danjard. As he speaks of arranging the lifting surface so as to cleave the air he must receive credit for an attempt, at least, to produce the form required, though there is not much to be said for the way in which he carries out the idea. The idea of cleavage is not carried sufficiently far to take in the whole plan of the lifting surface. It stops half-way.

I must apologise to our German visitors for not producing a slide showing the wing plan of a machine invented by Herr Friedrich von Drieberg in 1843. I was not aware of his drawings until too late to obtain a slide, but you will find a picture in Major Moedbeck's Pocket Book of Aëronautics, page 282, which illustrates one of them. He has the best idea of the shape in question of anyone up to that time.

Apart from those inventors whom I have mentioned I can find no others who seem to have given the idea of "cleaving the air" a thought until our own day is reached, and even now the idea is not general, for we have lately seen a most successful effort carried through on the old system, for the machine with which Mr. Farman won the Deutch-Archdeacon prize has the square front adopted by all those who pin their faith to the box kite form of machine, and even in the new one which is reported to be building for him this square front, I am given to understand, is not departed from.

To turn to those recent experiments in which the wedge shape has appeared, M. Santos Dumont had, perhaps, something of this sort in view when he reversed the usual order of things and designed a machine with the tail in front. This is a more stable shape than the usual method, as I hope to show you with paper models, but I believe that the power required to drive a machine of this sort has turned out to be so large in practise that he has now discarded it. The reason of this fact is, I think, a simple one. When an aëroplane with a square front edge is driven forward, a layer of air is compressed in front of it, which has a thickness depending upon the inclination of the plane, and the particles in their endeavour to recoil strike directly back, their escape being limited to above and below the plane; but if the forward edge is disposed as a wedge the particles are driven outwards, so that many of them do not hit the aëroplane at all in their recoil, and those that do have lost much of their retarding effect because their return is at an angle to the course of the plane.

Mr. Clark owes something of his success in producing the latest mechanical flyer to the fact that he has placed his largest pair of wings behind instead of in the front of his apparatus, but I should be interested to see the effect of setting the wings back at their tips, as I feel sure that the improvement in their flight would be marked.

Mr. Weiss, in his experiments with gliders, has really made the greatest strides in producing a shape which cleaves the air, and there is only one particular in which his models come short of the perfect shape as far as I am aware. It is that he does not go far enough in drawing back the front line of his aëroplanes, *i.e.*, from the point of the wedge to the base. This is probably owing to the fact that he keeps his wings broad at the tips, which tends to prevent successful results with an acute angled wedge. Perhaps he has good grounds for adopting broad tips to his wings, but if not, I think that the shape is a mistake, as it is not to be met with in Nature.

Perhaps I ought to bring mathematical calculations to bear out my argument, but I am unable to do so for the reason that my subject is new and as yet untouched, as far as I am aware, by mathematicians. This is not altogether a matter of importance, for my object is not so much to convince, as to bring the subject before you in hopes that it may receive mathematical treatment from those who are able to deal with it as I feel sure it deserves, and in order to dispose of the principal difficulty which experimentalists will meet with, viz., an easy means of obtaining data, I have brought with me the design of glider already shown which, I think, many of you will find useful in this and other ways. It is made in a very simple way. You merely fold a sheet of paper in halves and upon one side you draw half the wing plan of any machine which you desire to test. Having cut out the plan with a pair of scissors you spread out the paper as nearly as possible in its original form, after which you must bend it at right angles to the former fold to give it falling stability. Add some sealing-wax as ballast to provide it with gliding power, and a trial will at once give results which will be approximately true for machines of any size. I have with me models of various machines made on this plan, and I will bring my paper to a close by showing you their behaviour in the air.

Some interesting lantern slides were shown on the screen, and the flights of Mr. Balston's paper models of birds, etc., were greeted with much appaluse.

The President: We are much indebted to Mr. Balston for his interesting examples of flight and for his paper. I am sure it invites a lengthy discussion, and we unfortunately have not very much time for discussion. We hope that if there are any foreign gentlemen here, that they will help us with the discussion. (No response.) I will call upon the author of the next paper to read his paper.

The Efficiency of Aëroplanes, etc.

By W. R. Turnbull, M.E.

When we examine the numerous designs that have been proposed for power-driven aëroplanes it is most apparent that the designer, in most cases, has lost sight of the all-important subject of the efficiency of the different parts.

The aëroplanes are often quite large enough to give the required "lift," but the "drift" is enormous, the propellers are usually far too small in diameter, and the motor is so poorly cooled and adjusted, that it is not capable of giving anything like its rated power.

Any one of these faults is sufficient to make a failure of a possible success, but when they are combined, as they usually are, the machine is hopeless. I have just seen in Paris a machine glaringly wrong even in the most elemental principles, yet the builder had spent a large sum of money for a costly motor and its accessories.

The machines of Farman and the Wright Brothers have been designed with a good knowledge of the mechanical principles involved, and the workmanship of the Voisin Brothers is exquisite, but these machines are at best very crude; the stability in anything but calms and light winds is doubtful, and the propeller has been greatly compromised to suit the rest of the design.

In the most successful machine that has publicly flown we have 38 brake horse-power expended to carry a man at 30 miles an hour, and we have the assurance of the Wright Brothers that the necessary power increases at a much higher rate than the speed—"Langley's law" notwithstanding.

Personally I do not consider the soaring machine with air-screws and motor attached gives a practical solution of our ancient problem, but if this machine is really the prototype of the machine of the future, that will navigate the air regardless of wind and weather, its only

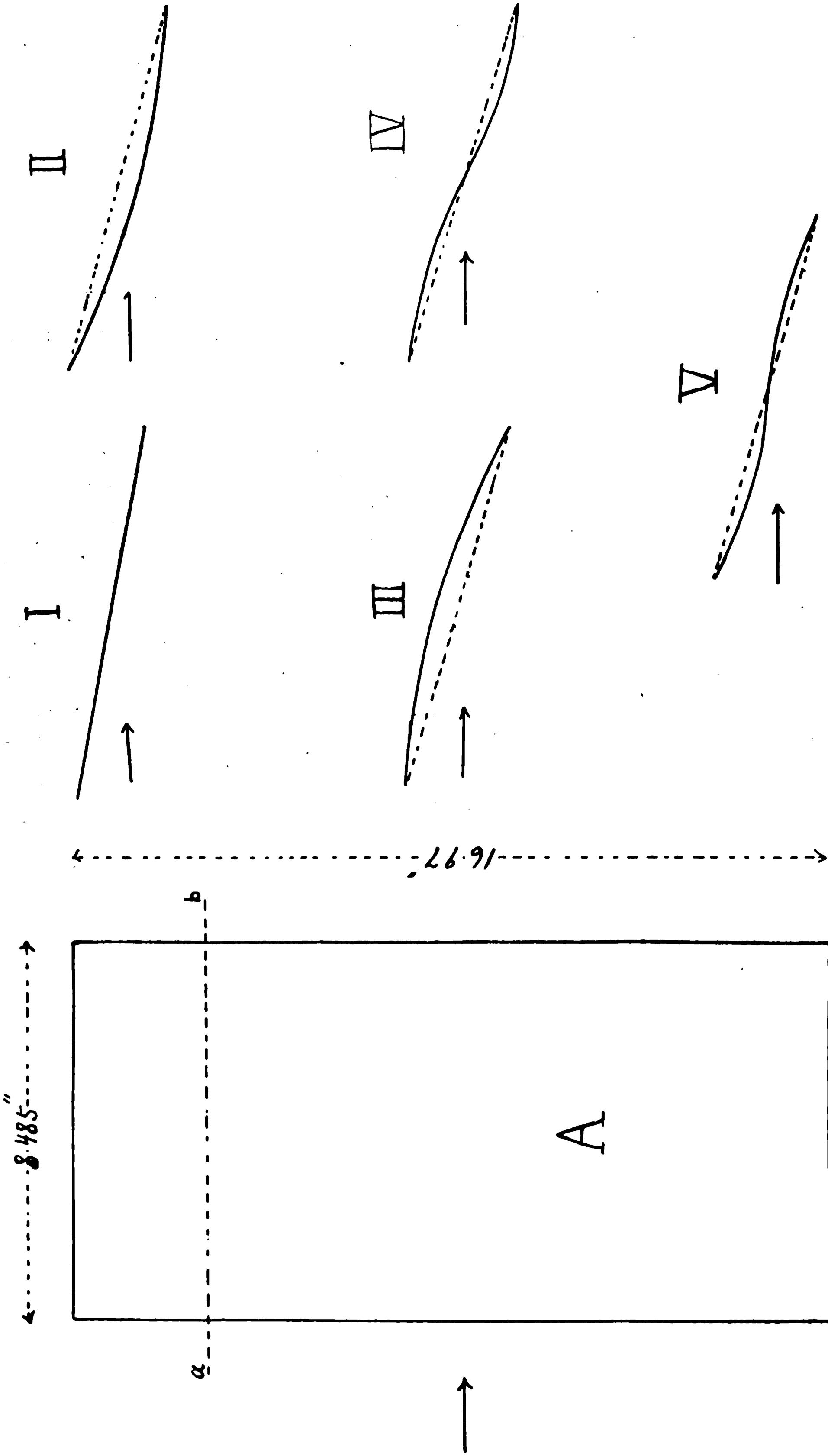


Fig. VI.

hope is in maximum efficiency at every point.

When one tries to design an aërodyne of practical form one must make compromises at every point; the shape of the aëroplanes is compromised by mechanical considerations, the propellers always have to be reduced in diameter and increased in speed to conform with the rest of the design, and the motors are improperly cooled to "save weight."

All these compromises mean losses in efficiency, and the unfortunate part of the problem is this, that loss in one part of the machine means loss in another part. For instance, if our planes are inefficient, our propellers have to do unnecessary work, and if the propellers, too, are inefficient, a much larger engine is required to drive them; all this means, in turn, larger aëroplanes than would be otherwise needed, and so on at "compound interest," so to speak.

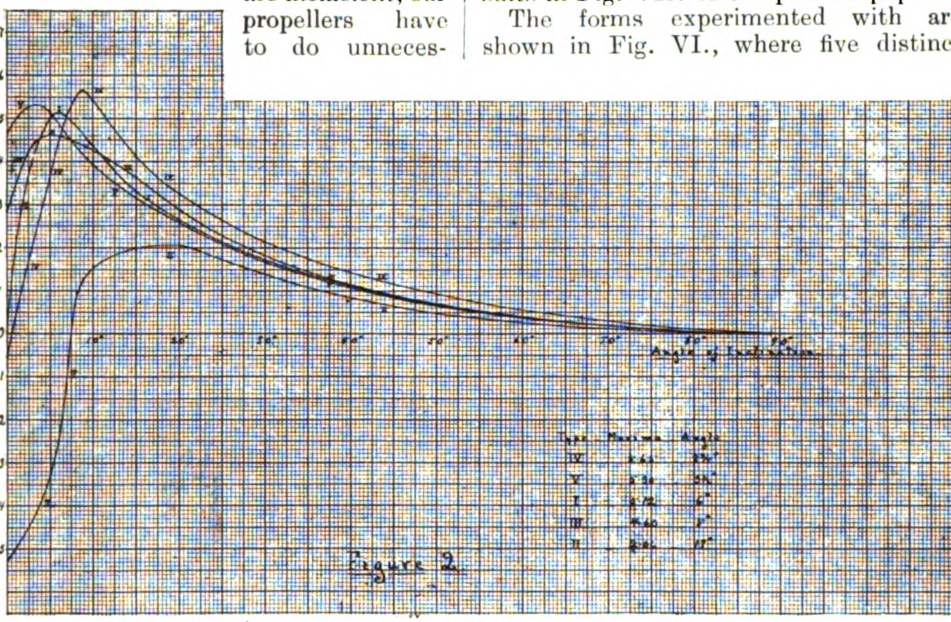


Fig. VII.

THE EFFICIENCY OF AEROPLANES.

The most efficient form of aëroplanes is probably not known, with certainty, at the present time, but it is likely that a thin "plane" of double curvature, concave underneath at the forward portion and convex underneath in the rear portion, is a close approximation of the best form.

Its curvature follows the so-called "stream-line" of fluids, but it is quite possible that some thickening of the forward portion, as we find it in the wing of a bird, is necessary for maximum efficiency.

In the bird, however, this thickening *may* only be demanded for mechanical strength, convenience in folding, etc.

In March, 1907, I published in the "Physical Review" a paper on the lifting power and stability of aëroplanes, and I have since worked out the efficiency of the various forms and present the results in Fig. VII. of the present paper.

The forms experimented with are shown in Fig. VI., where five distinct types are shown as follows:

Type I.—The plane surface.

Type II.—The single curvature surface, convex on the under side.

Type III.—The single curvature surface, concave on the under side.

Type IV.—The double curvature surface, concave at the forward portion, convex at the after portion, on the under side.

Type V.—The double curvature surface, convex at the forward portion, concave at the after portion, on the under side.

In order to simplify the problem and to make the results, with the five different types, strictly comparable with one another, I dealt only with surfaces having a rectangular plan view, and in which the width (at right angles to the air-current) was twice the length (in the direction of the air-current). While this method fails to cover the whole ground, since the number of possible plan views is practically limitless, I feel assured that, so far as general laws are concerned, the two-to-one rectangle is fairly typical of all forms.

A, Fig. VI., shows the common (developed) plan view and the various sections along any fore-and-aft line *ab* are shown from I. to V., the arrow in each case showing the direction of the air-current.

The forms experimented with were made of tin held in shape by three longitudinal ribs at the back; their lift and drift was measured in a uniform air-current of 10 miles an hour at angles from zero to 20°.

By dividing the lift in lbs. by the drift in lbs. of each of these forms, at corresponding angles, we obtain a measure of the efficiency of the different forms, as lifting agents. Knowing that the efficiency of all the forms *approximates* zero at 90° we can produce the curves to zero at 90°, although we are really concerned, in flight, with angles between zero and 20° only.

The curves so obtained are plotted in Fig. VII., in which ordinates represent efficiencies and abscissæ give the corresponding angles of inclination of the aëroplane to the air-current.

With the single exception of Type II. the efficiency of all these types is very good, but it is particularly good at small angles for Type V., and particularly good for Type IV. at angles from 7° upwards.

Type III., the form of maximum lift, *per se*, is not the most efficient form, for at small angles V. is better, and at larger angles IV. is much superior.

All the types reach maximum efficiencies at angles varying with their forms as expressed in the following table:

TABLE I.

Type.	Max. Efficiency.	@ Angle.
IV. ..	.. 5·65 ..	@ 8¾°
V. ..	.. 5·30 ..	@ 3½
I. ..	.. 5·12 ..	@ 6°
III. ..	.. 4·60 ..	@ 5°
II. ..	.. 2·06 ..	@ 19°

From this table we note that Type IV. gives the highest efficiency, and Type II. the lowest; and these are the only types, of the five, having automatic stability (as pointed out in my previous paper), so that all the advantages seem to point to Type IV. as the best form that can be used.

Moreover, a more efficient form still of Type IV. consists in making the forward two-thirds of this aëroplane concave underneath, and making only the rear third convex; whereas Type IV., shown in Figs. VI. and VII., has the concave and convex portions equal.

Farman, in his successful machine, used this latter form of Type IV. for his forward aëroplanes, but undoubtedly the rear cell of his machine reduced the efficiency, as a whole, and the aëroplanes of his machine are the most efficient part of it.

My deductions, from Fig. VII., may not be correct for all speeds and all plan views, but my experiments would indicate that with greater ratios of width to length the superior efficiency of Type IV. would be even more pronounced than in the "planes" with a ratio of 2 to 1.

THE EFFICIENCY OF AIR PROPELLERS.

The subject of air propellers is a most difficult one to deal with, as the data is very meagre, and we sorely need, at the present time, a very complete research on the subject.

Just as soon as we know the best type, and the best proportions and speed, for every diameter of screw, we can properly classify air propellers and obtain definite ideas as to their performance; in the meantime we must be content with makeshift methods.

So far as possible I have obtained the data of a large number of air propellers, both good and bad, I fear, and have compared them in Figs. VIII. and IX. as best I could.

Fig. VIII. gives the results for twenty-four propellers compared as to their tip speed and estimated brake horse-power, the estimate of brake horse-power being obtained by reducing the given indicated horse-power by 20 per cent. in accordance with the average results obtained in practice.

While the points in this figure are very scattered, a mean curve, for modern practice, may be drawn as shown; it passes through a point at 40-H.P. and 31,000 feet per minute, tip speed, where five modern propellers give practically the same result, and this curve may be considered that of the present-day propeller with two narrow concave blades,

The wide scattering of the points in this figure is due to the various forms and efficiencies of the different propellers, and emphasises the importance of careful research to obtain the best form.

Fig. IX. gives a better idea of the efficiencies that have been obtained in the past, although it has been difficult to get

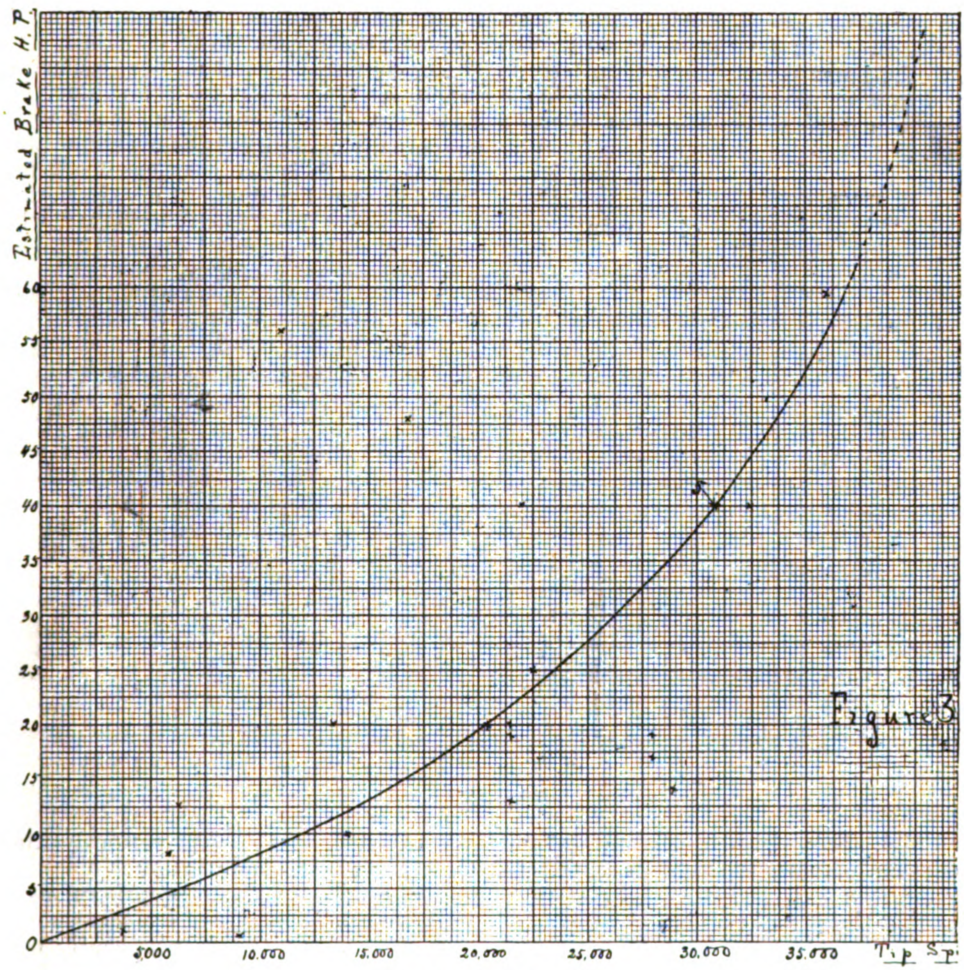


Fig. VIII.

driven at much too high a speed for good efficiency.

This curve gives no clue to the efficiency of air propellers, but it may be useful to those designing a typical modern propeller, for, with the speed and horse-power known, the diameter is at once determined by a simple calculation.

accurate data for the thrusts. Altogether only eight propellers are represented.

As in the previous figure, abscissæ are tip speeds in feet per minute, but the ordinates represent the thrust in pounds per brake horse-power, thus giving a measure of the efficiency at varying speeds.

Points A and B are the figures of

Renard, published in 1889, for the same propeller, of 23 feet diameter, at two different speeds. Point C is the result of Brequet (1907) for a helicopter screw of 26.5 feet diameter. All the other points are for modern high speed screws of about five to seven feet in diameter.

The falling off in efficiency at the higher speeds is most remarkable, for while it seems possible with the most efficient screws to get thrusts of 40 or 50 lbs. to the horse-power, the modern aërodyne has a screw of one-sixth this efficiency, or about seven lbs. per horse-power.

This particular compromise of using a small high speed screw to suit the rest of the design has cost the modern aërodyne an enormous toll, and it is right at this point that the present design is decidedly poor, for it means we have to carry an engine six times heavier than it should be, and that means much larger aëroplanes (with their additional weight) to carry the extra weight of the motor.

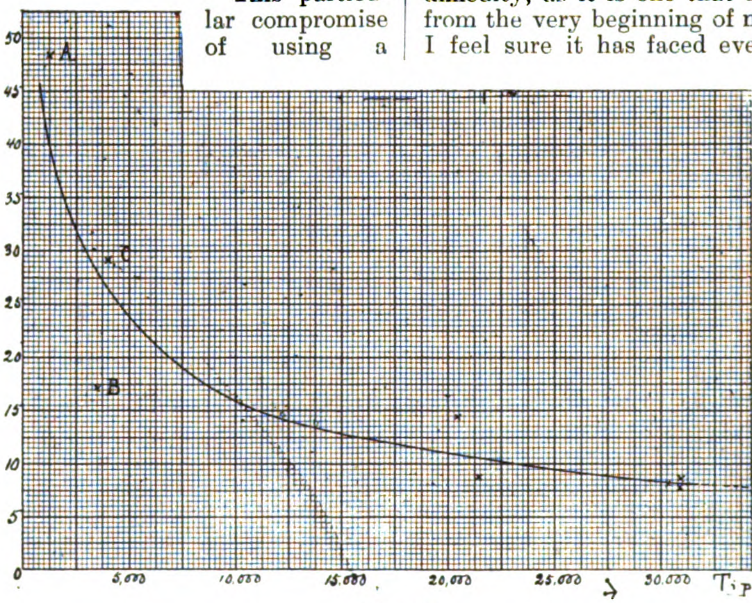


Fig. IX.

The efficient air screw is one of large diameter turning at a comparatively slow speed, and such a propeller is absolutely incompatible with the power-driven soaring machine, as we have it developed to-day by the Wright Brothers, Farman, and others.

These machines have succeeded in making short flights by the application of marvellously light, powerful motors, but they are machines of *great* inefficiency, and of uncertain stability as well.

Sooner or later we will be forced to study this subject of efficiency if we are to arrive at a practical solution of aërial navigation, and the present indications are that the air screw is not the ideal means of propulsion, at least, for aërodynes of the present type.

I cannot say what the ideal means of propulsion is for a soaring machine, for I do not know, but I am constantly shaping my experiments to overcome this difficulty, as it is one that has faced me from the very beginning of my work, and I feel sure it has faced every man who has taken up the subject seriously from an engineering standpoint.

The efficiency of air propellers, as is well known, is increased by a cross current of air, but this is necessarily of a variable and often vanishing amount, as a man cannot always sail "with a beam wind."

THE EFFICIENCY OF THE MOTOR.

The efficiency of the present-day gasoline aëronautic motor is impossible to determine, as it is a very variable quantity, much to the discomfiture of the experimenter.

By the efficiency I do not mean the thermodynamic or mechanical efficiency, but simply the weight of the motor and its accessories per brake horse-power.

Extravagant claims are, unfortunately, made by nearly all the manufacturers for motors weighing from 3 to 4 lbs. per H.P. down to 1.6 lb. per H.P., but these claims are not fulfilled. With practically all the aëronautic motors the cooling of the cylinders is not good, and after about 10 minutes' running the horse-power falls off to an alarming extent. If a motor weighing with its accessories 4 lbs. per H.P. delivers only one-half its power after a 10-minute run, it is an 8-lb. motor and not a 4-lb. one, and we have at this point a falling off in efficiency of 100 per cent.

Summing up the conclusions I have come to, the double curvature aëroplane of Type IV. is fairly efficient, giving a lift five-and-a-half times greater than its drift at its best angle; the gasoline motor has wonderful possibilities, and the present difficulties are bound to be overcome in time; but the *bête noir* of the whole problem lies in the unsuitability of the air screw as a means of propulsion, owing to the inability to properly incorporate it in a correct mechanical design, without impossible distortion and absurd mechanical construction.

I am sorry to be pessimistic about the screw-driven soaring machine as we have it to-day, for at one time I had great faith in it, but the more I have worked on the problem the more firmly I am convinced that it is not the prototype of that successful machine which some day will unquestionably solve the great problem.

NOTE.—After my paper a gentleman in the audience made some remarks, the purport of which were that because the Farman machine flew at a high speed the r.p.m. of the propeller had to be high. He overlooked the questions of *pitch* and *diameter*, however.

The figures given for the Farman machine show the relation of $\frac{\text{pitch}}{\text{diam.}}$ = 0.609, *the slip equals 45.2 per cent.*, and the pitch angle at tips about 11 degrees, r.p.m. = 1050.

Now, an efficient propeller for the Farman aëroplane, *giving the same speed of machine of 30 miles per hour*, works out about as follows:

$\frac{\text{pitch}}{\text{diam.}}$ = 1.2; slip = 15 per cent.; pitch angle 21 degrees.

With a diameter of 15 feet (*ignoring the rest of the design*) the pitch is 18.1 feet and the r.p.m. = 172, or about *one-sixth* of that used.

The PRESIDENT: We hope that some gentleman will lead off the discussion on this paper for a short time.

A MEMBER: I think that, in my opinion, the air propeller of the helicoptere type got its enormous thrust because it turned round in this position (demonstrating) and had a packed earth below it. If you were to take it and turn it around in the air, blowing in free air, it would not get the thrust. That is my opinion from running a screw propeller up against a wall, and it would give 20 per cent. greater thrust than it would if the wall was removed and the earth got away from it. Although it made a bigger load for the engine, that, I think, is the cause of the helicoptere type in a large scale giving a greater lift than the modern little one.

A MEMBER: Did not Colonel Fullerton say that Mr. Phillips had a drift 20 to 1? I understood the speaker to say the ratio of lift to drift was 5.6 to 1. I think in Mr. Phillips' paper he said it was 20 to 1.

Colonel FULLERTON: Are you alluding to Mr. Phillips' paper?

MEMBER: Yes.

Colonel FULLERTON: With type shown in Fig. 2 on the blackboard the lift was 20 times the drift.

MEMBER: And in this paper the best result was 5.6 to 1.

Mr. TURNBULL: I might say in reference to that, that Mr. Phillips has always claimed very much greater efficiency than any other experimenter. I have not a doubt but what his figures are right, because he uses an aëroplane of very peculiar form. The length in his case is, perhaps, 40 or 50 times the width of the aëroplanes. In the experiments that I made the length was in the ratio of 2 to 1. In Mr. Phillips' case it is probably in the ratio of 30 or 40 to 1, and, of course, that makes a great difference. With my figures they are simply comparative.

Mr. COWPER: May I ask the author how he obtained the figures that he mentioned and put on those diagrams? Were experiments made after Langley's method? And may I ask also whether he attained greater accuracy than Langley? I think everyone knows that the Langley results are contradicted at a certain inclination by Dine's results, and there is a considerable doubt attached to them. I should like to know what form of machine—if he found them for himself—he used. I am sure everybody is deeply grateful to the author for the paper, and that he has made and brought forward a very good attempt at a scientific theory of efficiency, in which he has given the curves relating to the various different forms. The question of efficiency has been very little considered, I think, by designers of practical machines, and we must be very grateful to the author for having brought it forward. There is a point with regard to screw propellers also, which many people neglect, *i.e.*, the difference between the conditions when the propeller is merely creating a draught and when it is moving through air and acting on stationary air, air that has not been disturbed. It is obvious that the conditions are absolutely different, and that the design of a propeller that will give the biggest thrust when stationary is not necessarily that one which will give the best thrust in a moving machine.

The President: We shall be delighted, above measure, to hear Sir Hiram Maxim. (Applause.)

Sir Hiram Maxim: Mr. Chairman, Ladies and Gentlemen, on account of my deafness it was quite impossible for me to understand what was said here to-night, though I caught a few words in regard to the screw thrust and the efficiency of screws. I must say that the efficiency depends in a large measure upon the degree of accuracy with which the screw is made. In my large experiments, where I had, we will say, 150 to 160 horse-power on each particular screw—the screws being 18 feet in diameter—I found when the machine was tied up and the engines were running full speed that the two screws gave a thrust of nearly 2,200 lbs. on a dynamometer that I had provided for the purpose. At that thrust, if we multiply the pitch of the screws by the number of turns they were making in a minute, we shall find that the slip of the screws was 60 miles; consequently, with 60 miles slip in the air, they gave a thrust of nearly 1,100 lbs. each screw. When the machine was running through the air at the rate of 40 miles an hour, of course, the slip was reduced to 20 miles an hour, and, according to the way some people look at it, the thrust ought to have fallen off, as the square of 20 is less than the square of 60; but it did not do so. It was constant, no matter what the speed was. Whatever the slip was, whether it was 20 running, or 60 standing still, the thrust was constant, and that was because the screw was constantly running into new air, the inertia of which had not been disturbed. When the screws were running and the machine tied up, the screws very soon established a current of air, and the whole engine-power was devoted to maintaining that current of air. I had a small apparatus for testing small screws; the shaft could play lengthwise, and I had an accurate dynamometer to register the thrust. I put a screw on and started the apparatus. The thrust went up to, say, 20 lbs—that is, the end thrust on the screw shaft was 20 lbs.—and then dropped back to 14 lbs. It occurred to me that this might be due to the momentum of the moving parts. I checked it at 14 lbs., but it went to 20 lbs. and came back to 14 lbs. just the same. This shows that the thrust when the air had not been disturbed was much greater than it was when it had once established a current. Suppose my screws were running at full power, and that there was a sudden gust of wind; the thrust would momentarily run up very high indeed. I made a screw with the framework covered with cloth; the efficiency was much less than with a well-made wooden screw. For instance, in my very accurate apparatus for testing screws 18 inches in diameter instead of 18 feet, I found that with a very carefully-made dynamometer, if I multiplied the thrust of the screw in pounds, by the number of turns in a minute and by the pitch of the screw in feet, it corresponded exactly to the readings of the dynamometer, providing I had a well-made wooden screw, that is, a perfectly accurate screw. With any form of built-up screw, such as a sheet metal screw, or one made of woven fabric, it would be much less. For instance, the best fabric-covered screw was only 40 per cent. as efficient as a well-made wooden screw. I found with a well-made wooden aëroplane set at an angle of 1 in 18 above the horizontal, that the lift would be 18 times greater than the drift; therefore, I think, a great deal depends upon the accuracy with which the work is done. The Wright Brothers have found that it is best to use a wooden screw. (Applause.)

Mr. TURNBULL: As to Sir Hiram Maxim's remarks, I might say that I visited Professor Graham Bell's laboratory last autumn, and he had a rather clever way of making a wooden screw. He simply took a number of strips of wood, laid them on one another, and fixed them like the sections of a lady's fan, and in that way. Then all that there was to do in order to finish the propeller was to smooth over the surface and thus the true screw shape was obtained. He claimed to have the true screw shape in that way, and it is a propeller that is very easily made, and when it is made of pine wood it is very light indeed.

Sir HIRAM MAXIM: I would say that the process of making screws described by the gentleman is the one employed by myself, and is a very common process. In some countries, when they have a screw propeller to make, they cast it from a wooden pattern, which is always made in that way. It is the draughtsman's business to lay out the screw in such a way that when these fan-like pieces are spread out they are exactly the right width between the corners for the thickness of the blade. There is a regular system of laying out screws, and when the pattern maker has glued the pieces together, he works them down just sufficiently to take out the corners. It is a simple matter. My screws were 18 feet in diameter and made of American white pine.

The PRESIDENT: Has any other gentleman anything to say? I thank the author for the paper and those who have helped in the discussion. I do not know whether Mr. Turnbull would like to say anything further in reply to the discussion on his interesting paper.

Mr. TURNBULL: No, sir. I might just mention that I brought some of my former papers with me. There are about twenty copies on that table, and it would, perhaps, lead some of the members to follow the present paper if they take those copies as they leave, and I will be very pleased to send copies to any who are not supplied. (Applause.)

The PRESIDENT: I will call on Mr. Clarke to read his paper.

A Model Aeroplane.

By T. W. K. CLARKE, ESQ., B.A.

(See Fig. XXI.)

The particular design of flying machine about to be described was the outcome of attempts by the writer to obtain an aëroplane model of high efficiency and of very strong construction. In view of the enormous number of cases in which experimenters have spent months, sometimes years, of hard labour evolving a machine, a veritable marvel of model construction, only to see it at the first trial dashed to pieces, or, at the best, damaged to such an extent that the time taken to put the model into working order again is entirely out of all proportion to the useful information gained, the writer recognised that, in order that

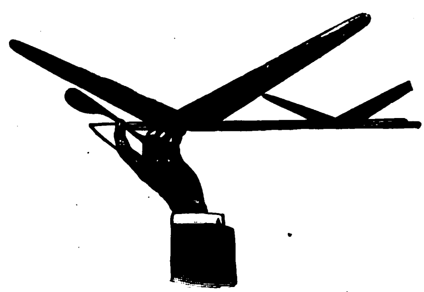


Fig. XXI.

any machine shall pass through the ordeal of the preliminary trials for getting the best positions for the surfaces, weights, etc., and shall be capable of being used for a consecutive series of experiments, it must be practically unbreakable, and the various parts must be simple and renewable. Lightness was considered of secondary importance, extra weight being only a matter of higher speed, while at the same time it ensures greater stability.

The question arose as to the type of machine to adopt. The general opinion seems to be held that a double-deck machine is steadier than a single-decker, but the writer found that there was no great difficulty in making the single-decker quite stable, so long as the surfaces, etc., are made sufficiently rigid; this latter requisite is, of course, more easily accomplished with a double (or multiple) decker, as the depth between the surfaces allows of the whole structure being stayed to form a complete girder. With the multiple-decker there is also the disadvantage that when the lower surface strikes the ground, the inertia of the upper surface puts tremendous strains upon the fore and aft bracing, and also the struts.

As to efficiency, the experiments of Langley and others show that the efficiency of superposed surfaces is not so good as that of single surfaces, although when separated by a distance greater than their width, the loss is small, yet when this distance is reduced, the loss becomes very appreciable; as an example, Mons. Santos Dumont's first double-decker showed a very low "speed-lift" efficiency. For these reasons the superposed system was discarded, and surfaces in tandem were adopted. The writer is not aware of any experimental work in connection with the interference of surfaces in tandem; his experiments with small gliders, formed by clipping two small paste-board surfaces to a backbone formed of a flat wooden lath, seemed to show that when the surfaces were separated by a distance less than three times the width of the front surface there were distinct signs of interference, causing unsteady and erratic behaviour, and, in any case, the farther apart the surfaces were placed the steadier was the flight. For preliminary experimental work the writer found Venetian blind laths very useful, as they are all of even thickness, ⅛″, made from clean yellow pine, and can be easily split with a cutting gauge to any width.

Quite good gliders can be made by clipping two such laths (slightly hollowed) crossways on to a third piece and weighting with a piece of metal. The writer has caused such a glider to float on a strong upward wind for just over 20 seconds.

For the propelled models a tough lenticular-shaped frame was found to be just the thing, and to this the surfaces were clipped by loops of elastic, being thus held in place by friction. This principle of a springy frictional grip was applied also to the propeller and serves three useful purposes:

(1) The surfaces or propeller slip or yield when any part of the machine strikes the ground heavily, otherwise the inertia of the surfaces would cause them to break away from any fixings.

(2) The surfaces can be adjusted in any direction.

(3) The surfaces or propeller can be changed.

To accord with the results determined by Lilienthal, Professor Langley, Mr. Phillips, and others, the surfaces were made as narrow as possible in the direction of their length and very wide, the ratio of width to length being, in some cases, as much as 20 to 1. The section was similar to those used by Mr. Phillips, and the under sides were hollowed, the maximum thickness being at ⅓ or ¼ of the distance from the front edge. The back edge was fined off, the front being left blunt.

The surfaces were fined off to a point as far as practicable at their extremities, not only for considerations of strength, but chiefly so as not to have an abrupt discontinuity of surface, such as we have in the case of surfaces which carry their full width right out to their extremities, which are square, and the writer thinks that, if only we could see the turmoil in the air which must be caused by such square ends, we should be inclined to go to a little more trouble and, in shipbuilding language, make the lines fair.

Experiments were made with three or more surfaces in tandem, but it was found that two only gave the best results, and the best results were those in which the front surface was considerably smaller, *i.e.*, about ⅓ or ¼ of the back or main surface, and inclined up at a positive angle to it of a few degrees.

These results were to be expected as the front surface must form a wake in which the rear surface travels, hence the necessity of making the front surface small, contrary to the custom of most experimenters, which is, with single-deck machines, to place a small surface behind, where it is continuously in the wake of the main surface; probably with the idea of copying the bird, but in this respect it may be noted that Mr. Weiss and others have shown that a bird's tail is by no means a necessity for its flight.

As to longitudinal stability, it has often been said that the great desideratum in an aëroplane machine is to so design it that the centre of pressure on the surfaces shall be fixed in a certain position, namely, so as to coincide with the centre of gravity of the machine and to remain there for varying angles of flight, but this is just what must not happen, the essential condition of automatic equilibrium is that as a machine begins to dive downwards, the centre of pressure shall move forward, ahead of the centre of gravity, and so produce a moment of recovery, which will bring it back to its proper slope.

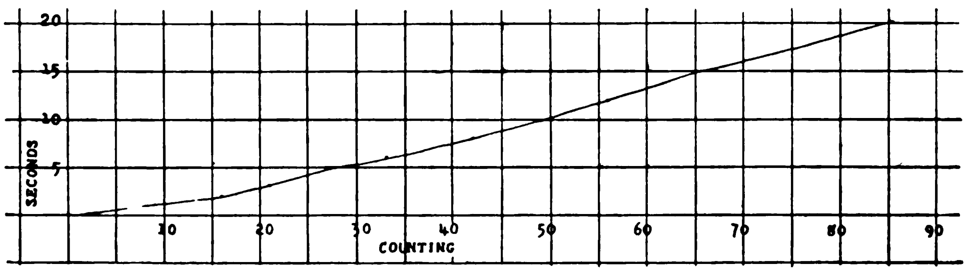
In the case of a machine with plane surfaces this (we know from experiments on plane surfaces) is what actually does happen; as the machine plunges, its speed forward increases, and the air impinges against the surface or surfaces at a finer angle, the resultant pressure moves forward and tilts the machine up and back to its proper position.

But when we come to curved surfaces it is not so simple, the centre of pressure does not necessarily move forward as the angle of incidence decreases, and the consequence is, that the surface by itself will probably be unstable; this is easily shown with a piece of card.

It follows that there must be some small downward curvature which is just neutral.

This innate instability of a simple curved surface can be counteracted in a complete machine by adding a small reverse curvature at the back of the surface; this is the method adopted by Mr. Weiss in his machines; or we may have, as adopted by the writer, two or more surfaces, the front one being set at a small positive angle, say, α to the back. Under these circumstances, when the back or main surface is inclined, say, β to the direction of motion, the front surface is inclined $(\alpha + \beta)$, and when α and β are quite small the pressures on the surfaces are proportional to these angles, and the ratio of the pressure on the front surface to that on the back is $\frac{\alpha + \beta}{\beta} = 1 + \frac{\alpha}{\beta}$ a ratio which increases very fast as β is reduced, so that when the machine begins to dip and the velocity is increased, β is thereby decreased and the pressure on the front surface increases rapidly, a righting moment is set up and equilibrium is restored; it is just the same action only somewhat more complex, as that which causes a dihedral angle given to the surfaces to preserve transverse equilibrium, and which is expressed by the statement that a necessary condition for stability is that the surfaces, taken as a whole, shall have a general convexity downwards.

DIAGRAM to show Time in Seconds corresponding to fast mental counting.



In this connection it may be noted that, as in ship design, we can very conveniently study the stability and rolling actions by means of a quantity called the metacentric height, and certain curves connected with it, which are calculated from the designs, so, in the case of aëroplanes, there are corresponding quantities and curves which will be of great use in estimating the stability and behaviour of large machines; the calculation of these quantities will be a problem considerably more complex than in the case of ships, but, in certain cases, *e.g.*, in the case of machines similar to the model described and having surfaces with curvatures giving neutral stability, the problem will admit of comparatively easy solution.

To get back to our subject. In order to carry out a consecutive series of experiments the writer had prepared a set of frames with blocks of various slopes attached for giving various tilts to the surfaces relative to the direction of thrust and to each other; sets of surfaces of different shapes, areas, weight and curvature; propellers of varying area and pitch; and skeins of elastic of varying amount. Each of the above was lettered and classified. Thus it was possible to vary different elements of the machine independently and so to try to obtain the best combination.

These results are given on the accompanying sheets.

Preliminary experiments with the propellers were carried out by suspending a frame with elastic and propeller (horizontally) by four parallel vertical threads and measuring the thrust by means of a spring balance attached to the frame. Various kinds of propellers were first tried, paper on wire frames, magralium sheet on wood, all magralium, but these wooden ones were found to be much the strongest and most satisfactory when the blades were well balanced and in an easy bearing. The thrust was generally about 85 per cent. of that which can be calculated from the Torque, and which, on the accompanying sheets, has been called the Thl. Thrust. This calculation follows from the ordinary statical laws of moments, or, better still, by application of the principle of virtual work in dynamics, for we get Thrust × pitch = Torque × 2π or Thrust = $\frac{2\pi}{\text{pitch}}$ × Torque, this being true at all speeds so long as the friction and edge resistance are neglected.

In the case of hollow-spooned propellers the chord was taken for measuring the pitch.

From the above we see that with a given Torque the thrust depends only on the pitch, not on the area of the blades, the latter being determined by the speed at which it will have to run, hence the process of designing a propeller was:

(1) To weigh the machine, say, $1\frac{1}{2}$ lbs.

(2) See at what angle it will glide, generally about 1 in $5\frac{1}{2}$ or 6, say 1 in 6 then required Thrust = $1/6 = \frac{1}{4}$ lb. = 4 oz.

(3) Find the maximum amount of elastic that can be used without unduly upsetting the balance of the machine and the corresponding Torque due to it, say 36 oz.-inches. Now it will be found that the average thrust is somewhat greater than $\frac{1}{2}$ the maximum thrust, for the extension of elastic is not exactly proportional to the tension, the ratio decreasing as the tension increases. Hence the average Torque would in this case be about 20 oz.-inches—the required pitch = $\frac{2\pi}{\text{Thrust}}$ × Torque.

$$= \frac{2\pi}{4} \times 20$$
$$= 31\tfrac{1}{2}'' \text{ approx.}$$
say, 32″.

The above were taken from an actual model, and experiment showed that this gave the right pitch.

(4) There still remains the area and diameter to determine. These were determined in the workshop, for experiment showed that the speed of the propeller was but slightly less when the machine was at rest than when in motion, hence the area must be such as to allow the propeller to revolve at a speed corresponding to the proper forward speed of the machine after allowing for slip, or in the present instance the machine weighed $1\frac{1}{2}$ lbs. and had $1\frac{1}{2}$ square feet of area given a load of 1 lb. per square foot, and its proper speed was found by experiment to be about 40 feet per sec. (37 feet per sec. was to be expected from the published results of various full-sized machines). Now without slip the propeller should go forward 32″ per revolution; if we allow 30 per cent. slip, it would progress 22″ per revolution, and 37′ divided by 22″ gives 20 as the number of revolutions per sec. for the propeller. This was slightly in excess of what gave the best results.

As to the shape, the section used was similar to that of the surfaces, viz., slightly hollow, fine on the back edge and blunter on the front edge, the contour was sometimes long and narrow, and sometimes spoon-shaped. When the blade portion of the latter was kept at a constant inclination rather than at a constant pitch there seemed to be rather greater efficiency, that is to say, a pitch increasing outwards slightly seemed to be a benefit, in such cases the pitch tabulated is that taken about two-thirds of the way outwards along the blades portion. Some of the earliest surfaces tried were only about $2\frac{1}{4}''$ wide, had a considerable dihedral angle, were shaped  and were somewhat heavy; these were very erratic in their behaviour, generally failing by a sudden rotation sideways, causing them to fall to the ground almost at starting; from subsequent experience the writer is inclined to think that, owing to the narrow bearing length on the frame, the spring clips were not strong enough to prevent the bending backwards caused by their inertia when being thrown off, another cause was the difficulty of making the inclination of the curved extremities of the wings the same as that of the central portion. When a surface wider in the centre and tapering finer towards the tips, of simple V shape with a much flatter dihedral angle was tried, the improvement was at once very marked.

As to the hollowness of the surfaces, it was found that if they were flat underneath, a much greater thrust was required and the machines were erratic; this is common experience with experimenters, but when a hollow is given they at once appear to float easier, as though on ball bearings.

But in the case of the heavier models the best results were given by a curvature less than what had been expected. In the case of a load of about 1 lb. to the square foot, the best curvature was 1-24th of the width, and with models $\frac{1}{6}$ lb. to the foot it appeared to be 1-12th of the width. A good rough method of comparing curvatures for these light models is to take one of uniform curvature which flies straight, and try the effect of flattening one wing. As has been shown, surfaces whose curvature is downwards and above a certain amount (the neutral curvature so called by the writer) are by themselves unstable and have a tendency to twist round, so that, although one of these machines is, as a whole, stable, yet the extended portions of the wings under certain circumstances are unstable and tend to dig down. This effect in some of the lighter models is very marked in a gusty wind, and were it not for this effect, the writer has hardly ever noticed any ill-effects from a strong wind; when well launched the wind is generally a help. Usually, at starting, it will give the machine a lift up of 50 or 60 feet, and if during a flight against the wind there should be an apparent sudden gust (which is not common), the so-called aspiration effect is very marked in giving a lift up. By this, the writer presupposes no mystic power in the air, as it would appear that many do, but effects that can be deduced from Newton's laws, which are quite sufficient even for flying machines.

The steering was originally effected in the models by sliding the back surface to the right, thus putting the drive on to the left of the machine and so driving it round to the right. From the tabulated results it will be seen that about $\frac{3}{8}''$ to the left was sufficient displacement to counteract the general tendency to the right, due to the reaction of the rubber, and another $\frac{1}{4}''$ or so would make the machine take a sweep to the left.

The explanation above has since been found by the writer not to be correct. The general tendency of the machine to go to the right has been found to be not so much due to the reaction of the rubber as to the actual distortion of the frame so caused, causing the surfaces to be in winding relative to each other; means to counteract this can be used to steer the machine.

As to vertical planes, the writer considers that they are worse than useless, as, in order that a machine shall automatically regain the level position after rolling sideways, it must be allowed to slip sideways.

So it is well to note with a wide dihedral angle and high centre of gravity (properly it should coincide with the centre of transverse and longitudinal resistance) we get long, slow rolling. With a sharp dihedral angle and low centre of gravity we get quick rolling and, no doubt, quick and easy recovery, but, at the same time, quick and easy upsetting.

The larger the machines the better they fly; this is very encouraging.

Referring to the tables of flights, the following are points of interest:

Nos. 45-49 show that when flat, undersided surfaces were tried no satisfactory flights were so obtained.

Nos. 71-73.—Here the remarks show the upward inclination of the flight at starting; this is a general characteristic of good flights. The superfluous power of the elastic at starting expends itself in gaining potential energy by rising, which is given out again as the power fails.

No. 84 was a good example of the transverse stability.

The flights on September 23rd were all good; it will be noticed that the substitution of a 3′ 9″ pitch propeller for one of 2′ 4″ made practically no difference in the distance flown, although the thrust was considerably reduced and the slip increased.

In No. 116 the wave motion (longitudinal) was very clearly shown, and will be of use in calculating metacentric distances; incidentally it may be noticed that with a man-carrying machine on these lines the period of oscillation (longitudinal) would be about 20 secs.

Nos. 91 to 95 and 124, which were fair flights, would seem to show that in a good flight, at starting, while the machine is being accelerated or driven upwards, the slip is about 20 per cent., and this gradually falls to almost nothing before the rubber is fully unwound, and the writer thinks that 12 per cent. is none too small a proportion to allow for slip when the machine is going well.

No. 129.—501 feet (on a down grade 1 in 25) was the best flight recorded in this series, but a few unrecorded flights with an almost identical machine subsequently by the writer have been better, and at the time of writing he has just heard from a friend that he has had a flight more than half as far again, but this was probably down a steep slope.

In the flight recorded as above the pitch of the propeller was 3′ 9″ and diameter about 9″, so that the inclination of the blade to the plane of rotation was considerably more than 45°; in fact, about 56°.

The economy of the motor may be roughly analysed as follows:

Loss in propeller blades due to edge resistance and skin friction ...	16%
(*i.e.*, the thrust would be only about 5-6th of what it should be by the formula.)	
Loss due to slip	12%
Loss due to friction of bearing	4%
Total loss due to propeller	32%
Loss due to friction and viscosity of the rubber, say	15%
Total loss	47%

After the first stretch rubber loses about 15 per cent. extensibility (as a consequence a new skein of rubber generally adds 60 or 70 feet to the flight), and a further 15 or 20 per cent. is lost after about 20 full windings. Water is of some use to lubricate the rubber and to prevent it from sticking.

Small cut rubber is slightly more efficient than coarse cut, but is more troublesome to keep in a good state.

The machine called No. 2 glider in the tables was a bamboo-built machine of considerable elasticity in its construction, having two pairs of superposed surfaces in tandem, all four being nearly equal and wing-shaped. It was intended subsequently to take a small "Fairy" engine.

The PRESIDENT: This interesting paper is worthy of a long discussion, but I am afraid our time is very short. If any gentleman has anything to say we shall be glad to hear it, if he is rather brief.

Mr. WOOSNAM: I am sure Mr. Clarke's paper raised a great many points that people would like to ask. I should especially like to ask two if he would answer them. Firstly, whether he found that there was any difference between the position of the centre of gravity when the machine was gliding without the action of the propeller and when it was being propelled. I think there must be a difference between the correct position for the centre of gravity in the two cases. It is a question of importance and must appeal to everyone. What is to happen to the machine when it is at a high altitude and the engine stops, as it must occasionally do; will it come down with a rush or glide gently down? Does this not depend upon the position of the centre of gravity? Did Mr. Clarke notice what the *amount* of difference, if any, should be in the correct position for the centre of gravity when the model is driven by the propeller and when it is gliding?

The other question was whether he found that there was any important difference in the distance apart of the two planes—whether there is one particular distance which gives the maximum efficiency, or whether it does not matter a great deal whether the planes are very far apart or not very far apart.

Mr. CLARKE: (1) No difference. In an

FRAMES. Each 3′ × 4½″ Lenticular of ⅜″ sq. Am. Elm hardwood ends, weight 5½ to 5¾ oz. **PROPELLERS.** Special Spoon Shape. Am. Elm.

	Front Surface Seating.			Diameter Area.	Pitch, angle of.	Am. Elm.
A	Parallel to Frame	—	α_1	—	—	
B_1	1° ,, ,,	—	α_2	—	3′ - 9″	
B_2	—	—	β_1	—	—	
B_3	—	—	β_2	—	—	
B_4	—	—	γ	—	2′ - 5″	
C	2° ,, ,,	—	δ	—	1′ - 10″	
D	—	Best relative angle	ϵ	—	2′ - 9″	
E	—	between surfaces	ζ	16 sq. in.	2′ - 4″	
F	—	about 2½°	ι	12½ ,,	2′ - 4″	

SURFACES. Max. thickness in each case about ⅛″ of Silver Spruce.

Letter.	Length across frame.	Breadth, *i.e.*, in direction of frame.	Hollow.	Shape (section).	Dihl. Angle.	Weight.	Area.	Remarks.
A_1	3′ - 10″	2½″ bare	Flat under		160°	4 oz.	·70′	
A_2	Same.	,,	,,	·	,,	,,	,,	
a_1	2′	2⅜″	,,		,,	1⅜	·32′	**Flat** on the under side
a_2	,,	,,	,,	·	,,	1½	,,	
B_1	3′ - 10″	2½″	⅛″ = 1/20		,,	3½	·70	
B_2	,,	,,	,,	·	,,	,,	,,	
b_1	2′	2⅜″	,,		,,	1⅜	·32	Same, with ⅛″ **hollow**
b_2	,,	,,	,,	·	,,	,,	,,	
C_1	3′ - 10″	2½″	¼″ = 1/10		,,	3½	·70	
C	,,	,,	,,	·	,,	4¼	,,	Same, with ¼″ **hollow**
c_1	2′	2⅜″	,,		,,	1½	·32	
c_2	,,	,,	,,	·	,,	1⅝		
D	4′ - 7½″	2⅞″ taper to 1″	1/16″ = 1/25		165°	3¼	·92	**Much wider, tapering, very slight hollow, flatter Dihl. Angle, and** more area. **A great improvement**
E	,, ?	—	—	,,	,,	—	—	
F_1	,, ?	2⅜″ to 1″	3/32′ = 1/19	,,	,,	—	—	
G	5′	4½″ to 1½″	3/16″ bare = 1/20	,,	,,	7¼	1·25	Seemed too big, *i.e.*, not enough W/A
g	2′	2⅜″	⅛ = 1/18	,,	,,	1½	·36	

																			1" forward.
44	,,	,,	,,	,,	,,	,,	,,	24½	—	—	—	—	—	—	—	—	—	—	Fell by head evidently not enough, but blocks did not extend sufficiently to put it further.
				low, 2⅜ max. width															
110	,,	,,	,,	,,	,,	,,	,,	26½	,,	,,	,,	,,	,,	—	—	54	11½	—	Big circle to R.
111	,,	,,	,,	,,	,,	,,	,,	26	1	½	184	,,	,,	—	—	39	7½	—	
112	,,	,,	,,	,,	,,	,,	,,	,,	⅛	0	190	,,	,,	—	—	23	3¼	—	
113	,,	+2	,,	,,	,,	,,	,,	25	¼	⅛	,,	,,	,,	29	330	54	11½	184	L.
114	,,	+3	,,	,,	,,	,,	,,	24	½	¼	,,	,,	,,	37	436	60	13¼	196	R.
115	,,	+2	,,	,,	,,	,,	,,	23½	⅜	¼	,,	,,	,,	43	462	52	10¾	,,	L.
116	,,	,,	,,	,,	,,	,,	,,	23	½	¼	186	,,	,,	35	414	56	12	195	Slightly R. **Three Waves amplitude about 120'**
117	,,	0	,,	,,	,,	,,	,,	22½	½	0	189	,,	,,	—	—	—	—	—	Fouled a tree.
118	,,	,,	,,	,,	,,	,,	,,	22	¼	,,	,,	,,	,,	32	354	53	11	193	Str. shallower waves.
119	,,	,,	,,	,,	,,	,,	,,	21½	¼	,,	190	,,	,,	31	369	56	12	190	
120	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	38	393	50	10¼	193	Launched by Mr. Bennett.
121	,,	,,	,,	,,	,,	,,	,,	21¼	,,	,,	,,	,,	,,	35	420	56	12	190	Ditto, ditto, slighting R.
122	,,	,,	,,	,,	,,	,,	,,	21	,,	,,	185	,,	,,	35	336	48	9½	190	Launched by Pat.
123	,,	,,	,,	,,	,,	c. 2' 4" 16 sq.'	,,	19	,,	,,	184	,,	,,	38	414	53	11	—	L 3° (1 in 19) fall from eye to spot.
124	,,	,,	,,	,,	,,	,,	,,	18½	⅜	,,	190	,,	,,	40	423 −6	50	10¼	181	Str. **Slip 1 p.c. (apparently).**
149	—	,,	,,	,,	,,	,,	,,	,,	,,	½	,,	—	—	—	252	42	—	168	Rose again.
150	—	,,	,,	,,	,,	,,	,,	22¾	,,	1	—	—	—	—	—	27	—	—	Curved R sharp at end.
151	—	,,	,,	,,	,,	,,	,,	,,	¾	0	—	—	—	—	—	—	—	—	Curved L. about 30' rad.

— means following wind. + means head wind.

201 / 141 } means 201' as measured along the actual path (curved) travelled, and 141' from start to finish in a direct line.

109 to 126.—In above total weight of machine, 1·25 lbs. ,, ,, ,, area, 1·5 ,, } $\frac{W}{A}$ = 0·83 lbs. sq.'

* Mr. Hargraves best published flight for **rubber-driven** models, 270 feet, on level ground.

H.P. developed by Rubber, 0·02 approx.; H.P. used by Machine, 0·009 approx. (*i.e.*, **W = 62 lbs. or 137 lbs. per Horsepower**).

No. 2 GLIDER.

TWINDECKERS IN TANDEM.

WEIGHT, 58 lbs. EMPTY. AREA, about 70 sq. ft.

BALANCE, Empty. 8″ ahead of central vert. strut.

" with 4 lbs. extra on front edge of sail, 11″ ahead of central vert. strut.

Front edge of sail is 11½″ ahead of central vert. strut.

Front edge of sail is 52″ ahead of central vert. strut. (32″ to sail and 20″ sail).

SUNDAY, OCTOBER 13. Set to Template.

Glide 350′ on curve. }
243′ on straight. } count 61 = 13½ sec. against 8 m.p.h. (12 f.p.s.) breeze.

350′ in 13½ secs. = 26 f.p.s.
12

Velocity in air 38 f.p.s.

$$\text{Load} = \frac{62}{70} = \cdot 9 \text{ lbs. sq.}'$$

A SMALLER MODEL. WEIGHT 7½ oz. = ·47 lb. Area 1 sq.′ Back surface set over 1″ R. Pitch of Propr. 2′ 10″.

Flight.	Count.	Time secs.	Elastic.		Remarks.
70′	—	7 ?	—		Turned L sharp.
70′	—	"	—		" " "
270′	57	12	—	22½	v. straight
					(142 + 8) Revs.
93	32	6	—	16	Badly launched.
108	34	6¼	—	17	Against fair wind L.
57	13	1½	10 × ⅛		
190	—		"		
249	—		"		L (121 + 6) Revs.
(450)					Finish 10′ above start.
225	40	7½	8 × ⅛		(125 + 7) Revs.
(360)					
327	50	10¼	"		(175 − 67) "

Flight in feet.	Count.	Time.	Speed f.p.s.	Remarks.
345	55	11½	30	Distance probably in excess.
360	50	10¼	35	
309	47	9¼	34	
255	45	8¾		
(450)				
234	52	10¾	22	
290	39	7¼	40	

SMALLER MODEL. Length one foot. Pitch about 1′ 7″.

Weight.	Area.	Flight.	Count.	Time.	Speed. f.p.s.	Hollow.
(1) ·05 lb.	·31 sq′	63′	26	4¼	15	about $\frac{1}{12}$ width.
(2) ·065 "	"	66′	22	3¼	20	

ordinary good flight the rubber runs right out while high up, and the machine glides down, over-winding the propeller while doing so, as in No. 36. The propeller in these cases, of course, causes a considerable resistance, and, owing to this and also that the speed is somewhat less, the gliding part of the flight is not so steady as that part during which the machine is being propelled. In order that a machine shall continue to glide after the thrust has ceased the line of action of this thrust must approximately coincide with the resultant resistance (longitudinal) of the framing and surfaces; if it be considerably below it the machine is bound to pitch forward when the thrust ceases (and also to pitch in gusty weather). In the models the thrust could probably, with advantage, be placed higher, but this would buckle the frame. No. 124 also shows that the machine came down so flat (on a road), after a good flight, that it slid forward six feet. (2) I have not noticed that any particular distance gives the maximum efficiency, but I find that, as might be expected, the farther they are apart the better; the wave-length of the trajectory is longer and the flight is steadier, and, consequently, longer as well. But, on the other hand, with models in which the front surface is too large and the curvature too great, I have noticed certain peculiarities which might be accounted for by considerations of wave phase as suggested by Mr. Woosnam.

The President: Has any other gentleman anything to say? You have seen these beautiful models in another place and on another occasion.

Mr. Cody: I should like to say a few words if I may, Mr. Chairman, and Ladies and Gentlemen. I am a great admirer of men of deeds and not of words. Consequently I admire Mr. Clarke's work very much, and expressed my opinion to Mr. Clarke when I first made his acquaintance. He is a man who struggles hard, and he has turned out something very valuable I think. If he could only turn it out larger I should very much like to see it. I am an experimenter in the same way, perhaps a jealous one, too, but I cannot help but admire a good thing when I see it. I have heard him talk to-night more than ever I have before, and I have known him a long time. (Laughter.) A man who does a thing and lets somebody else talk about it. He doesn't give himself half the credit he deserves. (Applause.)

The President: I am sure we all endorse every word that Mr. Cody has said, and we are exceedingly obliged to Mr. Clarke, as we are to the authors of the other papers. I am afraid we must go on to the next.

Owing to the absence of Mr. Lloyd, the Hon. Secretary read his paper.

Notes on the Present Position of Mechanical Flight in France.

By Herbert F. Lloyd.

For more than a century past the problem of human flight by means of heavier-than-air machines appears to have exercised a strong fascination on the minds of French inventors and engineers, and since November, 1906, as the result of Santos Dumont's classic experiments, and more recently the longer successful flights of Henri Farman and Léon Delagrange, even the general public has become interested in the subject, and has at last been taught to realise that dynamic flight is not only a possibility, but a fact, and that with each day which passes the success already attained is being steadily carried another step forward towards the evolution of the eventual type of perfected machine.

If we except the performances of the Brothers Wright in America, it is admitted that France has led, and is still leading, the aëronautical progress of the world, and it is not difficult to understand why this should be the case. Her engineers seem to possess a peculiar aptitude for this special branch of science, and her War Department has always been foremost in the design and application of balloons and dirigible airships, etc., to military requirements; also her progress in automobilism, and the consequent attention paid to the improvement of the petrol motor, has brought about the production of the special type of engine demanded for aëronautical purposes. But, perhaps, the greatest factor of all has been the unprecedented stimulus to private enterprise and the generous assistance to experimenters which has been afforded by the public-spirited support of such men as MM. Archdeacon and Deutsch de la Meurthe (who have probably done more than any-one else to encourage the development of aërial flight), Comte de la Vaulx, Armengaud, Michelin, and others.

At present, although the success of the few may have to some extent disheartened other aviators, the number of machines already built or in hand is certainly greater than at any previous date. There are now said to be more than 150 experimenters at work in France, out of which not more than 10 have as yet achieved any decisive result with man-carrying machines. Interest is chiefly concentrated at the moment on the aëroplane type, the best known being the machines of Farman and Delagrange, designed and constructed by the Brothers Voisin. During the last few months the writer has paid many visits to the historic military manœuvre ground at Issy-les-Moulineaux to witness their experiments, and it is, indeed, a most inspiring sight to see these splendid machines sweeping through the air in immense circles kilometre after kilometre. The fore and aft stability regulated by the box-tail and front steering plane seems to be almost perfect, and when the propeller is stopped, the apparatus glides smoothly to the ground; but the lateral stability is not so good, especially in making a sharp turn, or even in a light cross wind, when there is a pronounced and somewhat dangerous sideways tilt caused by the difference in lift between the inner and outer sets of planes. M. Farman himself does not profess to have solved the question of perfect equilibrium under all conditions, and these machines are only taken out on days when there is little or no wind, and when the ground surface is sufficiently dry and hard for an effective initial run, and it is obvious that, though they may possess adequate stability in calm air, they are as yet unfitted for use in rough weather. It is, therefore, difficult to believe that there is much hope of perfect equilibrium ever being successfully obtained in disturbed air for the large inert fixed surfaces inherent to the aëroplane system without some radical modification in design.

The achievements, however, of Farman and Delagrange, besides providing valuable data for other workers, show us that useful results can only be obtained by patient and protracted trials and gradually acquired skill, and our deepest admiration goes out to these men for the difficulties which they have overcome and for the great impetus which they have given to the science of flight. But it must also not be forgotten that a large portion of their success has been due to the ingenious design and sound construction which characterises the work of Charles and Gabriel Voisin, and which is the result of knowledge gained from their many years of practical experience in the art of flying. It is an education in itself to inspect their work, to observe the minute attention paid to details affecting air resistance, etc., and the manner in which the requisite strength has been combined with extreme lightness.

Messrs. Voisin are now engaged in the completion of Farman's monoplane, "The Flying Fish," which will be ready for its preliminary trials in a few weeks; the sustaining surfaces consist of five pairs of narrow wings mounted *en escalier* on a central framework 14 m. long; the 2-bladed propeller in front is driven through reduction gear at 1,100 r.p.m. by an 8-cylinder "V" Renault motor giving 47-H.P. at propeller blades; the weight of the motor complete is 143 kilos., and of the whole machine 600 kilos.; it is expected to exceed a speed of 60 miles per hour.

They also have in hand at their works near Billancourt some more aëroplanes of the same type as the Farman No. 1, and several machines on what may be called the 3-plane system, in which the sustaining surfaces are built up of three superimposed planes, with 2-bladed propeller in front. The first of these should be ready for experimental work about the end of June.

They also propose to construct a motor car driven by an air propeller behind and fitted with fixed planes extending along the sides of the body to the rear in order to give buoyancy—in short, a flying machine with the wheels in continual contact with the ground. Though an interesting experiment, such a machine would probably be difficult to control, owing to decreased road adhesion, and the propeller would raise clouds of dust and sweep it into the adjacent houses and fields. It may be recalled that M. Ernest Archdeacon, in 1906, built and experimented with a motor bicycle driven by a propeller, and a speed of 48 miles per hour is said to have been attained.

Dealing briefly with other aviators, M. Santos Dumont's efforts during the past year seem to have been frustrated by ill-fortune, and his recent experiments have not yet produced much favourable result.

M. Louis Blériot, that indefatigable investigator, who has built so many machines, and who made several flights on one of his monoplanes up to 400 and 500 m. in November and December, 1907, has also experienced mishaps and continual breakages, which, however, have probably been of great practical value in assisting him to eliminate possible causes of failure, which can only be discovered by actual flights. After carrying out certain important improvements in his latest machine, he has taken possession of the new sheds which he has just built in the Aëro Club's parc d'aviation at Issy-les-Moulineaux, where he will now resume his experiments.

M. Robert Esnault-Lelterie, whose work is distinguished by such originality of design, is the inventor of the well-known R.E.P. motor, which has seven cylinders disposed starwise round a central crank-chamber without any fly-wheel. He has made many successful short flights, and is now experimenting at Buc, near Versailles, with his latest machine, and it is probable that he will shortly obtain some interesting results.

MM. Gastembide and Mengin's bird-like monoplane, driven by a 50-H.P. Antoinette motor, turned over during flight in February, 1908, and was wrecked, probably owing to defective stability and absence of horizontal steering plane. Towards the end of March, 1908, trials were resumed, but the machine was unable to leave the ground, and further experiments appear to have been temporarily abandoned.

M. Pischoff, whose aëroplane, with propeller in front, is fitted with a 3-cylinder 25-H.P. Anzani motor, made several short flights in January, 1908, but the machine was wrecked through the wheels giving way. He is now said to be at work on a new and improved aëroplane.

The monoplane of Levarasseur and Ferber is of somewhat peculiar design, with two large concave pointed wings and a 100-H.P. 16-cylinder Antoinette motor. It is one of the most powerfully-engined aëroplanes which have yet been made in France, and is now approaching completion in the Antoinette workshops.

M. Henri Kapferer is about to make preliminary tests of his new monoplane, which is now at M. Esnault-Lelterie's ground at Buc. It has a 4-bladed propeller in front, 2 m. 10 diameter, driven by a 35-H.P. R.E.P. motor.

M. René Gasnier, the well-known balloonist, has a monoplane under construction; it is driven by a 8-cylinder 40-H.P. Antoinette motor, and presents several novel features in design.

Among the host of experimenters are Comte de la Vaulx, Archdeacon, also Maurice Farman, who will attempt to emulate the exploits of his famous brother, and others too numerous to mention here.

One point worth noting with regard to aëroplane experiments has been the extraordinary immunity of aviators from fatal injuries after falls in which their machines have been partially or completely wrecked. This is, no doubt, because their flights have usually been restricted to a few metres above the ground, but, on the other hand, this practice probably causes more risk of mishaps. For instance, it is possible that Farman's accident on March 28th, 1908, would not have taken place if his machine had not been in such close proximity to the ground, and Delagrange, on the evening of May 2nd, 1908, when his aëroplane was carried out of his control into a crowd of spectators by the light breeze then blowing, might have been able to soar over their heads if he had been flying at a slightly increased elevation.

Although the aëroplane at present holds the field, there are several inventors—possibly half-a-dozen—who are devoting themselves to machines of the so-called "gyroplane" type (*i.e.*, aëroplanes with reduced fixed surface combined with a system of auxiliary sustaining helices inclined to the vertical), and also "hélicoptères" or direct lift machines, which have no fixed surfaces, but are sustained and driven by propellers alone..

M. Louis Breguet, who is known to have made deeper researches into these systems than any other experimenter, but who has yet published little about the results obtained, has lately succeeded in making a machine with sustaining helices which rose into the air with its operator and motor in full order of march. He is strongly of opinion that sooner or later the aëroplane must be combined with auxiliary raising helices, and, as he has shown recently in an able paper on this subject, a gyroplane, under certain conditions, can leave the ground in a much shorter space than a simple aëroplane, the power used being identical in both cases.

No great success has so far been obtained in the case of a direct lift machine, but it is not impossible that an effective apparatus of this kind may be evolved in in the near future, and it might even have certain advantages as compared with the aëroplane, because it only requires a small area for experimental manœuvring. It is able to rise and alight in a restricted space, and it would be independent of the quality of ground surface, in addition to which the stability would probably be more easily perfected, though the power required would be greater, and there would be an increased risk of disaster in the event of the motor failing.

M. Paul Cornu's hélicoptère, which was completed at Lisieux in August, 1907, has since undergone repeated trials, and has raised itself with its operator from the ground on several occasions, though it failed to progress horizontally. This ingenious machine, which only weighs 260 kilos. with operator, consists of an open "V"-shaped framework 6 m. 20 long, built up of steel tubing, and mounted on four wheels. In the centre is the driver's seat, and in front of it the 24-H.P. Antoinette motor which drives, by means of a somewhat complicated belt system, the two large vertical propellers overhead (each is 6 m. in diameter with two blades of variable pitch); under the propellers in front and rear are two small vertical planes pivoted on a horizontal axis, and by their inclination and lateral displacement horizontal progression and steering direction are supposed to be obtained by the reaction of the air-currents from the sustaining helices.

M. Cornu has now decided to construct a new apparatus improved and modified from the experience gained, and in this new machine, which will be ready in a few months, he proposes to employ steel helices of small diameter and high speed of rotation.

M. Bertin, the motor cyclist, has also recently constructed a hélicoptère with the aid of his friend, M. Boulline, at Puteaux, though no tests have yet been made. This machine weighs 300 kilos. complete, and consists of a rigid framework of steel tubing containing a horizontal air-cooled 8-cylinder motor of 150-H.P., designed by M. Bertin, which drives through a disc clutch and bevel gears two metal twin-bladed vertical helices 2 m. 40 diameter at 1,200 r.p.m. In front is another gear-driven propeller, mounted on a shaft with universal joint, which can be utilised both for steering and propelling the apparatus. As to the future it is yet too early to forecast what is likely to become the eventual type of machine, but the problem of sustained flight with the aëroplane now seems to chiefly depend on the production of an engine which can run for long periods without failing, and which can be adequately cooled without material increase in weight. The motors at present used, taking the best-known types—Antoinette, R.E.P., and Renault—are now made of astonishing lightness per H.P., but still have various disadvantages for aëronautical work. They are difficult to set in motion, overheat after a few minutes' running, are rather complicated owing to the multiplication of cylinders and valves, etc., and do not develop their full rated power. Farman's 50-H.P. Antoinette motor probably does not give more than about 30-H.P. at propeller blades; also they are by no means economical in fuel consumption, which is a point which has not yet received the attention it deserves, and which must have due consideration in the case of long-sustained flights. The method of mixing is crude. In the Antoinette motor the carburettor is usually dispensed with, and the spirit pumped direct into the cylinders. These motors have not the flexibility of the steam engine, and the speed can only be varied within narrow limits—in fact, they must run at a high speed (1,200-1,800 r.p.m.) to develop the maximum power. Consequently the propeller, if direct coupled, is of too small diameter for the best efficiency, and if a reduction gear is introduced, too large a proportion of the available power is lost in transmission.

After the design of the fixed surfaces, and next in importance to the motor, comes the question of the propeller, and though the various experimenters in France have discovered much that is new about the efficiency of the various shapes, and the best diameter, pitch, speed, etc., they have kept most of this information to themselves, and the published results are conflicting and even misleading. But this is not surprising when it is remembered that the present knowledge of even marine propellers is rudimentary and largely based on empirical formulæ. Much less is known about propellers working in air, and it has been found practically impossible—in the case of Farman's aëroplane, for instance—to determine with even approximate accuracy the thrust of, and the power expended on, the propeller at various speeds in actual flight.

In conclusion, judging from recent progress in France, it is safe to say that the next few years will set the seal on the victory which has already been won for the mechanical flying machine.

Mr. Cody: If I may mention a few words about that engine, I believe I have had as much experience with the engine as anybody in this part, and the one I used gave 51-H.P. at 1,475 revolutions, and at 1,200 it gave 46.8-H.P. So there is a mistake in the reference to this engine, distinctly, because all of the engines go from 51 to 53-H.P. before they let them leave the works, I believe. I have seen four or five tested in Paris, and I may say that they are very reliable, because the one I had in charge ran 3 hours and 40 minutes, giving about 38 to 42-H.P. by using the carburettor, and not the injection direct of the petrol, and, of course, the carburetter does not give the amount of power that the injection direct does, because, I suppose, it has to suck its charge from the jet in the carburettor, and there is a certain amount of power lost in the suction. When the petrol is put in direct the tube is open and there is no power lost.

A Member: Mr. Lloyd is talking about an air-cooled engine, and not one cooled with water.

Mr. Cody: He spoke of the Antoinette—the one used by Farman.

A Member: Is it a water cooler?

Mr. Cody: Yes. I have seen most all these machines in France, I think, except Farman's "Flying Fish." I know exactly what I am trying to get at; I am certain that the Antoinette firm made no air-cooled engine, or had not done when I knew them, and that was as late as three months ago. I may say also that my engine is the only one that has ever run the time it did at radiator cool, and that I felt the engine a dozen times during the run, and it was always cooler than fresh milk, cooler than blood heat as it went in through the pump to the engine—really too cool to get the results I should have got if I had let the water get a little hotter. I put in a large quantity. I had 26 quarts of water.

A Member: They couldn't have that with an aëroplane machine, could they?

Mr. Cody: I hope they will. I hope to have it myself, but it only means a question of time. The machine will lift it, if it will lift two men and its engine—it will lift 150 lbs. of water, the weight of a man. And Farman's machine did lift, or Delagrange's machine did lift, Mr. Farman and himself—so did Mr. Farman take his father on board. If, instead of taking his father, he would take water equivalent to the man's weight, he would get sufficient power out of the engine and fly all right. That is the only thing, I think, the French people are waiting for to get efficient radiators to the Antoinette engine, which weighs 218 lbs., in running order; but the same engine weighs 228 lbs. with the carburetter fitted, and the lightest air-cool engine of the same power weighs over 300 lbs. I am quite prepared to run the Antoinette for three hours with 300 lbs. weight, not to count the petrol.

A Member: 300 lbs?

Mr. Cody: 300 lbs.

Colonel Fullerton: 50-horse power.

Mr. Cody: Forty-seven, although the engine standing on the bench gives 51-horse power, but you cannot get it to give that constantly. That is why the racing cars on the Brooklands track, in my opinion, fail so often. If you have seen the Brooklands racer—I have—and I have seen many races start with eight to 10 cars in them, and there is generally four or five cars drop out because there is no downhill, they never rest their engines —they are fully accelerated all the time, and the engines cannot stand it. But in a road race they go downhill at about 30-horse power and uphill they got at 100-horse power (with a big engine), and, consequently, they can keep their engine alive for a long time. But my experience with petrol engines has not been very long, it has been very much while I have been doing it, and I think that the only drawback to these light engines is that they start them off at their maximum horse-power and ask them to continue giving that maximum. There is no other condition where a petrol engine is asked to do that unless it is in a launch, and we all know how heavy the engine is in a launch to do any good. I hope I am interesting you. The point of the engine's efficiency is simply in the cooling, and as soon as we can get efficient radiators I hope we shall be able to fly all right; I hope to be able to get them. I am sure I will.

The PRESIDENT: We certainly have to thank the French for pioneering various enterprises, automobiles and aëronautics, and we are very glad indeed to have extracts of this interesting paper, and I hope we shall have an opportunity of reading it later on. We must go on, I am afraid, now to the next paper.

Owing to the absence of Mr. Wenham, his paper was read by the Hon. Secretary. The announcement by the Hon. Secretary that Mr. Wenham was 85 years of age and still took a great interest in the Society, of which he was one of the first members, was received with much applause.

Stability of Aëroplane Support for Flying Machines.

By F. H. WENHAM (Hon. Member of the Aëronautical Society of Great Britain).

The earliest attempts at flights by man have been by extended wings in imitation of those of bats or birds, all of which have ended with failure, or fatal accidents.

The bird-wing type for supporting a man and mechanism in air must extend at least 60 feet from end to end, and be very light and strong, for carrying the weight—an impracticable construction. All this is fully explained in a paper read by me in 1866 at the first meeting of the Aëronautical Society of Great Britain, of which I was the pioneer.

Perceiving that a single pair of far-extended wings was impossible for man flight, I evaded lateral extension by placing a system of five aëroplanes, or webs, above each other. The upper one slightly in advance. As all this is fully explained in the aforesaid paper I need not repeat it here. I only had the usual number of authors' copies, and as the present modern Aëronautical Society does not probably possess a copy, I herewith present one for reference.

Successful flights have recently been made in person by Wright Brothers in America and Farman in France. Both used only two superposed aëroplanes occupying a considerable extent of side room.

Lateral extension of surface involves a fertile source of danger by leverage from unbalanced side currents. If a machine with long wings performs a short turn during flight, either accidentally or intentionally, the velocity on the external radius is faster than the inner, and the extra side lift may cause the machine to turn over and disaster will be (and has been) the result.

The question of adequate lift in aërial machines has now been decided by means of supporting surfaces of textile fabric impelled by screw vanes. A screw working in air gives off such a feeble reaction that other means of propulsion should be sought for. Screw vanes acting vertically have not been successful, even for raising and conveying the mere weight of the mechanism required to drive them. In my essay of 1866 I occupy six pages relating to experiments with aërial screw vanes. The largest was six feet in diameter, with two vanes which could be altered for pitch in various experiments.

A screw acting as a blower for smelting furnaces for iron is never used. The blast from a fan-blower is far more energetic, in which the air is seized and emitted at a tangent, with a circumferential pressure of over six ounces per square inch.

In a recent experiment I tried the following arrangement, as shown by the diagram Fig. X.: *a*, *a*, is an ordinary fan-blower with the casing open on one side at the centre and the circumference surrounded by a fixed rim dished at an angle of 60°.

The dotted lines represent the direction of the aërial current, which enters at the open side of the blower case, impinges against the closed back, and then diverges from the angle of 60, making the final exit in a direction parallel with the axis of the blower with a reacting force in the line of flight.

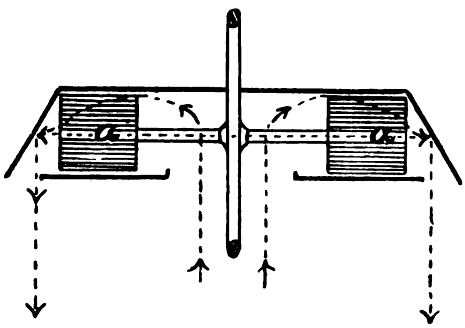


Fig. X.

The force of reaction was somewhat indecisive, as the current is twice deflected, but the effect was sufficient to warrant a trial of the arrangement on a larger scale.

Mr. Wenham, in the following letter, has touched upon an interesting point in connection with the question of longitudinal balance.

Birch Hill,
April 24th, 1908.

Dear Sir,—Many thanks for your letter of 21st. I am glad that you have decided that my brief paper is to be read before the Aëronautical Society of Great Britain (of which I was the parent in 1866). I then described my system of separated aëroplanes that have been successful with flight, so far as to place the possibility of man flight beyond doubt. Inventors adopt my ideas, but avoid mentioning my name. Before public use we have to consider the question of *safety*. Wright Brothers and Farman adopt only two aëroplanes extended above. I advocate *four*, as requiring only half the wing distance with corresponding safety from lateral oscillation.

But my main object in supplementing my paper with this letter is to record a defect that has not been noticed, but is detrimental to *longitudinal* stability, together with continual loss of propelling power.

The thrust from the propeller shaft should be in the centre of the pressure—that is, if the machine were placed to meet the wind, the force of this should be balanced by the pressure above and below this point, otherwise there would be a skew action like a horse drawing outside the shaft of a vehicle instead of a midway straight pull. The propeller can be driven by a belt so that the spindle can be placed in any desirable position to secure a balanced thrust.

For a single aëroplane of large surface the worked-up exhausted air should be got rid of by openings in the web. I have found these orifices to be an advantage, and this is demonstrated by me in a paper in the *Proceedings of the International Conference on Aërial Navigation, Chicago, 1893.* [If this book is not in the library of the Society I will present my copy.]

I enclose a photo of my appearance in 1866, as I cannot now attend Society meetings, being somewhat deaf, and am at the close of my 85th year.

As this letter is addressed to you, I leave it to your discretion to read it before the Society as supplementary to my last. Flight will now become general if safety in construction and use can be secured.

Yours faithfully,
F. H. Wenham.

The President: The author of the next paper not being present, the Hon. Secretary will read it.

Flying Ships of the Future.

By Edgar E. Wilson.

Within the limits of the present article it would be impracticable to deal adequately with exhaustive constructional details, or, in fact, many points bearing particularly upon the gist of this subject. Suffice it, then, to briefly refer to those facts by which the fundamental laws upon which is evolved the future complex and impressive airship of the near future is based, the lessons of Nature containing those laws, and which, in these modern days, are certainly insufficiently studied, and how man can reproduce these selfsame teachings by his methods culminating in the long-cherished, but by no means apocryphal and abortive, *subjugation* of the wide realms of the air.

The flying and soaring of all natural volant creatures is simply explained on well-known mechanical principles, and the majestic air-craft of the future will, in short, embody those principles *inter alia* by the ingenuity of man. The ulterior and chief object of this lecture is an ambitious one; indeed, I may add the objects are several. It will (1) explain concisely and succinctly the fundamental laws of flight as shown and explained by Dr. Pettigrew, who has shown the true pioneer path to success; (2) compare these trenchant lessons of Nature to present types of machines; (3) seek to elucidate the promise of useful aid in these present experimentalists and its ultimate adaptation to more perfected machines; (4) expound the principles upon which the progress of the flying problem on the one hand and the laws demonstrated by Nature on the other evolves a practical dynamic airship; (5) seek to divert into sound channels the prevalent wave or trend toward the illusive, incomplete, and dangerous so-called "aëroplane" (which has no real analogue in Nature), as so ardently yet illogically favoured by the majority of aëronautical students; (6) and lastly, to enunciate one or two fundamental and far-reaching laws in the design and perfection of true aërodynamical flying ships of the future, their true capabilities, distinction, and superior qualities wherein to merit the proud emulation of "the way of an eagle in the air."

Perhaps I may be pardoned for reviving and dwelling upon the lessons of Nature, but it is necessary in order to convey the points advocated to do so, in addition to which it will serve to teach the beginner in aviation the groundwork of this broad science, since, to the advanced philosophical enquirer, it is all too apparent that they begin at the wrong portion of the subject, repeat previous failure after failure, and finish at length in disaster or incomplete results.

The earliest flying creature known to science was the great extinct pterodactyle, of the order *Pterosauria*. This truly wondrous bird-reptile forms a striking testimony to the feasibility of flight by large wings, specimens having been discovered in the fossilised state in the cretaceous rocks in England with wings 25 feet tip to tip, and there can be no doubt that they flew. From these huge antediluvian pterodactyles (Greek: wing-fingered) we pass to the order of *Diptera*, or "two-winged," as the wasp, house-fly, or bluebottle, *Coleoptera*, or beetles, *Hymenoptera*, or butterflies, *Odonota*, as the dragon-flies, *Cheiroptera*, or bats, to the perfection of flight, the birds.

Varied in structure and contour, although these natural flying machines may be, it is significant that all fly on one and the same principle—the screw. And innumerable in variety, some being falcated or scythe-like, some oblong, others rounded or circular; whilst others are again linear or lanceolate, it is noteworthy that they *can* fly, thus proving that the travelling surfaces of the human-built flying machine need not be restricted to one particular design, but the main principles and agencies underlying both must not be transgressed from, and which are clearly set forth as this lecture proceeds. Note, therefore, there must be no escaping or divergence from natural laws. *A thorough knowledge alone will enable us to design fundamentally and construct a true flying airship.*

Therefore without unduly enlarging upon these varieties of formation, we know by Pettigrew's life-work that the bird's wings are of helicoidal curvature throughout, with semi-rigid margins anteriorly and flexible posteriorly, the whole wing graduating in form, the thickest commencing at the shoulder and tapering to a fine plastic point at the tip, which enables the wing to be naturally and automatically stable when struck by oppositionary winds or those of a vertical tendency. It is, however, the following points that the writer wishes to enlarge upon, as this is the key to the whole problem of successful flight, and the true dogma and distinguishing feature whereby the groundwork of artificial flight *must* be encompassed.

All wings, with the exception, of course, of the order *Hymenoptera*, or butterflies, in addition to being structurally and functionally powerful propellers, elevators, and sustainers of remarkable efficacy when in forward translation in helicopteral flight, have their travelling surfaces or "sail-area" reduced to apparently inefficient dimensions, and one would imagine wholly incapable of flight for a short period, to say nothing of lengthened duration. Quite so. To accomplish this seemingly impossible feat, Nature increases the "sail-area" by rapid motion, well knowing that when driven at high speed they augment the active area and practically convert the spaces through which they travel ***into solid bases of support,*** and as the wings or screws travel at much higher velocities than the air-currents they are in, they are superior to and control them by superior power (residing in the powerful pectoral thoracic muscles), greater speed, perfected travelling surfaces designed to satisfy the resiliency of the air, and the inertia of the mass of the flying animal. Slight though this last may be, there is no contradicting their ability to fly and soar upon even adventitious currents, demonstrating the truth of the assertion that "the whole of the wing is utilised to consummate the triple function of elevating, propelling, and sustaining.

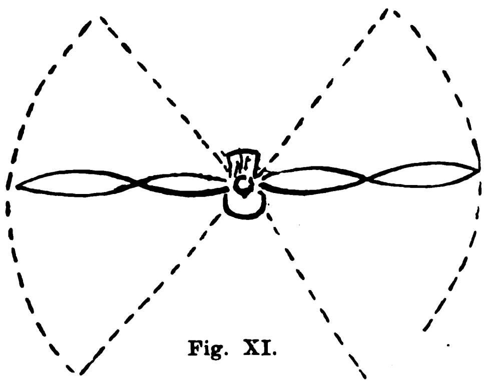


Fig. XI.

Figs. XI., XII., and XIII., will illustrate clearly this principle of augmenting the "sail-area" by a partial rotational motion, the last showing how man reproduces this law by means of the rotary screw propeller. Fig. XIV. illustrates the illogical "reproduction" of this law in the Farman-Delagrange machine, showing the immense preponderance of passive or useless dead "sail-area," and the ridiculously inadequate proportion of active or useful area in the tiny screw of two metres diameter. The dead "sail-area" is 560 sq. feet., against some 30 sq. ft. only of the screw when in motion. Hence, notwithstanding the great superiority of the inertia of the mass over natural flying machines, yielding, in fact, a weight of 1,100 lbs. against the 38 lbs. of the heaviest bird, the great bustard (*Otis tarda*) in conjunction with immense power (50-H.P.), this machine, so far from attacking and subjugating the whirls, waves, and eddies of even moderate winds by superior volition, power, and properly-fashioned surfaces which yield both natural and artificial stability, can venture only aloft a few feet off ***terra firma*** in a virtual calm zone, and, instead of eliciting an upward and responsive recoil of the predominant active surfaces as it should be, the tiny

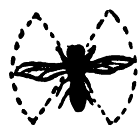


Fig. XII.

screw barely suffices to keep the machine aloft, whilst the operator is working in Herculean efforts to endeavour to maintain equilibrium, which is truly impossible when sudden gusts are encountered, and particularly those of a vertical tendency, and all aëroplanes are similar and susceptible.

In short, the most practicable and sensible contrivances likely to solve the problem are those which are designed

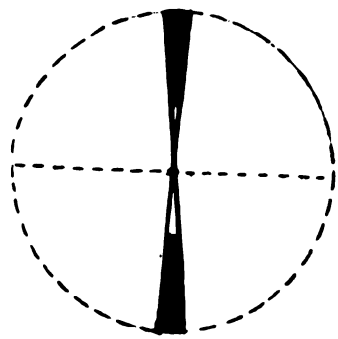


Fig. XIII.

and constructed to take advantage of natural laws, to imitate the bird, "that admirable type of aërial locomotion" according to Marey, as indeed it is, and which are:

(*a*) ***Hélicoptères***, or "screw-flyers," which are simply screws with vertical axis, acting in co-operation with suitable fixed aëro-curves or aëro-surfaces of bird-like concavo-convex design. These surfaces need not be vulvular. Propulsion should be effected by twin propellers.

(*b*) *Orthoptères*, or aviform mechanically-beaten wings, relying solely upon this design for propulsion, elevation, and sustentation.

Hence the problem resolves itself into a study of the bird and all winged creatures, the atmosphere, the hélicoptère, and orthopteric machine respectively, and their co-relation one to another. At this juncture it may prove advisable to enunciate the fundamental laws necessary to encompass true aviation, endorsing each in detail by experiments already well acknowledged and beyond reproach from controversialists.

Fundamental Laws.

(1) The aëroplane, as so distinguished by reason of its large, immoderate, inert, and passive surfaces, whether they be of the superposed "double-decked" type or monoplane single surface, either impelled from behind or towed by a tractor-screw before, should be now rendered utterly obsolete, their employment arbitrarily eschewed, and the principle relegated into one of limited possibilities. It has no true natural stability, is unsafe when flying transversely across the wind or when encountering currents of any strength or of vertical propensities. As a scientific aërodynamical machine it is a failure for these reasons, and is only suitable under favourable atmospheric conditions to win a prize when travelling at low altitudes. For war purposes it is utterly worthless.

(2) By a combination of natural and artificial stability attained by (*a*) multiplicity of rotational surfaces or screws in the hélicoptère type, the vibratory wings acting in co-operation with them to be of moderate alar extent, and which may, in fair winds, be fixed, the centres of pressure and gravity mutually coincident (this being universally known), and the auxiliary surfaces so utilised should be capable of flexure and folding closely against the sides of the aëronef as in Nature to present virtually undue head resistance.

(3) It is imperative that all wing-surfaces, whether in an advanced homogeneously designed aëronef with horizontal and vertical helices, shall be closely reproductive of birds' wings in design, hyperbolically arched transversely, sinuous, and of concavo-convexity in section, and must be flexible posteriorly and most particularly at the tip. This last confers natural stability in tumultuous winds, as vertical currents strike the wing its resiliency enables it to yield and spring back to the normal position instantaneously. The wing-surface, moreover, need be of membraneous construction, and should copy the design of the shaft or quill, the fulness of the penna and semi-rigidity of the anterior margin of a primary feather for simplicity of construction in preference to the complicated shape of the homologous wing.

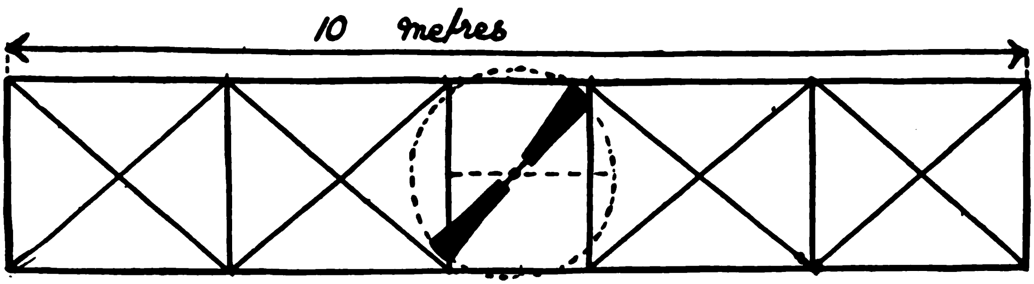


Fig. XIV.

(4) The wing-surfaces, screws, rudders, and, in short, all active or passive sustaining or steering area, should be constructed as lightly consistent with strength as will be found commensurate with safety. All wings, tails, or travelling surfaces in Nature are, fundamentally, exceedingly light, though the body is heavy and the weight concentrated. Hence, the ratio will increase only one-fourth instead of cubed by this law of light construction.

(5) In the hélicoptère principle additional systems of auxiliary wing-surfaces *must be employed*, on the score of safety in the event of equilibrium being lost

through stoppage of machinery, breakage of one or more screws, or other cause.

(6) These wing-surfaces should (*a*) be capable of being utilised under the conditions of law 5 as *independent* beating wings to prolong and continue the flight if desirable; (*b*) may be employed in normal flight simply as additional "sail-area" in moderate winds by a fixed, immovable position; (*c*) the proportion of the total "sail-area" should equal approximately as possible the weight of complete machine at the ratio of 2 lbs. per sq. ft., which, in the light of Farman's experiments, have been found efficient to alight safely; (*d*) for an advanced type of homogeneous machine on the compound wing and screw type two independent engines should be employed, one for work, the other as reserve in extremity.

(7) Twin propellers, if used, are best for forward motion of intermediate size and diameter, and must be placed at the rear of the aëronef, actuated, if convenient, by a smaller engine than required for the ascensional screws, a vertical rudder affixed in the centre of propellers as in marine practice. The rudder, so placed for horizontal steering, would conduce to stability on a transverse plane by artificial aid.

(8) The propellers should preferably be constructed on the Kress or Voght type to ensure by their flexible posterior margins variable pitch to accommodate them to the speed driven. Autorotation by this system will be negligible when the wind is blowing at right angles to the blades as in the marine helix, *i.e.*, when the flying ship is either stationary or in hovering flight. The propellers of Nature are, of course, in the fore part of the body. The reason that the human machine should place the aëronef's propellers as enunciated is that the ascensional screws are both propellers and elevators combined in that adopted by the writer, hence very slight propulsive aid from the twin propellers will be requisite in practice.

(9) All elevating helices and wing-surfaces in either aëronefs or aviform wing machines should be "stepped," whilst in the former the component auxiliary primary surfaces should coincide with the angle of incidence of the helices, and must be high above them to satisfy the need to work on fresh, undisturbed air; the ascensional screws to be on a level partially with the car.

(10) The construction and design of the aëronef should closely approximate to the fast flying bird type such as the swift (*Cypselus apus*), albatross (*Diomedea exulans*), frigate-bird (*Tachypetus aquila*), sparrow-hawk (*Nisus communis*), swallow (*Hirundo rustica*), and similar examples; the greatest width of the hull in the forward part and tapering to a more or less flattened section at the rear. In the orthopteric machines this reproduction of the bird's body can be followed precisely. In the structural emulation of the aëronef type it will be found more practicable to approximate the aquatic or machine vessel, since the stream lines of air will be divided into component waves, reducing head resistance to a minimum. Moreover, it must not be overlooked that the combined thrusts of the ascensional and propulsive screws will be enormous, literally forging the flying ship with the potential aid of gravitational energy and the immense inertia of the mass of the dynamic airship through all resistances tending to deflect the aëronef from its course, and the vertical elongation of the anterior margin of the hull, so far from proving undue "drift," will more than counteract it by the shape facilitating lateral control on the fin keel principle.

(11) The highest fundamental law in the case of the hélicoptère or ascensional screw type is the position of the main weight in forward translation, and accounts in all predecessor machines for their failure hitherto to secure propulsion through the erroneous position of the centre of gravity. Paucton, in 1768, Meerwin, Launoy Bienvenu, Deghen, Ottoris Sarti, Dubochet, Henson, Cossus, Bright, Pénaud, Camille Vert, Pline, Bréant, Nadar, Ponton d'Amécourt, De la Laudelle, Forlanini, Dandrieux, Castel, Phillips, Giffard, Lenoir, Renard, Léger, Santos-Dumont, Kress, Bertin, Cornu, Bréquet and Richet, one and all have the centre of gravity erroneously located.

(12) The final law has reference to the orthopteric type of dynamic flyer, and additionally propounds the inference that clearly failure to encompass flight in imitation of the bird in accordance with the figure of 8 waved line of progression when the wings are beaten in a vertical

direction *simultaneously* is the great complexity of this motion, one partisan school assuming that the reciprocal periodicity of wing beats in the up and down strokes should be irregular in duration, whilst the opposite school with equal confidence assure us that the period is equal, and no matter if the beats be of short or long duration and the amplitude either, forward motion must result when the pinions are actuated. Personally, I am inclined to favour this view also, on the basis of experiment and judgment, in that since reciprocal wing beats are portions of a circular disc or path (see Figs. XI. and XII.) it follows that forward component is the result, and Marey's views of the down-stroke, should power be suddenly lost. Since, therefore, this principle of reciprocal flight rejects it for practical work, we must seek a compromise in the system of Jobert, Holland, and McKee (the latter is here to-night), in that we have designated the "Roller" principle. This principle, also advanced by Rénard, unquestionably explains the secret of the hitherto imperfectly comprehended soaring flight of the condor (*Sarcoramphus gryphus*), buzzard (*Buteo vulgaris*), albatross (*Diomedea erulano*), eagle (*Aquila chrysætus*), and the rest of the gliding birds. Briefly, on the albatross, swift, etc., encountering powerful cross-currents in conjunction

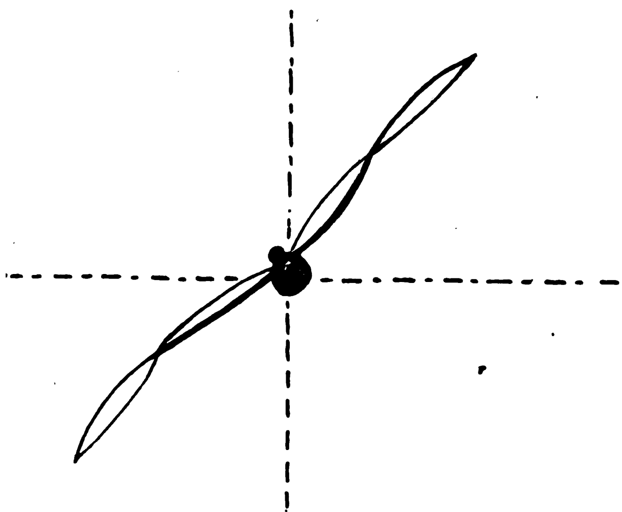


Fig. XV.

to the discrepancy by sphyomorgraphic records are due to the elasticity of the pinion on the one hand, and the superior contraction of the pectoral depressor muscles antagonising the inferior qualities of the elevator muscles on the other, in conjunction with the concavo-convex shape. I would furthermore condemn as unnecessary the servile copy of the whole wing embodied in the Frost, Hutchinson, and D' Esterre machine, splendid though their results have been in securing a lift of 170 lbs. with 1-H.P. in one single down stroke, if this be authentic. This machine, moreover, contains, with Major Moore's flying fox and many others, the fatal and insuperable inability to prevent loss of stability when at the lowest point with their swift flight; these vertical currents obviously have a tendency to deflect the course of the flight, hence the bird swings or rolls transversely and so transfers its wings into twin propellers, the feathering action also yielding a sinuous form of the wing (Fig. XV.). Consequently if we apply four wings in tandem á la Langley, Brown, etc., superposed or monoplanes, and impart a converse motion to the wings, the result is, we have a simple *reproduction* of Nature without any danger of disaster, whatever the angle of the amplitude be arrested at. Here, therefore, is a still further triumph over Nature. A bird, once shot, the equilibrium is gone, and the bird falls headlong. In our "Roller" type, were the engine to stop, the equilibrium is maintained, whilst diminution of the parachute area is impossible with the springs beneath representative of the pectoral cord. The second type of practical flying ships of the future, there is no doubt, must be on this principle of aviation (Fig. XVI.).

SUPPLEMENTARY REMARKS.

From the researches and experiments of physiological enquirers in the aëronautic engineering world comprising French, German, American, Italian, British, etc., the writer sincerely trusts that it is now clear, without bias nor prejudice, that a remarkable analogy exists in the co-relation of the laws of Nature and their evolution to those types of flying ships of the future, which may be appropriately termed the "Aëronef" and the "Roller" principles. The screw principle, form and flexibility of the bird's wings is unquestionably the distinguishing feature towards artificial flight, and the innumerable varieties of form in Nature's screws does not contradict the fact that all fly on precisely the same laws, and flight by mechanics is, therefore, the product of superior inertia, volition, power, and properly constructed flying surfaces (one primary feather, indeed, being morphologically or functionally and structurally equivalent to the whole wing), without which mechanical flight will never subjugate the conflicting waves of atmospherical space.

In the designs herewith shown (Figs. XVI. and XVII) the writer personally favours the aëronef type, in that the ship is susceptible of rising vertically upward or descending within a confined space, will be capable of hovering above one spot, can sustain itself aloft with its spinning helices at high velocities, rotating irresistibly in strong, tumultuous winds, whilst the fixed wing-surfaces can be flexed, and has the additional claim for superiority in the simple yet efficient mechanical motion of the screw, whereupon it may be found disadvantageous in the wing type in powerful winds by the great expanse of superficial area exposed, flexure, of course, resulting in a fall. With regard to artificial aids by means of automatically restoring equilibrium by movable centre of gravity to retain coincidence with centre of pressure due to changes of incidence, or gyrostats, interlocking devices by pendulum, etc., the length of this lecture prohibits an exhaustive description, which must be left for future lectures describing progress with a pioneer machine.

To succinctly summarise the proposed aëronef herewith portrayed under construction by the writer as a pioneer craft

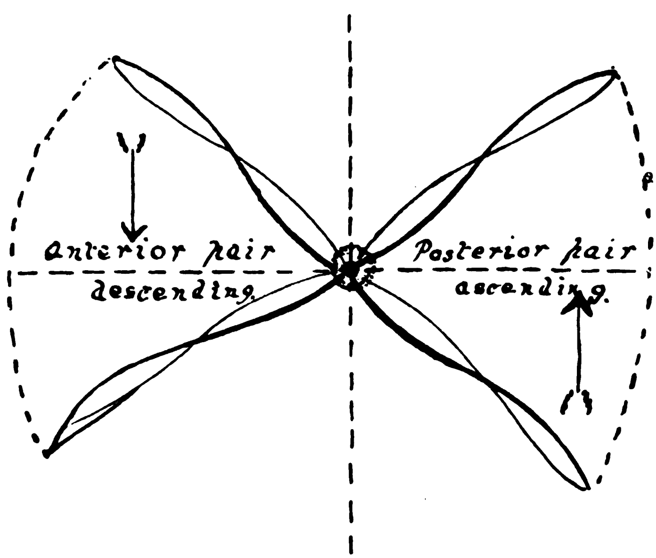


Fig. XVI.

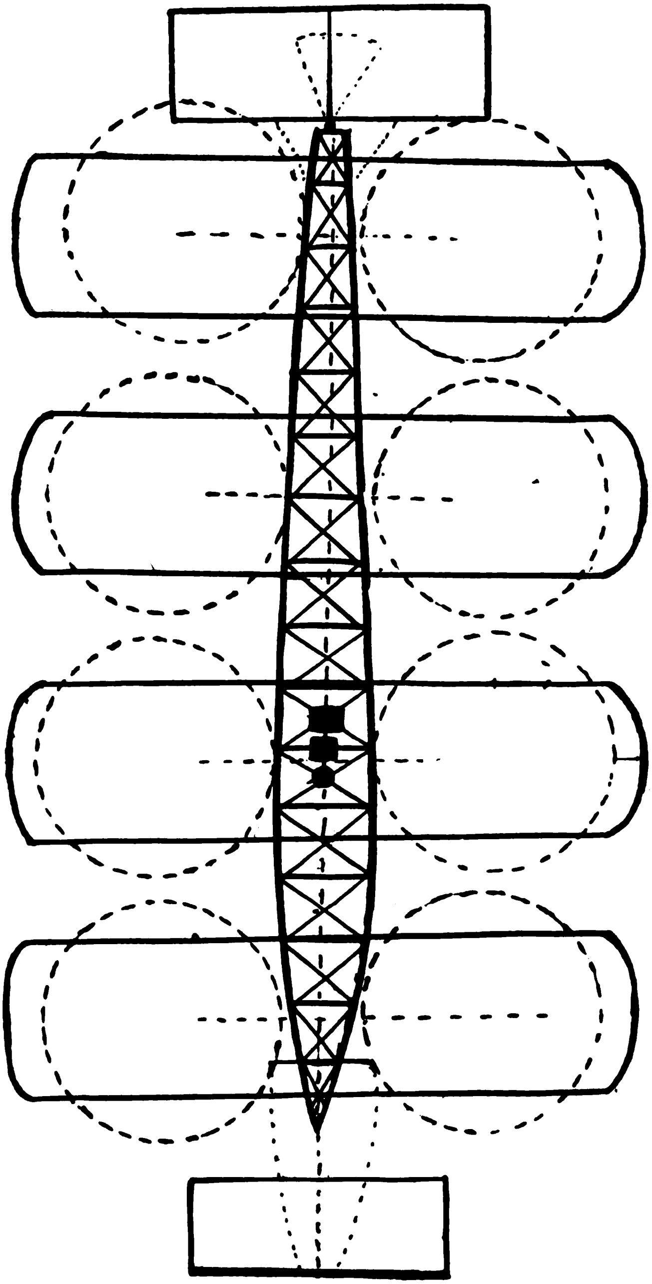


Fig. XVII.

embodying the whole of the foregoing laws, the machine is 32 ft. long by 20 ft., with eight ascensional screws as depicted, is capable of flight solely by these alone, but has the additional practical advantage of the wing-surfaces flexed above, and which are truly "automatic parachutes." Funds render the rapid completion slow; indeed, the writer would point out that were he a Henri Deutsch, a Santos-Dumont, or a Government official, he would certainly build a true liner of the clouds over 100 ft. long, 72 screws, and 250-H.P., which would present a magnificent spectacle of a glittering magnalium hull surmounted by swiftly-rotating helices irresistibly forging its path through the whirls and eddies of atmospherical space. Such a veritable example of *multum-in-parvo* would not exceed 5,000-lb. load, yielding 2,000 lbs. for complete machine and 1,500 lbs. for light engines, or 6 lbs. per H.P., leaving 1,500 lbs. for fuel and aëronauts. That the thrust of the helices at the ratio of 20 lbs. per H.P. is feasible will readily be seen by the thrusts of various experiment lists subjoined.

NAME.	No. of Screws	Diam. in feet.	Thrust in lbs.	Total H.P.	lbs. per H.P.
Giffard	1	8	165	6	27·5
Dahstrom and	1	8½	55	1½	36·7
Lohman ..	1	5	45	1	45
Moy	2	12	120	3	40
Renard	1	23	432	9	48
Maxim	2	17′ 10″	2,000	363	5·8
Kress	2	12	82(?)	1	82
Léger	2	20	240	6	40
Walker	1	30	1,250(?)	50	25
Santos Dumont..	2	20	400	28	17·5
,,	1	20	198	9	22
,,	1	6½	332	50	6·6
Bréquet.. ..	32	26½	1,190	40	29·2
Cornu	2	19·68	853	24	35
Rankin Kennedy	2	5	72	3	24
Pickering ..	1	12	48	1	48
,, ..	1	20	430	20	21·5
Farman ..	1	6½	375	50	7·4
Sidney H. Hollands ..	1	6½	26½	1	26½

By comparing the thrusts, particularly Maxim and Bréquet, it will be seen that the ratio of lift increases in proportion with additional area, whether passive or active.

A loss by friction of 30 per cent. is more than compensated by forward motion, the Copenhagen experiments and smaller ones by the writer having demonstrated that a wind blowing transversely across the blades increases the "lift," and augments it 75 per cent. With regard to stoppage of one or more screws or portion of machinery, it has been demonstrated that the remainder would continue working, and the fall is transferred in a series of wide curves in the form of a conic section whose base is upward, allowing ample time to operate the automatic parachutes which have opened within a second in a fall of 50 ft., in a vertical descent with experiments with specially designed parachutes made by the writer. That the flying ship of the future is unquestionably upon the lines of the aëronef and the roller principles it has been the effort of the writer to attain. That the winged roller system is superior to other wing types none will dispute. The Weiss model will repeat in gliding the drawbacks of the aëroplane on a large scale and is inevitable. In reality, this system is a copy of the simple experiments with planes given by Marey in "Animal Mechanism," and though this upward curve is seen in the poster margin of the rook (*Corvus frugilegus*) and magnified in the carrion crow (*C. corone*) and grey crow (*C. cornix*), it is significant that they vibrate these wings and rejoice in the possession of a rear tail of ample proportions. Yes, the future of aërial locomotion belongs to the true flying ships, and to which the subjugation of the blue waves of the atmosphere will assuredly fall.

The President: I think it only remains now to thank the authors for the interesting papers we have had, and I must thank Colonel Fullerton very much for reading the papers so excellently. (Applause.) Thanking you for your kind attention here this evening, with these few words I close the meeting.

Major Baden-Powell: May I interrupt you, Mr. President, one moment? Ladies and Gentlemen, I think that we ought to accord a vote of thanks to the President, who has taken the chair to-night, and though I have nothing much to say on this occasion, still we have to remember that this is the first occasion—I think I am right—on which the new President has taken the chair. And, therefore, it is a very opportune one to give him a good vote of thanks. I think that it may be of interest for me to mention that we have here to-night several very distinguished foreigners, come over to represent their various countries. There is Mr. Hergezell, who you all know by name, and Colonel Moedebeck, whose pocket-book we all know so well. I know they have been very interested in the proceedings, even though they say they have not been able to understand all that was going on. However, I will only ask you to accord a vote of thanks to the President for presiding to-night. (Applause.)

Colonel TROLLOPE: I beg to second the vote of thanks and couple with it the name of Major Baden-Powell.

The PRESIDENT: Major Baden-Powell, Colonel Trollope, Ladies and Gentlemen, I am extremely obliged for the honour and confidence you have placed in me.

The following paper was accidentally delayed in transmission, otherwise it would have been read at the meeting:

On the Conditions of Equality of Statical Stability, between the Dirigibles "Patrie" and "Zeppelin."

By CAPT. GUIDO CASTAGNERIS.

In a paper published in the Journal of the Aëronautical Society of Italy, p. 267 (1906), I explained some interesting points regarding certain constructional technical advantages, dynamic and economic, special to the systems of dirigibles, which have a cylindrical form of great length, a very much reduced midship section, and a minimum distance between the point of action of the ascensional force and the axis of the car, of which the "Zeppelin" shows, in practice, a very successful example.

Mr. Laboccetta, in his paper, in the same Journal, page 2, 1907, when comparing certain types of dirigibles, pointed out the influence of the co-efficients of resistance to forward movement, the value of extended forms, the importance of fair shapes and lifting power, and showed the advantages of the extended shape in certain cases. The "Revue du Genie Militaire," October, 1907, also alluded to the points which I considered in the Journal of the S.A.I. (1906), but like nearly all the other technical experts, omitted to draw attention to the very interesting question raised by the "Zeppelin" consequent on the smallness of the distance between the point of action of its ascensional force and the axis of its car, compared with its great length. I return, therefore, to this question, as it is daily becoming of greater importance, owing to the efforts made by the designers of dirigibles to arrive at good practical forms, smaller resisting force, greater economy of motive power, better stability arrangements, and higher efficiency generally from the commercial point of view. The idea of this paper is, therefore, to draw attention to the conditions necessary for comparing the values of the static stability of the two systems, having maximum and minimum distance between the centre of gravity and point of application of the ascensional force, as their chief feature.

The technical subjects, which have almost for the same reasons been the object of discussion among naval architects, will serve us as guides and sources of instruction for the similar aëronautical questions.

I repeat that it will only be by a truly impartial and careful examination of the different problems bearing on all the aëronautical systems and the questions of working, transport, etc., that public interest will be aroused, and rapid and wonderful progress made.

The two types of dirigibles to be compared have as chief characteristic the different distribution of the load, relatively to the longitudinal axis.

In the dirigibles of the type "Patrie" the load is almost entirely concentrated in a single car placed immediately below the midship section.

In the "Zeppelin" the load is divided between two cars, placed symetrically, relatively to the mean cross section.

To the type "Patrie" belongs the "Ville de Paris," the "De la Vaulx," the "Parseval," the "Gross-Basenach," and the "Nulli Secundus," the three last-named having a cylindrical instead of a spindle-shaped form. In the type "Patrie" one is obliged to concentrate the load in a single mass, not only on account of its small capacity, limited space for mechanism, safety, etc., but also because this course is necessary to ensure the chief and essential point, without which the whole system is dangerous, viz.: a powerful pendulum-like action of the load, tending to always restore it to a position vertically below the midship section.

The "Parseval," "De la Vaulx," and "Gross-Basenach," have their propellers fixed between the car and the envelope, an unsatisfactory arrangement from the safety point of view.

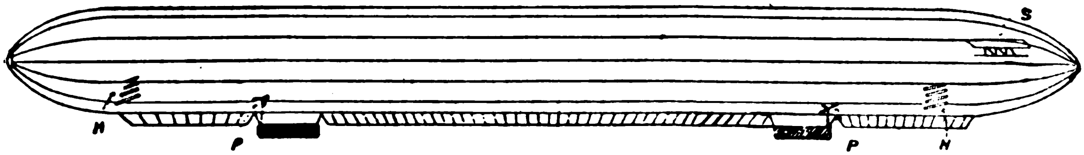


Fig. 1.—"Zeppelin III."

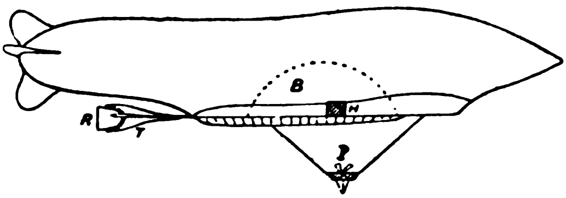


Fig. 2—"Patrie."

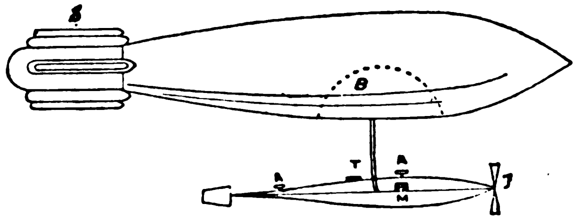


Fig. 3.—"Ville de Paris."

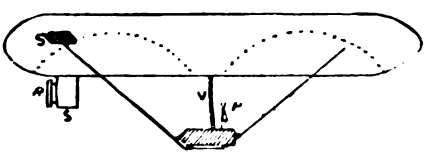


Fig. 4 – Von Parseval.

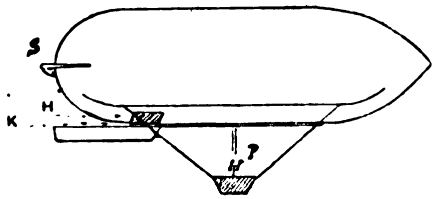


Fig. 5 —"Gross"

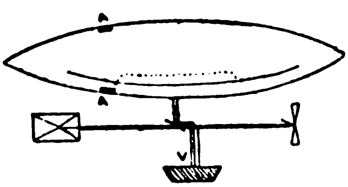


Fig. 6. - "de La Vaulx."

Fig. XVIII.

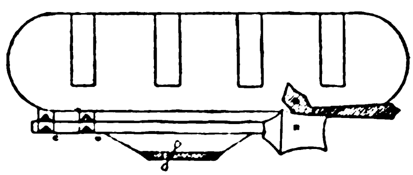


Fig 7. British Government Airship.

The "Zeppelin," on the contrary, is unique of its kind. Its great length necessitates a special distribution of the load, and this distribution rather makes one think that all idea of obtaining a natural pendulum-like motion for regulating the oscillating and pitching motions of the airship has been abandoned.

The first distribution of the load was made without any very exact knowledge of the requirements of the case. Later, in 1900, a moveable weight of 100 kilg. was hung 25-30m. below the cars, to assist in balancing the machine, but, subsequently, this arrangement was altered, and a rolling carriage (150 kilg.) running on a rail fixed in the gallery connecting the two cars substituted.

for the transportation of heavy weights (as in the case of Atlantic liners), it will be necessary to use propellers, coupled in pairs, of dimensions suited to the rotational speed of the motors, and when the length of these dirigibles is taken into consideration it is clear that all attempts at concentrating the load as is done in the "Patrie" must be given up.

The arrangements for the distribution of the loads in the different parts of the system, the necessity for avoiding lines of suspension of great length and angular divergence, the large diameters and heavy weights, and the importance of cer-

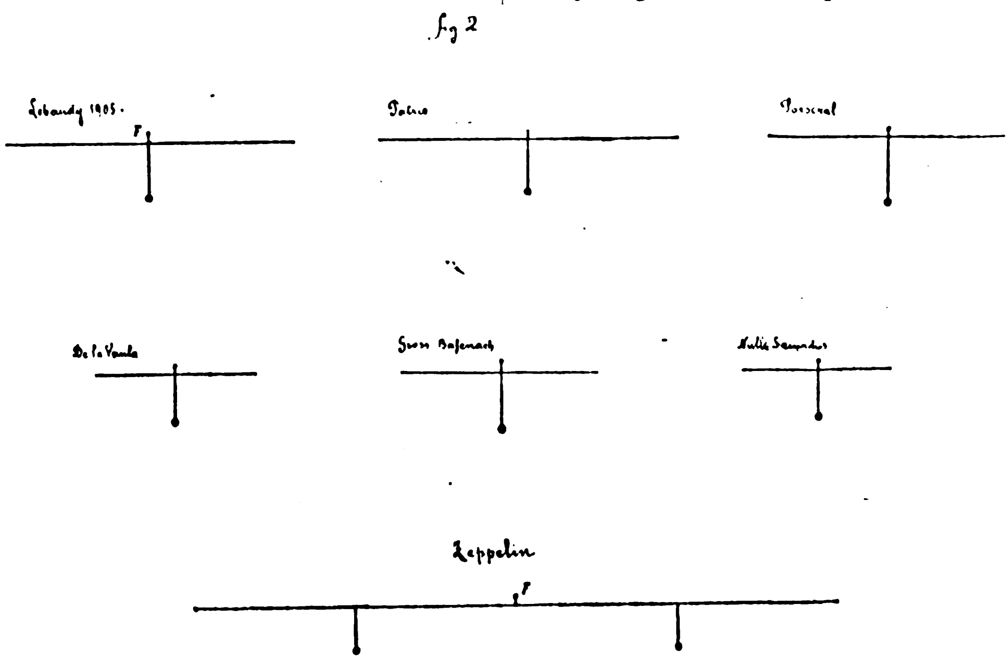


Fig. XIX.

Finally, the moving weights were done away with, and the system of "empennagement" invented by the late Colonel Renaud, of the French Engineers, adopted. This, with the balancing planes of the "Patrie" type, ensures for the "Zeppelin" a very satisfactory statical and dynamical stability.

The splendid trip made in September, 1907, lasting seven hours without landing, covering a distance of nearly 340 kilm. in a closed circuit, with departure and return in one day, gave an indisputable demonstration of the aëronautical qualities of this airship and of its stability.

Owing to the great size now demanded

tain arrangements for ensuring a rigid connection between the car and the envelope, impose a particular method of distributing the fixed loads and the use of dynamic balancing planes so as to ensure constant equilibrium during the small and unavoidable displacements caused by the variations of the moveable loads. Further, the variable loads, such as the ballast, petrol, cooling water for the motors, lubricating oils, etc., must be placed in a central reservoir (with small auxiliary reservoirs) in such a manner that the reduction in their weight does not alter the trim of the airship.

The "Zeppelin" is a good example of

the best distribution of the fixed loads as, notwithstanding its great length, it only requires balancing and "empennagement" planes of small dimensions. The results of the "Zeppelin" are, therefore, very important and instructive, and show that the popular idea that there should be a considerable distance between the axis of the car and the point of action of the ascensional force is quite erroneous.

mental tests alone that precise and definite data can be obtained.

In Fig. XVIII. are given diagrams of the different types of dirigibles which up to now have given the best and most useful results. Fig. XIX. and the table given below, show at a glance the distances between the point of application of the ascensional force and the axis of the car in the dirigibles mentioned.

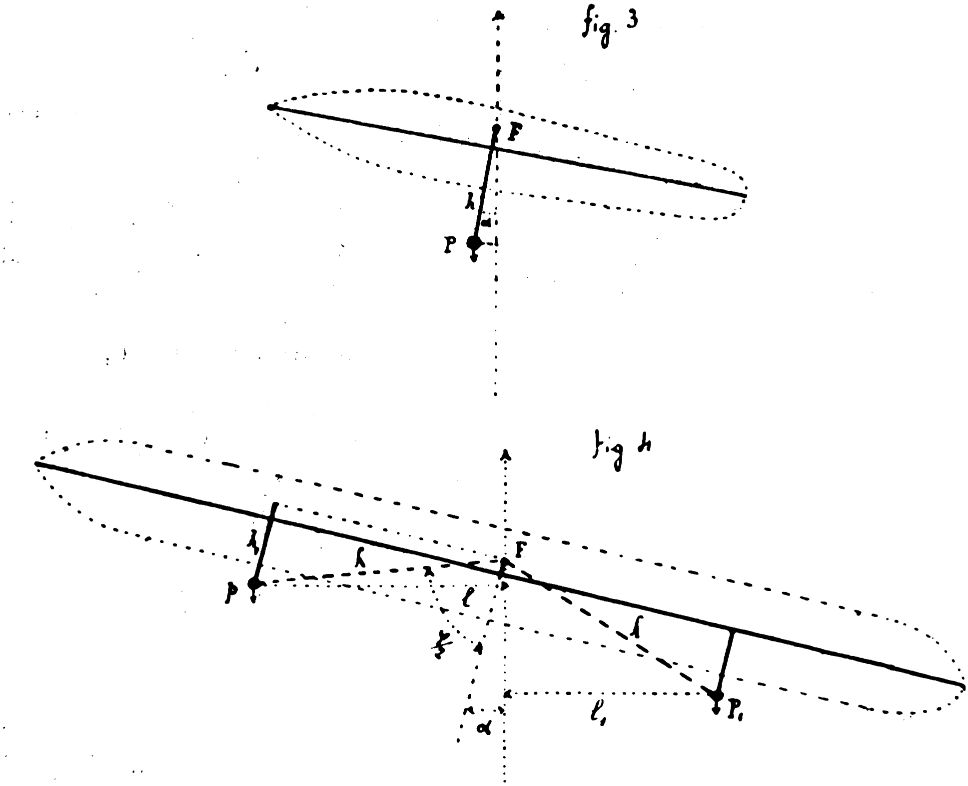


Fig. XX.

There is also nothing to prevent the investigation of the relations which should exist between the principal data of comparison of the statical stability qualities of the systems "Patrie" and "Zeppelin," and, as regards the latter airship, all the cases special to its load distribution can be equally well examined.

This examination is the more desirable because Count Zeppelin has always withheld information about the stability of his system. It is to be hoped, however, that he will now give to the world the results of his observations, as it is from experi-

TABLE I.

Name.	Length. Metres.	Distance between the point of application of the Ascensional Force and the axis of the car. Metres.	Ratio between Cols. 2 & 3.
France	50·42	9·80	5·14
Lebaudy	58·00	10·70	5·42
Patrie	60 00	10·90	5·52
Parseval	48·00	14·20	3·39
De la Vaulx	32·50	10·10	3·22
Gross-Basenach	40·00	11·50	3·49
Nulli Secundus	30·00	10·10	2·97
Zeppelin	128·00	8·70	14·70

In Fig. XIX. the point F on each diagram represents the approximate position of the point of action of the total ascensional force of the system. This point is, consequently, the centre of rotation of the oscillatory and pitching movements of the dirigible.

One sees from the figures that "The France," the "Lebaudy," and the "Patrie" have a ratio of distance between point of application of the ascensional force and length of dirigible greater than $\frac{1}{5}$; the "Parseval," "De la Vaulx," and "Gross-Basenach," a ratio greater than $\frac{1}{3}$; the "Nulli Secundus" of $\frac{1}{2\ 97}$; and the "Zeppelin" of $\frac{1}{14{\cdot}70}$

From Figs. XIX., XX., and the following tables one sees the general relations between the dirigibles "Patrie" and "Zeppelin," and the different elements, moment of inertia, and periodic times.

TABLE II.

Moment of Inertia J.

h = distance between F and axis of car.
h_1 = ,, ,, "Zeppelin."
λ = radius of gyration of the masses p p_1 "Zeppelin."
$p = p_1$ = weights of the cars "Zeppelin."
P = weight of the car "Patrie."
$P = p + p_1 = 2\,p$,
then

Type "Patrie." Type "Zeppelin."

$$J = Ph^2 \qquad J_1 = 2p\,\lambda^2$$

if

$$\lambda = \frac{h_1}{\cos\frac{\phi}{2}} \qquad h_1 = \frac{h}{n}$$

$$J_1 = P\left\{\frac{h}{n\cos\frac{\phi}{2}}\right\}^2$$

The moments of inertia will be equal in the two systems with respect to their cars in all cases where

$$n^2\cos^2\frac{\phi}{2} = 1$$

that is to say, for example, when

$$\left.\begin{array}{ll} n^2 = 1 & \cos^2\frac{\phi}{2} = 1 \\ n^2 = 2 & \cos^2\frac{\phi}{2} = \frac{1}{2} \\ n^2 = 3 & \cos^2\frac{\phi}{2} = \frac{1}{3} \\ n^2 = 4 & \cos^2\frac{\phi}{2} = \frac{1}{4} \end{array}\right\} \quad (1)$$

TABLE III.

Period of Oscillation T.

As a function of the radius of gyration of the weights of the cars.

$$\text{Type "Patrie" } T = \pi\sqrt{\frac{h}{g}}$$

$$\text{Type "Zeppelin" } T_1 = \pi\sqrt{\frac{\lambda^2}{gh_1}}$$

and substituting for h its value as a function of h type "Patrie."

$$T_1 = \pi\sqrt{\frac{h}{gn\cos^2\frac{\phi}{2}}}$$

This relation shows that the two periods are equal when

$$n\cos^2\frac{\phi}{2} = 1$$

and that as $\cos\frac{\phi}{2}$ varies from 1 to 0, T varies to infinity. Hence the "Zeppelin" type has a better statical and dynamical condition than the "Patrie" type.

TABLE IV.

Righting Couple—C_2

One has

Type "Patrie" $C_2 = Ph\sin\alpha$
Type "Zeppelin" $C^1 = pl - p_1 l_1$

Assume

$$p = p_1$$
$$2p = P$$
$$l = \lambda\sin\left(\frac{\phi}{2} + \alpha\right)$$
$$l_1 = \lambda\sin\left(\frac{\phi}{2} - \alpha\right)$$
$$C_2^1 = p\lambda\left\{\sin\left(\frac{\phi}{2} + \alpha\right) - \sin\left(\frac{\phi}{2} - \alpha\right)\right\}$$
$$= 2p\,\lambda\cos\frac{\phi}{2}\sin\alpha$$
$$= P\,\lambda\cos\frac{\phi}{2}\sin\alpha$$

This expression, compared with the formulæ for the moment of inertia, shows that the "Righting Couples" C_2 and C_2^1 of the two systems will be equal if

$$\sqrt{\lambda^2\cos^2\frac{\phi}{2}} = h$$

that is to say, in cases when, for example,

$$\begin{array}{ll} \lambda^2 = h^2 & \cos^2\frac{\phi}{2} = 1 \\ \lambda^2 = 2h^2 & \cos^2\frac{\phi}{2} = \frac{1}{2} \\ \lambda^3 = 3h^2 & \cos^2\frac{\phi}{2} = \frac{1}{3} \quad \ldots (2) \\ \lambda^4 = 4h^2 & \cos^2\frac{\phi}{2} = \frac{1}{4} \end{array}$$

From equations (1) and (2) one gets

$$h_1 = \frac{h}{\sqrt{x}} \quad \ldots\ldots (3)$$

$$\lambda = h\sqrt{x} \quad \ldots\ldots (4)$$

$$\cos\frac{\rho}{2}=\sqrt{\frac{1}{x}} \quad . \quad . \quad . \quad (5)$$

In conclusion, for conditions of equality of statical stability between the type "Zeppelin" and "Patrie," it is necessary that the angle of divergence of the two cars, and the distance of these cars from F, should satisfy the equations (3), (4), and (5). Further, it is seen from the above that by increasing the angle of divergence of the cars the time of oscillation is reduced.

THE AËRONAUTICAL SOCIETY OF GREAT BRITAIN.

The Aëronautical Society of Great Britain is the oldest institution of its kind in the world, having been founded in January, 1866. At this period a considerable interest was being taken in the subject of ballooning for scientific purposes, Mr. James Glaisher, F.R.S., having already made several sensational ascents for investigating the conditions of the upper air. He was instrumental in founding the Society, and became its Treasurer. The Duke of Argyll was just bringing out his book "The Reign of Law," in which he went deeply into the question of the flight of birds and of the possibility of imitating the action by machinery. So well-known and highly honoured a personage was naturally offered the Presidency of the Society, and he was well backed up by other leading men devoted to science and mechanics, the Duke of Sutherland, Lord Richard Grosvenor, and Lord Dufferin becoming the Vice-Presidents. Hatton Turner's great work, "Astra Castra," well known as the greatest published collection of matter relating to aëronautics, had appeared in the preceding May, and had doubtless added greatly to the public interest in the subject. The author was elected a member of the Council. Other members of the Council included Sir Charles Bright, M.P., F.R.A.S., William Fairbairn, LL.D., F.R.S., and several other well-known engineers.

Mr. Fred Brearey, a keen advocate of the heavier-than-air principle of aërial navigation, was appointed Hon. Secretary. At the end of the first year the membership had reached sixty-five.

The first general meeting of the Society was held on June 20th, at the Society of Arts, in which building its meetings have been held ever since. On this occasion Mr. W. H. Wenham read a paper on "Aërial Locomotion," which to this day remains one of the most instructive of the many which have since been read before the Society. The Annual Report for the year was the first of those which followed regularly for some twenty-five years.

These reports of the Society form a most valuable record of what has been done in England, and to some extent abroad, also, during this period. They contain a number of important papers with interesting discussions, as well as many reprints of older pamphlets, etc., some of which are out of print and almost impossible to obtain.

It may be desirable to briefly recapitulate the more important of these articles:—

During the second year of its existence the Society continued to prosper. Two meetings were held, and in the Second Annual Report it is stated "the Society has good reason for congratulation that since its formation so many fresh minds have been induced to study the question of aerial navigation." The number of members had increased to 91, and in the third year it attained 106.

The Society has held two exhibitions The first was in June, 1868, at the Crystal Palace. It is most interesting now to read the list of exhibits, which is remarkably complete, including 78 entries. Class I. was for light engines and machinery, and the Society offered a prize of £100 for the best exhibit. Several good machines were shown. The account of exhibit No. 7 is specially noteworthy, which was a "WORKING MODEL OF THE BRIGHTON OIL ENGINE. In this engine power is derived from explosion within the cylinder of inflammable gas or vapour mixed with atmospheric air. The vapour is produced by volatilization of certain liquid hydrocarbons." This was one of the first ancestors of the internal combustion engine which has now been the means of practically solving the mastery of the air. Stringfellow's steam engine, however, was the one which carried off the prize of £100. It was of just over one-horse-power, and "the weight of the engine and boiler was only 13 lbs., and is probably the lightest steam engine that has ever been constructed," so the Report tells us.

Class II. was for complete working aërial apparatus; Class IV. for working models, and Class V. for plans and illustrative drawings. Class VII. was for kites.

The second exhibition was in 1885, and was held at the Alexandra Palace. This, however, was not so great a success as the first, although a number of most interesting models were shown.

Meanwhile, in 1871, a series of experiments on air pressure were conducted under the auspices of the Society, special apparatus having been constructed by Mr. Browning and operated by Mr. Wenham, some highly interesting results were obtained and tabulated.

The Society continued its career of usefulness and issued its Reports regularly until about the year 1893, when its activity slackened a good deal. The membership had gradually died down, and Mr. Brearey, the Hon. Secretary, was getting an old man and had lost much of that keen energy which had so successfully stimulated the Society in its early days. Most of the leading lights of the Society had become inactive in their support. Mr. Glaisher, now in his 88th year, was the only original member of the Council remaining, and was unable to render much service.

In 1896 Mr. Brearey died, and though it looked as if the last glow of the dying embers had ceased, yet this really resulted in fresh blood coming forth and re-kindling the fire. In November of that year a meeting of the few remaining members of the Council (including Messrs. E. A. Barry, B. Baden-Powell, E. P. Frost, and Major Roberts) was summoned, when it was decided to endeavour to resuscitate the Society. Events of importance had been going on which had attracted much public attention to aëronautics. Sir Hiram Maxim had been conducting his well-known experiments. Lilienthal in Germany and Langley and Chanute in America had also aroused great interest. So that the time was ripe for action. Captain (now Major) Baden-Powell was appointed Honorary Secretary, and a strong Council, including Sir Edwin Arnold, the Earl of Crawford, Sir William Crookes, F.R.S., Mr. (now Sir) Hiram Maxim, Colonel Templer, and General Sir Charles Warren was formed.

In January, 1897, the quarterly "Aëronautical Journal" was started in place of the Annual Reports, and this has continued to be issued regularly ever since.

In 1899, Major Baden-Powell went off to the war in South Africa, and Mr. E. S. Bruce took his place as Honorary Secretary. Major Baden-Powell was later elected President of the Society.

A number of meetings have been held each year, both for the reading of papers as well as for out-door experiments and competitions. Among the latter may be specially mentioned the International Kite Competition, held on the downs near Worthing in 1903, and a display of apparatus at Sunningdale in 1907. The Society is now in a flourishing condition. Financially, it has recently benefited by the generous donation of £100 annually for five years from Mr. P. Y. Alexander, and last year a grant of £105 was given by the Mercers' Company in aid of research.

A good library has also been formed, which includes almost all the published works on Aëronautics in the English language.

Last year some important changes in the Officers of the Society took place, when Major Baden-Powell retired from the Presidency after seven years of office, and Mr. E. P. Frost was elected to fill the vacancy. Mr. E. S. Bruce also resigned the Honorary Secretaryship, and has been succeeded by Colonel J. D. Fullerton, late R.E.

53, Victoria Street, Westminster, London, S.W.

NOTES.

Dirigible Balloons.—The May, 1908, number of the Royal Engineer Journal contains an interesting paper by Colonel J. Capper, R.E., C.B., on Dirigible Balloons. The author gives a general account of the construction of the different parts, envelope, system of suspension, etc., with a great deal of general information of a kind likely to be useful to those who contemplate constructing airships of this type.

The "Ripping Cord."—"La Conquête de l'Air," of April 15th, 1908, gives a copy of a letter written by Mons. Jules Verne, describing an ascent made by him, in company with Mons. E. Godard (senior), at Amiens on September 28th, 1893, in the "Meteor" balloon. Describing the balloon and its appurtenances, the writer states: "Une 'corde de fracture' lui permet, au besoin, de fendre son aerostat au cas où le ballon, rasant la terre, demanderait à être instantanément vidé pour la necessité de l'atterrissement."

This is interesting as showing the value put on this kind of apparatus by an expert balloonist.

Foreign Aëronautical Publications.

(In this list a selection of some of the more notable articles only is given.)

The American Aeronaut.

February-March, 1908.—Motor Ballooning.—Farman's Triumph.—Airship Engines.

May, 1908.—Europe's Aërial Navies.—Some of the latest phases of the Flying Machine Sport.—Herring's Work.—The Regulation of Flying Machines.—The "Red Wing."

Aeronautics (America).

April, 1908.—The advantages of the Hélicoptère over the Aëroplane.—The first successful trials of the "Red Wing."—Equilibrium and Control of Aëroplanes.—Construction and Equipment of Wind-Tunnels.—The new Baldwin Dirigible.—Hydrogen for Dirigibles at low cost.—On the use of Liquid Hydrogen, etc.

May, 1908.—The Cornu Hélicoptère.—On the first Observations with Sounding Balloons in America.—On the use of Liquid Hydrogen, etc.

L'Aerophile.

April 1st, 1908.—The Breakage of Screw Propellers at high velocities.—The Starting of Aëroplanes.—The "Kapferer" Aëroplane.—The uselessness of "Level Indicators."

April 15th, 1908.—The Paul Cornu Hélicoptère.—The "Dufaux" Motor.—"Level Indicators."—Aéro-Club of France; a general account of Aëronautical work done in 1907.

May 1st, 1908.—Determination of Geographical Position in a Balloon.—The Brothers Wright; recent patents.—The "Useful" weight which an Aëroplane can lift.—The Aëroplane Roesch-Seux.

May 15th, 1908.—The "Bayard-Clement" Flying Machine.—Equilibrium and Turning.

June 1st, 1908.—The "Forlanini Hydroplane."—"How to increase the Velocity of Dirigible Balloons."—"Concerning Aviation."

Illustrierte Aeronautische Mitteilungen.

April 3rd, 1908.—International Commission for Aëronautical Cartography.—Flight Experiments in Sweden.—The German Aéro-Club.

April 18th, 1908.—On air propellers and hélicoptères.—The Propeller of the "Ville de Paris."

May 3rd, 1908.—The "Ellehammer" Flying Machine.—An Aërodynamical Laboratory.—The Tatorinoff Flying Machine, p. 238.

May 18th, 1908.—The Stability of Flying Apparatus.—The Astronomical Determination of a Balloon's position.

June 3rd, 1908.—The Stability of Flying Apparatus.—The Airship "La France," by Colonel H. W. Moedebeck.

WIENER LUFTSCHIFFER-ZEITUNG.

April, 1908.—The Art of Flying.

May, 1908. — Aërophotography. — The Wels-Etrich Flying Machine.

June, 1908.—The temperature at high altitudes.—On Aëronautical expressions.

LA REVUE DE L'AVIATION.

January, February, March, 1908.—Flying Notes.—Concerning Flight.

April 15th, 1908.—Notes on Lifting Propellers.—Aviation during the month.

SOCIETA AERONAUTICA ITALIANA.

No. 4.—The direction and velocity of the wind in hilly country.—Aëronautics as affecting military operations.—New Aëroplanes.—The United States Military Dirigible.—Light Motors for Aëronautical work.—Scientific Chronicle.

No. 5.—On the Conditions of Equality of Statical Stability between the Dirigibles "Patrie" and "Zeppelin."—Aëronautical Notes.—Scientific Chronicle.—Sporting Supplement.

Applications for Patents.

(*Made in April, May and June.*)

The following list of Applications for Patents connected with Aëronautics has been specially compiled for the AËRONAUTICAL JOURNAL by Messrs. BROMHEAD & Co, Patent Agents, 33, Cannon Street, London, E.C.

APRIL.

6566. March 24th. M. F. GUTERMUTH. Improvements in Wings for flying machines.

6593. March 24th. R. W. WARREN. Improvements in flying machines.

6741. March 26th. J. VRENGDENHILL. New or improved paddle, oar, rudder or helm and the like, for paddle steamers, airships, rowboats, driving or under-water boats and the like.

7129. March 31st. F. CAPONI. Improvements in aeroplanes.

7205. April 1st. M. KAY. Improvements in and relating to aeroplanes and flying machines.

7370. April 3rd. J. SAWARD. Airship.

7632. April 6th. W. S. MIELCAREK. Improvements in airships.

7686. April 7th. J. HOLZINGER. Improved propeller for use in air or water.

7971. April 10th. S. ROGERS and F. M. FOGARTY. Improved propellers for aerial and marine navigation.

8099. April 11th. C. A. CHAPPELL. Improvements in or connected with flying machines, aeroplanes, aerocurves, kites and the like.

8306. April 14th. W. MICHALK. Improvements in aerostats.

8360. April 15th. A. JOUVENEAU. Improvements in or relating to flying machines or the like.

8488. April 16th. F. L. MARTINEAU. Improvements in and relating to aerial machines.

8591. April 18th. A. WORSWICK. Improvements in propellers and wings for aeroplanes and the like.

8627. April 18th. G. W. HART. Improvements relating to the wings of flying machines.

8628. April 18th. A. DEMOULIN. Improvements in and relating to aeroplanes and flying machines.

8643. April 18th. R. ESNAULT-PELTERIE. Improvements in aeroplanes.

8681. April 21st. A. B. MEES. New or improved mechanism for lifting, propelling, and steering in the air.

8842. April 23rd. L. P. SHADBOLT. Improved method of steering an aeroplane.

8844. April 23rd. J. S. JUN. Improvements in and relating to the control of motor propelled vehicles, boats, and flying machines.

MAY.

9513. May 2nd. H. S. BOOTH. Improvements in flying machines.

9799. May 5th. MOTORLUFTSCHIFF STUDIENZ-GES. Safety valve for air balloons.

9898. May 6th. C. R. B. BROWN. Improvement in aeronautical machines.

9970. May 7th. V. HUMBERT. flying machine.

10161. May 11th. J. KAY. Improvements in steadying balloons, also when applicable to airships, flying machines, and the like.

10528. May 14th. R. ESNAULT-PELTERIE. Improvements in aeroplanes.

10801. May 18th. H. E. WILLIAMS. Improvements in and relating to machines used for navigating the air.

10900. May 20th. P. G. C. FU PIETRO. New aeroplane.

11155. May 22nd. H. H. PUFFARD. Improvements in flying machines.

JUNE.

11719. May 29th. W. TARTARENOFF. Improvements in flying machines.

11763. May 30th. W. FAIRWEATHER. Improvements in airships.

11948. June 2nd. V. WISNIEWSKI. Improvements in or relating to airships and flying machines.

12013. June 3rd. J. L. GARSED. Improvements in the method of and means employed for steering aerial machines.

12102. June 3rd. J. MILLER. Improved airship.

12131. June 4th. R. ALLEN. Improvements in and relating to aerial navigation.

12148. June 4th. N. W. AASEN. Improvements in rocket parachutes.

12247. June 5th. A. CLEMENT. Improved dirigible balloon.

13016. June 18th. J. R. PORTER and J. E. MALLINSON. Improvements in and relating to flying machines.

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BACK NUMBERS.

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The following are some articles of special interest which have appeared during the last few years:

Lord Rayleigh on Flight;
The Balloon Work of the late Mr. Coxwell; and
A Theory of Flight. By D. M. Boyer Smith. April, 1900. 1s.

On Forms of Surfaces Impelled Through the Air and their Effects in Sustaining Weights. By F. H. Wenham. July, 1900. 1s.

Cloud Photography from a Balloon. By the late Rev. J. M. Bacon; and
The Lifting Power of Air Propellers. By William George Walker. October, 1900. 1s.

The Paris International Aeronautical Congress. January, 1901. 1s.

The Experiments with the Zeppelin Airship. April, 1901. 1s.

Aeronautics in France. By Wilfred de Fonvielle. July, 1901. 1s.

The Chief Scientific Uses of Kites. By A. Lawrence Rotch. October, 1901. 1s.

Aerial Navigation by Means of Bodies heavier than Air. By Sir Hiram Maxim; and
Atmospheric Currents. By William Marriott. January, 1902. 1s.

The Berlin Congress of the International Aeronautical Commission. July, 1902. 1s.

The "Peace" Balloon of the late Senhor Augusto Severo. By Dr. Carlos Sampaio. October, 1902. 1s.

Contributions of Balloon Investigations to Meteorology. By Dr. W. N. Shaw, F.R.S.; and
Recent Aeronautical Progress. By Major B. Baden-Powell. January, 1903. 1s.

The Development of the Aeroplane. By Major Baden-Powell; and
Scientific Balloon Ascents. By Charles Harding. October, 1904. 1s.

Kites, Kite-Flying and Aeroplanes. By W. H. Dines;
Man-Lifting Kites; and
Captive Balloon Photography. January, 1905. 1s.

Automatic Stability. By E. C. Hawkins, J.P. April, 1905. 1s.

Some Remarks on Aerial Flight. By F. H. Wenham;
Demonstration of a Bird-like Flying Machine. By Dr. F. W. H. Hutchinson; and
Balloon Varnishes and their Defects. By W. F. Reid. October, 1905. 1s.

The Acoustical Experiments Carried Out in Balloons by the late Rev. J. M. Bacon. By Gertrude Bacon. January, 1906. 1s.

The late Prof. S. P. Langley. April, 1906. 1s.

The Use of Kites in Meteorological Research. By Dr. W. N. Shaw;
The Stability of the Conic Shape in Kites and Flying Machines. By R. M. Balston. January, 1907. 2s.

The Distribution of Weight in Aeroplanes. By M. F. Fitzgerald;
Special Report and Photographs of the Kite Display on Chobham Common. July, 1907. 2s.

Three Airships of Three Nations, with plates of the "La Patrie," The "Parseval," and British Military Airships. October, 1907. 1s.

The Starting Methods of Aeroplanes. By José Weiss; and
Mechanical Aerial Navigation. By Rankin Kennedy. January, 1908. 1s.

Experiments with Dipping Planes. By Major B. Baden-Powell; and
The Farman Flying Machine. By Col. J. D. Fullerton. April, 1908. 2s.

THE AËRONAUTICAL JOURNAL.

OCTOBER, 1908.

The Aëronautical Journal.

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NOTICES
OF
The Aëronautical Society of Great Britain.

At a Council Meeting of the Aëronautical Society of Great Britain, held at 53, Victoria Street, Westminster, on July 15th, 1908.

1. The following gentleman was elected a Vice-President of the Society:

MAJOR B. BADEN-POWELL (late) Scots Guards.

To date July 15th, 1908.

2. The following gentlemen were elected members of the Society:

DR. ROBERT LAURIE, M.D., B.Sc.
MR. ALBERT C. NESFIELD.

To date July 15th, 1908.

3. A Committee was appointed to report upon the feasibility of obtaining an experimental ground for the Society.

President.
MAJOR B. BADEN-POWELL,
Vice-President.
Members:
R. K. BALSTON, Esq.
THE VISCOUNT HILL.

4. The undermentioned lady has been elected an Hon. Member of the Society, in recognition of the distinguished services to aëronautical science of her late husband, F. H. Wenham, Esq., Hon. Member of the Aëronautical Society of Great Britain:

MRS. F. H. WENHAM.

MISCELLANEOUS NOTICES.

1. The following books and publications have been presented to the Library:

By COLONEL TROLLOPE (late Grenadier Guards).
"La Conquête de l'Air" (current numbers).

By MM. W. DE FONVILLE AND G. BESANCON.
"Notre Flotte Aerienne."

By MONS. VICTOR TATIN.
"Eléments d'Aviation."

By the "Smithsonian Institution."
"Researches and Experiments in Aërial Navigation," by S. P. Langley.

By V. S. FRANK, Esq.
Photographs of various Flying Machines.

2. The Press cuttings supplied to the Society during September quarter will be available for issue on November 1st, 1908. Any member who wishes to have them should apply to the Hon. Secretary on October 19th, 1908. They will be given to the first applicant.

3. Members and others contributing to the Journal are requested to kindly observe the following rules when drawing up their MSS.:

(*a*) Write on one side of the paper only.

(*b*) Leave a margin one inch wide on the left-hand side.

(*c*) Draw diagrams, etc., on very white paper with very black ink, as this greatly simplifies reproduction.

(*d*) Forward their communications to the Hon. Secretary at least 14 days previous to the date of the meeting at which the paper is to be read. Papers containing diagrams, sketches, etc., which it is required to show on lantern slides should be sent in as early as possible.

4. The following extract from the "Bollettino Societa-Aeronautica Italiana" is published for general information:

"The diagrams of Dirigible Balloons, appearing on page 122 of No. 5 of the 'Bollettino,' and reproduced on page 93 of the 'AËRONAUTICAL JOURNAL OF GREAT BRITAIN,' were taken from an article by Mr. J. H. Ledeboer appearing in 'AERONAUTICS' (London, March, 1908). By an unfortunate oversight we omitted to acknowledge the source of these diagrams in either case."

Helicoptere v. Aeroplane.

By H. CHATLEY, Esq., B.Sc.

1.—CONTROVERSIES.

Ever and again in the history of aëronautical development during the last century there occurred a movement in favour of the hélicoptère or vertical screw machine, and now when flying machines have advanced to a practical stage the question again appears. Many will have doubtless followed with interest the series of letters which has been appearing in "Engineering" since early in the year, in the course of which several engineers of repute have advocated the hélicoptère in no uncertain manner.

The author has, therefore, ventured to think that a short paper comparing, as far as is possible, the hélicoptère and the at present favoured gliding machines, would interest the members of the Aëronautical Society. He would, in the first place, wish to say that his own opinion as to relative superiority of the two types is perfectly neutral.

2.—COMPARISON OF THE TWO TYPES.

It is argued by those in favour of the hélicoptère that the type is superior to others in the following respects:

(1) It takes full advantage of the propeller thrust without the mediation of an aëroplane or second supporting surface.

(2) It is independent of the speed of translation, and can hover over one spot.

(3) It is more stable, having no large surfaces of high resistance exposed to the air currents.

Against these the aëroplane advocates set the following:

(1) A hélicoptère is supported by the direct thrust of a propeller, while an aëroplane, by utilising a wedging surface, multiplies that thrust as far as lifting is concerned, from 3 to 20 times. Therefore, by reason of this multiplication, it is possible to lift a certain weight with an aëroplane with a less powerful and weighty motor than is required for a hélicoptère. (See Appendix A.)

(2) While the hélicoptère is undoubtedly superior in its capacity to hover, it would be at a most serious disadvantage in gaining speed, seeing that the helices themselves would have a very considerable lateral resistance and additional motors would be required.

(3) Apart from the small gyrostatic effect of the helices, a hélicoptère is in a state of neutral equilibrium, whereas an aëroplane of the right form, weight, and speed, may be automatically stable, or, with a little manipulation of mechanism, be made so.

There are other points, but none so serious as these, and the author proposes to devote his attention to them.

3.—PROPELLER THRUST.

Undoubtedly the question of the propeller should be placed foremost, and here at once we have a difficulty which seriously affects both sides of the question, viz., it is not possible to say what effect a propeller of given dimensions, driven at a given speed and a given slip by a motor of known efficiency, will produce, unless the propeller has already been tried under almost identical conditions. With marine propellers the difficulty is great, but in air it is even worse. Mathematical study of the subject is only a very poor crutch to lean on when designing a propeller, and yet when a new form is being thought out, calculation on possibly false assumptions is unavoidable. It is a comparatively easy matter to get a rough value for the thrust from a propeller when the axis of the latter is not advancing, *i.e.*, when there is 100 per cent. slip, but when the slip decreases, the values given by calculation may vary 50 per cent. from the truth, and this is the very case which bears most on the subject and, at the same time, is most difficult to try by experiment. Certainly we can say that the thrust decreases with the slip, but the efficiency apparently increases up to a certain point. Applying this idea to the hélicoptère and accepting the claim of 40 lbs. thrust per H.P. made by several experimenters for their propellers, we may say that such a machine, with thrust blocks having little friction, might hover with a horsepower $= \frac{\text{Total Weight}}{80}$.

The aëroplaner would claim to lift, say, 5 × 40 lbs. per H.P., but, as a matter of fact, he does not do so, for the reason that, although he may have a lift to drift ratio of 5 to 1, yet when the required speed has been reached the thrust is no longer 40 lbs., but possibly only 6 lbs. per H.P., so that the actual lift is no better than that of the hélicoptère.

Nevertheless, this same fact will prevent the hélicoptère from attaining great heights, seeing that great vertical velocities (and consequent decrease of slip) would cause decrease of thrust.

It has been suggested by Mr. Rankine Kennedy that since a screw propeller is effectively an aëroplane (or, rather, aërocurve) and *vice versâ*, an aëroplane is a propeller of infinite diameter, that since the gliding type of machine uses a combination of the two (propeller and plane), while the hélicoptère uses only the propeller, the latter must be more efficient mechanically and, therefore, preferable. The author does not feel able to accept this reasoning in its entirety, for two reasons:

(1) The area adaptable to the aëroplane is impossible in a propeller. (On the question of speed mention will be made later.)

(2) In the present state of aërodromics it does not follow that a machine which is more efficient (mechanically) than another is necessarily superior from a practical point of view. Thus the Farman machine is, mechanically, far less efficient than the Phillips machine, and yet the latter has not been so successful in its flights.

The comparison at present must be one of lifting effort, *not* efficiency. The two are not necessarily concurrent. If the propeller of the aëroplane can exert horizontally a thrust of, say, 10 lbs. per H.P. at its proper speed of advance and slip, and the aëroplane has a lift to drift ratio of 5, then a lift of 50 lbs. per H.P. follows necessarily, with an obvious superiority over a 40 lbs. lift per H.P. for the hélicoptère.

There is yet another question which arises in connection with the area, which has been referred to by Sir Hiram Maxim in his correspondence to "Engineering," viz., the importance of area as such. Many years ago Drs. Hutton and Robins found that resistance varies as some power of the area greater than unity. The work of Langley, Kummer, and Eiffel has shown that the greater the perimeter, the greater the pressure per square foot. Thus a circular area has the least coefficient of plane resistance, and a long narrow parallelogram approaches the maximum. Now, the perimeter of such figure increases more rapidly than the longer dimension. Thus a parallelogram 2 × 1 has a perimeter of 6 feet, but a parallelogram 4 × 1 has a perimeter of 10 feet, so that while the dimensions have increased in the mean ratio of $\sqrt{\frac{4}{2}} = 1.414$, the perimeter has increased in the ratio $\frac{10}{6} = 1.\dot{6}\dot{6}$.

A further most important consideration in propeller matters is the effect of one blade on the supply of air to others. As Professor Thurston and others have pointed out, the thrust diminishes if a propeller runs with its axis and plane of revolution stationary on account of the churning of the air, which reduces the relative velocity of the air. Again, a propeller in a cross stream of air gives more thrust than when there is no such current. Vogt has, the author believes, shown this experimentally. Furthermore, an advancing propeller does not lose thrust to the full extent that the slip would indicate, on account of the increased facilities for air supply. (See Appendix B.)

Applying this principle of facility of supply to the two types we may draw the following conclusions:

(1) An advancing aëroplane has a greater lift than a hélicoptère can obtain (identical propellers being used), since the copious supply of air maintains a thrust comparable with that on a stationary propeller.

(2) A stationary hélicoptère (in the absence of wind) will tend to lose ascensional force.

(3) A cross wind will increase the ascensional force on a hélicoptère, but will make the centre of pressure eccentric in each propeller. Such a wind will, of course, be produced by the mere motion of the machine, except when this motion is in the same direction and of the same magnitude as the wind.

(4) Shields round the propellers will destroy this cross draught effect, but will reduce lateral resistance and tend to keep ascensional force constant.

[Of this more below.]

Summarising the factors which determine the thrust of a propeller we may notice the following:

(1) **Area.**—Thrust varies directly as this, but also the rotational resistance varies with it.

(2) **Pitch.**—According to Eiffel's recent results 30° pitch angle (*i.e.*, mean pitch angle of blade, *not* maximum pitch angle) gives maximum reaction.

(3) **Diameter.** — Resistance and thrust vary as the square of this.

(4) **Speed.**—The thrust and resistance vary as the square of this item.

(5) **Slip.**—Thrust and resistance decrease with decrease of slip (*i.e.*, increase of actual advance).

(6) **Section of Blades.**—Stream line forms the chords of which lie in the direction of the pitch angle will give minimum resistance, and if of the Phillips concavo-convex type give a maximum lift to resistance ratio.

(7) **Smoothness of Blades.** — By making the surfaces of the blades polished, skin friction is almost eliminated.

(8) **Cross Draught.**—The thrust is increased by a quantity varying as the square of the cross draught velocity.

(9) **Advance.**—Do. do. do.

(10) **Number of Blades.** — Interference and churning increase with the number of blades.

(11) **Feed Tunnels.**—Destroy cross draught unless *horizontal* at inlet, but distribute pressure on propeller uniformly.

(12) **Discharge Tunnels.** — Reduce thrust unless short, diverging, and vertical.

Mr. Chree Brown's suggestion that there is a vortex about a propeller is noteworthy, and would undoubtedly serve to explain the effect of deficient air supply.

4.—LIFT AS THE PREDOMINATING FACTOR: MECHANICAL EFFICIENCY.

It has already been mentioned that, from the point of view of sustentation, the lifting force available is much more important than mechanical efficiency. There can be no denying that the majority of machines are very inefficient, and while every effort should be made to improve them in this respect, the mere fact of continuous support is a far more important criterion, seeing that upon this safety and dirigibility mainly depend. A brief consideration of mechanical efficiency in the two types will, however, be useful. In a hélicoptère of the usual type there are n vertical screws (n being some multiple of two), and m (1 or 2) horizontal screws. For constructional reasons and manipulation it is very difficult to avoid using separate motors for sustentation and propulsion, so that at least two motors, respectively for these two purposes, will be required. If these have powers H and H_2, and the weight of the whole appliance is W and the resistance at the maximum speed of translation is R, we may say that W must be less than 30 H_1 lbs., and R less than 20 H_2 lbs. These numbers are assumed for the following reasons:

(1) The usual maximum thrust in lbs. per H.P. is 40. (Kress's uncertain result of 80 odd lbs. is probably not easily realisable.) This will be appreciably reduced by the transmission mechanism and the n thrust blocks, so that 30 lbs. per H.P. is certainly not too low a figure to adopt.

(2) The thrust from the propulsive screw will diminish with the slip, so that taking into account gearing losses, 20 lbs. per H.P. is a high figure.

[It will be noticed that the author previously gave a much lower figure. He here assumes the fullest possible allowance for the effect of air supply occurring during translation.]

In each case the maximum derivable thrust is found by reducing the H.P. to foot lbs. per sec. by multiplying by 550 and dividing by the speed of advance, but as this may be zero in the case of sustentation without ascension the mechanical efficiency of the lifting screws is indeterminate. A crude comparison may be made by saying that in each second the weight is lifted $g/2 = 16.1$ feet, *i.e.*, the distance which it would fall during one second. In this case the efficiency works out to

$$\frac{W \times 16{\cdot}1}{\frac{W}{80} \times 550} = 0{\cdot}878.$$

Such a method of computing efficiency is mechanically false (as may be seen by assuming 40 lbs. per H.P. when the efficiency becomes more than unity), but is, perhaps, useful for purposes of comparison. As a matter of fact, no work is performed in lifting if there is simple sustentation, the energy absorbed by the propeller being actually all given to the air, the lifting force being the reaction or rate of change of the momentum of the air.

As regards the propulsion, the efficiency will probably be about 50 per cent. (see Langley's dynamometer-chronograph experiments), and in any case will only differ from that of an aëroplane's propeller as the result of the disturbing effect of the sustaining surfaces.

With regard to the efficiency of the aëroplane type, the thrust acting against the resistance multiplied by the speed of advance gives the useful work done, and this, divided by the actual work done on the propeller in the same time, gives the efficiency of the latter.

Under these circumstances the author fails to see that a simple comparison can be drawn between the efficiencies of the two types, and can only reiterate his opinion that lift per H.P. is the real criterion.

5.—SAFETY AND STABILITY.

The "Engineering" controversy originated in a discussion as to the safety of the aëroplane, and the author in a letter referred to Lord Rayleigh's analysis and the practical results obtained by Blèriot, Archdeacon, and others in free gliding. There seems to be no doubt that machines can be built which will be automatically stable when certain conditions as to poise, weight, and resistance are satisfied. There is no necessity now to consider this question, which has been pursued at length by Weiss and others. As regards the stability of the hélicoptère, as the author endeavoured to show in "The Problem of Flight," the equilibrium is practically neutral. Single-screwed hélicoptères would, it is true, have a certain stability on account of the moment of momentum of the propeller, but unless the weight of this were considerable or the speed very high it would seem unlikely that any great reserve of stability could be available. As to two-screwed hélicoptères, unless the axes were geared together as in the Brennan gyrostat, the gyroscopic effect would be zero, since to produce balance of pressure on the blades and prevent wheeling they must revolve in opposite directions.

By the use of independent gyroscopes or a differential gearing on the propeller shafts automatic balance in a hélicoptère is possible, but beyond this fact (which is equally true in regard to the aëroplane) the appliance has no necessary stability.

6.—RESISTANCE TO PROPULSION.

There is the further question of collapse when the engine stops accidentally. The parachute action of screws would not seem to be very reliable.

The question of propelling a hélicoptère has not, as far as the author is aware, received much attention. By forming the hull of an enclosed and stream line form the resistance of this part of the vessel may be reduced to a minimum, but when we come to consider the propellers themselves serious difficulties arise. There can be little doubt that a revolving propeller laterally displaced causes considerable resistance. The mere fact that its thrust is increased would indicate a corresponding increase in the resistance overcome both by the screw itself and by the source of lateral motion. The author is endeavouring to ascertain the approximate value of this resistance, but he has no doubt whatever that it will be a most serious source of hindrance to propulsion.

The alternative is the enclosed propeller. If a casing of stream line form be placed round the propeller it will necessarily greatly decrease the lateral resistance, but, unfortunately, it seriously affects the propeller, as already mentioned, and it would seem inevitable that any form of screw shaft which endeavoured to take advantage of the cross draught (by horizontal openings or otherwise) would greatly increase lateral resistance and thereby reduce the maximum velocity attainable. It must further be considered that this lateral resistance, if reasonably high speeds are desired, will necessitate a powerful and, therefore, weighty propelling motor, the weight of which has to be sustained by the lifting screws, which again will need to be more highly powered.

From this point of view the hélicoptère is at a great disadvantage.

7.—SKEW HELICES.

The suggestion has several times been made that oblique screws to effect combined propulsion and sustentation might be employed. This is undoubtedly feasible, but is open to the following important objections:

(1) The sustentation should be obtained with a minimum power from the outset (*i.e.*, the maximum vertical thrust is required from each horsepower), and if oblique acting screws are used, only the vertical component of the thrust would sustain the load. The difference between the thrust and its vertical component, although usually small, would necessitate a serious increase in the weight of the motor. (The author is not prepared to say at present whether this increase is greater than that necessitated by the use of a separate propulsive motor.)

(2) Speed could only be obtained at the expense of lift, since if at all times the thrust is a maximum, as one component (the horizontal) increases, the other (vertical) decreases. Moreover, decrease of thrust would accompany the decrease of slip.

It should, perhaps, be here noted that the use of auxiliary aëroplanes in this connection would, perhaps, get over the difficulty.

(3) The constructional difficulties would be serious. It is true that the slewing (or skewing) axis might pass through, say, the driving shaft, and by the use of bevel gearing the mechanism would not be interfered with, but the arrangement will certainly be complex and, perhaps, dangerous. (See Appendix C.)

8.—ORTHOPTERIC ANALOGY.

The late Professor Pettigrew repeatedly expressed his opinion that the action of a wing was comparable with that of a screw propeller, and there has recently been a tendency with some experimenters and theorists to develop this idea. While the author has the greatest respect for Pettigrew's work, especially in the question of elasticity, he ventures to question the mechanical identity of the two mechanisms. Professor Marey, who consistently opposed the English naturalist's view in this subject, certainly appears to have a better claim for consideration. Granting that a vibrating elastic wing is of helical *form*, it is not necessarily of the same action as a screw propeller. The argument adduced by the supporters of the idea is practically this: The wing, under the action of its inertia, the reaction of the air, and its elasticity, becomes helical in form and swings through an arc, acting as a screw. On the back stroke the helicoid surface changes hand, so that the action is continued in spite of the reversal of motion. As a matter of fact, an examination of Marey's sphygmographic records show that there is no such definite helical action. The wing truly twists during its cyclic period, but its action is throughout that of an aërocurve directed forward. The author is inclined to think that Mr. Turnbull, in his well-known paper to the "Physical Review," comes nearest the truth.

In any case the bird's wing is equally

adducible as a natural basis for an aëroplane as for the hélicoptère.

Finally, the author would wish to express his opinion that both types are well worthy of study, and that certainly neither of them is the final form of the flying machine.

APPENDICES TO PAPER ON HÉLICOPTÈRE v. AËROPLANE.

A.

Lord Rayleigh's comparison of the efficiencies of helix and aëroplane (Manchester Memoirs, Vol. xliv., 1899, No. 5).

Rapid flight of aëroplane.

$$U = \sqrt{\left(\frac{W \sin \alpha}{\kappa S}\right)}$$

Direct maintenance by screw rotating about a vertical axis.

$$U = \sqrt{\left(\frac{W}{4 \rho S^1}\right)}$$

U = rate at which W must be lifted to do the work actually performed by the machine.

W = weight.

α = angle of elevation of aëroplane.

ρ = density of air.

S = area of aëroplane.

S^1 = disc area of propeller.

κ = resistance of unit area of aëroplane moving directly normal to current at unit velocity.

The ratio of the values of

$$U = 2 \sqrt{\left(\frac{\rho \sin \alpha}{\kappa} \cdot \frac{S^1}{S}\right)}$$

Taking $\kappa = .0024$ and $\rho = .0012$ (metric units) the ratio $= \sqrt{(2 \sin \alpha\, S^1/S)}$

"Since α may be made small, and S the area of the plane may be a large multiple of S^1 the area swept over by the screw, it would appear that the advantage must lie with the aëroplane, even if the object be mere maintenance, and not a rapid transit from place to place."

B.

EFFECT OF CROSS DRAUCHT ON SCREW PROPELLER.

(After CHREE BROWN.)

If α be the velocity of the screw at any point, in the absence of wind, thrust $\propto \alpha^2$.

If there is a cross wind of velocity β, then on one side of the screw the thrust varies as $(\alpha + \beta)^2$ and on the other side, thrust varies as $(\alpha - \beta)^2$. The total thrust, therefore, varies as

$$\{(\alpha + \beta)^2 + (\alpha - \beta)^2\} = (2\alpha^2 + 2\beta^2)$$

i.e., thrust varies as the sum of the squares of the screw velocity and the wind velocity.

Strictly speaking, the summation should not be taken at the two sides, but over the whole disc area, *i.e.*,

Thrust varies as $\Sigma_0^{2\pi}$ (vector sum of α and $\beta)^2$.

Mr. Brown's reasoning is, nevertheless, substantially correct, and there is no necessity to introduce a complex integral here.

C.

SKEW HELICES.

If the thrust be taken for any one screw as Cn^2, where C is a constant and n are the revolutions per unit time, it will necessarily follow that if n is a maximum (as determined by the resistance to rotation, which is practically independent of rotation), the lift when the axis is inclined to the angle θ, the vertical lift will be $Cn^2 \sin \theta$ and the horizontal force $Cn^2 \cos \theta$. Since $\sin \theta$ is less than 1, and when simply sustaining $Cn^2 = W$, the weight, when θ exists, Cn^2 is less than W and the weight is not sustained. If n is increased more power is required to overcome the rotational resistance.

THE LATE MR. F. H. WENHAM, HON. MEMBER OF THE AËRONAUTICAL SOCIETY OF GREAT BRITAIN.

Members of the Society will hear with great regret of the death of Mr. F. H. Wenham, one of its Hon. Members.

Mr. Wenham was one of the leading members of the Society at its foundation, and may almost be called the "father" of aëronautics in this country. His paper on "Aërial Navigation (1866)" is one of the most important ever published on aëronautical science, and contains a a great deal of most valuable information.

It should be specially noticed that he was the first to advocate the superposed planes now used by Farman, the Messrs. Wright, and others, and there can be no question that his idea of reducing the great width required for support by placing narrow supporting surfaces one above the other is one that has been most helpful to aviators.

Mr. Wenham always took a great interest in the Society, though his health of late years prevented his doing much active aëronautical work. The paper by him, published below, appears to be almost, if not quite, his last contribution to Aëronautical Science.

On the Construction of Detailed Parts of Aeroplane Flying Machines.

By F. H. Wenham (Honorary Member).

(See Fig. 3.)

I write promptly on this very important subject, as time with me is on the wing. I have passed fourteen years beyond the three score and ten of life allotted to man. For many years I have at times brought up the subject of flying, and if I say a few words concerning myself I may, perhaps, be exempt for incurring a charge of egotism.

My training has been that of a marine engineer. I was present at the early trials of "Archimides"—the only screw steamer then afloat. I was but a small boy then, but ever since have taken a keen interest in screw propulsion. It may, therefore, be asked why I did not apply a screw propeller to my design of a flying machine in 1866, but no motive power except steam was then known, and I could not imagine the practicability of carrying a supply of water and fuel up in the air and therefore had to consider the possibility of the strength of a man being sufficient to propel the machine. For this purpose the adaptation of a screw propeller was *not* feasible, as the man, having other matters requiring his attention, could not be solely occupied in turning a winch-handle. I, therefore, proposed to adapt a pair of oars to be worked by treadles.

No rudder would be required, each oar being independent of the other, and could be manipulated singly. I am still inclined to believe that an active man of light weight could fly short distances by his own muscular exertion.

The power consumed in driving the recent flying machines is enormous, but by studying and improving every detail this may be much reduced.

Either for propulsion or sustentation in air flat surfaces are not as efficient as hollow curvatures, which from the upward pressure or lift on the air on the fabric take this form—perhaps not correct, but sufficiently near as not to be worth while to shape to a curve—the number of transverse ribs as weight and aërial resistance is so detrimental. Smooth surfaces are most effective. I have obtained the best results in models by using thin tinplate, but for large surfaces metal is impracticable. Thin glaced holland is suitable for the webs, but it must be rendered hygroscopic or the successful flight of one day may be a failure the next, caused by the flaccidity of the web from the absorption of moisture; the fabric should, therefore, be varnished. There is no extra resistance from cutting a long stretch of fabric across in short lengths and superposing them in sections. The power for propulsion is the same, and we have the advantage of an arrangement in manageable compass. It is just worth while to make the wooden rods for distancing the webs oval for diminishing forward resistance.

For the purpose of starting for a rise it seems imperative that the machine should first run over the ground on three wheels attached beneath. These will probably be smashed up by the shock of the first descent, thereby crippling the machine for another rise. These wheels should be without spokes, or as disc or flange-wheels of vulcanised rubber, which on alighting may be crumpled up. They will serve as buffers against the shock of the fall, but regain their form. They should be as small in diameter as available, as they have to be carried as dead weight.

Next as to the important consideration of the screw for propulsion. Some inventors seem to consider the form of this to be of little consequence, and think anything will do, and figure discursive shapes, from a butter patter to a smoke-jack fan, whereas correct form is of the *very greatest importance*, as the screw is the recipient of the whole force of the engine, and should in no part be a drag on itself from malformation. Any defect of figure will cause great loss of force and propulsive effect, which must be strictly economised. Woven fabric is very insufficient for screw blades, as no permanent or correct form can be given to such a material. Aluminium sheet would be perfect, but the difficulty of construction would be prohibitive.

Large screw propellers for ocean steamers are not cast from wood patterns, but the moulds are "strickled" up either in loam or sand, a practice well known to foundrymen. The strickle is guided by a tinplate fixed at the periphery.

Various experimental screws that I have made for the purpose of ascertaining the best form for propulsion were cast in gunmetal from wooden patterns, in themselves a suitable material and form for aërial propulsion. The block of wood glued up in pieces to a rough shape for a two-bladed screw, each one-sixth of the circle, was turned and trimmed at the extremity of the blades to a circle of the required diameter, and the sides made flat and parallel, with the centre, which was bushed with a brass tube, to slide freely on a turned iron rod held firmly between centres. The block was laid on a plain surface and the pitch with its curvature marked with a pencil on the ends for the blades from a card tinplate, and the same operation repeated exactly on the opposite side. The wood was then pared away down to each pencil mark to a narrow ledge as a guiding line for a fixed round-ended tracer, against which the ledge on the pattern was pressed, while a rapidly rotating drill-ended cutter of the twist form pared away the wood towards the axis in narrow zones, which were afterwards rasped down to a smooth face. Care must be taken that the double-edge cutter must at the end be the same in size and outline as the end of the guide pin. The traverse of the cutter was not directed as a straight line towards the axis, as the screw blades require to have a disked form in their outline in order to utilise the radial force of centrifugal action. A perfectly plain smooth disc in rapid rotation will throw off centrifugally a current of air. This we utilise by the disked form of the screw. For this radial curvature I have at present no formula; it is merely empirical, and assumed on mere judgment, and is something like a curved line from the inside of a saucer. This duplication of cross curves may appear very formidable, and difficult to the constructor of aërial machinery, but is, in fact, a very easy piece of work. The slip or yield of the air will be about 25 per cent., therefore the curve of the air blade must end in that ratio, starting from a pitch equal to the diameter.

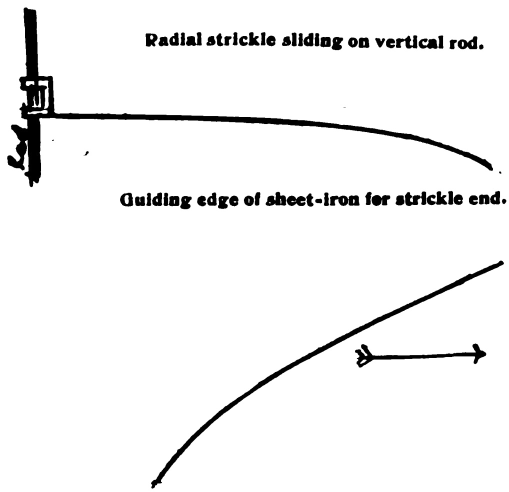
First build up a pedestal in cement to the diameter of the screw laid off on opposite sides to one-sixth of the circle. Two templates will be required, one of them of thin sheet-iron lined out for the entering angle with expanding the pitch of the screw, and the sheet cut to this line; the other or radial template, or "strickle," is swung from a fixed vertical central rod. From this "strickle," guided by the edge of the sheet-iron template bent to the circle of the screw, a plasterer can form up the face of the screw blades in hard drying cement, the same on both sides for each blade. This forms the mould for the wooden screw. This is made up of layers of veneer of any suitable kind of wood. These are steamed or soaked in water to render them pliable. The faces of the mould are first covered with paper to absorb any exuding glue, and the veneer laid on. Another veneer glued over is laid on this somewhat diagonally in order to cross the grain, and in this way a thickness of several layers may be added as required. This will make a very strong and tough construction of blade. The central boss should be built up and strengthened by two iron hoops and bushed with a metal tube. I trust that these directions are comprehensive, but any skilled cabinet maker knows the work of veneering.

The back of the blade may be strengthened by a longitudinal rib. The glue is to be made rather too thick for working, and then be thinned with strong acetic or chromic acid; this will cause the glue to be waterproof. When dry finish the smoothed blades with a coat of varnish.

The screw spindle should be placed in the flying machine exactly in the centre of effort or pressure; that is, air resistance above and below the axle should be balanced, as a skew thrust will cause a waste of power.

The diagram is an outline of the edge of the strickle and sheet-iron guide. There is a difficulty in making a comprehensive drawing of the complete screw propeller for the practical man. I therefore send a model made many years ago in a lathe and carved to form by a rotating cutter driven from the overhead precisely by the method of template guides herein described. This form of screw enlarged, selected out of several that I made, when tried in my steam yacht gave most decidedly the best result and should be equally suitable as an air propeller.

Fig 3.



The Probable Cause of the Explosion of Count Zeppelin's Airship.

By Lt.-Col. Moedebeck.

After the tragic fate which befel Count Zeppelin's airship the question naturally arose how such an explosion was possible. The first supposition was that when repairing the defective motor a fire had been used under the balloon, and that as the latter was borne from its anchorages the escaping hydrogen was set alight by this fire. But examination proved that no such fire had been lighted. The two mechanics, Schwarz and Laburda, who were in the airship at the time of the disaster, as soon as they realised the violence of the hurricane and saw that the soldiers, owing to the anchorages having given way, could not hold the vessel down, did undoubtedly with great presence of mind open the valves, their object being to reduce the lifting power of the balloon and thus prevent its being blown away. But as there was no fire near, this action would not account for the explosion, for which there seems to be only one plausible reason, viz., the electrical ignition of the gas, although on this point opinions differ widely. In my opinion the following explains simply how the disaster occurred:

The balloon material, which is india-rubber coated, has the peculiar property of becoming electrified in dry air. When rolled up or creased in any way it rustles, and gives out electric sparks, the latter being (as shown by the experiments undertaken by Professor Bonsteim and Captain Dele for the Berlin Aëronautical Society) clearly visible in the dark.

Now, the lower parts of the material of which the gas cells are composed would, owing to the height to which the airship had ascended (1,100 m.) and the release of gas from the valves, become creased or folded upon each other, and the rubbing thus produced would be quite sufficient to generate the electric sparks above referred to. Under ordinary circumstances, when the space between the gas cells and the outer envelope of the airship is full of atmospheric air, continually renewed, as when it is in full flight, these sparks would be harmless enough, but when the ship is at anchor, as at Echterdingen, this is not necessarily the case.

We know that the carefully made tissue of the Continental Caoutchouc Company resists the penetration of hydrogen very strongly, but some may have leaked through into the space between the cells and the outer envelope, while it seems very probable that when the mechanics opened the valves and the long axis of the balloon became inclined, more hydrogen entered this space and an explosive mixture was formed.

According to the description given by eye-witnesses, the explosion took place after the fore part of the vessel (dragging its anchor) struck the ground. The shock thus caused would have been transmitted to the creased and wrinkled gas cells, and the tearing of the material, already in an electrified condition, might easily have generated sufficient sparks to detonate the explosive mixture.

It may be mentioned that this evil can be avoided in future.

On the Flying Fish.

By L. Shadbolt, Esq., M.D.

I have been requested to write a short paper on the flight of the flying fish and the lessons which this act may afford in the steering and management of an aëroplane in flight.

As yet we are still striving to attain success in aërial flight by means of a machine heavier than air. Many remarkable flights have been recorded quite recently, and the art of aviation has advanced during the past few months by leaps and bounds. It now appears clear that under favourable conditions, still air, or with but a moderate wind and an open course, an aëroplane may be constructed, or soon will be, which can remain in the air as long as the motive power which drives the propeller is maintained, or practically as long as the supply of petrol capable of being carried holds out.

But we are far from mastering the art of aviation under varied conditions, of accurately balancing the machine in gusts of wind, of guiding it with precision, and executing sudden changes of course with safety. The enormous sail area also of the present machines render their management difficult and hazardous. There is much yet to learn in the relations of sail area to weight carried, the velocity necessary, and the angle at which the under side of the sails must impinge on the air, and so on. These data, as well as many more, and their relations one to another, require to be, as it were, fixed and formulated and made to co-ordinate.

The accurate observation of the flight of animate beings may afford many valuable hints towards the mastery of this difficult and complex subject. With this in view I believe that a few observations on the flight of the flying fish (*Escocoetus californiensis*) may prove of interest.

The flight of the flying fish is an act unique in Nature. It is, at least during the major part of its duration, a pure glide, and, therefore, more analogous to the flight of an aëroplane than the flight of any other creature. It is true that birds often glide, but the flight of birds is a more complex act in that they are all capable of imparting to their wings a vertical up and down motion known as "flapping." Flying fish do not flap their wings, which, as is well known, are modified pectoral fins. With the exception of a slight tremulous motion of the posterior segments of the fins during the first second or so of flight, they are held extended as long as the fish is in the air. There is, I believe, only one other creature in Nature whose flight is a pure glide. I refer to the flying squirrel of the Malay islands. In the case of this animal, however, the glide is always downwards. It is, I believe, incapable of a horizontal or upward motion while in the air.

Having made many long voyages in tropical and subtropical latitudes, I have had some opportunity of observing the habits and mode of flight of the flying fish.

The largest-sized flying fish I have actually handled weighed about one pound and measured exactly 16 inches in length. During a gale they sometimes fall upon the ship's deck in great numbers, especially at night. After stormy weather I have known the seamen to go round with buckets to collect them, so great a quantity strewed the decks. They are probably not capable of rising to the ordinary height of a ship's gunwale, but are carried up by the upward current of air caused by the wind impinging on the ship's side. I remember finding one morning after a gale an extremely small specimen, not exceeding half an inch in length, lying upon the poop deck, which was some 10 feet above the surface of the water, obviously carried to that height by an upward current of air, not by its own exertions.

On examining a fresh specimen the following points may be noted:

When the pectoral fins are fully extended the anterior margin of the fin is somewhat in advance of a line drawn horizontally through point C Fig. 1 at right angles to the long axis of the fish's body.

When the fins are extended thus and the fish is held belly downwards in its position during flight, it is found that no vertical movement is permitted in the anterior segment C of the fin. The joint is, so to speak, locked as far as vertical movement is concerned, and though it yields, to some extent, to forcible vertical movement, it is plain that the joint is not constructed for a movement similar to the flapping of the wings of a bird. When, then, the fin is extended, its anterior margin is practically immovable in a vertical direction.

It is otherwise with the posterior segments of the fin. These are capable of vertical movement, the greatest movement being permitted in the segment the most posterior, the range of vertical movement decreasing in each successive segment as the anterior joint is approached. The fish can thus raise or lower the posterior margin of the fin and so alter the angle at which the fin meets the air, at will. This angle I will term, for the purpose of clearness, the angle of incidence, being the angle at which the general plane of the fin is held to a horizontal line passing through the long axis of the fish's body. It is the angle at which the under surface of the fin impinges, or is incident, on the air.

Briefly the flight may be described as follows:

The fish always leaves the water obliquely and at a high velocity. I believe that the velocity during the first second or so of flight is increased by rapid undulatory movements of the posterior segments of the pectoral fins. I have certainly repeatedly observed a tremulous movement, always at the beginning of flight, but have failed by the eye to note whether the movement in question is one of the body, tail, or fins. I believe it to be of the posterior segments of the fins, for reasons which will presently appear. The fish leaves the water at a very acute angle, and the lower segment of the tail skims the surface of the water often for many yards before rising above it. The result is that a streak is caused on the surface of the water by the wake of the tail. The formation of this streak on the water is a conspicuous feature in the flight of the flying fish. It is clean and sharp, and to my mind proves (1) that the tail at that moment is not in vibration, and (2) nor is the body in vibration, as otherwise its movements would be imparted to the tail. The tremulous movement observed must be then in the fins, and from the anatomical structure of the fins already described it seems clear that it is the posterior segments of the latter which are in vibration during the first second or so of flight, which then, as already mentioned, becomes a pure glide.

Fig. 1.

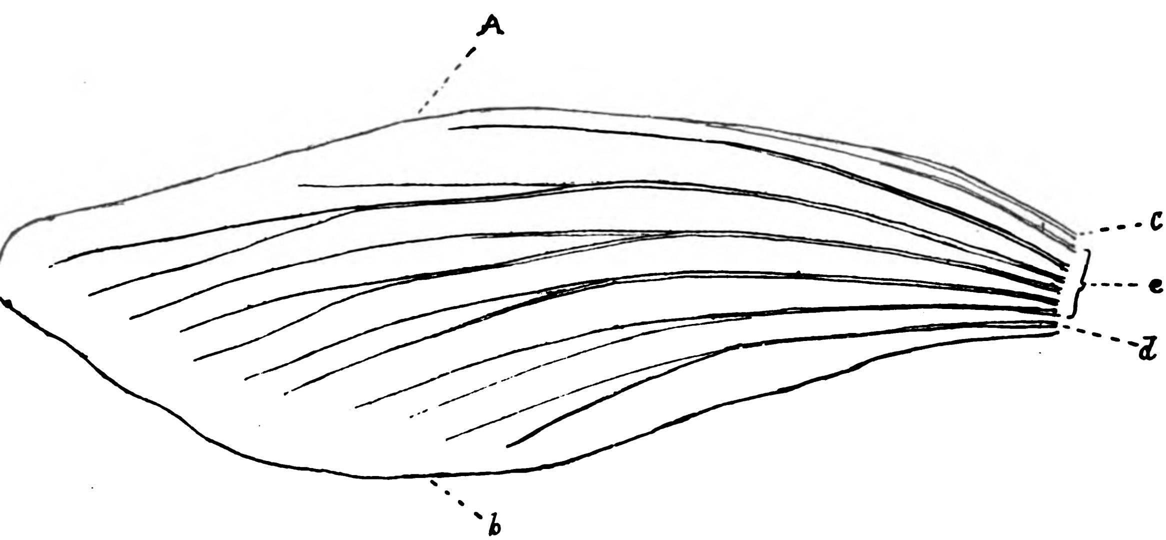


Fig. 1.—Outline of left pectoral fin of a Flying Fish, 9 inches in length, as seen from above. (a) Anterior margin. (b) Posterior margin. (c) Anterior bony segment. (d) Posterior bony segment. (e) Intermediate segments. From a specimen in South Kensington Museum. Natural size.

The body of the fish is not perfectly horizontal during flight, but slightly inclined upwards towards the head. The lower segment of the tail is always held at a lower level than the body. Towards the end of flight this position becomes more marked, and the tail drops still further. The velocity varies, being greatest at the beginning of flight and least at the end. It is less than that of the stormy petrel or seagull. I would roughly estimate it at from 12 to 15 yards per second.

The position at which the pectoral fins are held when regarded *from above* is one slightly in advance of a horizontal line passing through the base of the fin at right angles with the fish's body. When regarded from *in front or behind* the tip of the fin is at a higher level than the base where it joins the body. When seen *from the side*, the angle, which I have termed the angle of incidence, varies with the velocity. At the commencement of the glide, when the velocity is greater, the fin, when regarded from this aspect is almost horizontal, the angle gradually becoming greater as the velocity lessens, until finally when the flight is almost exhausted it reaches nearly 45°. The maximum length of flight, I have observed, is some 200 yards.

These details can only be noted in the largest specimens and under the most favourable circumstances, when the distance is short, the light good, and the sea calm.

Finally, the tail again skims the surface for a yard or two before the fish ends its flight by falling in with a clumsy splash.

The flying fish is able to alter its course during flight, and when so doing always tilts laterally as in the case of a bird gliding in a horizontal curve, the fin on the outside of the curve described rising to a higher level than that on the inside. I believe that the curve is changed by the tail, not from actual observation, but from conjecture. The tail is of a peculiar structure (see Fig. 2), the lower segment being about twice the length of the upper. It has been seen that the tail during flight occupies a low position relative to the body of the fish, and becomes lowered still further towards the end of flight. This low position of the tail relative to the centre of gravity would cause on deflection the lateral tilt above referred to.

Some lessons, to my mind, which the aviator may learn from the flying fish is to employ a vertical rudder placed below as well as behind the centre of gravity, and one which can execute similar movements to those of which the tail of this creature is capable. I have proposed in a former paper a form of rudder answering partly to these requirements, the idea of which was first suggested to me by the tail of the flying fish.

But there is much yet to learn of the flight of the flying fish beyond what these crude observations can supply. It is a model which may well be studied. Nature, in the course of ages, has relentlessly weeded out the unfit of all forms of life. She may often fail in producing a perfect individual, but in the type she is unerring. And Nature has produced and perfected myriads of types, each one the best of its kind for coping with the particular conditions with which it is sur-

Fig. 2.

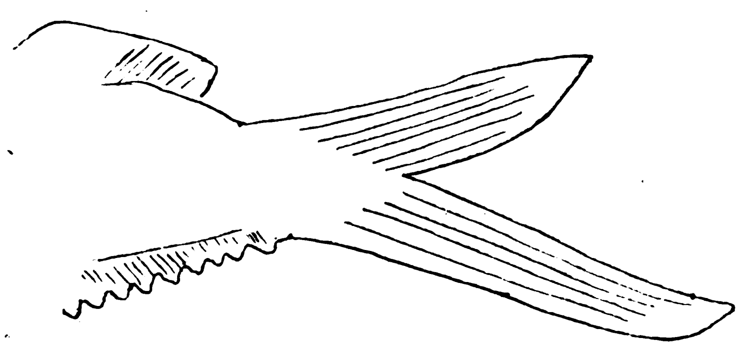


Fig. 2.—Outline of tail of Flying Fish. From same specimen. Natural size.

rounded. Thus man may well turn to Nature for instruction and imitation, and in the complex and difficult subject of artificial flight Nature offers for his study a perfect model, the flying fish, from which he should learn much.

Note on the Farman Flying Machine.

By Col. J. D. Fullerton, R.E.

"Aëronautics" (U.S.A.), Aug., 1908, appears to have submitted the article published in this Journal, April, 1908, on the Farman Flying Machine, to Mr. Farman, who has made the following corrections:

I.—GENERAL DESCRIPTION.

(1) For canvas read "Continental rubber cloth."

(4) For 12° read "8°."

(5) For 12° read "8°."

(8) For 12° read "18°."

The Wright Bros.' Flying Machine.

By Col. J. D. Fullerton, R.E.

(See Figs. 4, 5, and 6.)

The following account of this machine does not, of course, pretend to be accurate as to all the details, but it is hoped that the general description and sketches will be found useful to those who desire to study a very remarkable apparatus.

1.—GENERAL DESCRIPTION.

The machine consists of:

A.—A body.

B.—The sustaining surfaces.

C.—The apparatus for steering in a horizontal plane.

D.—The apparatus for steering in a vertical plane.

E.—The motor.

F.—The propellers.

G.—The radiator.

H.—The seats for passengers.

2.—MISCELLANEOUS INFORMATION.

The weight of the machine alone is 375 kilg. (826.7 lbs.); two passengers may be taken to weigh 150 kilg. (330.7 lbs.), hence the total weight, in order of march, is 525 kilg. (1,157.4 lbs.)

The approximate velocity when flying on a level course in still air is 42 miles per hour = 61.6 ft. per sec.

The area of the sustaining surfaces is 50 sq. m. (538.2 sq. ft.), and, consequently, the load is 10.5 kilg. per sq. metre (2.15 lbs. per sq. ft.). This assumes that all the weight is carried by the sustaining surfaces, but it is probable that a small portion of it is borne by the surfaces of the vertical steering apparatus.

When the full power of the motor is used the weight carried per H.P. is 21 kilg. (46.3 lbs.), but probably only a part of the power is necessary for level flight. Exactly how much is required is not known, but some accounts state that Mr. Wilbur Wright only uses about 15 H.P. This would make the weight carried per H.P. 38.3 kilg. (84.7 lbs.). A very good performance. The "gliding angle" is about 5°.

3.—THE BODY—A.

This consists of two curved frames shaped something like skates. The lower sustaining surface rests upon them, and the fronts form standards for the surfaces for steering in a vertical plane.

The body is made of wood (spruce) except at the joints, which are of steel.

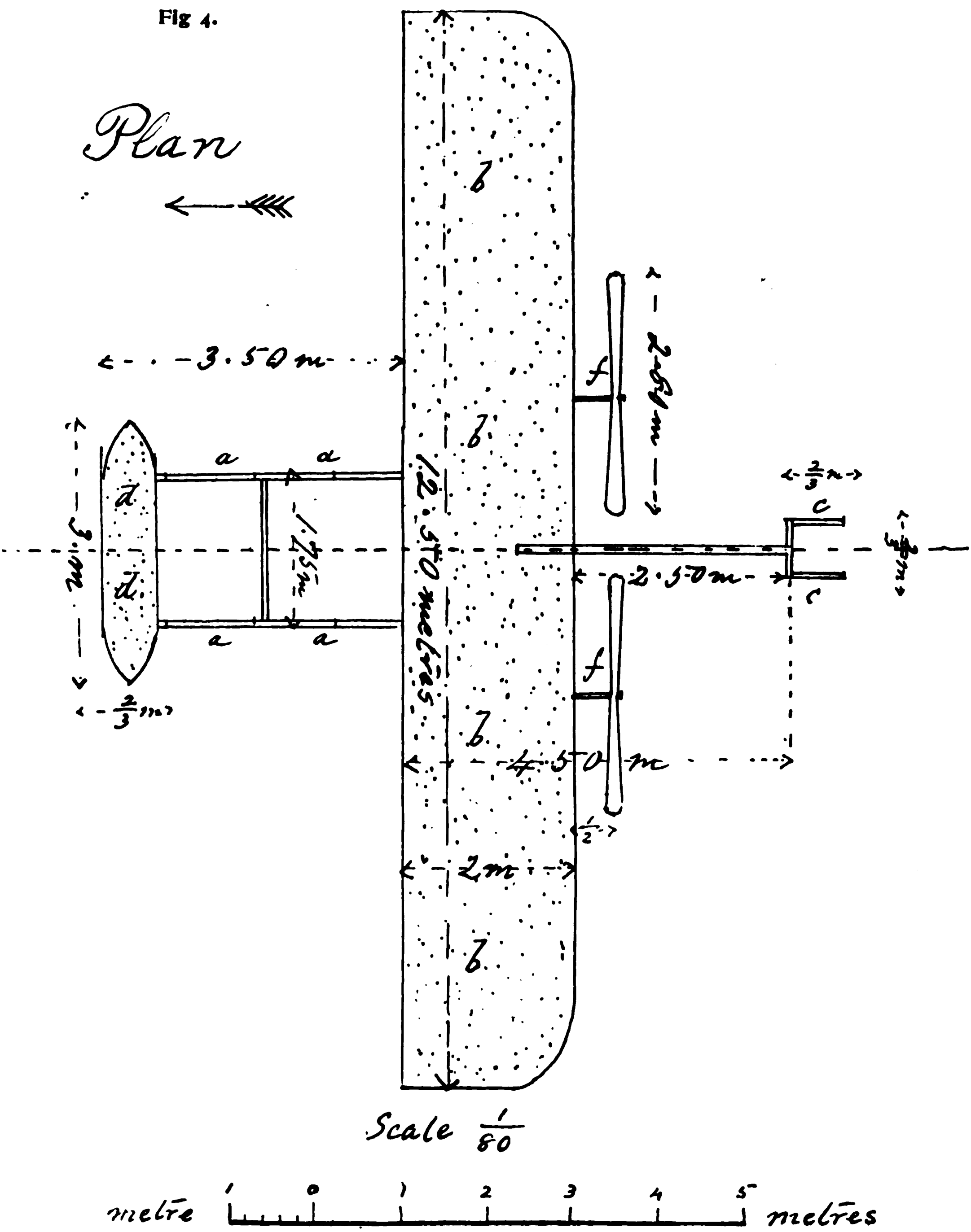
The angle between the straight or rear portion of the skates and the chord of the arc of the section of the sustainers is about 5°, and the "gliding angle" appears to be about the same.

The passengers sit upon two stools placed upon the front portion of the lower sustainers (see H.H.), their weights being so arranged as to balance the w·ights of the motor, radiator, etc.

4.—THE SUSTAINERS—B.B.

There are two sustainers, each 12.5 m. by 2 m. wide, the two having an area of 50 sq. m. (538.2 sq. ft.) The framework is constructed of American spruce wood, and consists mainly of two 1¼-inch sq. stringers about 4 feet apart, running the whole length of the sustainers, and cross pieces at right angles to them. The whole is covered with canvas, the rear edge of which is strengthened by iron wire. In section the sustainers are said to be of the buzzard's wing type, but are apparently only slightly concave on the

Fig 4.


Plan
3·50m
2·60m
a
a
a
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b
b
b
b
d
d
3m
1·75m
12·50 metres
2/3 m
c
c
2·50m
2/3 m
f
f
4·50m
1/2
2m
Scale 1/80
metre
1
0
1
2
3
4
5
metres

underside. The arching appears to be about $\frac{1}{20}$ m., or about 4 inches in a width of 2 metres, the greatest height being at a point about one-third of the length of the sustainer from its front edge.

The chief features, however, of the sustainers are the arrangements by which the outer portions of each can be warped so as to vary their angles of inclination, and the method by which they act in unison with the rear rudders C.C.

The system is somewhat complicated, and is best understood by studying the Patent Specifications, but briefly, if, say, the left side of the machine is from any cause pressed downwards, the pilot can, by suitable levers, cause the marginal and rear edges of that side to rise (thus reducing its angle of inclination), while, at the same time, the similar portions of the other side, working in unison, fall. This restores the balance, but as there is a tendency for the whole machine to rotate round its longitudinal axis, the vertical rear rudders C.C. are automatically brought into play, with the result that the machine is held on to its true course.

The vertical distance between the two sustainers is 1.8 m. (6 ft.); they are connected together by uprights about $1\frac{3}{4}$ inches in diameter, further support being given by a system of cross wires between the uprights.

5.—APPARATUS FOR STEERING IN A HORIZONTAL PLANE—C.

This really consists of two parts in the rear rudders C.C. (two) and a small vertical rudder fixed in D. These work together, and the pilot can, consequently, see the angle of inclination of C. without turning round. The rudders C.C. consist of flat surfaces (canvas on wood frames) each 1.80 m. high and $\frac{2}{3}$ m. wide. They are worked by a system of levers, the general method of using them being, of course, exactly the same as that employed in sea-ships.

6.—APPARATUS FOR STEERING IN A VERTICAL PLANE—D.D.

This consists of two small planes D.D., oval in shape, each 3 m. long by $\frac{2}{3}$ m. wide; total area of the two about 4 sq. m. (43.05 sq. ft.). The planes rotate in unison round an axis fixed on the standards formed by the ends of the skate-like ends of the body frames, and can be set, by a system of levers, at any required angle. Ascent or descent is carried out by increasing or decreasing the angles of these planes, and the longitudinal equilibrium is maintained in a similar way.

The use of the small vertical rudder, 1 m. high, in the centre of these planes has already been described.

7.—MOTOR—E.

This, like the rest of the machine, has been designed by the Messrs. Wright themselves. It is a 4-cylinder 25-27 H.P. motor; bore 108 mm., stroke 100 mm., water-cooled, magneto ignition, with automatic valves. The cylinders are cast separately, the water jacket is of aluminium, and no carburettor is used. The bare weight is 70 kilg., the total weight with radiator, etc., being 90 kilg. (198 lbs.). The weight of the engine per H.P. is 3.6 kilg., or 7.92 lbs. The revolutions per minute = 1,650.

The motor is placed on the lower sustainer a little to the right of the centre line of the machine. Petrol is supplied from a long cylindrical tank fixed in a handy position to one of the uprights connecting the two sustainers.

The power of the motor is transmitted to the propellers by chains running in guide tubes, the left-hand one being crossed to give the opposite movement to the propeller.

8.—THE PROPELLERS—F.F.

There are two 2-bladed propellers each 2.8 m. (9 ft. 4 ins.) in diameter. The pitch is not known, but is said to be rather large. The pitch angle is probably about 24°. The propellers are of wood, make 450 revolutions per minute, suitable gearing reducing the revolutions of the engine shaft in the proportion of 33 to 9.

The thrust line is at 1 m. above the lower sustainer; ball bearings are not used.

There are no details to be obtained as to the actual thrust of the propellers, but it appears to be about 100 lbs. The efficiency of the propellers is approximately 75 per cent.

9.—THE RADIATOR—G.

This is attached to one of the uprights connecting the two sustainers. No de-

Fig 5. Section on Centre Line.

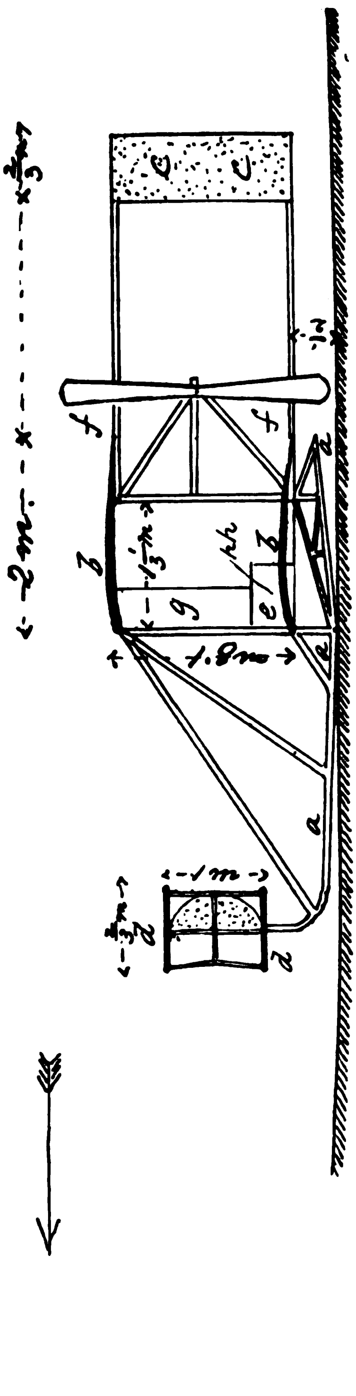
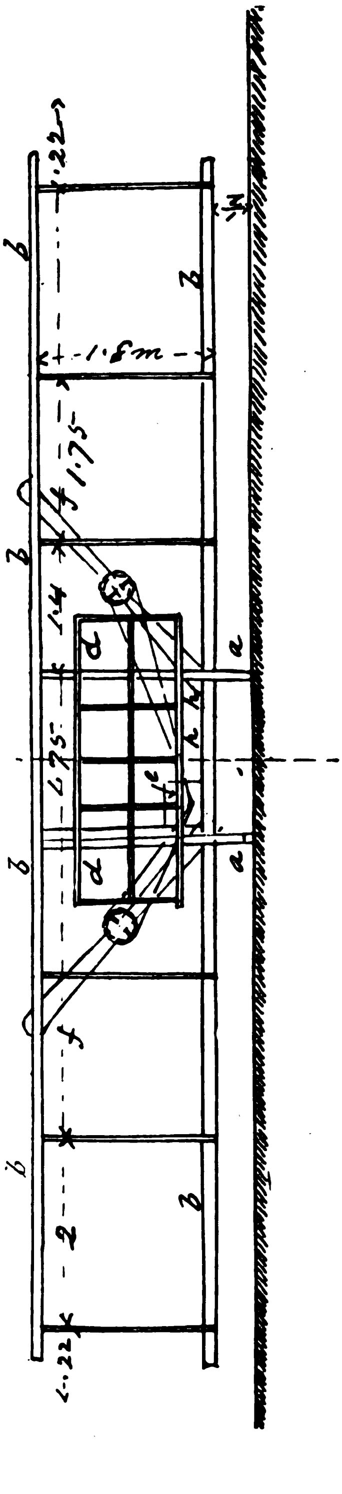


Fig 6. Front Elevation.



tails regarding it are available, but it appears to consist of about 36 ft. of copper tubing.

10.—SEATS FOR PASSENGERS—H.H.

These have already been alluded to. Footrests fixed to the front edge of the lower sustainer are provided.

11.—STARTING ARRANGEMENTS.

The machine can be started in three different ways:

1st. By placing it on a small carriage and running it along a level, smooth piece of ground under its own power. It is reported to rise in the air after a distance of 250 m. (820.2 ft.) has been traversed.

2nd. When there is a fair amount of wind (velocity not given) the machine is run along a wooden rail some 25 m. long, under its own power, and rises in a distance of about 20 m. The rail is movable, and can be fixed up so as to enable the machine to face the wind when starting. A groove in the machine body fits into the head of the wooden rail.

3rd. In calm weather the necessary extra impetus is given by a sort of catapult arrangement, consisting of a heavy weight 700 kilg. (1,520 lbs.) and a cable, one end of which is attached to the weight, and the other to a catch on the front of the machine. When it is desired to start, the propellers are put in action, and the weight dropped; the combined thrust thus produced drives the machine along the rail and the release of the catch after some 20 m. has been traversed causes it to sail away in the air.

There does not seem to be any difficulty in starting the machine by any of these methods. The second is, of course, the most favourable.

12.—ALIGHTING.

This is done by shutting off the power in the air and letting the machine slide down at a gentle slope. It appears to be quite easy, especially if the ground is smooth and level. Alighting on the skate-like runners does not seem to have given any trouble.

13.—REMARKS.

There is no doubt that this machine is by far the most successful one that has appeared so far. It has its faults, but taking its performances as a whole, no machine at present under trial can compare with it. The principal points to note about it are:

A.—The Body.

This, contrary to the French usage, has no starting wheels, and the machine rises in the air by means of its skate-like runners. For small, fast-flying military machines this would be a serious disadvantage, as they must undoubtedly be able to rise from any reasonably smooth, level piece of ground. There would not, however, be any difficulty in fitting wheels to these machines, and the Messrs. Wright are probably quite prepared to make such an alteration in their design.

As regards machines used for ordinary civilian purposes, wheels are not so important, as there is no doubt that some sort of land harbours, such as those advocated by Mr. Weiss in the "Aeronautical Journal" for January, 1908, will be found necessary, and as these would, of course, be supplied with all starting and alighting requirements, the question of starting wheels would be one of very minor importance.

B.—The Sustainers.

The main feature of these is, of course, the flexible arrangement for maintaining the equilibrium. This appears to work well in the hands of an experienced pilot like Mr. Wright, but it must be confessed that the system seems somewhat complicated and difficult to work. Only comparatively small alterations in the shape and inclination of the surfaces can be made, and the system, as a whole, appears to be too rigid and unsuited to any but small and slow changes of air pressure. Several accidents have already occurred on landing, which would probably not have happened had the crosswise equilibrium arrangements been modelled more on those of a bird. Whether this design is likely to be generally adopted remains to be seen, but in all probability it will, in future machines, be very considerably modified.

D.—The Apparatus for Steering in a Vertical Plane.

This appears to work well, and some such arrangement is, of course, necessary for all except small machines. The longitudinal balance obtained by this method is, however, very delicate, and seems to require constant attention.

This is apparently due, not so much to the steering apparatus, as to the peculiar design of the machine as a whole.

E.—The Motor.

The motor seems to work satisfactorily and stands a good deal of knocking about very well. It can probably develop about 32 H.P. as a maximum, but the power used in the ordinary flights is evidently very much less; say about 15 H.P.

This fact does not seem to be quite appreciated. Comparisons are constantly made between the weight carried per H.P. in the earlier machines and the 84.7 lbs. per H.P. carried by this one. But such comparisons are fallacious, as the powers given for the earlier machines are the maxima which the motors were able to develop, *and not the actual powers expended*, as can easily be seen from the results obtained with the early gliders.

The newest Wright machines are almost exact copies of the gliders, the only differences being increased size and the additions of a motor and extra passenger.

Now, the gliding angles of the gliders was about 5°, say $\frac{1}{12}$, and, assuming the same value for the present machines, the

$$\text{H.P.} = \frac{\frac{1}{12} \times 61.6 \times 1157}{550} = 10.8 \text{ lbs.}$$

which is the net H.P. required to propel the machine at 42 miles per hour. Assuming the efficiency to be .75, the actual B.H.P.

$$= \tfrac{4}{3} \times 10.8 = 14.4 \text{ H.P.}$$

(and this is probably a fair estimate of the capabilities of the present flyer).

The balance of the power provided is for the extra work to be done when ascending, and to cover contingencies such as defects in motor, loss by gearing down, etc., etc.

F.—The Propellers.

With so few details concerning them it is impossible to calculate the power developed, etc. They, however, appear to be very efficient, and this efficiency is due to the fact that the Messrs. Wright have realised Langley's saying, that the best propeller is not the one which drives the largest amount of air to the rear, but the one which, so to speak, glides at the smallest possible angle to its path, and, consequently, puts the smallest possible amount of air in motion. The blades of propellers are, so to speak, "flying surfaces" moving along certain courses, and, like the ordinary sustainers, should make the smallest possible angle with their true course in order to reduce the power required to drive them.

CONCLUSION.

The other details do not call for much comment. It only now remains to congratulate the Messrs. Wright on the splendid work done by them, and to wish them every success in their future experiments.

NOTE.

Members of the Society will hear with much regret that shortly after the above paper was completed a very serious accident occurred when Mr. Orville Wright and Lt. Lahm, U.S. Army, were practising circular flights. On September 17th, 1908, the two were in the air at a height of about 75 ft., when one of the propeller blades broke, and though Mr. Wright did his best to guide the machine, it dived forwards and struck the ground with considerable velocity. Both aëronauts were injured; Lt. Lahm, unfortunately, so seriously that he died shortly afterwards, while Mr. Wright was much bruised and knocked about. Lt. Lahm was a most skilful aëronaut, and his death is a great loss to American Aëronautical Science. Mr. Wright is reported to be progressing favourably, and it is hoped that he will be able to continue his experiments later on.

Miscellaneous Notes.

THE ARMY AEROPLANE.

A second series of trials with the new military aëroplane was held on Laffan's Plain yesterday and was witnessed by Col. Capper, Mr. Cody, and a large number of the Balloon Factory Staff. The machine was wheeled from the balloon shed at Farnborough by a party of Royal Engineers. When the plain was reached Mr. Cody took his place in the centre compartment, and the propellers were set in motion. Apparently no attempt was made to rise from the ground, but three runs of from one-half to three-quarters of a mile

were made at a very fair pace. The experiments were repeated again in the afternoon.

The aëroplane appears to consist of two horizontal parallel canvas planes some 40 ft. long by 20 ft. in depth. They are connected by rods of about 7 ft. in length, which give the structure the appearance of the roofed upper deck of a house-boat. From the rear projects a huge fantail of canvas, which in turn supports a canvas rudder. From the front a projecting canvas plane balances the tail at the back. The motor and propellers, which resemble those attached to the old military dirigible balloon, are housed amidships within the canvas structure, and the whole machine runs upon light cycle wheels.

Another correspondent writes:

In appearance Mr. Cody's aëroplane from a distance bears a marked resemblance to the Wright machine, consisting of two canvas surfaces about 40 ft. long and 7 ft. wide, one vertically above the other, and, roughly, 8 ft. apart, the canvas being stretched over a light framework of wood and metal. Attached to the extremities of the lower plane are two small horizontal planes or rudders, while a third small vertical plane is fixed over the centre of the upper plane.

The tail-piece and principal rudder are behind the main body of the machine, and a horizontal plane or rudder is rigged out on two arms in front of the centre, by which the course can be inclined upwards or downwards. The small end planes and the vertical central plane are used in conjunction with the main rudder when turning to right or left, the inner plane on the turn being depressed, while the outer one is correspondingly raised, the vertical plane working in connection with them and assisting to preserve stability. The machine will turn far more readily if slightly tilted inwards—as can be noticed when a bird turns in its flight—than if kept in the horizontal position, and this important fact has been dealt with, I think, more efficiently by Mr. Cody's method than by that of the Wright Brothers, whose entire planes on right and left of the centre are slightly raised and lowered on opposite sides when turning. This naturally destroys the rigidity and solidity of the whole structure. In front of Mr. Cody on the lower plane is the motor—which, I understand, is a light type of 8-cylinder Antoinette—and on each side of him are the double-bladed propellers.

Further trials will in all probability be carried out at Farnborough before the aëroplane is transported to Scotland, where secret tests were in progress for some weeks last year upon a machine designed by Lieutenant J. W. Dunne.—"The Times," September 25th, 1908.

FARNBOROUGH, September 26th.

The tests of the new aëroplane, which has been designed and constructed here by Mr. Cody, in the military balloon factory, are to be carried out on the same system of gradual progression that has so wisely been adopted by Colonel Capper in his trials of the "Nulli Secundus." I am informed that there is no idea of attempting any aërial flight for the present, and, to quote Colonel Capper's own words, "only preliminary experiments are now being made, with a view to finding out the elements of balance and of control, so that anyone expecting to see anything at all sensational in the flying line will be greatly disappointed."

For this large craft to career about the ground on light wheels at about 20 miles an hour, considerable space is required, and in the interests of public safety this is doubtless the reason why spectators were kept so far from the machine by the mounted police on Friday last.

Any sudden deviation from her intended course would involve almost certain collisions and probable disaster to onlookers who were close to her, and, therefore, it seems highly desirable that Laffan's Plain, Hove Common, or whatever place is selected for further trials, be given a wide berth by those anxious to see our newest aërostat, both for their own safety and in order to give Colonel Capper and his staff as free a space as possible in which to carry out these early experiments.

At a later date, when practice in steering, balancing, and general control has been obtained, and new propellers suitable for aërial flight have been fitted and tested, opportunities will doubtless frequently occur for the public to see Mr. Cody and other officers manœuvring the craft in mid-air.—"The Times," September 28th, 1908.

Further trials of the military aëroplane were made at Farnborough last evening. The machine was towed to Farnborough Common about 5 o'clock by sappers of the Royal Engineers, and after a few minutes of preparation Mr. Cody mounted to the steering seat. Several runs, ranging from a quarter to half a mile, were made, in which the aëroplane appeared to answer her helm perfectly. After the final run home Mr. Cody declared that during his last trip for something like a hundred yards there was an entire absence of vibration, and he surmised, therefore, that the aëroplane must have lifted. Returning along the clearly-marked track of the wheels, Mr. Cody and an officer discovered a sudden cessation of the track for a measured distance of 78 yards. Several spectators standing near declared that the aëroplane lifted from the ground for some distance. Mr. Cody, however, attached no importance to the circumstance, which he said was, after all, only a jump. He declared further that with the present propellers he will not attempt anything in the nature of a flight. But when he has thoroughly mastered the steering, he says that much larger and more powerful propellers will be fitted to the aëroplane for the purpose of flight.—" The Times," September 30th, 1908.

AERIAL NAVIGATION.

Successes of Mr. Wilbur Wright.

LE MANS, September 28th.

This afternoon and evening, in perfect weather conditions and in the presence of many well-known aëronauts, including Mr. Frank Butler, Mr. Percival Spencer, the Comte de Lambert, M. Paul Jamin, and others, Mr. Wilbur Wright gave a very fine demonstration of his flying powers. After his usual deliberate examination of his machine, he started at about 2.45 and flew 1 hr. 7 mins. 24 4-5 secs. Of this time only 1 h. 7 mins. 11 2-5 secs. counts for the Aëro Club cup competition, but during the latter period he covered 48 kilometres 120 metres, thus raising the achievement of last week by about nine kilometres. When he alighted about 20 yards from the turning post where I was standing, he explained that owing to the too free working of the lubrication pump he had run out of lubricating oil. "Otherwise," he said, "I could have gone on for two or three hours."

Mr. Wright's habit is to speak the truth, and, indeed, so perfect is his control of the machine in a light breeze, such as prevailed this afternoon, and so regular the working of his motor, that there appeared no reason why he should not have continued flying so long as any petrol remained in his tank. He lost no water during the flight, and did not vary his speed more than a second or two per kilometre in 10 kilometres.

Next Mr. Wright took as passenger M. Tissandier, whose father distinguished himself as a balloonist during the siege of Paris. It was now dead calm, but the flight was, in some respects, more impressive than the preceding one. The machine flew higher, frequently attaining 45 ft., and with the steadiness of a train. The speed was the same as before—namely, nearly a kilometre a minute. The flight lasted 11 mins. 35 2-5 secs., beating Mr. Orville Wright's "record" with a passenger by 2 mins. 19 2-5 secs. M. Tissandier had little enough to say about his "sensations." "I tried," he explained, "to have some, but there were not any, except," he added, "that of absolute safety." He had driven me out to the ground at a speed slightly exceeding 60 miles an hour, so he is probably somewhat impervious, but his experience tallies with that of his two predecessors, the brothers Zens.

Mr. Wright's next record was to carry a second passenger in one day in the person of the Comte de Lambert. The flight was equally uneventful, and lasted 7 mins. 15 secs. By this time the sight of the great beast wheeling its droning flight against the sunset had become almost commonplace—so quickly does the extraordinary become familiar.—" The Times," September 29th, 1908.

HYDROGEN FOR FILLING BALLOONS.

According to M. Mouricheau-Beaupré's communication to the Académie des Sciences, the following simple method of preparing hydrogen for filling balloons is available. An intimate mixture is made of finely divided aluminium with powdered bichloride of mercury and sulpho-cyanide of potassium. When water is added to this powder there is a violent evolution of hydrogen gas, which can be regulated by the volume of water employed, so as to keep the temperature down to moderate limits.—" The Times," September 30th, 1908.

Foreign Aëronautical Publications.

(In this list a selection of some of the more notable articles only is given.)

L'Aerophile.

July 1st, 1908.—The Dirigible "République." —Zeppelin IV.—The Dirigible "Italia."—The Wright Brothers.—Trials of Bleriot VIII.—On the Soaring of Birds.

July 15th, 1908.—French Aviators Abroad.—Zeppelin IV.—Trials of the "White Wing."

August 1st, 1908.—Sailing Flight.—The Dufaux Aëroplane.—On the useful weight in Aëroplanes.—Cheap Hydrogen.—Study of Sailing Phenomena.—The Coefficient of Resistance of the Air.—A Mathematical Theory of the Aëroplane.

August 15th, 1908.—The Gyroplane "Breguet Richet, No. 2."—The Dynamics of Sailing Flight.—Zeppelin IV.—The First Flights of the Brothers Wright.

September 1st, 1908.—Vibrations and Aërial Screws.—Jet Propulsion and High Speed Aëroplanes.—The Gastambide-Mengin Aëroplane. —The French Dirigible "République."—German Dirigible Balloons.

September 15th, 1908.—The Messrs. Wright in France and America.—Flights by Delagrange. —Some Reflections on the Wright Aëroplane.—Bleriot VIII.—The "Luyties" Helicoptère.—Three New French Dirigibles.—The Dirigible "République."

Societa Aeronautica Italiana.

July, 1908.—Apparatus for the Study of Friction. — Aviation. — Dirigibles. — Scientific Chronicle.—Review of the Reviews.—Sporting Supplement.

Illustrierte Aeronautische Mitteilungen.

July 15th, 1908.—American Airships.—The Permanent International Commission of Aëronautics.—Varieties.

July 29th, 1908.—Stability of Motor Airships in a Vertical Plane.—Count von Zeppelin's Trials on July 14th, 1908.—The French War Airship "La République."—The Aërial Experiment Association.—Flight Experiments in Sweden.—The Phillips Flying Machine (extracted from the "AERONAUTICAL JOURNAL").

August 12th, 1908.—Count von Zeppelin's Experiments on August 4th and 5th, 1908.—Short Notices.—Flight Experiments in Sweden.—New Flying Experiments.

August 26th, 1908.—Accidents and Measures for Rescuing Airships.—Indiarubber or Varnished Balloons?—New Experiments with the Parseval Airship.—Capt. Ferber's Flying Machine No. IX.—New Flight Experiments,

September 9th, 1908.—The "Vacuum" Airship.—The Disaster at Echterdingen.—The "Malécot" Airship.—Is Sailing Flight by Man Possible?—New Flight Experiments.

September 23rd, 1908.—On Aërodynamical Flight.—On the Descent of Airships.—New Flight Experiments.—The Schrader Flying Apparatus.

WIENER LUFTSCHIFFER-ZEITUNG.

July, 1908—The Farman and Delagrange Flights.—The "Von Zeppelin" Airship.—Notes.

August, 1908.—Trials of the "Zeppelin."—The Winning of the Armengaud Prize by M. Farman.—The German Army Balloon.—Notes.

September, 1908.—Count Zeppelin.—The Loss of Zeppelin IV.—Critical Articles on Zeppelin IV.—Zeppelin V.—Wilbur Wright Flies.—Notes.

AERONAUTICS.

July, 1908.—June Aëroplane Flights in America.—Aëronautics in Europe.—Aeronautics in Great Britain.—A Dirigible to Carry Three Passengers.

August, 1908.—Farman in America.—The Month Abroad.—The Stability of Aëroplanes.—Kite Manipulation and the Record Flight.

Applications for Patents.

(*Made in July, August, and September.*)

The following list of Applications for Patents connected with Aëronautics has been specially compiled for the AËRONAUTICAL JOURNAL by Messrs. BROMHEAD & Co., Patent Agents, 33, Cannon Street, London, E.C.

JULY.

13259. June 22nd. R. M. BALSTON. Improvements in or relating to flying machines.

13315. June 23rd. R. McLEAN. Improved flying machine.

13529. June 25th. A. FILLING. Improvements in the construction of kites.

13809. June 30th. C. LORENZEN. Improved form of aerial machine.

13948. July 1st. C. A. CHAPPELL and M. KAY. Improvements in and relating to flying machines.

14013. July 2nd. J. R. SCANDLING. Improvements in and relating to flying machines.

14196. July 4th. E. E. KELWAY. Method of and improvements in apparatus for propelling and manœuvring ships and torpedoes, also applicable to airships and the like.

14327. July 6th. J. DEIXLER. Improved flying machine.

14596. July 9th. C. A. CHAPPELL. Improvements in and relating to flying machines.

AUGUST.

15924. July 27th. T. W. K. CLARKE. Improvements in aeronautical machines.

16153. July 30th. F. WOOD. Improvements in aerial and the like machines.

16250. July 31st. M. STIGLER. Improvements in or relating to flying machines and the like.

16295. July 31st. C. A. PIM and STRANGE, and GRAHAM, LIMITED. Improvements in connection with vessels which require to be steered, or have their course altered, whilst travelling in the air, or in or on water, or on land.

16300. July 31st. I. O. TZIMBALISH. Improvements in and relating to airships and the like.

16541. August 5th. N. BLOOD. Improvements in or relating to flying machines.

16544. August 5th. J. E. PFEIL and R. REUTER. Improved arrangement of working surfaces for propellers, fan blades, steering and supporting surfaces for water and air vehicles and the like.

16606. August 6th. W. FRIESE-GREEN and THOS. FRIESE-GREEN. Improvements in and relating to air-cars or airships.

16607. August 6th. D. F. SHEARER. Improvements in or relating to flying machines.

16834. August 11th. A. PASFIELD. Cyclopane.

16842. August 11th. C. L. BOURQUER. Improvements applicable to cycles, motor cars, motor engines, aeroplanes, and the like.

16868. August 11th. J. H. BROWNING. Airship without gas.

16926. August 12th. H. L. TODD and J. A. WYLIE. Improvements in airships.

16941. August 12th. E. M. LINDHOIST. Driving device for boats, flying machines and the like.

17037. August 13th. J. Lyle. Improvements in means and apparatus for rising into and traversing the atmosphere.

17107. R. Schwarz and F. W. Weber. Bird-like flying machine.

17131. August 14th. F. L. Bartelt. Improvements in apparatus for aerial propulsion.

17150. August 14th. J. Weiss. Improvements in and relating to bird-shaped aeroplanes.

17169. August 15th. W. E. Hitch. Improvements in or relating to the means for propelling vessels through fluids.

17324. August 18th. G. M. Windsor. Arrangement for the purpose of aerial flight.

17370. August 18th. R. d'Equevilley-Montjustin. New or improved flight machine.

17413. August 19th. Siemens Bros. Improvements in and relating to airships.

17499. August 20th. C. Davies. Improvements in balloons, airships, and the like.

17502. August 20th. P. Lentz. Improvements in or relating to aeronautical machines.

17695. August 22nd. O. Ricoldoni and G. A. Crocco. Improvements in and relating to airships.

SEPTEMBER.

17798. August 25th. W. E. Hitch. Improvements in and relating to airships.

17855. August 25th. F. W. Schroeder. Improvements in aerial ships.

17877. August 25th. F. W. Dafwa. Improvements relating to flying machines.

17995. August 27th. F. W. Brewster. Improved aeroplane.

18059. August 27th. H. B. Webb. Improvements in toy aeroplanes or flying machines, some principles of which are applicable to large machines.

18065. August 28th. F. W. Lanchester. Improved mechanism for imparting stability to an aerodrome in flight.

18084. August 28th. W. E. Hitch. Improvements in and relating to airships.

18197. August 31st. C. Russell. Aero-propeller.

18223. August 31st. S. Schuckertwerke. Apparatus for determining the course of airships and the like.

18420. September 2nd. J. MacMillan. Improved air propeller or screw for use in air or water.

18696. September 7th. I. E. Mercir. Improvements in the control of structures using aeroplanes.

18877. September 8th. M. Kober. Improvements in or relating to rotating rudders for aerial machines.

18932. September 9th. F. Walton. Improvements in or relating to flying machines.

19178. September 12th. J. Westaway. Improvements in aeronautical machines.

19179. September 12th. J. Westaway. Improvements connected with aeronautical machines.

19180. September 12th. J. Westaway. Improvements connected with aeronautical machines.

19536. September 17th. C. G. Rodeck. Improved balloon-aeroplane.

19677. September 18th. A. J. Fredriksen. Improvements in flying machines or airships.

19805. September 21st. E. H. Hare. Improvements in aeroplanes.

19982. September 23rd. J. E. Fraser. Rotary orthopter aeroplane.

19985. September 23rd. G. Daws. Improvements in dirigible balloons and airships.

20033. September 23rd. M. Tweedie. Improvements in aeroplanes.

20038. September 23rd. Sir H. S. Maxim. Improvements in and relating to flying machines.

20110. September 24th. J. B. Judge and P. C. Rolland. Improvement in or connected with flying machines.

20160. September 25th. J. H. Brown. Method of attaching caster wheels to aeroplanes or flying machines so called.

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