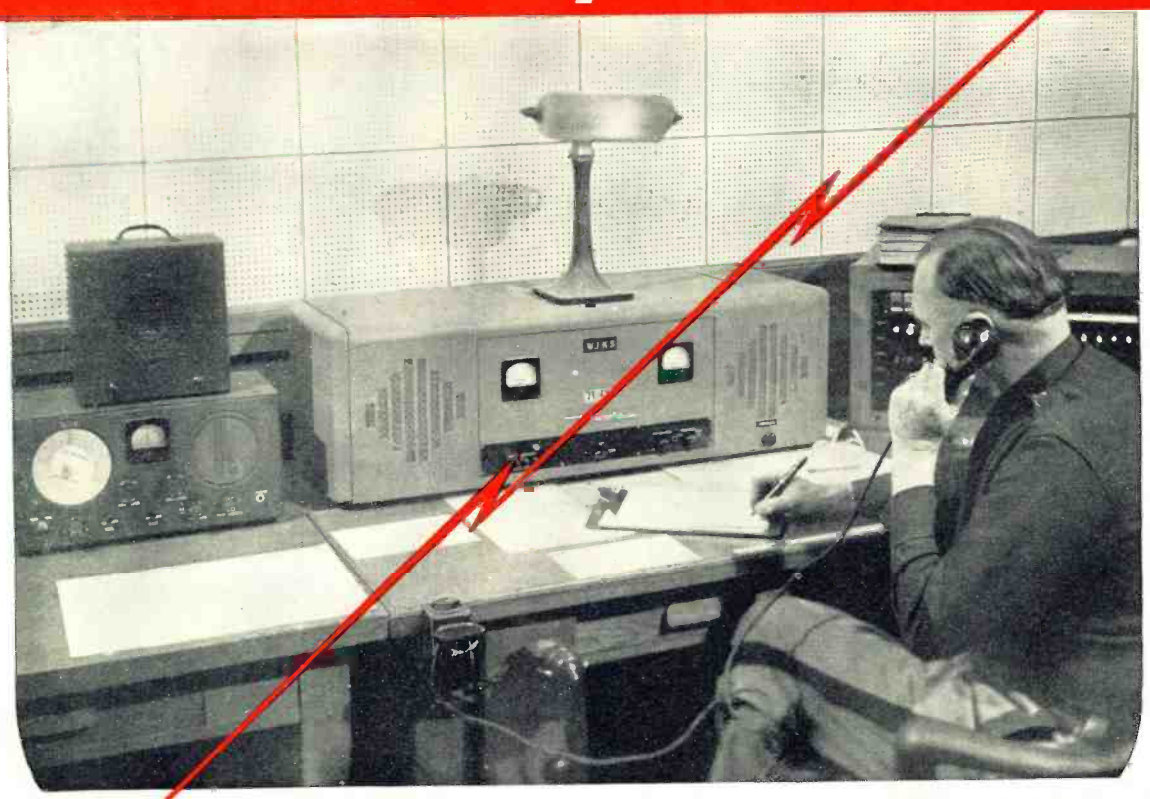
RADIO NEWS

NOVEMBER
1943
25c
In Canada 30c

It's Easier To Cope With Crime



WITH A *Motorola* 2-WAY RADIOTELEPHONE SYSTEM

One police patrol car equipped with a 2-Way Radiotelephone set is worth three cars without radio. Thus the installation of 2-Way Radio provides you with an immediate extension of your police facilities.

With police officers leaving the force to join the military services nowadays, you more than ever need to conserve manpower. 2-Way Radio will help you do this—you will be able to make each patrol car do the work of three. And you save tires, gas and car repair as well.

YOU CAN GET A *Motorola* 2-WAY RADIOTELEPHONE SYSTEM

Communities which can show either a vital public need or a vital military need for a Police Radiotelephone System can obtain one by merely making application for allotment from the Government Pool. For full information on how to proceed, simply write or phone us. A Motorola field engineer will survey your requirements and get you started. No obligation.

For the development and production of Radio Communications Equipment for our armed forces, Motorola organization was awarded the Army-Navy "E" with added Star for continued excellence of performance. Motorola is proud of the part it has been privileged to play in the speeding of Victory.

Radio Communication Systems
Designed and Engineered to Fit Special Needs
GALVIN MFG. CORPORATION · CHICAGO

I will send you a Lesson Free to show how I train you at home in spare time for Good Jobs in Radio

J. E. SMITH, President
National Radio Institute, Established 29 Years

He has directed the training of more men for the Radio Industry than any other man in America.

The 915 U. S. Broadcasting Stations give steady jobs to hundreds of Radio Technicians, Operators, with average pay among the country's highest paid industries.

Radio Repairing is a booming business today because **no new Radios are being made.** Many make $50 a week in full time jobs—others $5, $10 a week EXTRA for spare time work!

Civilian Radio Operators are needed for good Government jobs and in Aviation Radio, Police Radio, Commercial Radio. Now is a good time to get started in these fields.

Here's your chance to get a good job in a busy wartime field with a bright peacetime future! There is a real shortage today of trained Radio Technicians and Operators. So mail the Coupon for a FREE lesson and my 64-page, illustrated book, "Win Rich Rewards in Radio." It describes many fascinating types of Radio jobs; tells how N.R.I. trains you at home in spare time; how you get practical experience by building real Radio Circuits with SIX BIG KITS OF RADIO PARTS I send!

More Radio Technicians, Operators Now Make $50 a Week Than Ever Before

Fixing Radios pays better now than ever before. With new Radios out of production, fixing old sets, which were formerly traded in, adds greatly to the normal number of servicing jobs.

Broadcasting Stations, Aviation and Police Radio, and other Radio branches are scrambling for Operators and Technicians. Radio manufacturers, now working on Government orders for Radio equipment, employ trained men. The Government too needs hundreds of competent civilian and enlisted Radio men and women. You may never see a time again when it will be so easy to get started in this fascinating field.

I Send You Six Big Kits of Real Radio Parts

My "50-50 Method"—half building and testing real Radio Circuits, half learning from easy-to-grasp, illustrated lessons—is a tested, proven way to learn Radio at home in spare time. Think how much PRACTICAL experience you'll get by building a Superheterodyne Circuit, Measuring Instrument, and A.M. Signal Generator—by conducting 60 sets of experiments on these and other Circuits you build with standard Radio parts I supply! Within a few months you can be ready to run your own Spare Time Shop, fix the Radios of your friends and neighbors—get paid while learning!

Be Ready to Cash in on Jobs Coming in Television, Electronics

Think of the **NEW** jobs that Television, Frequency Modulation, Electronics, and other Radio developments will open after the war! You have a real opportunity. I will train you to be ready to cash in when Victory releases the amazing wartime Radio developments for peacetime uses!

Many Beginners Soon Make $5, $10 a Week EXTRA in Spare Time

Right now, probably in your neighborhood, there's room for more spare and full time Radio Technicians. Many N.R.I. Students make $5, $10 a week EXTRA money fixing Radios in spare time while learning. I send EXTRA MONEY JOB SHEETS that tell how to do it!

Find Out What N.R.I. Can Do for YOU

MAIL THE COUPON BELOW for my FREE Lesson and 64-page book. They're packed with Radio facts. You'll read a description of my Course —"50-50 Method"—6 Experimental Kits—Extra Money Job Sheets. You'll see the fascinating jobs Radio offers and how YOU can train at home. And you'll have my free lesson to KEEP. No obligation—no salesman will call. Just mail Coupon at once in an envelope or paste on penny postcard! **J. E. SMITH, President, Dept. 3MR, National Radio Institute, Washington 9, D. C.**

Extra Pay in Army, Navy, Too

Men likely to go into military service, soldiers, sailors, marines, should mail the Coupon Now! Learning Radio helps Service men get extra rank, extra prestige, more interesting duties, much higher pay. Also prepares for good Radio jobs after service ends. Over 1,700 Service men now enrolled

TRAINING MEN FOR VITAL RADIO JOBS

I Trained These Men

Chief Operator Broadcasting Station
"Before I completed your lessons, I obtained my Radio Broadcast Operator's license and immediately joined Station WMPC where I am now Chief Operator."—HOLLIS F. HAYES, 327 Madison St., Lapeer, Michigan.

1st Lieutenant in Signal Corps
"I cannot divulge any information as to my type of work but I can say that N. R. I. training is coming in mighty handy these days."—RICHARD W. ANDERSON (address omitted for military reasons).

$10 a Week in Spare Time
"I repaired some Radio sets when I was on my tenth lesson. I really don't see how you can give so much for such a small amount of money. I made $600 in a year and a half, and I have made an average of $10 a week—just spare time."—JOHN JERRY, 1337 Kalamuth St., Denver, Colorado.

FREE LESSON

I'll send you a free lesson, "Getting Acquainted with Receiver Servicing," to show how practical it is to train at home for Radio. It's a valuable lesson. Keep it—use it—without obligation. Tells how Superheterodyne Receivers work—why Radio Tubes fail—how to fix Electrodynamic Speakers, Output Transformers. Gives hints on I. F. Transformer repair—how to locate defective soldered joints—Antenna, Oscillator Coil facts—Receiver Servicing Technique, etc., etc. 31 illustrations.

Good for Both 64 PAGE BOOK SAMPLE LESSON Free

J. E. SMITH, President, Dept 3MR,
National Radio Institute, Washington 9, D. C.

Without obligating me, mail your Sample Lesson and 64-page Book FREE. I am particularly interested in the branch of Radio checked below. (No salesman will call. Write plainly.)

- ☐ Radio Service Business of My Own
- ☐ Service Technician for Radio Stores
- ☐ Spare Time Radio Servicing
- ☐ Gov't Civilian Radio Job
- ☐ Aviation Radio
- ☐ Operating Broadcasting Stations
- ☐ Army, Navy Radio
- ☐ Operating Police Radio Stations
- ☐ Operating Ship and Harbor Radio

(If you have not decided which branch you prefer—mail coupon for facts to help you decide.)

Name..... Age.....

Address .....

City..... State.....4FR

RADIO NEWS

NOVEMBER, 1943 Vol 30, No. 5

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DEPARTMENTS

Cover Photo—by U. S. Army Signal Corps

RADIO NEWS is published monthly by the Ziff-Davis Publishing Company at 540 N. Michigan Ave., Chicago, Ill. New York Office, 270 Madison Ave. Washington, D. C., Office, Earle Bldg. Special Washington Representative, Col. Harold E. Hartney, Occidental Hotel. London Editorial Representative, A. Spenser Allberry. Subscription Rates: In U. S. $3.00 (12 issues), single copies, 25 cents; in South and Central America and U. S. Possessions, $3.00 (12 issues); in Canada $3.50 (12 issues), single copies 30 cents; in British Empire, $4.00 (12 issues); all other foreign countries $6.00 (12 issues). Subscribers should allow at least 2 weeks for change of address. All communications about subscriptions should be addressed to: Director of Circulation, 540 N. Michigan Ave., Chicago, 11, Ill. Entered as second class matter March 9, 1938, at the Post Office, Chicago, Illinois, under the Act of March 3, 1879. Entered as second class matter at the Post Office Department, Ottawa, Canada. Contributors should retain a copy of contributions. All submitted material must contain return postage. Contributions will be handled with reasonable care, but this magazine assumes no responsibility for their safety. Accepted material is subject to whatever adaptations, and revisions, including "by-line" changes, necessary to meet requirements. Payment covers all authors, contributors or contestants rights, title, and interest in and to the material accepted and will be made at our current rates upon acceptance. All photos and drawings will be considered as part of material purchased.

FOR THE Record BY THE EDITOR

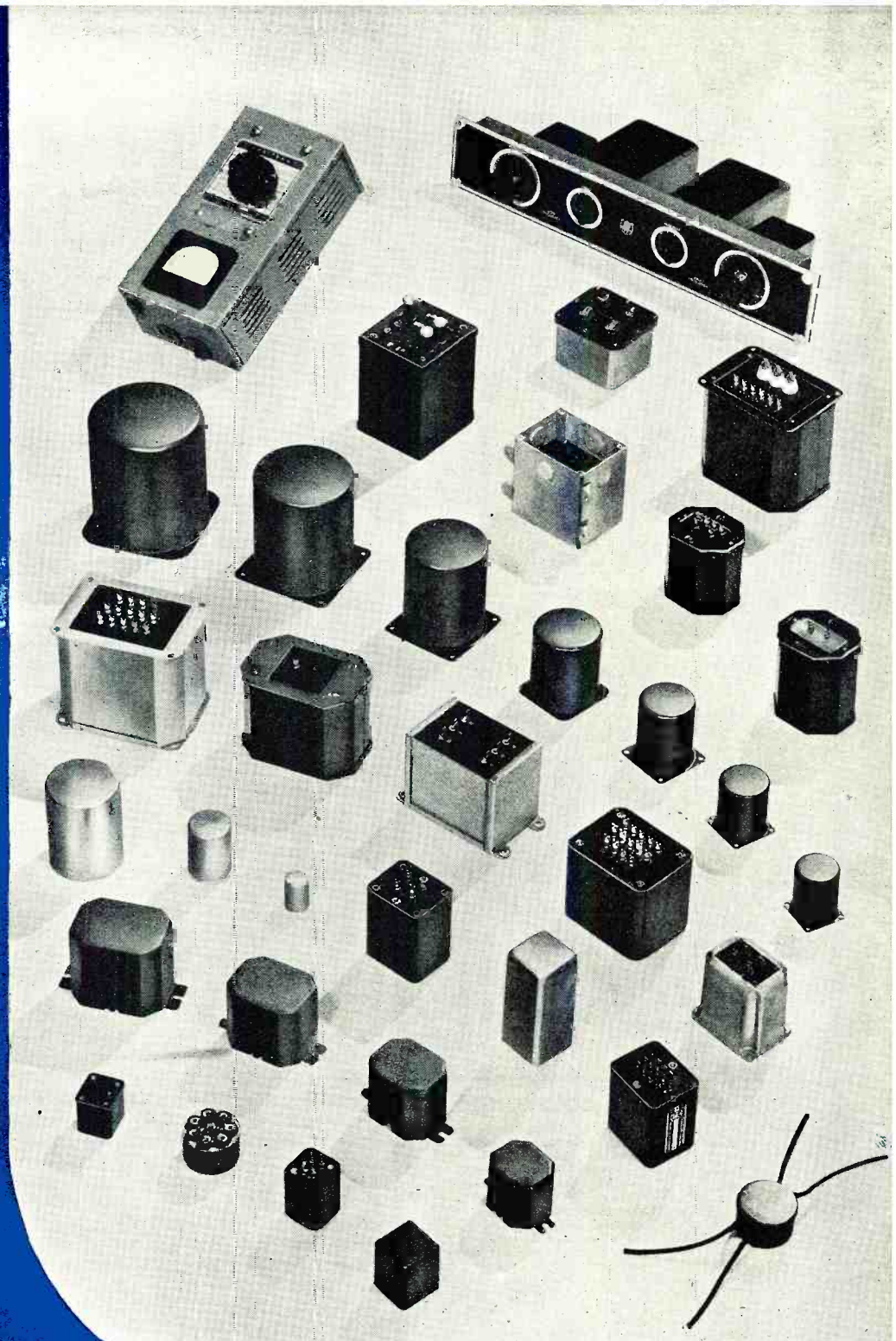
THE American public, particularly those living in the vicinity of Washington, D. C., have at last had the opportunity to see where their money was going, that they had so wisely invested in war bonds. A huge display of military might was assembled around the Washington monument and approximately 2,000,000 persons were able to see for themselves the maze of equipment required to fight a modern war. We were privileged to spend several days going through the various exhibits. We were chiefly concerned with the products and activities of our Army Signal Corps under the brilliant leadership of Major General Harry C. Ingles, Chief Signal Officer. Price tags were placed on various pieces of equipment to point out how costly they were to produce if they were to meet the rigid specifications required by our fighting forces. For example, the famous "handy talkie" was displayed and listed at $212. That's a lot of money for a small compact transmitter-receiver. When one considers that thousands of these are in operation at every front he begins to realize that a considerable amount of money is needed to produce these and other items coming under the communications classification. The famous SCR-299 mobile unit having a price of $9,000 was examined by thousands of visitors. This set was recently credited, by the Chief Signal Officer himself, as "helping to bring Rommel to his knees in North Africa."

Many prominent radio manufacturers made special trips to Washington to see the elaborate exhibits. We had the privilege of meeting many of them. In every case they were most proud of the equipment which they were producing and were inspired to even greater production as a result of their visit where they were able to feel the public reaction first hand.

One of the most interesting exhibits was that of captured enemy communications equipment. The American manufacturer is to be congratulated on turning out equipment which is far superior to that in use by our enemies.

(*Continued on page* 110)

UTC LEADS THE FIELD



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Spot Radio News

IN DEFENSE AND INDUSTRY

by **LEWIS WINNER**
RADIO NEWS Washington Correspondent

Presenting latest information on the Radio Industry.

POSTWAR PROBLEMS were the featured topics of discussion at the annual fall meeting of the RMA Executive Committees in New York recently. The potential problems with which the industry is faced when peace-time reconversion is at hand, were analyzed by the postwar planning committee, of which R. C. Cosgrove, vice president and general manager of Crosley, is chairman. Thus far, there has been no word from Washington as to just when radio manufacturers would be permitted to begin civilian production again. Accordingly the members felt that it was best that they present to Washington the highlights of the numerous proposals for reconversion as a guide towards the evolving of a final program. Some of the methods employed by other industries which have already received the green light for limited production were discussed for inclusion in the proposals for Washington.

The subject of costs was also studied at the meeting. At the present time the problem of costs are governed by conditions entirely different than those prevailing during normal periods. For now the elements of time and quality have of necessity predominated, while costs have been a secondary consideration. In civilian production, the cost factor is the governing one because of competition. This does not, of course, mean that quality is overlooked, but only that costs are a major factor in production.

A program involving a code of standards to govern radio advertising was also discussed. The committee, headed by John Garceau, advertising manager of Farnsworth Radio and Television Corporation, discussed the judicious exercise of self discipline in advertising to forestall the possibility of any government regulation, such as was promulgated recently in respect to one particular type of advertising.

The radio technical planning board, discussed in these columns last month, was approved unanimously at this meeting. At the present writing, there are nine sponsors of the plan including RMA and the IRE the American Institute of Electrical Engineers, American Institute of Physics, American Radio Relay League, F-M Broadcasters, Inc., International Association of Chiefs of Police, National Association of Broadcasters and the National Independent Broadcasters. Complete details involving the actual operation of this board will be discussed at another meeting. This report will probably be available for presentation in these columns next month.

A BIT OF A HALT TO ARMY RAIDS on civilian goods has been prompted by a recent WPB directive. The directive, effective during the fourth quarter of the year, which officially began October 1, specifically names the Army, Navy, Maritime Commission, Aircraft Resources Control Office and persons buying for direct export as being ineligible to purchase goods earmarked for the civilian use, from manufacturers. This directive, of course, does not permit manufacturers to disregard priority rated orders. It instructs the manufacturers, however, to notify the WPB immediately if the filing of these orders would cause them to dip into civilian allocations. In the event the government requests some equipment, the WPB can authorize the manufacturer to disregard the order or make adjustments it considers appropriate. This adjustment phase of the directive was prompted by an earlier directive . . . in preparation, but not released . . . that did not permit any sale to the Armed Services out of civilian quotas except on the emergency triple A rating, which is reserved for the strategic needs of the highest urgency.

Quotas in the present plan include X-ray apparatus and tubes, electrical physiotherapy apparatus, household articles, chronometers, nails, watches, cutlery. Another quota list under consideration includes a liberal assortment of items employed in radio work.

This WPB curb activity follows closely Arthur Whiteside's civilian activities. The next few months should see interesting activities on these fronts.

FM SEEMS TO BE WINNING new friends daily. The newest FM enthusiast is the popular Washington analyst, W. M. Kiplinger. In a specially prepared article appearing in a national magazine, Mr. Kiplinger points out that frequency modulation will become as important in the postwar era as synthetic rubber and high-octane gasoline. Considering the vast sums of

money and immeasurable time spent towards the development of the rubber and gasoline, frequency modulation appears to be riding along with fine company.

The import of FM was given added weight by FCC chairman James Lawrence Fly and George Adair, assistant chief engineer of the FCC, in recent addresses in Washington. Both of these experts appeared before a luncheon session of the Federal Radio Education Committee and pointed out that attention to FM should be given now. Chairman Fly said that full advantage of the choice frequency modulation frequencies should be taken now. He explained that after the war there will be a reshuffling of frequency assignments and the choice FM channels may not be available. Plans should be laid now for the use of the five educational panels, emphasized Mr. Fly. The use of FM broadcasting as an educational aid was emphasized by George Adair. He suggested ways of modernizing educational programs through the use of FM stations by school systems.

The FM march seems to be gaining momentum.

FORMALITY FLEW OUT THE WINDOW during the recent FCC House Committee meetings. For the FCC set up its own little press office outside the Banking and Currency Committee hearing room in the new House Office Building to keep the news men advised on the daily activities of the investigating Committee. Heading the FCC information department is Earl Minderman, who maintained a consistent barrage of important FCC news releases.

News conferences of the informal and formal type were held by the FCC with such specialists as FCC chief engineer Jett, general counsel Charles R. Denney, Jr. and other department heads, in attendance.

According to Mr. Denney, this method of keeping the public informed is being employed, because too many months would pass by before the FCC would have an opportunity to answer the charges of the Cox Committee. In many instances, explanations of testimony supplied during sessions were prepared immediately following the session and supplied to the press. FCC secretaries used information on every case cited, from the files that were set up in the anteroom of the hearing room.

This activity will probably reach a breath-taking pace during the next few weeks as the issues discussed, become more and more involved. There seems to be plenty of action on this front in Washington.

ANSWERS TO MANY IMPORTANT RETAILER QUESTIONS covering activities under the recently issued Used Consumer's Durable Goods regulation MPR-429, were recently supplied by the OPA. Many dealers, for instance, wanted to know if used radios were governed by this regulation. The OPA says that used radios still remain under control of the general maximum price regulation. Used radio phonograph combination sets are also under the general price regulation ruling.

The term "wholesale" has also been defined in these questions and answers. According to the OPA a sale at "wholesale" is a sale to a person who buys to resell. The determination of the selling price for a used article that has been acquired for resale has also been solved by OPA. They say that first the dealer must find the price of a new article which is the same as or similar to the used article he is pricing. Then he must define whether the article belongs in class *1* or *2* as defined in MPR-429. In class *1*, used merchandise includes only articles in good working order and in which no parts are missing. The merchandise must be clean, of good appearance, and must be in condition for use without the need of repairs. Class *2* includes all articles not in class *1* and ordinarily sold in "as is" condition. After determining the class *1* or class *2* status, the dealer should set his ceiling price for the used article at either ¾ or ⅓ of the price of a new article of the same or similar kind, depending, of course, on whether the article belongs in class *1* or *2*. In other words class *1* used merchandise shall be allowed maximum prices no higher than 75% of the price of new merchandise. Class *2* is permitted maximum prices no higher than 33⅓% of the price of a new item.

This Used Durable Goods regulation does not, of course, cover the maximum price regulation concerning assembled radios and phonographs that was recently issued. This particular ruling applies to household radio receiving sets and phonographs assembled by distributors and dealers from parts which they had accumulated. We discussed the method of determining ceiling prices on these assembled units, last month. Incidentally the department of information of the OPA have just issued a bulletin, known as the Retailer's Bulletin 46 covering dealer-assembly price ceilings. Copies are available from the nearest district offices of the OPA.

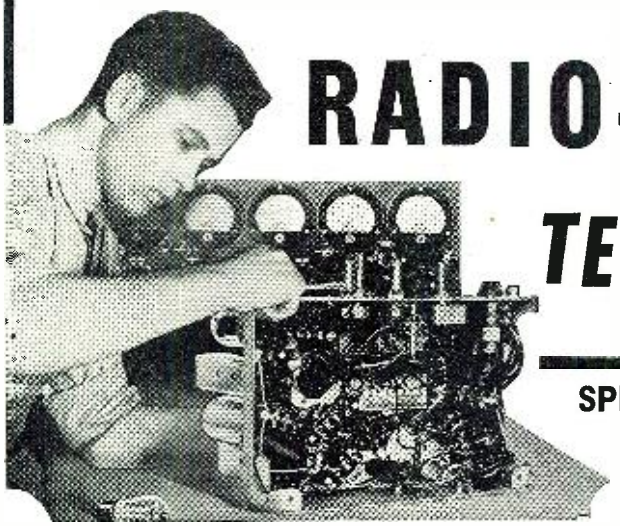
FM STATIONS WILL HAVE NEW IDENTITIES beginning November 1. Instead of the complicated and hard-to-remember character-number calls, FM stations will hereafter be able to use four-letter calls, such as WAAZ. If the stations operate a broadcast station as well as an FM station in the same city, they will be able to use, if they wish, the letters of the broadcast station and follow it with the letters FM, viz., WAAZ-FM.

This new ruling will affect approximately 45 stations now in operation and, of course, all new stations. There are 4000 four-letter calls that FM stations can inspect for use. All three letter calls have been assigned. All call letters beginning with *W* will be assigned to stations east of the Mississippi; all station calls with the letter *K* will be assigned to the stations west

HERE S YOUR SUCCESS CHANCE

BE A

RADIO-ELECTRONIC TECHNICIAN!



SPRAYBERRY TRAINS YOU QUICKLY FOR WAR AND PEACETIME WORK

You Learn in Easy Step-by-Step Stages

No Previous Experience Needed

The offer I make you here is the opportunity of a lifetime. It's your big chance to get ready for a wonderful future in the swiftly expanding field of Radio-Electronics INCLUDING Radio, Television, Frequency Modulation, and Industrial Electronics. Be wise! NOW is the time to start. Aside from future considerations, just think of the IMMEDIATE possibilities in Radio during war time. They're tremendous! Best of all, it's easy for the beginner to get started through my quick, practical training.

IF YOU REMAIN A CIVILIAN OR ENTER MILITARY SERVICE . . . Radio Training Will Enhance Your Future!

• *READ THESE LETTERS* •

One Job Nets About $26.00

"Since last week I fixed 7 radios, all good-paying jobs and right now I am working on an amplifier system. This job alone will net me about $26.00. As long as my work keeps coming in this way, I have only one word to say and that is 'Thanks to my Sprayberry training' and I am not afraid to boast about it." — ADRIEN BENJAMIN, North Grosvenordale, Conn.

Sprayberry Graduate Wins Out in Army Test

"Since I completed your elegant Course in Radio I have been drafted into the Army and put into the Signal Corps. I had to compete to get the job I now hold and as a result of my training with you, I made the best grade and got the job. The point I am driving at is if it hadn't been for your thorough course in Radio I would probably be peeling potatoes now. I recommend your training to all because it is written in language that the average layman can understand." — ARCH PLUMMER, JR., Fort Meade, Md.

Student Makes $15.00 to $20.00 A Week in Spare Time

"After starting your Course I began doing minor radio service jobs and I want to say that I have been flooded with work. So much so that I have had to neglect my lessons. I want to say your training has done a great deal for me. I am making $15.00 to $20.00 a week in spare time. Even so, I'm going to go back to my studies and finish the Course."—SANFORD J. CHICOINE, Whitley, Ontario, Canada.

PREPARES YOU FOR A BUSINESS OF YOUR OWN

. . . . or Good Radio Jobs, Civilian or Military

The Sprayberry course is short, intensive, and interesting. It starts right at the beginning of Radio. You can't get lost. It gets the various subjects across in such a clear, simple way that you understand and remember. I make it easy for you to learn Radio Set Repair and Installation Work . . . by practical proven, time tested methods. I teach you how to install and repair Electronic Equipment, and give you the broad fundamental principles so necessary as a background no matter what branch of radio you need to specialize in. Soon you'll be qualified for a good paying job in one of the nation's Radio plants doing war work OR, if you enter the Army, Navy, or Marines, my training will help you win higher rating and better pay. Let me prove what Sprayberry training can do for you.

JUST OFF THE PRESS!

"How to Test and Repair Radio Sets Without Meters"

Developed in the Sprayberry laboratory, this instructive volume tells about an amazingly simple, yet efficient method for Radio trouble-shooting and repair without use of regular equipment made scarce due to war. Send for this free book now while the supply lasts and along with it, I will send you another big free book describing my Radio - Electronic training. Mail coupon.

SPRAYBERRY ACADEMY OF RADIO
F. L. Sprayberry, Pres.
625-L University Place, N. W.
Washington9, D. C.

Please rush my FREE copies of "HOW TO TEST AND REPAIR RADIO SETS WITHOUT METERS" and "HOW TO MAKE MONEY IN RADIO."

Name ..... Age .....

Address .....

City ..... State .....

Tear off this coupon, mail in envelope or paste on penny postcard.

NOW! BECOME A MONEY-MAKING RADIO SPECIALIST

of the Mississippi and in the territories. According to the FCC, there are 2900 *K* calls and 1100 *W* calls now available.

Under the old system, the same geographical status held true for the K and W calls. The number designation, however, indicated the frequency on which the station was operating, and the last letter indicated where the broadcast may be coming from.

With this step, FM stations appear to have won a well deserved permanent status.

A FOUR YEAR STRUGGLE for nighttime station service by the City of New York station WNYC, appears to have ended in victory, at least for the duration. This station which operates on the same frequency, 830 kilocycles, as WCCO, Minneapolis, owned by CBS, has heretofore been denied nighttime service, because of possible interference with WCCO. Columbia contended that such a nighttime transmission interfered with service to the rural areas in the north central districts of Minnesota. The application for the nighttime service originally made in 1939 was also opposed by the State of Minnesota. During December of last year, temporary permission to operate until 10 P.M. was granted to WNYC. The permission was then revoked later being reinstated.

After receiving additional requests from WNYC that the additional time was essential to aid the war effort, CBS agreed to withdraw its opposition and permit WNYC to remain on the air at night, providing such time was used for wartime service. Officials and engineers of CBS emphasized that such transmission would still cause interference, but that for the duration, the listeners would be tolerant.

WNYC operates with 1000 watts, while WCCO uses 50 kilowatts. Sun rays appear to retard daytime transmission of WNYC and thus no interference is experienced during the daytime.

Although formal FCC approval has not been granted to the nighttime appeal, there is every indication now that CBS has withdrawn its objection, such permission will be granted.

A round of applause to CBS for their spirit of cooperation!

MICA AND QUARTZ HAVE AGAIN become headline news in Washington. As the result of two accord between Brazil and this country, we will buy from Brazil all strategic quantities of the minerals produced in Brazil, independent of any development in the war. These constitute a renewal of those which expired on May 14 and will remain in effect until May 14, 1944. The renewal of the pact was announced by Jefferson Caffery, American Ambassador to Brazil.

Incidentally the WPB has been giving mica a wealth of attention recently. In view of the importance of mica to so many electrical and radio components, a mica research project has been set up by the National Research Council. This project conducted by the Bell Telephone Laboratories is to determine whether types of mica which had not heretofore been considered suitable for use in capacitors might be proven suitable.

Since its formation, the Mica-Graphite division of WPB has realized that one of the best ways of overcoming the shortage of high quality mica was to find military uses for the lower qualities. It was the policy of the division to allocate for radio tubes, spark plugs and for electrical insulation, a lower quality of mica that has been formerly used. Since lower quality was not always useful for capacitors, instruments were devised by the Bell Laboratories to test the electrical qualiities of such mica. Some lower qualities of mica when tested on these instruments were found to be free of conducting veins and spots and as low in power loss as mica free from stain. To judge its practical worth, a limited quantity of capacitors was made with the lower quality mica. Tests proved that the mica was as satisfactory as the better grades.

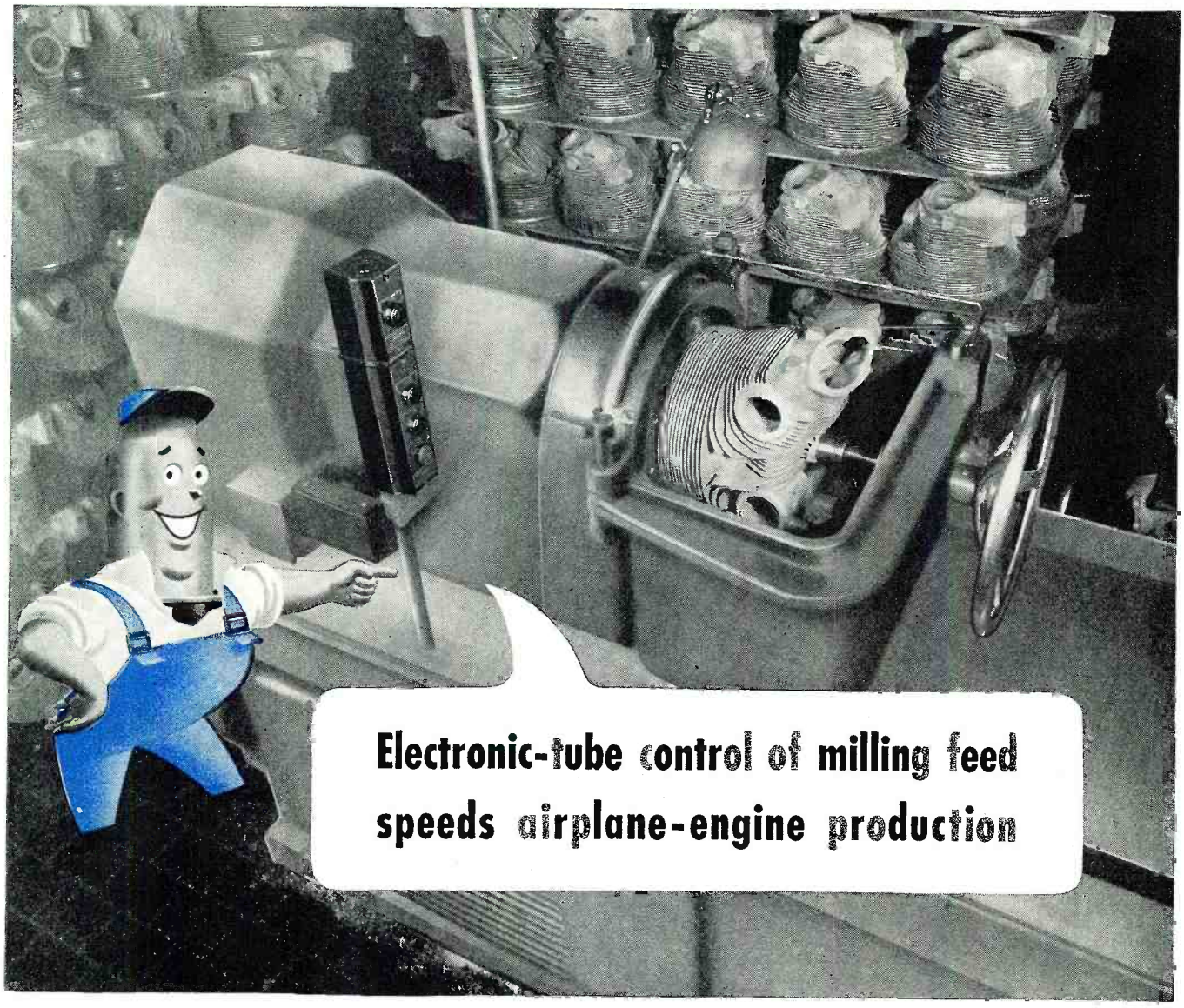
Since, of course, only a limited quantity of capacitors were made up for the tests, complete revision of all commercial types was not prudent. Accordingly an enlarged program of study has been agreed upon. In the new test program now under way, nine different types of mica, not being used at present for capacitors are being tested. Six of these types are of domestic origin and three of foreign origin. The six types of domestic mica chosen are all included in the Colonial Mica Corporation (a Metal Reserve Company Agency) buying program. The pieces of mica tested weighed nearly 1½ tons. Each of the types have been distributed among capacitor manufacturers to produce specified types of capacitors. After their manufacture has been completed, they will be submitted to the Armed Services for the customary tests.

Unfortunately, the special Bell instruments only test the electrical characteristics. The physical characteristics still must be appraised visually. Some types of mica which showed up well on the electrical test instrument, have had physical defects which made them unsuitable for capacitor use. Such defects included excessive waviness, softness, minute rock inclusions, etc.

The American Society for Testing Materials is also conducting a mica test program. The ASTM is considering tentative specifications to cover natural block mica for use in capacitors. To meet the specifications under consideration, the mica must test satisfactorily on the Bell instruments for power loss and absence of conducting veins or spots. In addition, the mica must meet the various visual and physical standards such as flatness, splitability, hardness, freedom from cracks and pinholes.

Tests for the WPB are being carried out by E. H. Dawson and O. M. Phelps of the Mica-Graphite division, using the facilities of the Colonial Mica Corporation in Asheville, North Carolina.

Howard F. Weirum of the Newport,



Electronic-tube control of milling feed speeds airplane-engine production

How the General Electric thyratron acts as a synchronous switch and a power rectifier

THE Plan-O-Mill is a versatile machine tool for milling external and internal, right and left hand threads and forms. Here you see this equipment cutting threads on aircraft cylinder heads.

The General Electric Thy-mo-trol is standard equipment on the Plan-O-Mill. Thy-mo-trol is an electronic motor control unit that gives separate control of feed-in and feed-around.

It is a General Electric electronic tube, the thyratron, which makes possible the operation of Thy-mo-trol. The thyratron acts as a lightning-fast automatic switch, responding to and correcting load variations so that cutter speed stays constant. It is also a rectifier, converting alternating current into direct current.

Change of gears and sheaves are unnecessary in this motor control operation. Feed changes are automatic, and cutter speed remains constant regardless of variations in load. If the load limit is exceeded, motor control shuts the power off, protecting the feed mechanism.

It is the purpose of the G-E electronic tube engineers to aid any *manufacturer* of electronic devices in the application of tubes. Through nation-wide distribution, G.E. is also prepared to supply *users* of electronic devices with replacement tubes.

FREE BOOKLET ON ELECTRONIC TUBES

We would like to mail you, without charge, an illustrated book entitled "How Electronic Tubes Work," written in easy and understandable language, and showing typical electronic tubes and their applications. Address *Electronics Department, General Electric, Schenectady, N. Y.*

• *Tune in "THE WORLD TODAY" and hear the news direct from the men who see it happen, every evening except Sunday at 6:45 E.W.T. over CBS. On Sunday listen to "The Hour of Charm" at 10 P.M. E.W.T. over NBC.*

GENERAL ELECTRIC

162-B15-8850

THERE IS A G-E ELECTRONIC TUBE FOR EVERY OCCASION

New Hampshire office of Colonial Mica is also conducting a test program of mica. Mica from the southern Black Hills is being forwarded by the Custer, South Dakota office of Colonial Mica to New York, where similar tests are being made.

The mica problem is a difficult one, but American ingenuity appears to be solving it, and in a thorough way!

THE JUNK PILE is the name of a most interesting WERS paper published by the Maryland Council of Defense. Although only four pages in size, the paper contains many paragraphs of important data. For instance, one section is devoted to a materiel listing with notations of such parts as 955's, mica capacitors, 80 rectifiers, etc., that are available. There is also a listing of parts that are needed. Other information included are new licenses issued to WERS units in Maryland, WERS signals, FCC rulings of the month, etc.

This fine paper, although small in size, is big in purpose, and serves as a sterling example of American effort today.

FIBERGLASS HAS CATAPULTED to peak prominence as an insulating material during the past months. Many new plants have been opened to produce this fibrous glass textile. The latest plant to open was purchased by the Defense Plant Corporation, and will be operated under lease to Owens-Corning.

Although it was assumed that the increased production of this material would provide some stock for civilian use, the increased requirements of the Armed Services prevent such distribution at the present time. All of the raw material is going into a variety of objects employed by the Army and Navy.

There is, however, one material that may find its way back into civilian channels—steel. Thus far the WPB has allocated steel for a few civilian items. This allocation was predicated upon the requirements presented by the Office of Civilian Requirements of which Mr. Whiteside is head man. According to officialdom in Washington, there are many surveys in progress to seek methods of providing the civilians with some of the major items using steel. It appears as if there are adequate quantities of secondary grades of iron and steel available for the civilian end uses, but there may be a production bottleneck prompted by the shortage of manpower. Every attempt, however, is being made to adjust this situation so that production can be maintained on an equitable basis.

HERE IS A BELIEVE IT OR NOT. Aluminum and mahogany are being used for a road in Dutch Guiana. This roadway which has been called the "million-dollar highway" is built on a base of mahogany and surfaced with aluminum. It was constructed by United States Army engineers in record time. These two precious materials were employed because in Dutch Guiana, they are the cheapest and most readily available. As a matter of fact, mahogany is one of the most common and durable woods and available just for the cutting. In addition Dutch Guiana has the world's richest deposit of Bauxite which is the ore from which aluminum is obtained.

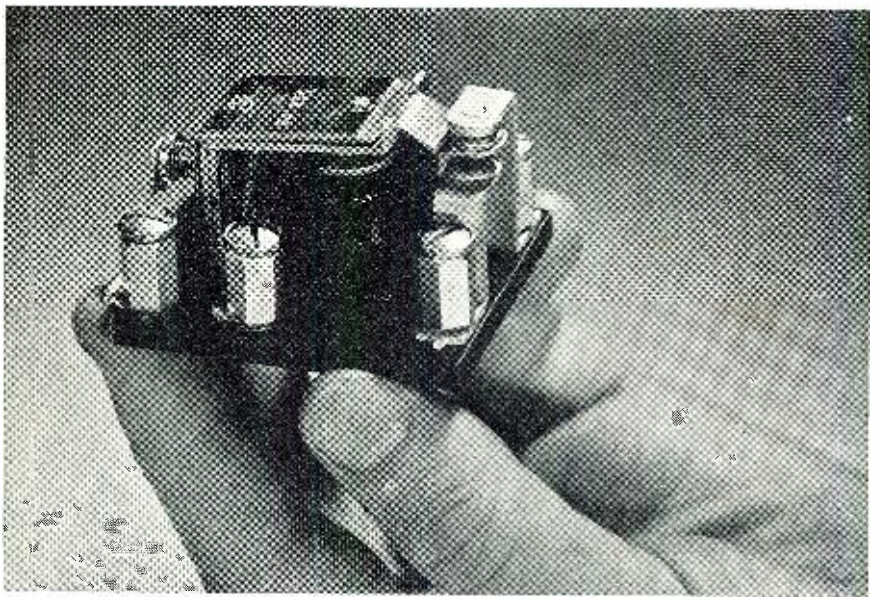
What fine chassis we could make, if we were in Dutch Guiana now.

WITH TELEVISION INTEREST MOUNTING daily, many postwar plans are being made by outstanding specialists. At NBC, a postwar television planning committee has been formulated to study future expansion. The committee consists of John Royal, vice president in charge of television and short waves who is acting as chairman; William S. Hedges, vice president in charge of stations; O. B. Hanson, vice president and chief engineer, and C. L. Menser, vice president and manager of the program department.

Advertising as well as industry experts are holding meetings to discuss the postwar possibilities of television. At a recent meeting in New York, Richard Hubbell of the advertising agency, M. W. Ayer & Company, spoke on advertising and television. Mr. Hubbell is a well known television consultant for many magazines and author of the manuscript, "4000 Years in Television." Appearing at this meeting also, was Arthur Levey, president of Scophony Corporation of America. Mr. Levey discussed large screen television in theaters, schools and homes. He also told of the black and white and natural television that was in the process of development. He pointed out two particular patents which had just been granted to Dr. A. H. Rosenthal, SCA director of research and development. These patents, issued as a part of a group of patents covering the Skiatron system, will provide, according to Mr. Levey, television projection that will be equivalent to that available in our motion picture theaters today. Mr. Levey also described the possibility of television broadcasting on a subscriber basis as a means of solving financing problems. He said that his company had produced a method whereby transmitted pictures are scrambled at the source just as speech is scrambled at the source in transatlantic telephony. Such receivers would be provided with key patterns, he explained, by means of which the received signals would be unscrambled again so that only subscriber receivers would be able to receive a clear and intelligible picture.

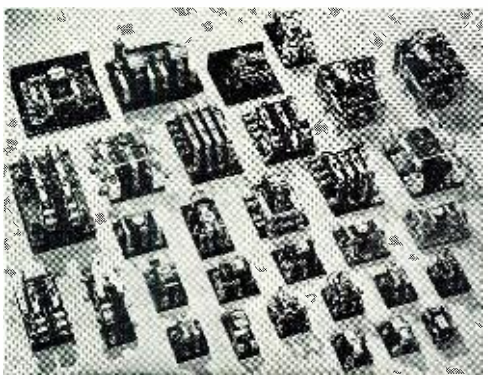
Television has even been responsible for a new kind of consultant . . . a telegenics consultant. The famous girl model agency head, Harry Conover, was recently named to this type of consulting position by WOR. WOR says that Mr. Conover will conduct a series of teletests and will assist in the exploration of the commercial possibilities for television. A special television department has already been organized by Mr. Conover in his agency to train

(*Continued on page* 86)



UST THE RELAY YOU WAN

When you can select the relay that exactly meets your requirements from a regular line, you have saved man power, time and money. WARD LEONARD RELAYS include types and sizes for every application. They all have crisp action, are dependable and durable yet consume but little current. Send for the data bulletins of interest to you.



(WL) Relay Bulletins

Special Bulletins are available describing light, intermediate and heavy duty relays in various contact combinations, high voltage relays, metal and molded base midgets, aircraft power relays, transfer relays, sensitive relays, thermal and motor driven time delay relays, latch-in relays, and various types of radio relays.

NAVY NAVY

WARD LEONARD

RELAYS • RESISTORS • RHEOSTATS

Electric control (WL) devices since 1892.

WARD LEONARD ELECTRIC COMPANY, 47 SOUTH STREET, MOUNT VERNON, NEW YORK

MICROPHONES—*Under Glass*

—We call it the [redacted] room at the plant because that's where we make those very special [redacted] microphones. But this we can say. New techniques in microphone manufacture involve such extreme care that workers operate in dustproof glass enclosed areas which are air conditioned and humidity controlled. Precision made—they are designed to stand up and perform under extremely difficult combat conditions.

ARMY E NAVY

SHURE
MICROPHONES

Shure Brothers, 225 W. Huron St., Chicago

Designers and Manufacturers of Microphones and Acoustic Devices

CASH PRIZE CONTEST!

FOR RADIO MEN IN THE SERVICE!

"Write A Letter"

As you know, the Hallicrafters make SCR-299 Communications trucks. We are proud of our handiwork and proud of the job you men have been doing with them on every battle front.

RULES FOR THE CONTEST

We want letters telling of actual experiences with SCR-299 units. We will give $100.00 for the best such letter received during each of the five months of November, December, January, February and March!

We will send $1.00 for every serious letter received so even if you should not win a big prize your time will not be in vain.

Your letter will be our property, of course, and we have the right to reproduce it in a Hallicrafters advertisement.

Good luck and write as many letters as you wish. V-Mail letters will do.

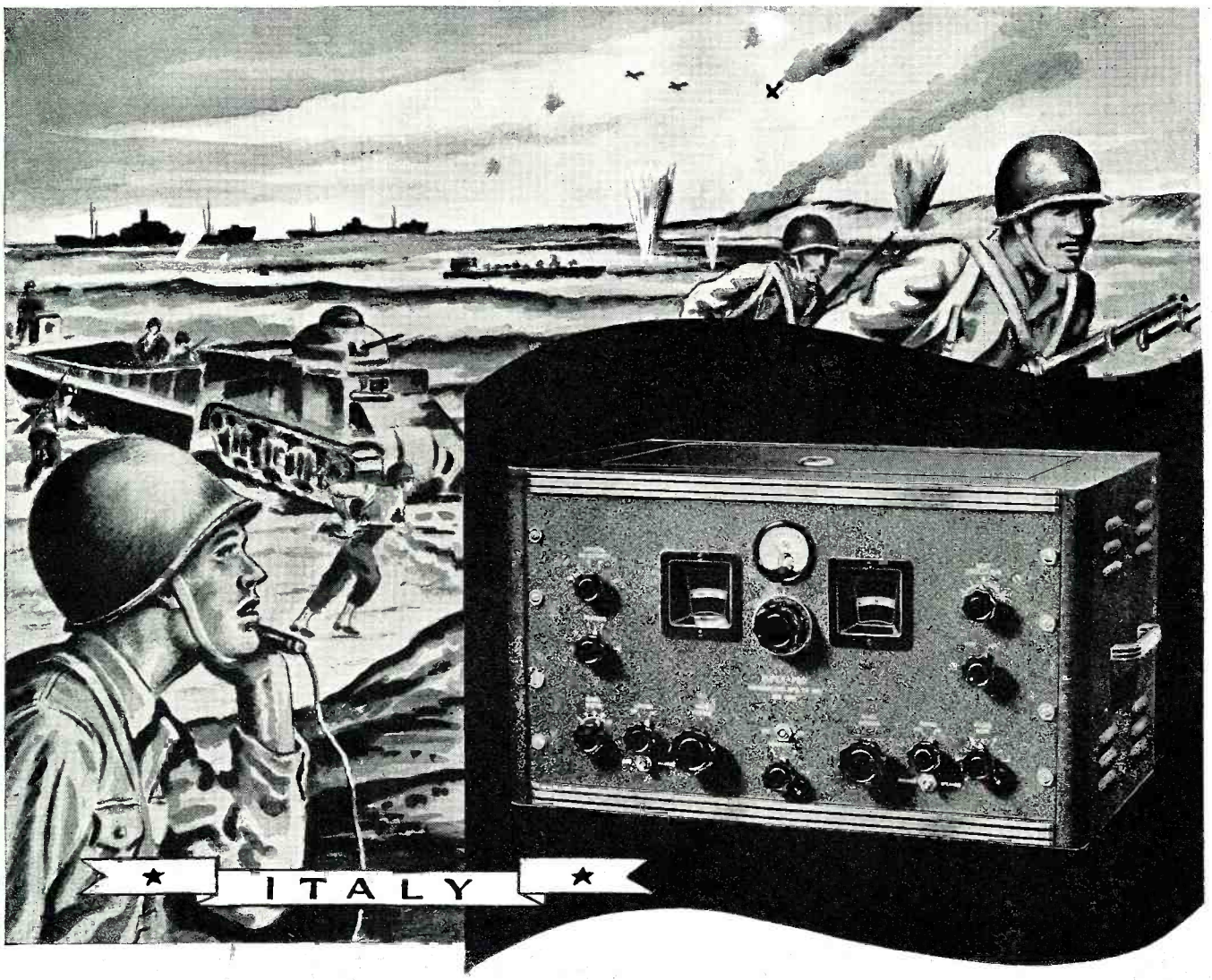
W. J. Halligan

BUY MORE BONDS!

the hallicrafters co.

2611 INDIANA AVENUE, CHICAGO, U.S.A.

MAKERS OF THE FAMOUS SCR-299 COMMUNICATIONS TRUCK



The Fight Begins!

EVERYWHERE Allied forces are on the march—backed by the finest technical equipment available. HAMMARLUND radio receivers are right in there pitching for nothing less than unconditional surrender of the rest of the axis.

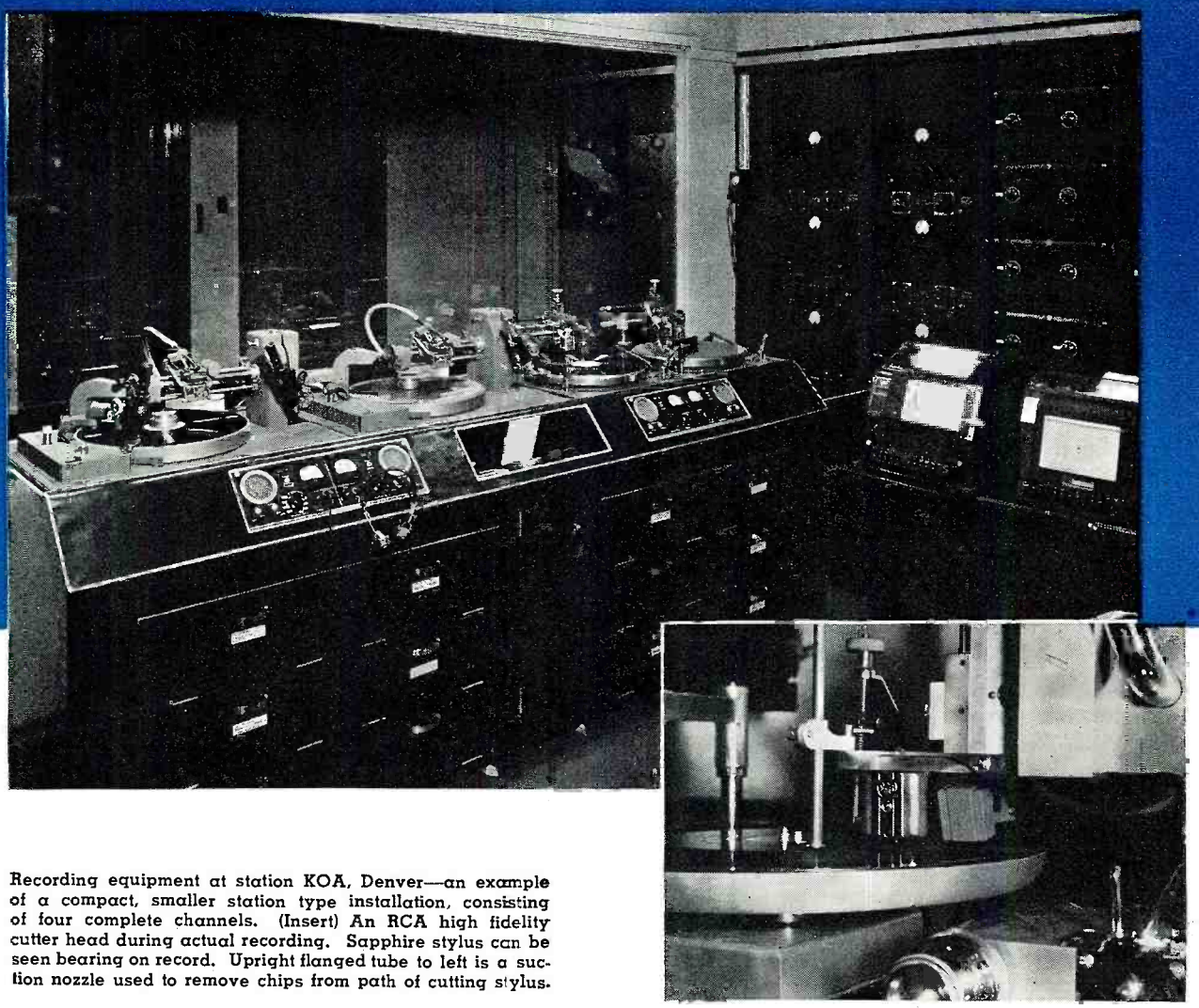
THE SIGN OF QUALITY IN RADIO

THE HAMMARLUND MFG. CO., INC.
460 West 34th Street, New York, N. Y.

HAMMARLUND

TECHNIQUES OF SOUND RECORDING

By FRANK E. BUTLER



Recording equipment at station KOA, Denver—an example of a compact, smaller station type installation, consisting of four complete channels. (Insert) An RCA high fidelity cutter head during actual recording. Sapphire stylus can be seen bearing on record. Upright flanged tube to left is a suction nozzle used to remove chips from path of cutting stylus.

Sound recording techniques and the equipment's versatile application in present day radio broadcasting.

THE association of sound recording in connection with radio broadcasting technique has assumed an importance equal to that of photography and electro-plating employed in printing and by the "press." Memory and integrity in description are human attributes, which unfortunately, are not the most reliable or dependable when accuracy is of vital importance. For this reason, scientific and unemotional records, as provided by modern sound recording, prove to be an adjunct to broadcasting which must be reckoned as of immense, definite value.

However, sound recording has many applications in radio broadcasting beyond that of being a "memory substitute" and its remarkable versatility has made it one of the most valuable and important tools for program production that the progressive broadcaster and engineer possess. One outstanding use of its later adaptations is in so-called "delayed" broadcasts wherein a program, or incident, is recorded at the time and place it is produced . . . or "happens" . . . and then, at a later time, or from one or more other studios, is "played-back" for actual broadcasting or reproduction. For example, an evening program originating and being broadcast from New York City, if it were broadcast simultaneously on the West Coast, would due to the three hours difference in time between these two points, be heard in the late afternoon, at a time when, possibly, the listening peak was at a low point and thus its value would be depreciated, due in no wise to the

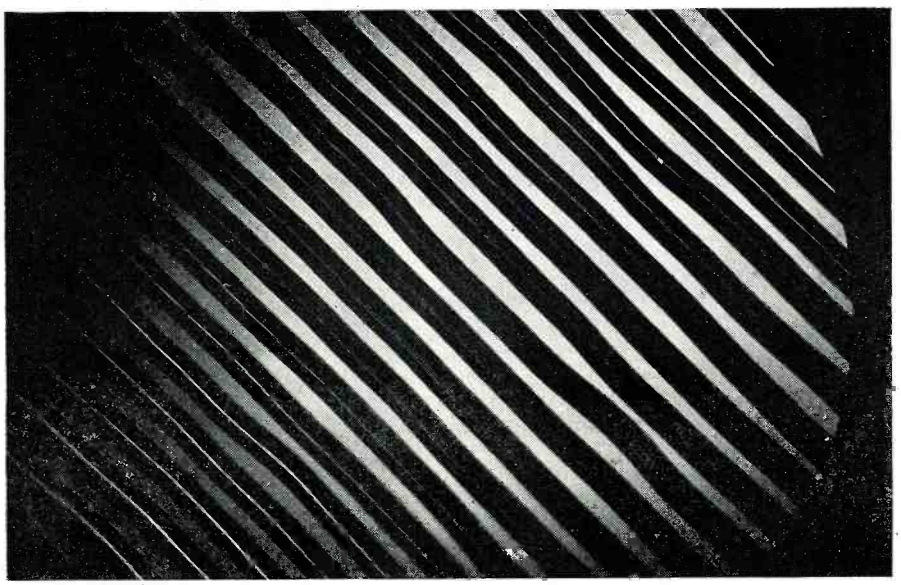
Portions of each of two or three recordings can be "taken off" to be combined as a single program on a new record.

"show" or quality of the subject broadcast. Recording makes it possible to get the substance of a program . . . as it occurs . . . and "spot" it for rebroadcast at a more desirable time.

This feature is also a great convenience and of special value in picking up events of public interest which happen at a remote location outside the broadcasting studios and which occur at times unsuitable for general broadcasting. Such events as ship launchings, airplane maneuvers, horse races and other sporting events come under this classification.

Occasionally, accidents or sudden calamities such as floods, fires or railroad wrecks have been recorded so that eye-witness interviews of the survivors or rescue workers can be obtained in the only way possible, because in such cases, the wire line which would ordinarily have to be installed for remote or field pick-ups could not have possibly been set up in time when moments, not hours are important. Further, in the case of wire line arrangement, the pick-up positions must be determined in advance; hence, the broadcasting program is thereafter limited by this fact. However, portable recording equipment is not so limited; it can be moved from place to place, easily and quickly, at any time as may be required, to follow the interesting or selected phases of action as each develop or are planned. In addition to this, the program material so obtained by sound recording, may be collected generously for later editing or other uses. This gives a finished product which can provide, within the limited time allotted to any single broadcast, a more interesting and concentrated picture of what transpired than could possibly be provided by an instantaneous pick-up or scene flash. These statements do not mean to imply that "recordings" replace the latter practice which will always be employed, but they do provide a most useful adjunct to news gathering of this character.

The light bands are the raised or "land" portions between the grooves. Note wavy paths of traces indicating presence of program material.



Another field of usefulness is that of talent auditions by which recordings are made in advance for presentation before a board of program critics or for the judgment of a prospective client. Entire radio shows are built up and recorded for the same reason. Dress rehearsals of programs in preparation for actual broadcasting are recorded and played back to obtain the accurate, overall effect for sharp criticism and final adjustments. By this means, a particular passage or voice range or musical composition may be repeated as often as may be necessary to arrive at a decision, without depending upon memory.

Many transcriptions are made purely for future reference. Legal requirements often dictate and require the continuous recording of the entire output of certain program material, especially if its substance is anticipated as being of a controversial nature. These are generally made in order to insure an accurate transcript and record of what was actually played or spoken. Outstanding events, both public and private, which may be of historical interest are preserved for the future; copies of the recordings often being presented to the distinguished personages who participated.

Sound effects, as used in radio broadcasting, require reproduction of a surprising range of activities. About half of these are produced mechanically or manually, including such sounds as that of telephone and door bells ringing, pistol shots, door closings, footsteps, etc. However, the illusion of street noises, crowd applause, airplanes in flight, speeding automobiles, animal and insect sounds, etc., are best obtained from recordings of the actual sounds since these prove to be more realistic than imitations.

Much valuable sound effects material is gleaned from actual broadcasts; the desired passages being "spotted off" on separate records, either during the actual broadcast or from a recording of it which has been made for some other purpose. Recorded sound effects produced during a show sometimes require as many as six separate playback turntables to combine a sequence of sounds which occur too close together to permit changing of records or relocating the tone arm if a single turntable was used. On shows where identical passages of this sort are repeated many times, or where a sound effects signature is required, a complicated sound effects is often combined and recorded on a single disc, thus simplifying the operation and insuring a uniform performance.

It is a commonly known fact, that a sound wave, no matter how complicated is its structure, can be correctly pictured and understood by a single wavy line or "trace." Such a plain, one-line drawing is a true representation of the fluctuation, not only of wave motion but of its energy, with respect to time, and it is upon this sim-

ple, yet scientific principle that the art of sound recording is based.

Sound, being a form of mechanical energy, can be made to perform certain functions and thereby can be changed into other forms of force, such as electricity, magnetism, light, etc. These transformations are of primary importance in modern sound recording since they not only provide diverse media, but also because, in the case of transformation into electricity, they furnish electronic means of amplification of sound energy. Thus the relatively small inherent power in the original sound wave becomes of minor importance, since it can be increased to any desired level to compensate for energy losses. Such losses are the result of the transformation process . . . the modification or control of the sound energy . . . or the operation of the actual element.

Prior to the invention of the electrical recording technique, the entire recording process depended upon utilization of the original energy content of the sound wave. This energy, obviously, was of very small magnitude and its conservation was of extreme importance. This was accomplished generally by reducing to a minimum the air path between the sound source and the recording element by the use of horns to concentrate the sound both at the source and at recording apparatus.

In the early days of making musical recordings it was necessary to modify certain band instruments, such as arranging violins with a horn concentrator in the place of the ordinary wind-body resonator. Orchestra assembly required the placement of each instrument in as direct a line and as near to the recording or pick-up horn as possible. Obviously, this was not compatible with normal orchestral practice and was generally inconvenient and unsatisfactory, except with small groups. However, with the advent of electrical recording and the use of electronic amplification, a microphone replaced the horn and the orchestral seating arrangements were returned substantially to normal.

Today, there are several practical methods of recording sound electrically, but the system most widely used is that in which a "trace" of the sound wave is produced in a spiral pattern on the surface of a flat disc. This is the method used in making the familiar records sold for use in home phonographs. Two techniques of producing the "sound-trace" are employed: One is the so-called "lateral" method, in which the profile is produced laterally or parallel to the surface of the record. The other, "vertical recording," in which the "trace" is produced in a vertical plane, the lines having the appearance of a succession of "hills and valleys" (from whence this type derives its name). The former type is in somewhat more common use and is the method referred to in the following description, although the equipment used for both methods is essentially similar, with the exception of the ac-

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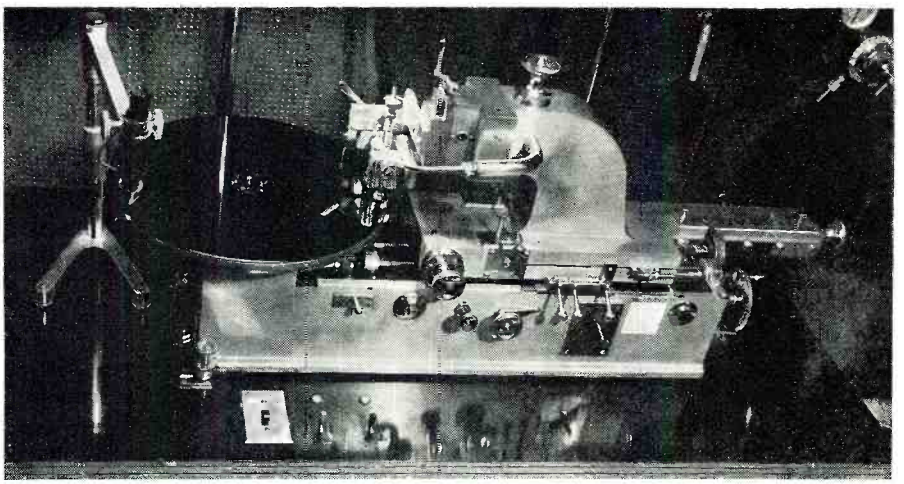
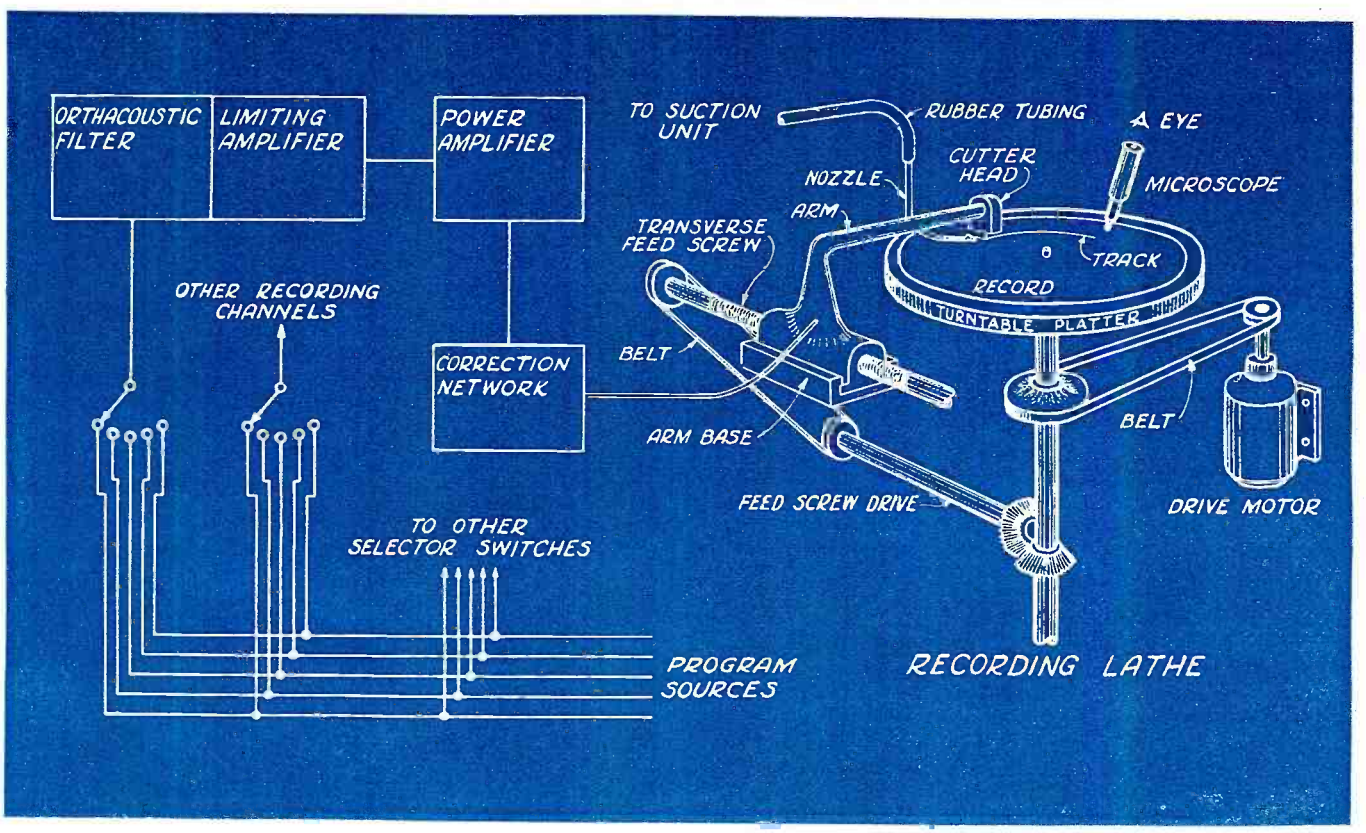


Blank disc shown on turntable with cutter head in position in readiness for recording. Microscope for viewing groove is at left.

An NBC recording channel showing the mechanical arrangement of the recording mechanism.



Electronic Aids in Chemistry

By CLARK E. JACKSON

A survey of the part that electronic equipment is playing in speeding up chemical laboratory operations.

IN the past, it was not uncommon for chemists and electrical men to regard each other with some misgivings. All, but the broadest-minded of them, felt that they were working in totally unrelated fields, and consciously or unconsciously nurtured rivalries. The interdependence of the sciences was not acknowledged.

Today, however, the multitudinous contributions of the one science to the advancement of the other have softened the old animosities. The most insignificant worker in one field is aware of a debt of gratitude to the other.

Modern chemistry has given radionics an imposing number of new, efficient insulating and structural materials, longer-lived batteries, better tubes, and closer control of quality in manufactured products. Radionics, in return, has supplied chemistry with sensitive instruments that perform tests previously entrusted to the vagaries of human faculties, and has opened new vistas for chemical research.

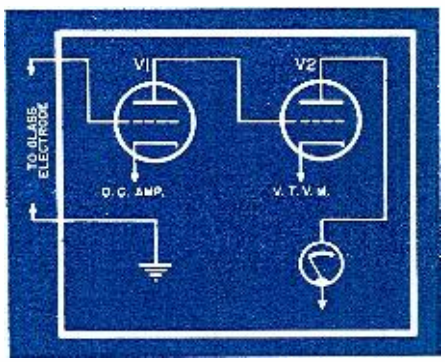


Fig. 1. Fundamental arrangement of pH meter.

The field of application is quite broad. Radionic aids to chemical research are numerous, and it would be impossible to describe all of them in a single article. Representative of the chemical and bio-chemical research fields which have benefited by radionic instruments are: analysis of organic and inorganic materials, including insulations, dyes, paints, foods, and medicines; toxicology; vitamin research; petroleum products development and control; explosives research; virus studies; blood investigation; plastics and ceramics development; and the like. Virtually all of these fields are contributing daily to the war effort.

The radionic engineer will be interested primarily in the circuits and systems employed in chemical laboratory instruments, and in the manner in which this apparatus is employed. It will be the purpose of this article to describe several of these equipments. Being confined to description of a selected number of devices, we will illustrate those pieces of equipment which best typify a specific classification.

Prominent among the instruments given to chemistry by radionic research are pH indicators, gas samplers, meters and bridges for testing dielectric properties, turbidity meters, color comparators, electronic pyrometers, the electron microscope, densitometers, viscosimeters, absorption analyzers, electronic chronographs for recording the progress of chemical reactions, strobotacs for measuring the speed of ultra centrifuges, and radio-frequency oscillators for concentrated heating. Many other devices are under development.

pH Measurements

Electricity has long aided the chemist in pH measurements—determinations of hydrogen ion concentration. The conventional method, in use for some time, employs a laboratory-type precision potentiometer to measure small voltages developed at a special glass electrode in contact with the solution under test. Modern glass electrodes have resistances of several hundred megohms, a property which, in the case of direct measurements, makes immediate demands for a voltmeter with high input resistance.

The electronic d.c. voltmeter preceded by a low-drift d.c. amplifier, as illustrated in Figure 1, provides such a voltmeter for direct measurement of glass-electrode potentials. With sufficient amplification, the instrument may detect voltages as low as a few millivolts. Because of its high input resistance, the meter circuit may be standardized directly against a standard cell without danger to the latter.

In order to maintain the high order of input resistance, leads to the glass electrode are isolated and leave the instrument by way of terminals sheathed in high-quality non-hygroscopic insulation. A glass-enveloped tube with top-cap grid is employed in the V1 position to afford a long grid-ground path, and the glass envelope is coated with Ceresin wax to prevent the formation of moisture films and to maintain a grid-ground resistance in the vicinity of several hundred-thousand megohms. Grid emission in this tube is minimized by operation at filament temperatures lower than normal, and photo-electric emission is prevented by shielding the tube completely from light rays.

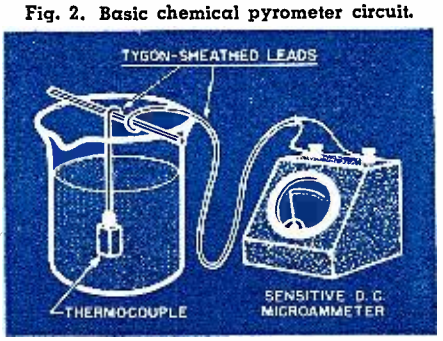
Chemical Pyrometers

In some chemical tests, it is important to determine the actual magnitude of small values of *heat of reaction*. In certain chemical processes, such as those involving heat of oxidation, finite temperature levels, and even temperature increments, frequently are too tiny to be indicated reliably by common thermometers. In still other cases, the chemical reaction is in progress within a closed chamber which must neither be entered nor opened. In each of these instances, the sensitive thermocouple finds immediate application.

Modern thermocouple design enables a number of specialized applications for the measurement of heat in chemical tests. Highly-sensitive vacuum couples are now available which may be lowered directly into chemical solutions. Leads, extended to the indicating apparatus, are enclosed in acid and alkali-resisting sheaths of special materials such as Tygon. When the already high degree of thermocouple sensitivity is found insufficient in a particular application, the addition of a d.c. amplifier will increase the sensitivity.

Figure 2 shows the simplest chemical pyrometer circuit. A glass-enclosed vacuum thermocouple is suspended in the chemical solution or merely placed in contact with it. Tygon-encased leads extend from the couple to a sensitive d.c. microammeter. To prevent further thermoelectric action in the

Fig. 2. Basic chemical pyrometer circuit.



circuit, the leads between components are continuous, having no joints or splices en route.

Heat at the thermocouple gives rise to an electromotive force which deflects the sensitive microammeter. The meter scale may be graduated directly in degrees to give temperature indications.

The sensitivity of the arrangement may be increased several thousand times by interposing a d.c. amplifier between the thermocouple and an electronic d.c. vacuum-tube voltmeter. With this arrangement, room temperature alone is likely to give a considerable deflection of the meter, and an auxiliary bias voltage is introduced at the grid of the voltmeter tube to buck out the residual voltage due to this temperature. When the apparatus is employed at ambient temperatures above or below room temperature, the bias adjustment may be set accordingly.

When a rapid indication of temperature changes throughout the progress of a chemical reaction is not necessary,

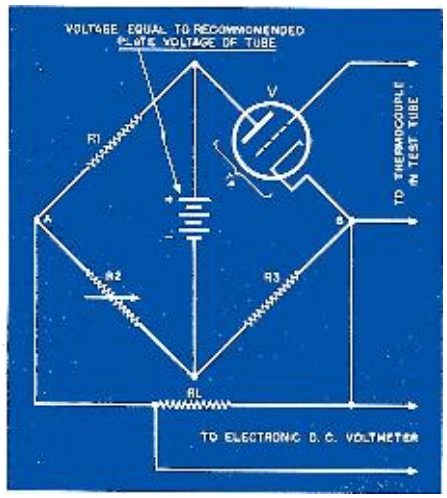


Fig. 3. Bridge circuit for temperature measurements of a chemical reaction. R_L and the indicating voltmeter are sometimes omitted and a sensitive zero-center galvanometer connected between points A and B. The galvanometer scale may then be graduated to show increase and decrease of temperature.

the bridge circuit of Figure 3 occasionally is employed. This is a four-arm resistance bridge in which the plate-cathode circuit of a triode, V, is one arm. Bias to the grid of this tube is supplied by the thermocouple, the plate resistance altering in accordance with this bias. The bridge is balanced, by adjustment of the variable arm, R2, so that no voltage is developed across the load resistor R_L with the thermocouple at normal resting temperature. When the thermocouple temperature alters, the triode plate-cathode resistance shifts and the bridge is unbalanced. A voltage consequently appears across R_L, and may be indicated by a sensitive voltmeter whose scale is graduated in temperature units. If a triode with high transconductance is employed, a small change in thermocouple voltage will produce a relatively large change in plate resistance and the voltage across R_L will be considerable. Thus, small changes in thermocouple temperature will produce large meter deflections.

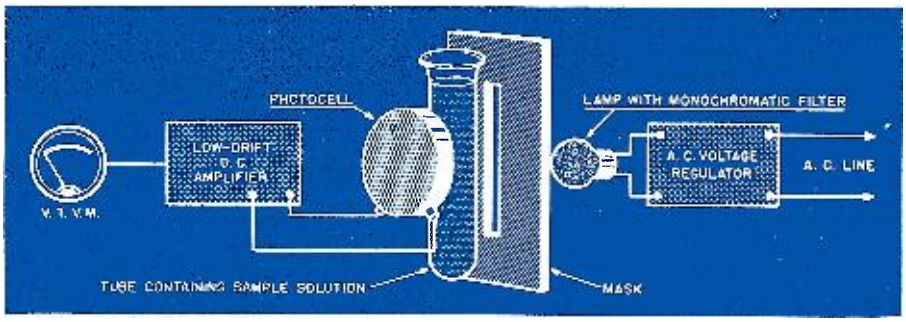


Fig. 4. A photoelectric cell used to measure the turbidity of chemical solutions.

An alternative method of temperature indication makes use of the balancing resistor, R2. If this resistor is reset to balance the bridge at each new thermocouple temperature, its control dial may be graduated directly in degrees. Likewise, a sensitive galvanometer might be employed in the same position as the load resistor R_L.

Turbidity Meter

The turbidity of various chemical solutions may be measured with the aid of a photoelectric cell, as indicated in Figure 4. Light rays are passed through a test tube containing the solution and impinge upon a photocell. Distance between the test tube and the cell is maintained at a fixed value. Turbidity of the solution modifies the light rays reaching the cell, and the indication of the meter, operating from the cell through an amplifier, is altered. By previous calibration, the meter scale may be made to read in arbitrary units of turbidity.

Research laboratories state that quantitative turbidity indications may be obtained by means of photoelectric equipment with a degree of accuracy and dependability far exceeding that of the human eye. By employing suitable color filters and calibrating meter shunts, the circuit might also be employed as a color comparator so that the color of the chemical solution may be evaluated together with its turbidity.

Dielectric Constant Meter

Insulating solutions, such as oils and melted waxes, and non-aqueous solutions of certain non-electrolytes, are subjected to various dielectric tests in order to determine quality and characteristics. Measurement of dielectric constant is one of these tests.

The standard method of checking dielectric constant of these materials consists of measuring the capacitance of a fixed air capacitor—first in air—and then immersed entirely in the test solution. The dielectric constant is then the ratio of the "solution capacitance" to the "air capacitance." The standard "cell," in which this operation is performed, is occasionally varied in design, taking the form of a glass container for the air capacitor. The capacitance is checked either at 1000 cycles-per-second by means of a bridge or at radio frequency by means of an oscillator. The cell is then filled with the test solution and the capacitance remeasured.

A simple cell (See Figure 5) consists of a glass beaker in which the fixed air capacitor is placed for measurement with and without the solution. In Figure 5, connections are shown to a radio-frequency oscillator. This is a variable-frequency unit, and the test cell is connected directly across the tank circuit. The control dial of the tank capacitor is graduated directly in micromicrofarads. The variable oscillator feeds into a mixer stage, as does also a fixed-frequency oscillator (generally operating with crystal control).

In the initial adjustment, the test cell is completely disconnected from the oscillator. The variable oscillator is then set to zero beat with the fixed oscillator. The tuning capacitor dial reading at this point is recorded as C1. The empty test cell is then connected and the variable oscillator again adjusted to zero beat, calling the second dial reading C2. The difference be-

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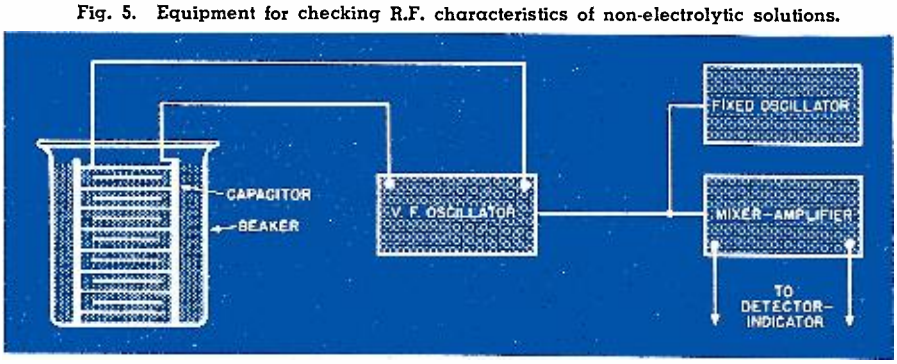
Fig. 5. Equipment for checking R.F. characteristics of non-electrolytic solutions.



THE SAGA OF THE VACUUM TUBE

by **GERALD F. J. TYNE**
Research Engineer, N. Y.

Part 8. Covering the period during which the elements of the triode tube were redesigned to obtain increased performance.

WHILE Fleming was working in England and the de Forest Audion was being put into use in the United States, important work in electronic research was being done in Continental Europe. To go back a little, in 1895 Roentgen announced the discovery of the mysterious penetrating rays which, because their properties were not at that time understood, were called *"X" rays.* As was to be expected, this announcement sent the European savants off into new fields of exploration. One of the earliest finds was that by Becquerel of the radioactivity of uranium, whose rays, like X-rays, produced electric conductivity in air and other gases by ionization.

The earliest of the discoveries in the field of thermionic rectifiers, those of Arthur Wehnelt, have already been discussed and will not be repeated.

At the time Fleming and de Forest were laying the foundations of the great tube art in connection with their work on wireless detectors, von Lieben in Vienna was working on the problem of the telephone relay or amplifier.

Robert von Lieben, the son of wealthy parents, was born in Vienna in 1878. Although he grew up in intellectual surroundings he always disliked formal education, and preferred to educate himself in his own way. Very early in life he showed an aptitude for scientific investigation. At that time electrical engineering was a promising field and it beckoned to von Lieben. He learned the practical phase of this work in the Siemens-Schuckert works in Nuremberg, and then went to the University of Goettingen for physical and chemical research, under the renowned chemist, Nernst.

Returning from Goettingen in 1903 von Lieben set up his own physical laboratory in his parental home. During the years 1905-1910 he developed the *"amplifying relay"* with which his name is associated. With the aid of his father he purchased a telephone factory in Olmutz (Moravia). This concern brought him into association with Eugen Reisz. Von Lieben was much intrigued with the idea of producing a telephone relay. His former professor, Nernst, said of him "No problem impressed him so much as the construction of the telephone relay, or more commonly expressed, a device which is capable of amplifying without distortion small changes in electrical currents".[143]

In his Vienna laboratory in 1905 von Lieben checked Wehnelt's experiments with the oxide-coated cathode, and remembering the cathode-ray beam ar-

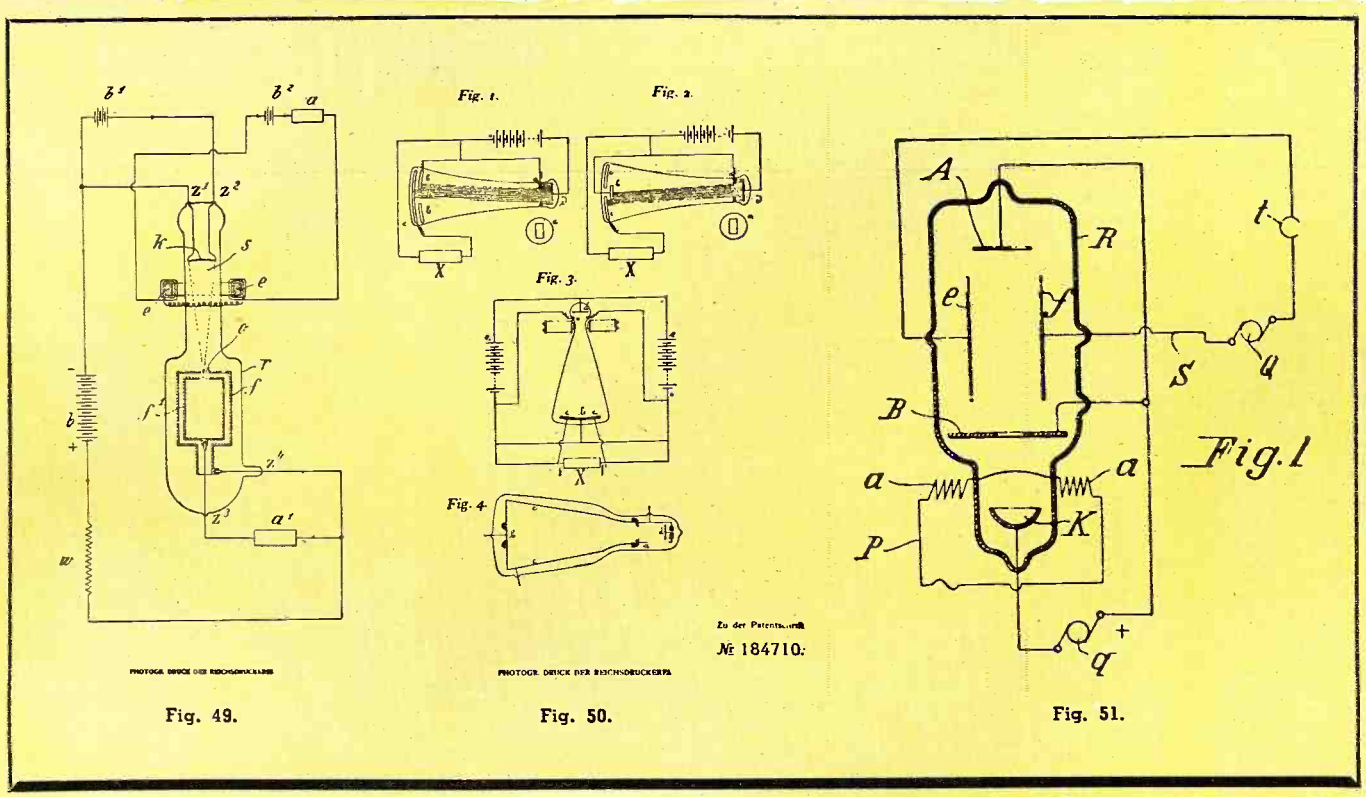


Fig. 49. Fig. 50. Fig. 51.

rangement used by Braun* in 1897,[144] hit upon the idea of constructing a telephone relay using this combination. He started by controlling the rays magnetically, although electrostatic control of the cathode-ray beam was known at that time. His work soon produced results, and on March 4, 1906 he applied for a German patent[145] on a device which he called a "Cathode Ray Relay." The object of the invention was to enable current variations of small energy at the input terminals to release current variations of greater energy at the output terminals, with frequency and waveform corresponding to that of the input. The patent states that the device is particularly suited to telephone applications such as "relaying of speech to great distance, cable telegraphy, wireless telephony, strengthening of speech, etc."

The diagram given in the patent is shown in Figure 49. It shows magnetic control of the cathode rays, but the patent states that either electromagnetic or electrostatic control may be used.

In this tube, which was described as *"highly evacuated,"* von Lieben used a cathode which was in the form of a hollow mirror, covered with calcium oxide. This cathode was described as being heated by the battery "b¹". The hollow mirror focused the cathode rays on the inner of two concentric cylindrical anodes "f" and "f¹", through the aperture "o". The focus of the rays was altered by the input current flowing in the magnetic field coils "e", which caused more or less of the cathode rays to impinge upon the inner cylinder and thus vary the inner anode current, which also flowed through the load device "a¹". The battery "b" provided the energy in the anode circuit.

Even before this von Lieben patent was published two other men, Max Dieckmann and Gustav Glage of Strasburg, applied on October 10, 1906, for a patent[146] on another type of cathode ray relay which they claimed was capable of giving an output absolutely proportional to the input. In their patent application reference was made to the von Lieben arrangement.

Several possible structures were shown in the diagrams forming a part of the Dieckmann and Glage patent. These diagrams are reproduced in Figure 50. The cathode was a plane and said to be "conveniently treated in order to facilitate the emission of electrons," and the aperture in the diagram "a" was used to obtain a "sharply defined bundle of cathode rays of comparatively large, preferably rectangular cross-section." The axes of the deflecting coils were placed at right angles to the direction of flow of the cathode rays, unlike the von Lieben arrangement in which the magnetic field was parallel to the cathode-ray beam. The magnetic field in the Dieckmann and Glage device acted to deflect the cathode-ray beam from side to side, instead of altering the focus, as von Lieben's did. By means of this deflection more or less of the beam could be caused to fall on the center or side plates, and the currents in the individual anode circuits could thus be modulated.

This relay had the elements of the modern "electron gun" and the configuration shown in the middle figure was even capable of "push-pull" operation, provided the proper auxiliary apparatus was used at "X". The patent also states that the longer the distance from the diaphragm to the screen the greater would be the sensitivity, but that the shorter the distance the lower the operating voltage required. The structure shown in the bottom figure of the patent was given to illustrate how the electrodes might be arranged so as to keep the electron path free from the influence of interfering phenomena. Hence the device may also be said to be self-shielded. Whether the electron emission was obtained by heating the cathode or not is not stated.

About the same time (1908) Otto von Baeyer of the University of Berlin described[147] a three-electrode tube consisting of a central filamentary cathode rendered incandescent by a

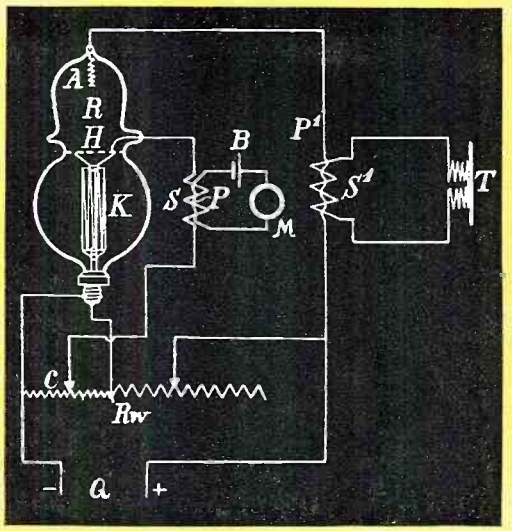


Fig. 52.

Fig. 53.

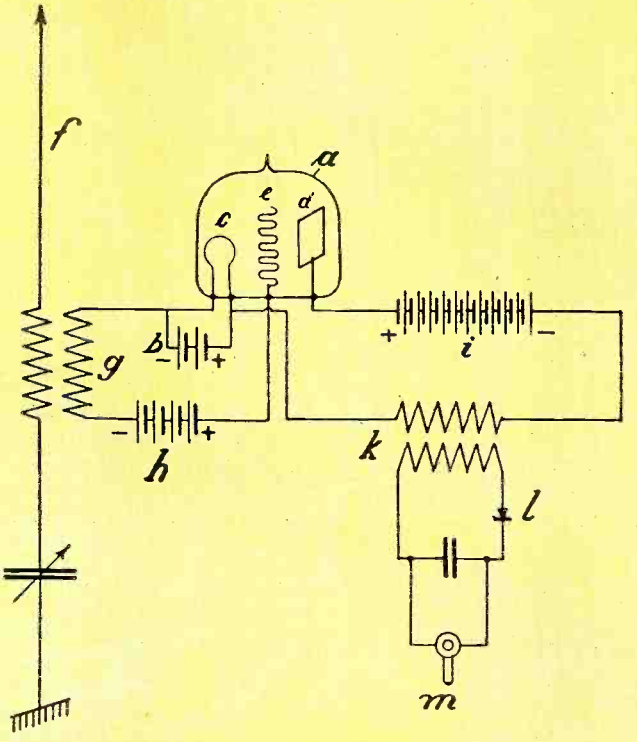


Fig. 54.

* *This Braun tube was the first embodiment of the cathode-ray oscillograph tube, the development of which will be the subject of a subsequent article.*

battery, surrounded by a cylinder of wire gauze, which in turn was surrounded by a cylindrical sheet metal anode. The whole was contained in a cylindrical glass tube which was partially evacuated, to a pressure of about 0.01 mm. mercury. This structure resembled that of some of the triodes which were still years in the future. Von Baeyer used this device to measure the ionization produced by cathode rays emitted from the filament. For this work the inner gauze cylinder was operated at a potential positive to the cathode and the outer cylinder at a potential negative to the cathode, in order to collect on the outer electrode the positive ions produced by the cathode rays in their passage through the space between the gauze electrode and the outer cylinder. Had the potentials been reversed the tube would have been an amplifier.

In the meantime von Lieben continued to strive for a better telephone relay. He was hindered in this work by extensive illness. While serving his year of military duty he had been catapulted from a horse onto a wooden fence, sustaining injuries to his chest. This later resulted in a glandular abscess which eventually brought about his death in 1913, at the early age of 35.

Reisz did most of the later development work on the cathode-ray relay, although several important details of later designs[148] are due to von Lieben, who was very active despite the severe pain due to his physical condition. Later these two were joined by Sigmund Strauss, and subsequent German patents on the cathode-ray relay were issued to all three jointly.

The next development of von Lieben, Reisz, and Strauss is covered by German patent D.R.P. 236716[149], which bears the application date of September 4, 1910. The diagram of this patent is reproduced in Figure 51. It will be noted that the structure bears much resemblance to that disclosed by Dieckmann and Glage in the patent previously discussed. The current to be amplified flows through the coils "a" and the magnetic field thus set up acts on the cathode ray stream. This is described as causing changes in the ionization of the attenuated gas in the open space between the plates "e" and "f". The diaphragm "B" is used to screen the cathode rays in such a way as to prevent their striking the plates "e" and "f". The load device is shown as a telephone in the circuit composed of the generator "Q", telephone "t", plates "e" and "f", and the ionized space between the plates. Note that the hollow mirror type of cathode is still retained. No method of heating the cathode is shown, but the patent specification states that:

"The material used and the temperature of the cathode "K", as well as that of the gas in the discharge tube are so chosen that, with comparatively small potential difference, emission of the cathode stream results."

Note also that the inventors have abandoned the "high vacuum" referred to in the previous patent, and now speak of ionization of the attenuated gas.

"The difficulty of producing the hollow mirror cathode, the non-uniform emission of the cathode rays from the glowing oxide, and particularly the difficulty of maintaining a constant vacuum in the discharge tube were the main reasons" which motivated further development of the 1906 device[148]. From D.R.P. No. 236716 described above it will be seen that the difficulties related to the "high vacuum" were overcome by the utilization of the ionization of a rarefied gas instead of depending on pure thermionic emission.

The next patent issued to these inventors was German patent D.R.P. No. 249142[150]. It bears the application date of December 20, 1910, and is described as a supplement to D.R.P. No. 236716. In this specification, reference is made to the work of de Forest and his use of an "auxiliary cathode" in the form of a sieve or grid. Concerning de Forest's device the statement is made that "the currents to be magnified were led through the cathode and said electrode (grid or sieve)".

This statement would seem to indicate that von Lieben and his associates recognized the Audion structure to be an amplifier, even though de Forest himself had been unable to make it perform this function.

The invention, referred to in this patent, (D.R.P. No. 249142) is described as a modification of the one shown in the previous patent (D.R.P. No. 236716). The modification consisted of the use of electrostatic control by means of an auxiliary electrode to produce the variations in the amplified current, instead of using the variable ionization previously obtained by electromagnetically bending the cathode-ray stream. This auxiliary electrode is described as a "grid, grating, or mesh" so constructed that it "perfectly divides the cathode space from that of the anode". See Figure 52. The effect of this auxiliary electrode is said to be that of modifying the resistance of the space between the cathode and the anode. This results in variations of the anode current corresponding to changes in the resistance of the space.

It will be observed that there is provided, in the potentiometer "c" a means of adjusting the steady state potential of the grid. Concerning this adjustment the patent says:

"The adjustable potential thus brought to bear on H, has been found to be of the greatest importance in the successful operation of the relay, because a proportional variation of resistance of the gas discharge tube happens only at a certain definite value of potential difference, and this depends on the gas pressure and temperature of the cathode, etc."

Figure 53 shows a von Lieben tube of this type, made in 1911.

The diagrams show, in all but one case, a ribbon cathode looped back and forth in the manner of an incandescent lamp filament of that time. This ribbon is oxide-coated, and is heated by a battery. In one suggested form, not shown in Figure 52, the hollow mirror cathode and external magnetic control are retained.

Mention has been made above of the reference in this patent specification to the work of de Forest, and the recognition by von Lieben of the potential

(*Continued on page* 58)

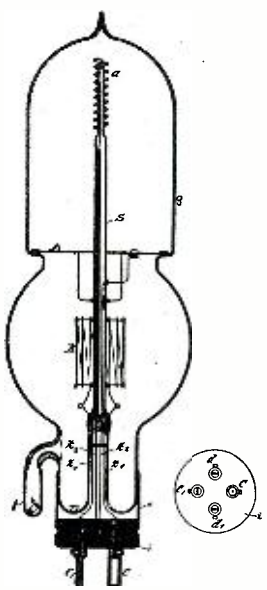


Fig. 55.

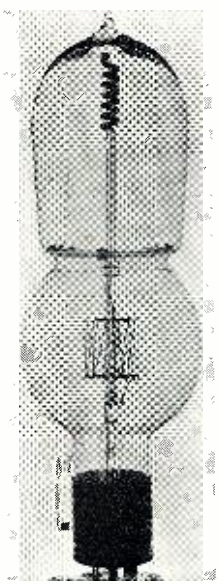


Fig. 56.

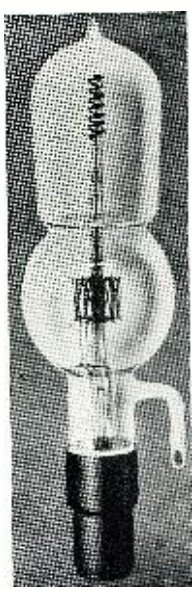


Fig. 57.

RADIO IN WARFARE

By LESLIE W. ORTON
Technician, London, England

Radio—in the development of secret military weapons and how shortly after their use other equipment destroys their destructive powers.

WHEN discussing the uses to which radio may be employed in warfare, the layman is inclined to consider that a nation which could control machinery and other apparatus by radio would have a whip hand over any adversary. The author intends to prove in this article, that such would not be the case.

Hitler's Secrets

Doubtlessly you have heard of the secret weapons with which Hitler has proposed, from time to time, to gain his ends. Whilst their operation remained a secret, some of these inventions were definitely disconcerting. Two instances which may be recalled are the magnetic and acoustic mines.

The former, you may remember, was used shortly after the outbreak of war. Its mechanism comprised magnetic apparatus which reacted when the mine neared an area of metal such as that provided by the sides of a ship.

When first used the magnetic mine resulted in the loss of a great many ships, but it was not long before one of the mines was captured and dissected. The secret of its operation then being exposed, it was only a short time before an antidote was found and put into operation. The result? The magnetic mine lost much of its terror.

The acoustic mine, as its name implies, was set into operation by the sounds of approaching ships. It also resulted in shipping losses before its secrets were discovered.

And so it is with everything. A secret weapon may be invented. For a time its employment may prove disconcerting, but fortunately the time between the use of such a weapon and the discovery of how it functions is generally very short. It is then only a matter of time before apparatus is evolved and constructed to render its use of little value.

Raids by Radio Controlled Aircraft

As long ago as 1924, experiments were conducted in America and elsewhere to discover the possibilities of using apparatus which was directed and controlled by radio.

It was found that it was possible to control aircraft by radio, no pilot being present in the machine. In Britain a special aeroplane described as the "Queen Bee" was constructed and used as a target by the Royal Air Force and Navy. It was controlled by radio.

The public reaction to the knowledge that aircraft could be so controlled was interesting. Fanned by enthusiastic journalists, many of whom preferred to see the sensational and ignore the common sense side of the invention, they were led to believe that it would be possible for a belligerent to send a fleet of bombers, completely unmanned, over an enemy city, to shower bombs upon that city and to return to their base with comparatively little loss.

Now let us take a look at realities. As far as the operation described above is concerned, the fleet could do everything suggested if and it is a very big "if"—the country to be raided took no action to prevent it.

Such a fleet as that described would have to be controlled by operators sitting at switchboards at a specially constructed station perhaps hundreds of miles away. If the fleet were endangered by fighter aircraft, the operators would be unaware of the fact and as a result the raiders would be practically defenseless and extremely vulnerable to attack. The consequence might well be that not one of the machines comprising the fleet would return to its base.

But let us assume that the danger of the fleet being attacked is not present. The bombers might operate at an altitude too great to be reached by

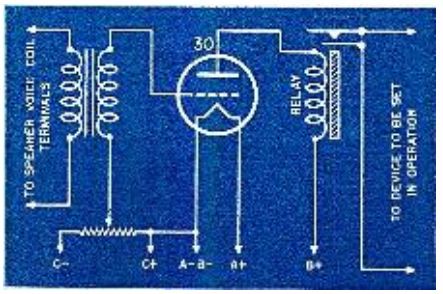


Fig. 1. Radio control of external circuits.

fighter aircraft. What then would be the situation?

Before answering that question, it might be well to give you some idea as to how aeroplanes are controlled by radio.

Some years ago there was a craze for opening buildings thousands of miles away by radio. Perhaps you remember some of the instances. In America an important official gave an opening speech, pressed a button and switched on the lights of a great building thousands of miles away.

This was done by the employment of sensitive relays at the receiving end. When the official pressed the button a sharp impulse was received, and this tripped the relay which actuated a master switch, resulting in the lights being turned on.

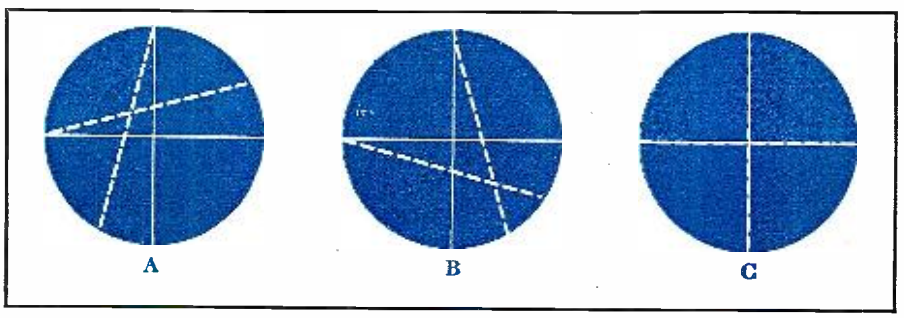
Now, it is obvious that the switch which turned the lights on (and was actuated by radio) might equally as well have switched on machinery actuating lathes, etc., resulting, it might be, in the machinery of a whole factory working.

In other words, what the radio impulse does depends upon the apparatus attached to the circuit set in operation by the relay. Thus, sound transmitted by radio can readily cause an aeroplane engine to start up, to vary its speed, etc. Impulses can also operate the elevators, the rudder and bomb release mechanism, etc.

Such a procedure might be carried out by actuating various parts of the aeroplane by sending different sets of noises, or wave-lengths.

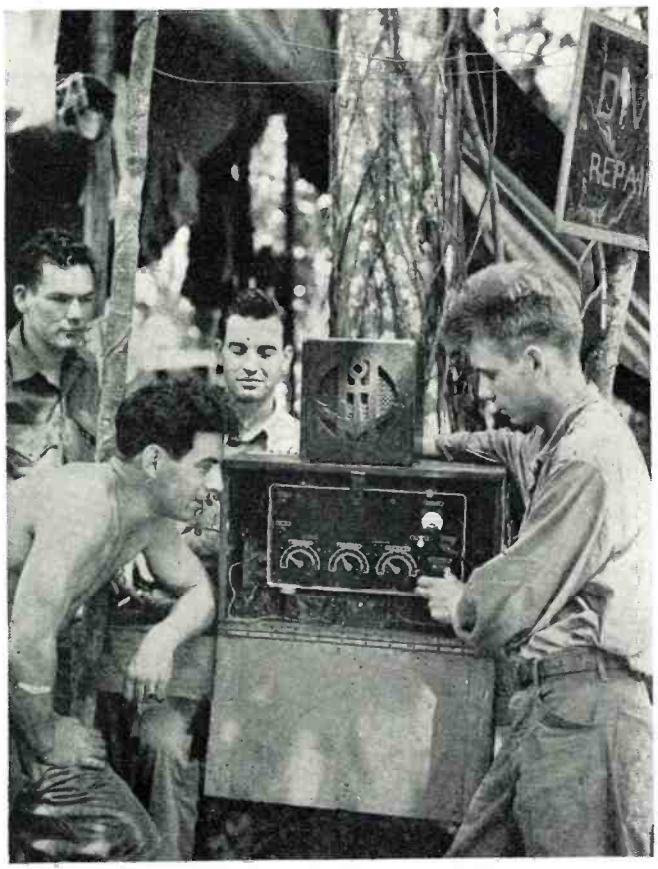
(*Continued on page* 76)

Fig. 2. Illustrating the azimuth principle of blind landings.



The interior of a traffic control tower atop airfield of an advance bomber base in Algeria close to the Tunisian border.

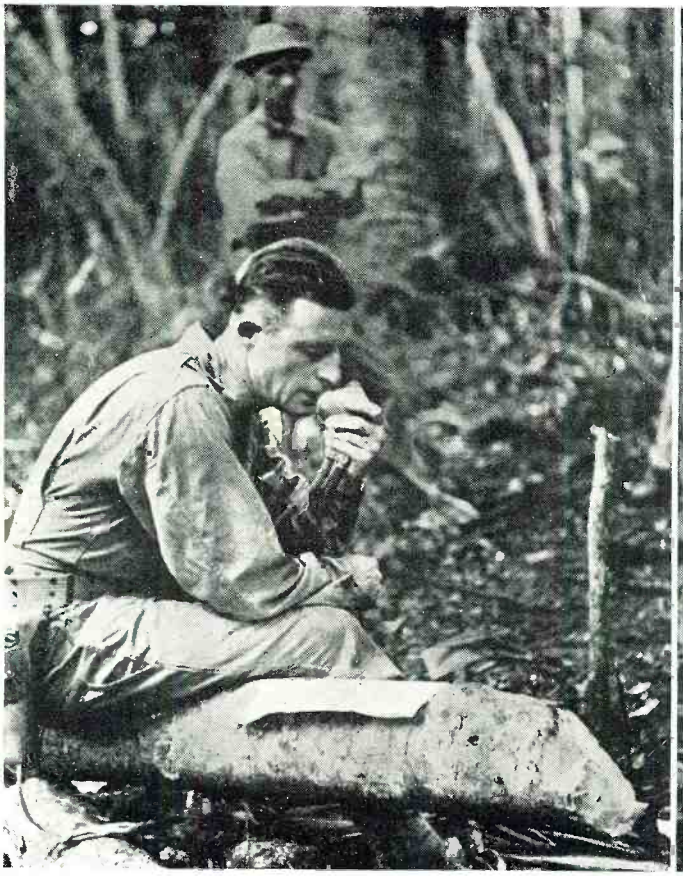
Life raft is equipped with kite antenna and automatic SOS transmitter which provides means of locating lost pilot.



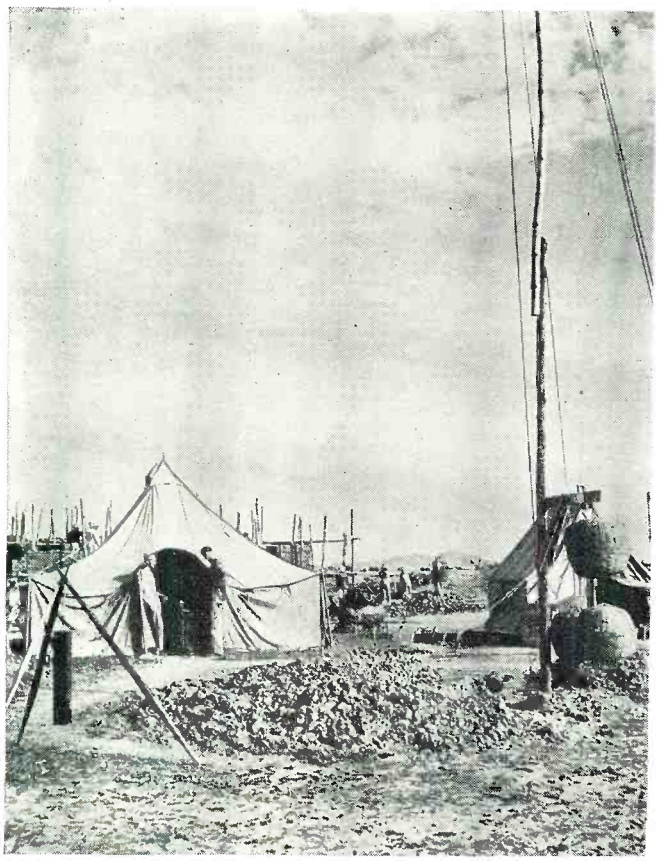
This Japanese radio on Guadalcanal is finally doing its "bit." entertaining the boys with news and music from the U. S. A.

WAR FRONT PHOTOS

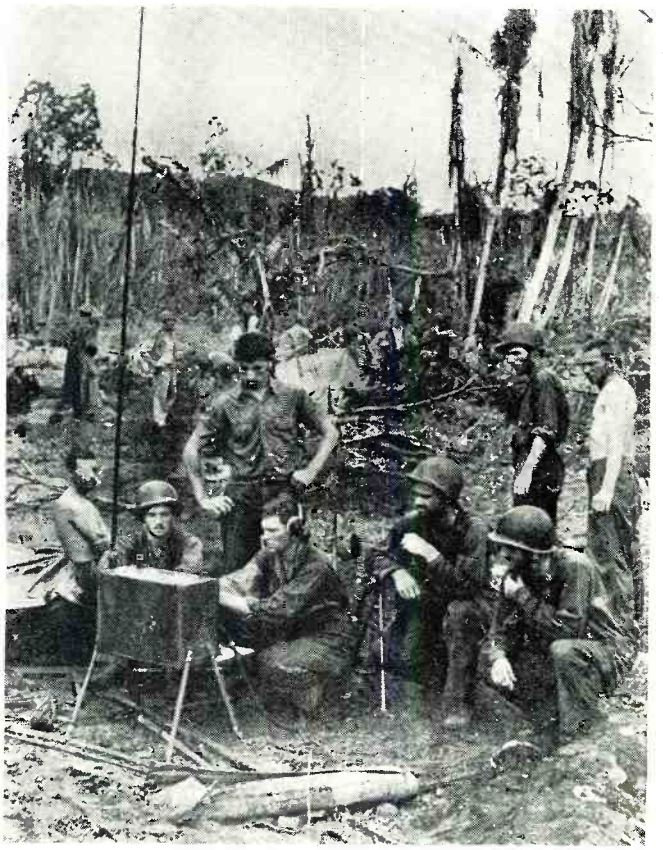
RADIO has gone to war. In almost every phase of life at the front the soldier utilizes his sending and receiving equipment. Propaganda messages are broadcast to the enemy. Moments of relaxation are obtained by inter-unit broadcasting, and that void feeling, "homesickness," is relieved by listening to news from the U. S. Important battle orders are communicated to isolated groups from headquarters. The man in the life raft is no longer entirely lost in a vast sea—he has his transmitter for contacting the outside world. Thus communications equipment has literally brought all of the battle fronts close together, and erased most of the barriers of space.



With microphone and loud speaker, in the steaming jungles of Guadalcanal, the Yanks called to the Japs—"Surrender or be killed!" This method of communication, with its increased audio volume, has great value in demoralizing enemy troops.



Radio repairmen in front of their repair depot, rather crude yet functionable, at a U. S. air base in India.

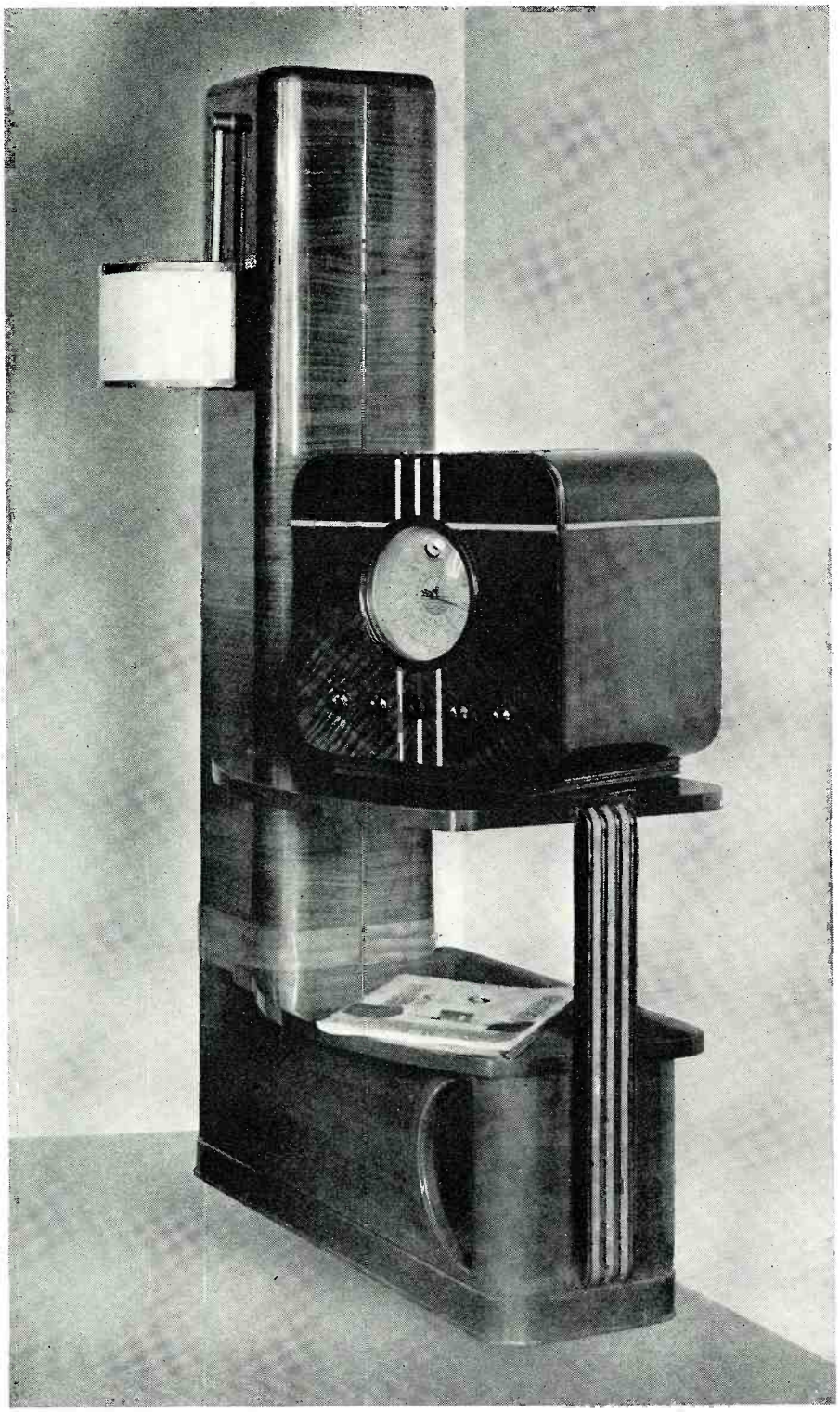


Jungle-hardened U. S. fighting men on Guadalcanal around communications receiver, awaiting further orders.

UNIQUE SOUND REPRODUCERS

by WILLIAM H. HUTTER

Sound reproducers, artistically designed for home use and constructed to produce utmost clarity and brilliance.



FROM many years spent in laboratories where efforts were constantly being made to find better methods of sound reproduction with the invariable result that newer instruments always fell into preconceived patterns, the author determined to start afresh and scientifically design a reproducer that would give tone and voice unheard of breadth, clarity and brilliance.

Without going into the many technical limitations that now beset radios and phonographs and other listening devices commonly used in the home, let us look into the radio speaker, where even a superficial examination reveals obvious shortcomings. The speaker is usually set underneath or beside the chassis in the cabinet some twelve to eighteen inches off the floor. When sound emanates from the speaker it is directional to the extent that it strikes the floor where to a large measure it is absorbed by the carpet.

Secondly, all notes emerge from the conal center of the speaker with no mechanical provision being made for variance, with the possible and inadequate exception of toy lifts labeled "Bass," "Treble," or "music," which do not in the slightest enhance the acoustic value. Thus, highs and lows are blended into a mumbo-jumbo of ear shattering unpleasantness.

Even if these were the only reasons for attempting to devise newer and better sound receivers, the author was convinced that they were motive enough. Keeping this in mind, the sound resonators that are to be described were developed.

The following aims were set up and achieved. They are: that the acoustic apparatus be suitable for use in conjunction with a radio set or any other suitable source for delivering energy to be converted into sound; that the acoustic or sound emitting unit may be attached to or be an integral part of the radio cabinet; or it can be constructed as one or more separate units, to be placed in desired locations and operated and controlled from the remotely located radio set; that the sound be diffused or distributed instead of being projected in one or more

High fidelity reproducer with speaker mounted at top of column. The high frequencies are projected towards the ceiling while the lower frequencies are emitted through the opening at the bottom

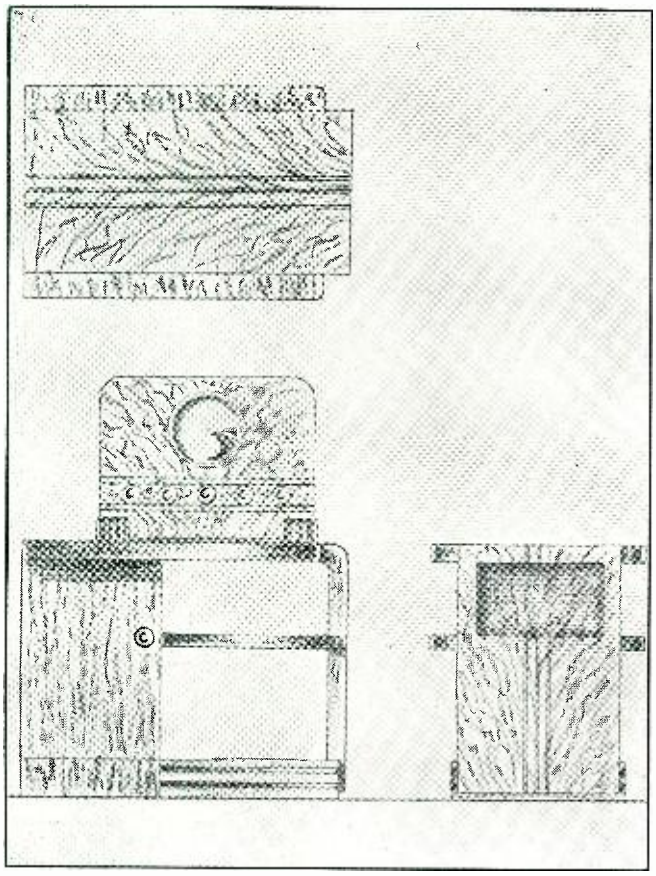
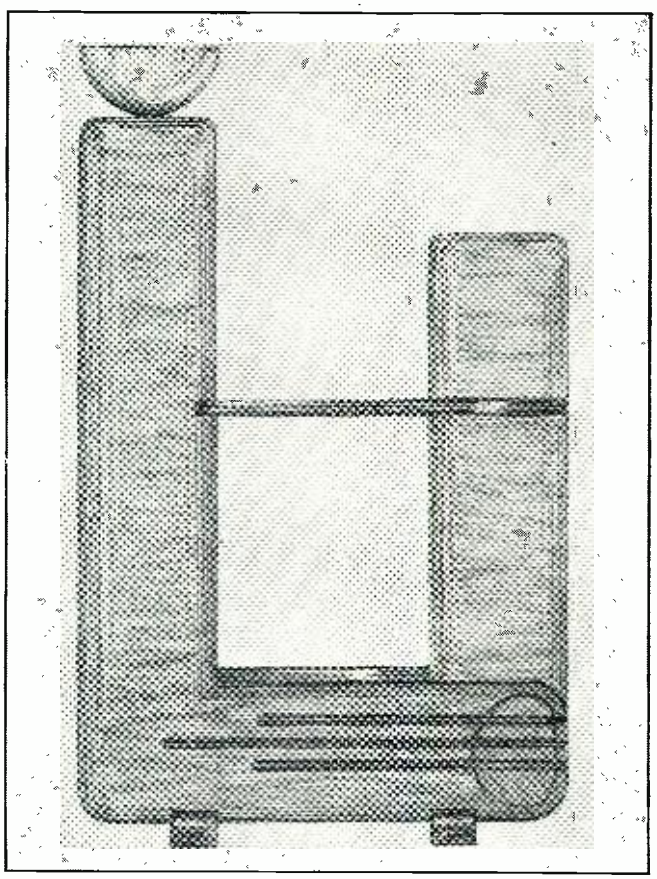


Table style reproducer with speaker mounted inside compartment.



Dual resonators with each column tuned to a different frequency.

definite directions; the quality and fullness of tone be infinitely improved; and in general, to provide novel acoustic apparatus adapted to resonate over substantially the entire audible frequency range, and to respond with fidelity to the sound vibrations from such converters as loud speakers.

The figures shown on these pages are illustrative of the flexibility of design that these acoustic units lend themselves to. Figures 1. and 2. are essentially rectangular in shape with speakers placed at the center and low. They can be mounted, as shown in figure 4 on any sound reproducing unit whether it be a radio, phonograph or combination of both. It, however, must be remembered that where more than one speaker is employed on a single reproducing unit, they must be arranged in the proper phase relation.

Fig. 1.

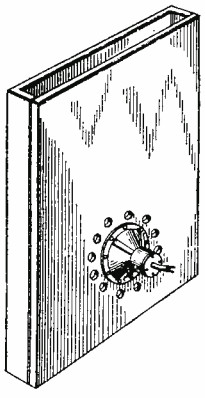


Fig. 2

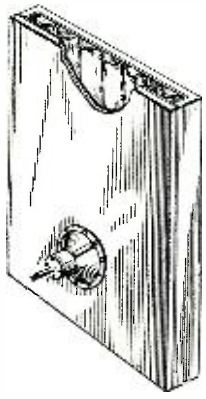


Figure 5 is illustrative of the multiple column where a battery of speakers are used. This is suggested where it is desired to resonate sound at various or different frequencies to better amplify and improve the tone quality. The particular shape of the columns is of no consequence. But it is very important that the resonance features of each column approximate those of the associated speaker.

Fig. 3.

Figures 1 and 2 may take a general rectangular shape and serve as front and back, top and bottom, opposite sides or walls of the radio. Figures 3, 5 and 7 can be separated from and even remotely placed in respect to the source of sound and be substantially tubular in shape.

Turning to figures 1, 2 and 4, one loud speaker may be selected which is responsive to relatively high frequencies while the other would be tuned to low frequencies. The former would be mounted near an end of the side wall of the receiver as shown in Fig. 4 and the latter near the end of the other side wall. The side, which has the high-frequency speaker mounted upon it, is provided with a plurality of apertures about the periphery of the speaker in order to eliminate sounds of low frequency and to establish an equilibrium of air pressure at opposite sides of the speaker. (A-Fig. 4.)

Now to the side wall carrying the high-frequency loud speaker, attach a channel of a suitable sounding board material, preferably ½" thick, such as straight grain spruce, provided with a sound insulating *gasket* of rubber or felt between the wood channel and speaker sound board, to prevent sound leakage. This channel should possess a hard well polished finish and then

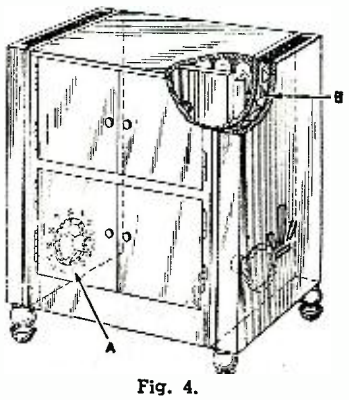


Fig. 4.

it is susceptible to various modifications in shape and construction, such as cross bracing, sectionalization and aperturing to better provide the column with resonance characteristics approximating those of the associated loud speaker and create greater fidelity of sound.

To the side wall, on which is posted the low-frequency speaker, a channel

of heavier material is used. This column is lined with suitable sound damping material and may be provided with drapes (B) arranged to hang from near the top of the column inwardly to absorb high-frequency sounds.

The columns, as shown in figures 3 and 7, may be constructed to resonate at high and lower frequencies, respectively, as described above. The construction principles are identical, the difference occurring in the shape of the column.

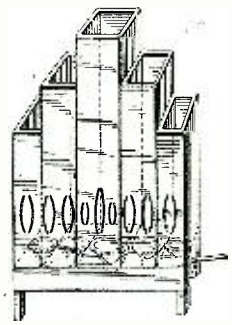


Fig. 5.

It has been determined that by far the most responsive performance is made possible by the columns identified by the figures, the multiple 5, and 7. Firstly, these columns lend themselves more easily to a variety of designs inasmuch as they are remotely removed from the source of sound energy. Secondly, it can assume a number of colors and does not necessarily have to conform to the radio color as do those columns that are mounted on the sides of the radio.

These columns can be made of a good grade of wood and can be hexagonal, square, or columnar in shape. Standing about five feet six inches from the floor, the column can be painted to blend in with the background.

The base can be perforated, as figure 7 shows, or can be apertured to relieve air pressure. The inner sides should make allowance for accommodating a speaker of about 18 inches in diameter which can rest on the bottom after allowance has been made to snugly receive the speaker so that no tone is lost.

In this, as in the other columns previously described, sound insulating material of about an inch thick should line the column interior. And, as described of the other type of column, highs and lows are separated and emerge from different ends of the column. Highs find their way to the bottom, while the low tones seek the top levels.

Here, the maker must first decide whether he prefers a high or low frequency speaker. In making this choice, the accent should be placed on taste, so that in the final analysis the aural reception blends in more completely with the personal desires. Beyond the simple mechanical requirements that must be followed to achieve high sound fidelity, the constructor of such a column is free to choose from a limitless number of physical columnar designs and colors.

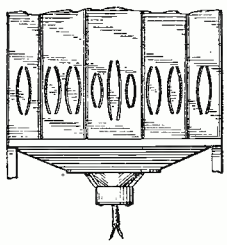


Fig. 6.

Perhaps the outstanding characteristic that immediately strikes the most uninitiated in sound reproduction is the rich fullness of sound and the sharply etched brilliance of tone.

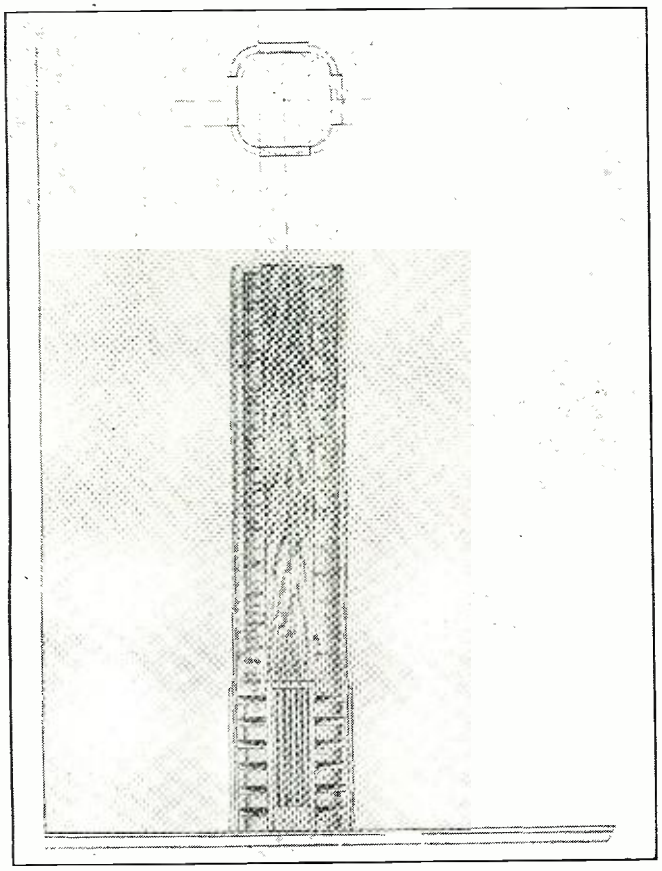
Fig. 7.

Often, it has been the author's experience to take guests into his home, turn on the radio, ask them to close their eyes and then ask the listeners to point out the source of the sound. Invariably they fail to do so. This is due to the sound rising to the ceiling and falling as rain from on high.

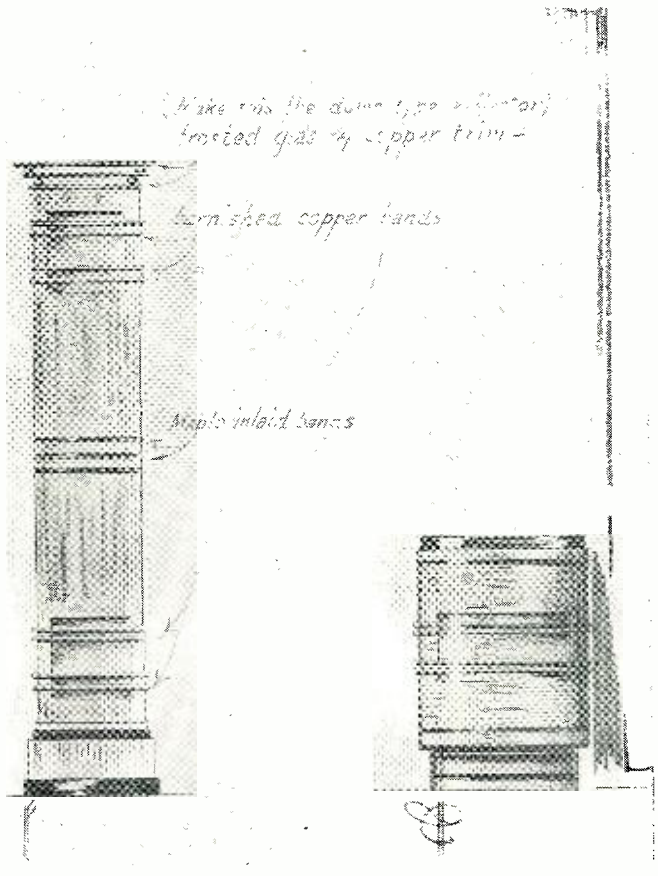
Principally, this arises from the fact that the tone is diffused rather than directional as in most conventional and present day speakers. Moreover, when the gain is increased to the fullest extent on any present day radio, and the sound is emitted through this type of column, there is still a clarity of tone that is unrivalled. Each tone distinctly sounded and the total tonal blending in a harmony of sound that is a pleasurable revelation to the listener.

—30—

Column resonator, approximately 5½′ high for 100 cycle resonance.



Reflectors mounted on the top are to project a diffused response.



GENERAL-PURPOSE TEST UNIT

by RUFUS P. TURNER
Consulting Engineer, Radio News

A home constructed unit used for inductance, capacity and frequency measurements; monitor; mixer; adjusting resonant circuits and other laboratory tests.

WHEN two frequencies, either radio or audio, are to be compared in the radionic laboratory (as in checking unknown frequencies against a standard), the need is felt for a permanent unit embodying the functions of mixer, monitor, and indicator. Such an apparatus is third party to the measurements, although its importance is unquestioned. There is accordingly a tendency to employ some makeshift substitute which, though satisfactory to a particular measurement, is not usually applicable to more than a few types of tests and almost always is over-sized. In most cases, a monitor unit is some instrument, or collection of instruments, intended for other use.

We find, for example, that when an unknown radio frenquency is to be compared with a standard signal, the technician must provide a radio receiver for the comparison unit or must assemble a detector-amplifier unit. Very likely, the assembled unit will be dismantled after the test, since its restricted utility hardly justifies its shelf space unless repeated tests of the same sort are to be made. Availability of a receiver for test purposes will depend also upon other urgent uses to which the set is applied in the laboratory.

Likewise when two audio frequencies are to be compared, it is likely that an audio amplifier and vacuum-tube voltmeter must be connected into a comparator circuit.

In both of these cases, which are typical, the instruments temporarily tied-up in the comparator circuit are more elaborate than actually required, and their connection entails a certain amount of additional labor and chance of error.

A permanent comparator unit might be constructed for all a.f. and r.f. tests. Essentially, the circuit of such a device would be identical with that of a simple monitor, but would offer simplicity, compactness, and wide-range utility. It is also apparent that the instrument would be useful for a series of other tests and measurements aside from frequency comparisons, and would recommend itself to the small laboratory as an instrument of considerable usefulness.

Such a comparator unit is described in this article. This instrument was built from surplus material in the author's spare parts collection, and may be modified by the reader to accomodate components of other values and tubes of a different type. Most radionic experimenters have available the parts necessary to build such a unit and need not call upon their suppliers for strategic materials needed in the war effort. The principle of operation will be recognized as well-known, and as long as it is adhered to, the actual design is amenable to considerable modification.

Principle of Operation

Essentially, the comparator circuit is identical with the familiar aperiodic frequency monitors employed in transmitter checking. The basic arrangement is shown in Figure 1. The two radio-frequency signal voltages to be compared are fed into two separate tube grid circuits, as shown in the sketch, and the beat note between the two is delivered to an output terminal by way of the common plate circuit. Either headphones or a v.t. voltmeter may be employed to indicate the beat note voltage or the condition of zero beat.

With this simple set-up, one signal frequency may be adjusted to zero beat with respect to another, or the difference between two frequencies (one being known) may be measured.

It is seen that the usefulness of the circuit might be increased still further by providing one of the tube plate circuits with some component for making measurements. Thus in Figure 2, a switching arrangement is indicated whereby there might be added to the plate circuit (1) a tuned L-C combination, A: (2) a variable condenser, B: or (3) a coil, C; or, with neither of these units switched into the plate circuit, the instrument is available for insertion of any external component such as coil D, capacitor E, parallel resonant circuit F, or series resonant circuit G.

To understand how the comparator may be applied to a number of radionic measurements, let us examine the test possibilities when each of the above units are connected in the shunt-fed plate circuit:

(1) Assuming that resonant circuit A is built into the instrument, its dial may be graduated directly in kilocycles and megacycles. If a signal voltage of unknown radio frequency is then applied to the grid input circuit, circuit A may be tuned for peak deflection of the v.t. voltmeter and at this point the unknown frequency may be read directly on the dial. The comparator thus functions as a direct-reading frequency meter.

(2) On a basis of frequency settings and a known value of inductance in the coil of circuit A, the tuning dial may also be made to read directly in micromicrofarads and unknown capacitances measured by the *difference method*. In making this type of measurement, the circuit A is resonated at the maximum setting of its tuning condenser by means of a variable-frequency oscillator feeding into the comparator grid input terminals. The unknown capacitor is then connected to the comparator output terminals, and circuit A is resonated by means of its tuning dial. The difference between the two capacitances indicated by the tuning dial at the two resonant points is then the unknown capacitance.

(3) An alternative method of measuring capacitance would make use of the inductor C. With the latter switched-in, the unknown capacitor would be connected to the comparator output terminals, and the resonant frequency of the resultant coil-capacitor combination determined by means of a variable-frequency oscillator connected to the input terminals. The unknown capacitance value might then be determined by means of the equation:

$$C = \frac{25{,}400}{f^2 L} \ \mu\mu\text{fds.} \quad \ldots\ldots\ldots\ldots \quad (1)$$

Where f is the oscillator frequency in mc., and L is the inductance (microhenries) of coil C.

(4) If variable condenser B has a dial reading directly in microfarads, unknown inductance values may be determined in a similar manner. With condenser B in the circuit, the unknown coil is connected to the comparator output terminals, and the resonant frequency of the resultant L-C combination determined by means of a variable-frequency r.f. test oscillator connected to the input terminals. The inductance value might then be calculated by means of the equation:

$$L = \frac{25{,}400}{f^2 C} \ \text{microhenries} \quad \ldots\ldots \quad (2)$$

Where f is the resonant frequency in mc., and C is the capacitance at resonance ($\mu\mu$fds.).

(5) For rapid determinations of inductance, the dial of tuning condenser B might be made to read directly in microhenries, provided the same oscillator frequency be employed for all inductance measurements. An advan-

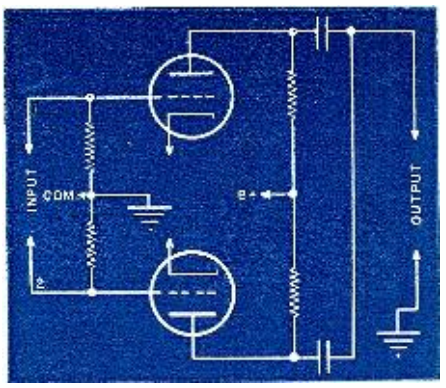


Fig. 1. Basic circuit of comparator unit.

tage of measuring inductance with the comparator is the fact that the measurement might be made at the actual frequency at which the coil is to be operated.

(6) It is a simple matter to determine the resonant frequency of a coil-capacitor combination, such as F or G in Figure 2. These combinations, which might be resonant circuits, filter elements, wave traps, or compensating circuits, are inserted into the comparator plate circuit and their resonant frequencies, either RF or AF determined by means of a suitable variable-frequency oscillator connected to the input terminals. It is merely necessary to tune through the oscillator range until the peak deflection of the v.t. voltmeter indicates attainment of the resonant frequency.

These are only a few of the uses to which the simple comparator circuit might be put. The circuit itself may be simplified considerably by employment of a multi-grid tube in place of the separate triodes and applying separate signals to different signal grids. Any of the converter tubes will be entirely satisfactory for this purpose. Such simplification has been carried out in the complete comparator unit shown in Figure 3. And in addition an internal v.t. voltmeter has been added together with a switching arrangement which makes possible any of the circuit arrangements shown in Figure 2.

Complete Comparator Unit

The circuit diagram of the complete comparator unit is shown in Figure 3. The essentials of the basic circuit will readily be recognized in this schematic.

The circuit is built around a 6A8 tube, although any other pentagrid converter might be employed. Input signal voltages are applied to the No. 1 and No. 4 grids. It will be seen that separate input terminals are provided for a.f. and r.f. input: Terminals T1 and T2 are for separate audio input voltages; T3 and T4 for separate radio-frequency input voltages. Terminal T5 is common to both input circuits. The audio input circuits contain 0.1-μfd. blocking capacitors, while the r.f. input circuits contain 0.00005-μfd. units. This is in order that a minimum amount of impedance will be offered the input currents. Each input circuit contains a high-resistance gain control (R1 and R2) for adjustment of input voltages to suitable values.

The plate circuit is shunt fed through resistor R4 and coupling capacitor C7 or C10. C10 is switched-in for increased capacitance when the comparator is employed at audio frequencies. The selector switch S2 permits the switching-in of tuning condenser C9 in parallel with either of the coils (L1 to L4), into the circuit with no coil, the switching-in of any of the coils without the tuning condenser, or removal of all coils and condenser from the circuit.

With S2 in position 1, the plate circuit contains C9 plus L1; in position 2, C9 plus L2; in position 3, C9 plus L3; in position 4, C9 plus L4; in position 5, C9 with no coil; in position 6, L1 alone; in position 7, L2 alone; in position 8, L3 alone; in position 9, L4 alone; and in position 10, all coils and condenser have been removed from the circuit. S2 is a double-pole, 10-position rotary selector switch with ceramic insulation.

The tuning condenser C9 is a regular midget single-section broadcast receiver component with a maximum capacitance of 500 $\mu\mu$fds. The minimum capacitance of such a unit will fall close to 20 $\mu\mu$fds. The coils have been so selected that, with C9, a frequency range of 100 kc. to 35 mc. may be covered in four bands as follows: L1, 5mh, 100-500 kc.; L2, 400 μh, 450-1750 kc.; L3, 17.5 μh, 1.7-8.4 mc.; and L4, 1 μh, 7.1-35 mc. All ranges overlap.

L1 is a Miller Type 954 iron-core r.f. choke. L2 is a Miller Type 951 iron-core r.f. choke with several turns removed during the preliminary alignment of the comparator to enable coverage of the frequency band. L3 is composed of 33 turns of No. 24 enamelled wire wound on a 1-inch-diameter form and spaced to a winding length of 1¼ inches. L4 is 8 turns of No. 20 enamelled wire, wound on a 1-inch-diameter form and spaced to a winding length of 1 inch. For best results, the entire bandswitching assembly, including the tuning condenser, coils, and selector switch, should be enclosed within an ample shield box. Short leads to the switch are essential; the lower-frequency coils are mounted farthest from the switch in order that the higher-frequency ones may be placed directly at the switch terminals.

Several output terminals are provided. T8 is common to all output circuits. T6 is used exclusively for measurements of series-resonant and other such circuits in which the capacitance of the blocking capacitor C7 would introduce an error in results. T7 is to be used for all other measurements. The 0.1-μfd. capacitor C10 may be switched in parallel with coupling capacitor C7 by means of S1, when making audio measurements, in order to reduce the impedance of the path to these lower frequencies.

An output v.t. voltmeter is included. This circuit, built around the triode section of a 6Q7GT tube, may be switched-in at will by means of S3. An input terminal T9, operated in conjunction with ground terminal T8, permits the use of the v.t. voltmeter for external measurements. S3 is preferably a low-loss anti-capacitance switch, and the leads between this switch, terminal T7, and the 6Q7GT grid are kept as short as possible.

Power to the entire instrument is supplied by an internal power unit. The transformer may be a midget unit since the total power requirement of the comparator is slight. The rectifier tube may conveniently be a type 80, 5W4, or any similar type. Regulation of the plate and screen voltages is highly desirable, although not mandatory. For simple regulation a pair of gaseous tubes are arranged in series, as shown in Figure 3. The 6A8 screen is connected to the junction between the VR150 and VR105 for a potential of 105 volts. 6A8 and 6Q7 plates receive 255 volts from the extremity of the series leg.

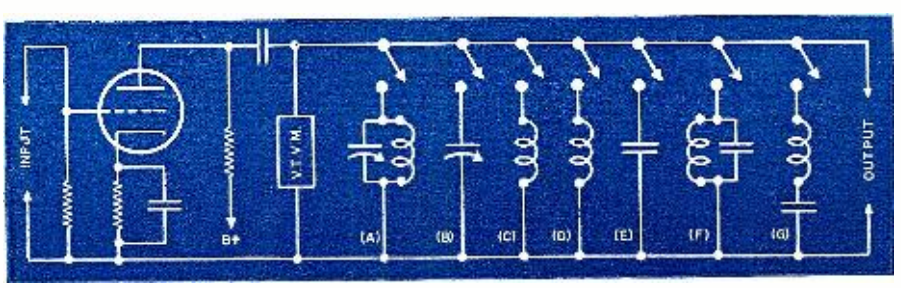
AC-DC arrangement of the power supply is not recommended for the comparator unit, unless it is known definitely that the instrument will never be employed for checking other devices, such as oscillators, receivers, etc., which are also connected to the power lines.

Calibration and Adjustment

After the wiring of the comparator has been completed and checked, calibration and adjustment may be undertaken according to the following steps:

Power Supply: Disconnect the leads A, B, and C temporarily from the power supply and proceed to adjust the voltage regulator. Insert a d.c. milliammeter between the contact arm of R11 and the anode of the VR150 tube. Switch on the power supply and adjust the resistance of R11 until exactly 30 milliamperes flow through the regulator tubes. After fastening the slider of R11 tightly, the voltage regulator adjustment is completed, restore the connections A, B, and C.

Fig. 2. Switching arrangement, making possible the various different tests of which the instrument is capable of performing.



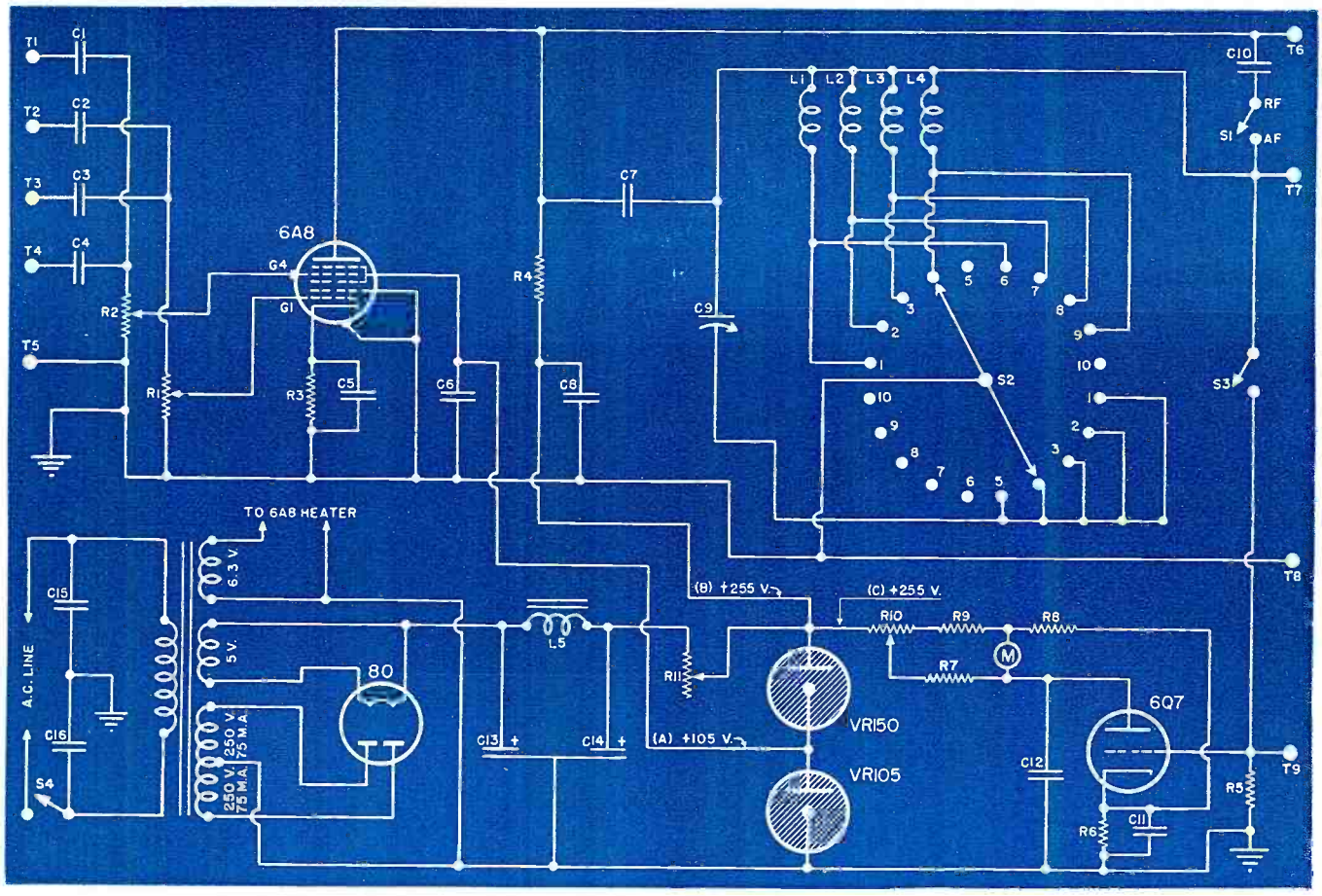


Fig. 3. Schematic diagram of the completed unit, showing the elaborate switching arrangement.

C_1, C_2, C_5, C_{11}, C_{15}, C_{16}—0.1 μfd. 200-volt tubular —Aerovox 284
C_3, C_4—.00005-μfd. mica—Aerovox 1469
C_6, C_8, C_{10}, C_{12}—0.1-μfd. 400-volt tubular—Aerovox 484
C_7—0.002 μfd. mica—Aerovox 1467
C_9—500-μμfd. midget broadcast type tuning condenser
C_{13}, C_{14}—8 μfd. 450-volt d.c.w.v. dual tubular electrolytic—Aerovox PRS-450-8-8
R_1, R_2—0.5-megohm potentiometer—I.R.C. Type CS
R_3—800-ohms 1-watt—Aerovox 1098
R_4—50,000-ohms 1-watt—Aerovox 1098
R_5—1-megohm ½-watt—Aerovox 1097
R_6—1400-ohms 1-watt—Aerovox 1098
R_7—20,000-ohms 1-watt—Aerovox 1098
R_8—240,000-ohms (0.2 meg. and 40,000 ohms in series) 1-watt Aerovox 1098
R_9—7000-ohms 1-watt—Aerovox 1098
R_{10}—3000-ohm wirewound potentiometer — I.R.C. Type W3000
R_{11}—2000-ohm 10-watts with slider—Ohmite

M—0-500 d.c. microammeter—Triplett Type 221
L_1, L_2, L_3, L_4—See Text
L_5—10-hy. 50 m.a. midget filter choke—U.T.C. R-18

S_1, S_2—S.P.S.T. toggle switch—Arrow
S_2—2-pole 10-position rotary ceramic selector switch—Centralab
S_3—S.P.S.T. anti-capacity switch—Centralab rotary section

T—Midget power transformer—U.T.C. R-1
T_1 to T_9—Insulated binding posts or banana jacks —Gordon

Tubes—VR150, VR105, 6Q7GT, 6A8 and 80

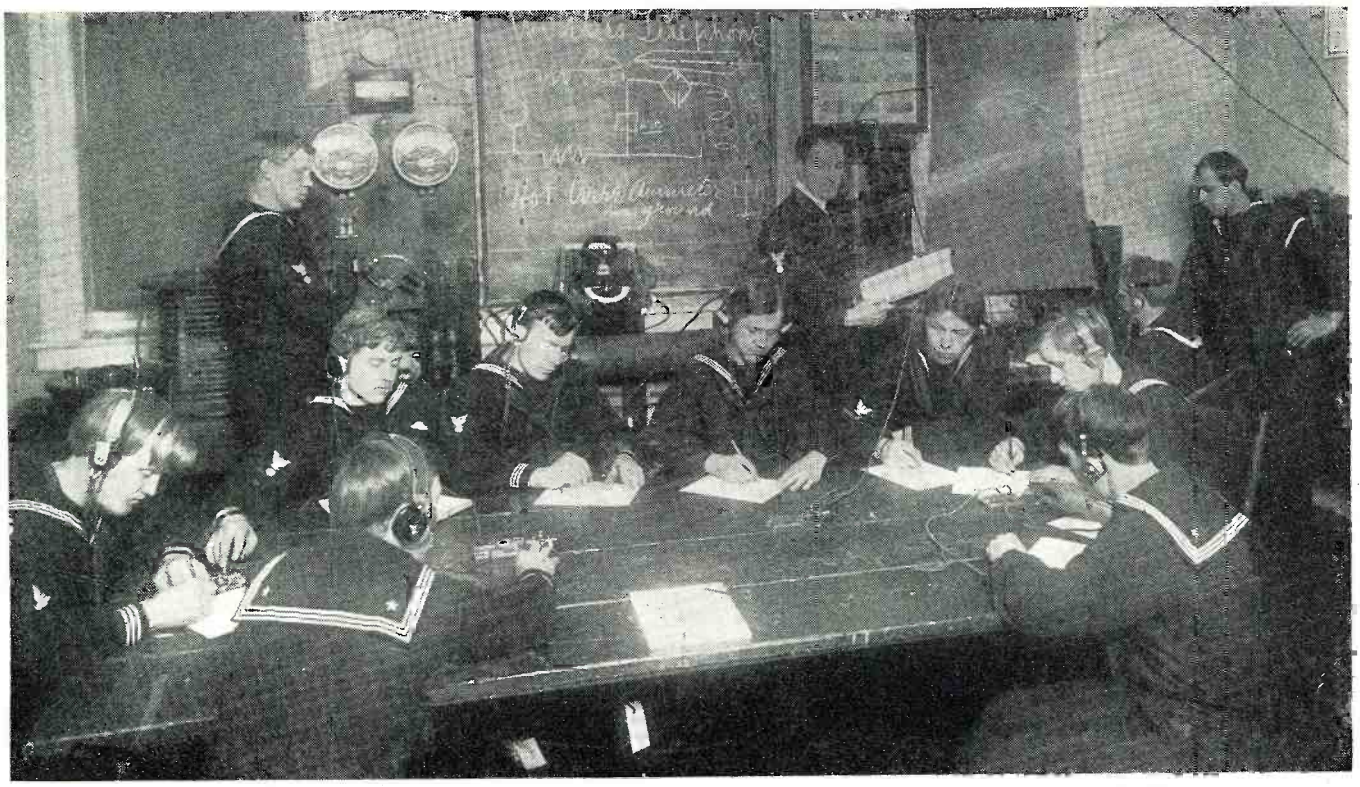
V. T. Voltmeter: Open S3 and switch on power supply. Observe that meter M begins to read as tubes warm up, this deflection being either above or below zero depending upon the setting of the zero-control potentiometer R10. After the tubes have come up to operating temperature (allow 10 minutes), adjust R10 until the pointer rests exactly at zero on the meter dial. Next, connect a source of low-voltage variable a.c. voltage to terminals T8 and T9 and bring the level of this voltage up from zero slowly, observing that the meter begins to read up scale. A reliable a.c. voltmeter must be connected across the a.c. source to determine the value of input voltage at various settings of the potentiometer or variac with which variations are obtained. Noting the meter deflections corresponding to various values of input voltage, a special direct-reading voltage scale may be prepared for the meter, or a curve may be drawn to show meter deflection against known a.c. voltages. With the 0-500 d.c. microammeter, the full-scale deflection will be approximately 2.0 volts.

Frequency Calibration: A good-grade test oscillator is required for this adjustment. Connect the oscillator to input terminals T4 and T5. Switch on the comparator unit, set the oscillator to 100 kc., and set S2 to position 1. Close S3. Adjust C9 until a sharp upward deflection of the v.t. voltmeter indicates resonance. The dial of C9 is then marked 100 kc. at this point. Reset the oscillator to 150 kc. and locate the new condenser setting for resonance, marking this point on the C9 dial. Locate a number of such points until the frequency 500 kc. is reached. Change S2 to position 2, set the oscillator to 450 kc., and proceed as before. Each range should thus be aligned to the oscillator frequency points until the final calibration is completed with S2 in position 4.

On the highest-frequency range, it may be necessary to "prune" the inductance value of the small coil in order to make the lower-frequency band limit reach the proper position on the dial. Points may be moved down the dial by pushing the outermost turn of the coil closer to the next adjacent turn, and may be moved up the dial by urging the top turn slightly away from the next adjacent. Likewise, it will be necessary to remove a small number of turns from coil L2 during the alignment process in order to increase its resonant frequency.

The dial attached to variable condenser C9 may be a regular component marked off in arbitrary figures if the builder has no objection to keeping tuning charts to show the frequency calibration. Or it may be one of the

(*Continued on page* 82)



An early day code training class which is far removed from our present methods of teaching. Radio students of the U. S. Navy being taught code transmission. Note rather ancient diagram on blackboard.

RADIO—IN ITS INFANCY

by MORLEY COOPER

Interesting tales of the early days of radio in the U. S. Navy, when the quenched-spark transmitter was used.

WHEN I watch the radio amateur of today operating intricate apparatus so very casually, my mind takes me back some thirty-odd years to the days when both radio and I were very young and crude.

A lot of water has passed over the dam since that time, both for me and for radio. When I was seventeen years old, I enlisted in our Navy and, more or less accidentally, became one of the first wireless operators to qualify for ship service. Those were the days! Have any of you lads ever heard of Slaby-Arco, or Shoemaker, or Telefunken? Weird contraptions they were, those early sets, and as full of trouble for the operator as was the automobile of that same period.

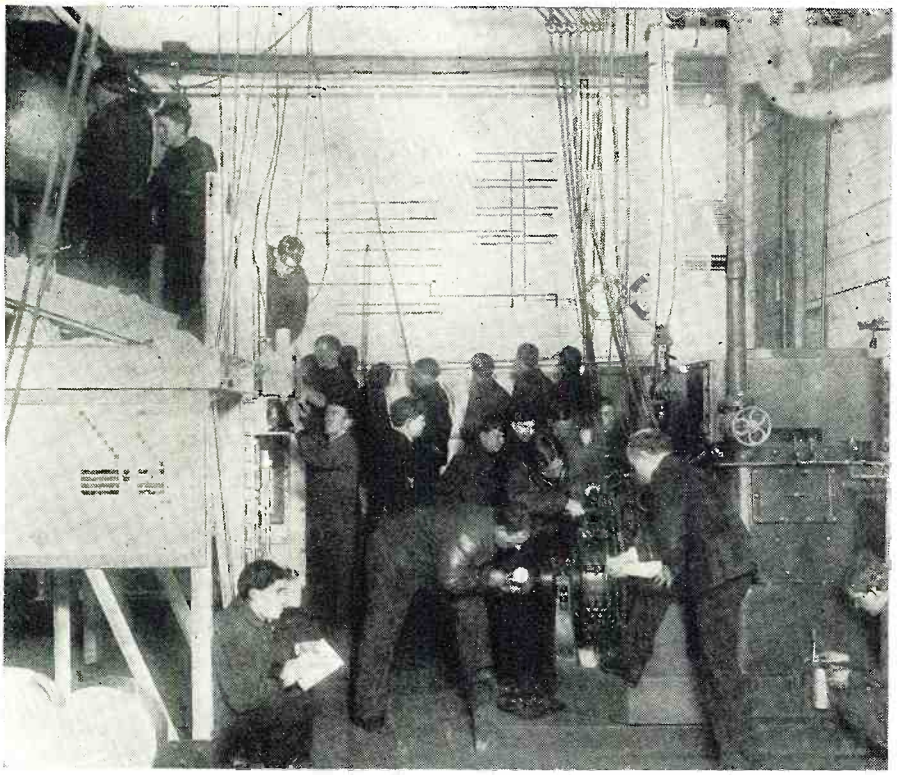
We, however, were very young and embued with the romance of this new calling. We really accomplished things with our cumbersome apparatus. The coherer-and-decoherer receiver was replaced by the first electrolytic detector about that time, the vacuum tube, of course, being unknown. With the electrolytic detector and a quenched-spark transmitter, we worked thousands of miles—believe it or not.

At that time, the Navy was only a few years removed from the days of the sailing frigates, and even the use of electricity for ship lighting was still a novelty. You can imagine the effect this new-fangled method of communication had on the horny old seadogs who made up the bulk of a battleship's crew in those days. They were quite sure that this unnatural contraption would never replace the method God intended for sailors to use—signaling with flags from the bridge. And the joke of it was, the quartermaster sometimes established communication by wig-wag, when entering a harbor, before we could get a message through by wireless. But not very often.

After I finished the course in the electrical school at Brooklyn Navy Yard, I was sent to China, by way of Panama and San Francisco. There was no Panama Canal then, and we went overland from Colon to Panama City, embarking on another ship there for San Francisco.

On the Prairie, from New York to Colon, I stood my first ship's wireless watch. The apparatus was set up in the wheelhouse at the stern of the ship. We had a fairly rough passage, and much of the time I was horribly seasick.

About halfway, on this trip, some of the electricians got a clever idea, and broke out an experimental portable wireless set, which they placed on top of the wheelhouse. One of the boys then started pounding out our call letters, and of course we could get this in our earphones. The chief electrician, who was not in on the gag, answered the call. The man on the



Radio students, known then as electricians, being taught electric power operation.

roof asked if Blank, the chief electrician, was aboard, signing the letters of another man-of-war. Upon being assured that Blank was at the key on the Prairie, the operator above then started cussing out the chief, calling him everything he could think of. Of course, the little portable set had no antenna, and could be heard only aboard the ship.

The chief electrician, Blank, however, thoroughly enraged by this abuse, opened up his spark-gap wide, and turned the air blue for hundreds of miles around, using language that only an old-time gob could have mastered. This interchange kept up until the chief went nearly crazy. He was so mad that he danced around while he was sending. Finally, the operator on a United Fruit boat cut in and asked us what all the excitement was, and whom we were talking to. The chief very profanely told him that the operator on such-and-such a battleship was abusing him. The United Fruit operator said there was no one else talking that he could hear, and the chief told him he was crazy. Finally, the United Fruit man threatened to report the chief for using obscene language on the air. Shortly thereafter the operator on the roof came down and told the chief that it was all a gag. The chief would not speak to any of us for a week.

Arriving in Manila, I was transferred to the cruiser Chattanooga, and was wireless operator aboard her at the time my elder brother, Gene, came into the harbor. He, also, was a naval wireless man, on board the battleship Alabama. I picked him up several hundred miles out, and we gossiped, between official messages, until they anchored near us in the Bay, off Cavite. On shore leave, I visited the Alabama and had a long chat with my brother, whom I had not seen for years. He was not looking well, and did not go ashore in Manila. A few days later, his ship left to continue its cruise around the world.

Two months later, I was taking down, from the Cavite Naval wireless station, a series of cabled news bulletins from Washington, which we were in the habit of posting outside the wireless shack. Almost the first bulletin was the news of my brother's death, near Naples, with an account of his burial at sea in the Mediterranean. The Cavite operator, a friend of mine, interrupted his broadcast to ask if it was my brother who had died. I was quite overcome at the news, and could barely answer him coherently.

In Manila Harbor at the time, there lay the entire United States Fleet, that beautiful, white Big Sixteen which Teddy Roosevelt sent around the world. The wireless operators aboard this fleet knew my brother well and, learning thus whom I was, each in turn sent me condolences and told what a real man my brother had been. The whole affair took on something of the dignity and solemnity of a funeral, and I know Gene would have felt mighty proud could he have known how his old shipmates loved him.

In Shanghai, some months later, I was operator aboard the gunboat Wilmington, which cruised, at times, up the Yangtse as far as Hankow and Ichang. Ashore in Shanghai, I had become acquainted with the Father who was president of Shanghai College, a Franciscan school for Chinese. On the roof of this school was a small wireless set which the Fathers were using to instruct young Chinese in wireless telegraphy. At times I transmitted to these fledglings, sending very slowly.

On Christmas Eve, since our gunboat was flagship, I sent out Christmas greetings to each ship in the harbor. After getting acknowledgments from all ships present, I remembered my Chinese friends at the College, and called them. When the lad haltingly answered, I said "Merry Xmas," and signed off. After a pause, he sent the signal which indicated that he did not understand. I repeated, this time spelling out "Christmas." A longer pause, then came the reply, "What you mean—Merry Christmas?" I gave it up because I realized they were not familiar with our holidays.

In this same harbor, I overheard one of the funniest messages I ever listened to, and it was not intended to be humorous at all. It was a routine requisition from a German battleship to her supply ship, which boat evidently carried refrigerated meats for the Germans aboard the larger ship. It

(*Continued on page* 118)

An early photograph, when radio was new, of sailors aboard a naval vessel.

INDUSTRIAL APPLICATIONS OF THE OSCILLOSCOPE

by GUY DEXTER

☆

A review of the many applications of the cathode-ray instrument in industrial measurements.

☆

IN a certain factory where a large amount of heavy machinery is in continuous operation, a noise reduction campaign was undertaken. The management had become convinced for three reasons that this was a feasible step to take. In the first place, the machinery had to be kept mounted on wood flooring as the second-story location prohibited simple concrete footings; secondly, there had been a significant increase in the number and severity of cases of "nerves" compelling workers to leave the shop; and thirdly, close adjustments of smaller machines and test instruments located within the close quarters were being disturbed by the heavy vibration.

Most of the machinery was not of late design, but it had been determined satisfactorily that certain mechanical modifications, which would insure smoother operation, might be made economically by the factory machinists. The program consisted of determining the exact nature of the noise and then operating upon the machines to eliminate the cause.

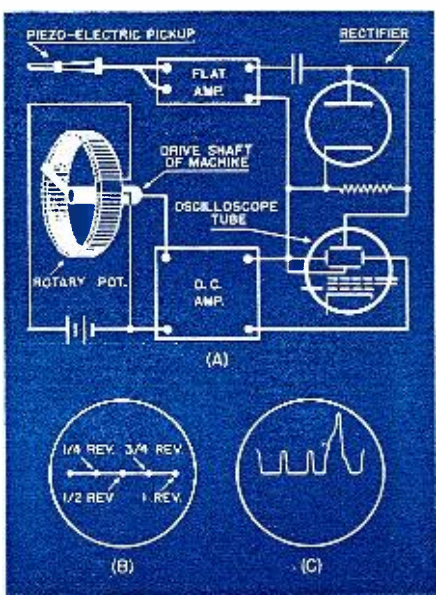
An outstanding offender was a large rotating machine which ran at a relatively high speed. The intense vibration it set up was noticeable only at the normal operating speed. Hence, it was difficult to ascertain the exact cause of the vibration under any except dynamic conditions, and this was made impossible under ordinary circumstances by the speed at which the machine moved. Several possible remedies were known from the beginning, but it would have been costly to try them one by one. No conclusive indications were obtainable at low speeds or when the machine was tested standing still.

The diagnostic problem was finally solved by the plant engineer by means of a cathode-ray oscilloscope which disclosed (1) each vibration and its apparent waveform, (2) the amplitude of each vibration, and (3) at which part of the machine's revolution each vibration occurred. Since all of these pulses could be seen at one time, their relative amplitudes could be compared readily.

The circuit employed for this determination is shown in Figure 1A. In this arrangement, the cathode-ray beam is displaced horizontally on the screen by a sweep voltage controlled by the machine's rotation. The setup for accomplishing this horizontal sweep is based principally on a battery, and a smooth-acting potentiometer with an endlessly-rotating contact arm propelled by the rotating shaft of the machine. The potentiometer takes the output voltage from zero to the potential of the battery continuously once during each revolution of the machine. Since the battery voltage is too small for complete horizontal displacement of the beam, a direct-coupled d.c. amplifier is interposed between the potentiometer and the horizontal plates of the oscilloscope tube.

By adjustment of the d.c. amplifier gain control, the entire horizontal trace may be spread across the oscilloscope screen, and the length of this line will represent one complete revolution of the machine. Various points during a complete rotational cycle may thus be located along the horizontal line, as in Figure 1B. It becomes simple to locate any fraction of a revolution in this manner.

Fig. 1. Circuit used to determine the location and cause of extreme vibration in large rotating machines.



D.c. pulses corresponding to machine vibrations are applied to the vertical plates of the oscilloscope after having been obtained in the following manner: Vibrations are received by means of a piezoelectric (crystal) vibration-pickup unit (Figure 1A) placed in contact with the machine, its mountings, or a nearby spot on the floor or table upon which the machine is mounted. The electrical impulses generated by this mechanical vibration are then amplified. Following the amplifier is a linear rectifier which delivers d.c. pulses to the vertical plates. The d.c. pulses are applied to the vertical plates at the instant when the horizontal trace reaches the point corresponding to the rotational position of the machine at the time of the vibration. The result is that each noise pulse appears along the horizontal axis at the point which properly represents the position of the machine.

A typical pattern is shown in Figure 1C. This is the type of picture which was obtained by the factory engineer. Note that the predominant vibrational peak occurs in the sketch at three-quarters of a revolution. The other peaks at one-quarter, one-half, and one revolution are of simpler waveform and lower amplitude.

This problem of vibrating machinery and its close diagnosis by means of the oscilloscope typifies a large class of industrial and scientific operations to which the cathode-ray instrument has been applied. Originally devised for picturing alternating-current waveforms, the oscilloscope has found ready application wherever reiterative phenomena are to be observed. Industry and research have found it particularly invaluable for viewing simultaneously a number of rapidly occurring conditions in the manner of a birdseye view. The unique features of the oscilloscope, which recommend it for these applications outside of the radionic field, are the inertialess character of its electron beam and its use of *persistence of vision*.

The oscilloscope is fundamentally a curve-tracing instrument. Although originally designed to trace a particular type of curve—the a.c. wave—it is more or less readily adaptable to the

tracing of all types of curves due to electrical effects or to effects which may be translated into electrical variations. It is consequently a great time saver, since it can give in a single glance a complete performance curve, which would take hours to plot by the point-by-point system.

Not all of its applications may be reviewed in a single article, so numerous have they become since 1933. We shall, however, describe several of the novel applications of the oscilloscope, believing them to typify the advances in this field and to stimulate further investigation on the part of the student of radionics.

Measuring Tube Characteristics

The plotting of tube characteristic curves is one of the most burdensome of such operations. Hours are frequently consumed in the careful measurement of current values at numerous voltage levels in taking the data for these curves, and considerable time is consumed in the checking of the values obtained and in drawing the actual curve. The tedium involved in this process is eliminated entirely by employing an oscilloscope to reproduce the curve directly. The entire characteristic is available at a glance, and

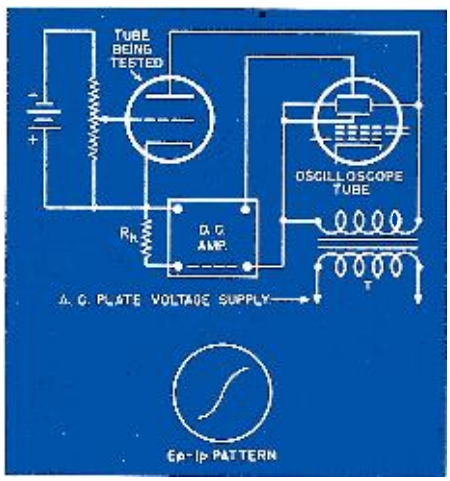


Fig. 2. The oscillograph, used to trace the plate-voltage — plate-current curve.

the oscilloscope screen may readily be calibrated to indicate current and voltage values.

Figure 2 shows the basic circuit of apparatus for tracing the familiar plate-voltage—plate-current curve oscillographically. An alternating voltage is applied both to the horizontal plates of the oscilloscope, and to the plate of the tube under test by transformer T. This results in a horizontal displacement of the cathode-ray beam in accordance with the numerous instantaneous values of the a.c. cycle. Maximum horizontal displacement corresponds to peak value of the voltage cycle.

Plate current, resulting from the various instantaneous voltages applied to the plate of the tube under test, is caused to flow through the small resistor R_k in which a voltage drop is produced which is proportional to the

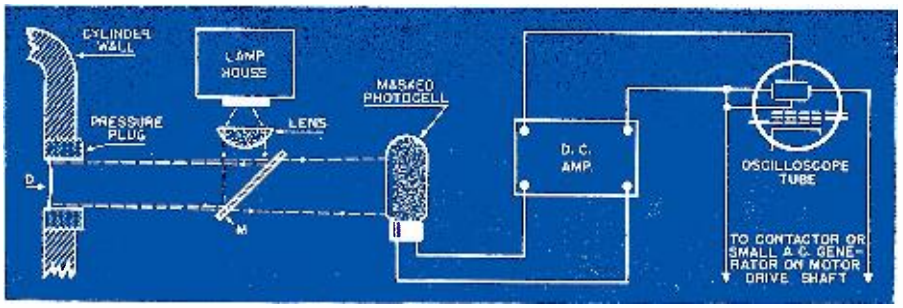


Fig. 4. Apparatus used to study engine pressure conditions oscillographically.

value of plate current flowing. This voltage is in turn applied to the vertical plates of the oscilloscope to deflect the beam vertically. At any instantaneous value of plate voltage, the electron beam is deflected horizontally through a distance corresponding to that potential. But, for this value of voltage, a certain plate current flows through the tested tube and produces a drop which is applied to the vertical plates through a d.c. amplifier. The result is that the beam is likewise displaced vertically proportional to the plate current. For all other instantaneous values of plate voltage, this also holds true. Over the entire range of instantaneous values, the beam is, for each voltage, under the influence of both horizontal and vertical deflecting plates and the Ep-Ip curve is traced on the screen, as also shown in Figure 2.

A battery and potentiometer are provided in the grid circuit of the tube under test in order that plate curves may be obtained at various grid voltage levels. A family of such curves might be obtained simultaneously by providing an electronic or mechanical switch in the grid circuit to select a new value of grid voltage immediately after one curve has been completed on the screen.

The resistor R_k must be very small in order to prevent large inaccuracies. The voltage drop, produced across it as a result of plate current, is necessarily very low and is insufficient to produce vertical deflection of the cathode ray beam. For this reason, it becomes necessary to include a d.c. amplifier between the tested tube and the vertical deflecting plates.

The oscilloscope screen may be calibrated for the voltage and current values. A variable horizontal voltage is first applied, its value being changed and the corresponding length of the horizontal trace being noted. The screen may be marked off in actual voltages thus obtained. A similar continuously-variable voltage is then applied to the input of the d.c. amplifier, and the length of the vertical trace noted with respect to these voltage values. Knowing the value of resistor R_k, these voltages may be converted into current values, and the vertical axis of the screen so graduated.

Figure 3 shows the circuit of an apparatus for showing the grid-voltage —plate-current characteristic curve of a tube. Here, a d.c. voltage is applied to the plate of the tube under test from a battery or well-filtered source of rectified line voltage. A pulsating d.c. voltage is applied to the grid of the tube in series with a small amount of battery bias. This pulsating voltage is preferably delivered by an unfiltered a.c. power supply which will give full-wave 120-cycle pulsations.

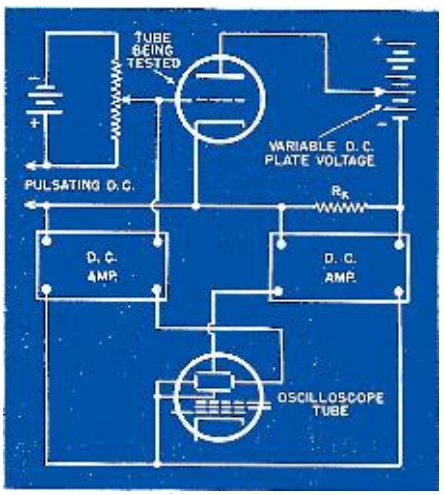
Since the pulsating grid voltage is of a low order of magnitude, it is amplified through a d.c. amplifier before being applied to the horizontal plates of the oscilloscope tube. Plate current variations, resulting from the various instantaneous values of grid voltage, produce a voltage drop across the resistor R_k which is then applied through a second d.c. amplifier to the vertical plates of the oscilloscope. These two amplifiers must be of identical design in order to prevent phase shifts which will result in a loop instead of a line on the screen.

Here, as in the Ep-Ip assembly, a family of curves may be obtained, this time by employing an electronic or mechanical switch to select desired values of plate voltage, a new selection being made at the end of a particular Eg-Ip curve trace.

While we have shown triodes under test in each diagram, we do not mean to imply that only this type of tube may be checked oscillographically. All other types may be examined with equal facility. Likewise, other characteristics than Ep-Ip and Eg-Ip may be plotted on the oscilloscope screen. These include Esg-Isg, Eg-Ig, Esg-Ip, etc., etc.

(*Continued on page* 66)

Fig. 3. Circuit used to show oscillographically the grid-voltage—plate-current characteristic of a tube.



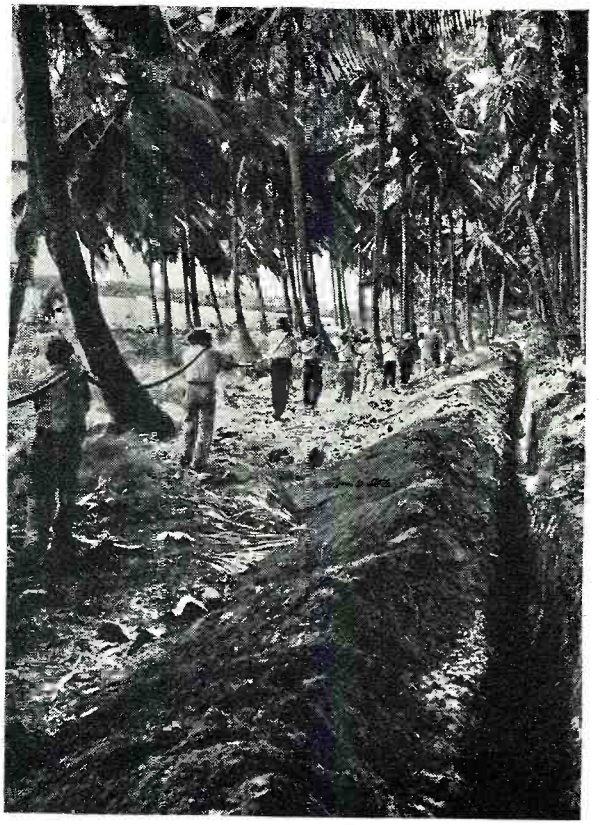
Communications equipment of all sizes are needed by our military forces. Left, a large mobile unit. Right, a field switchboard.

EQUIPMENT AT OUR FRONTS

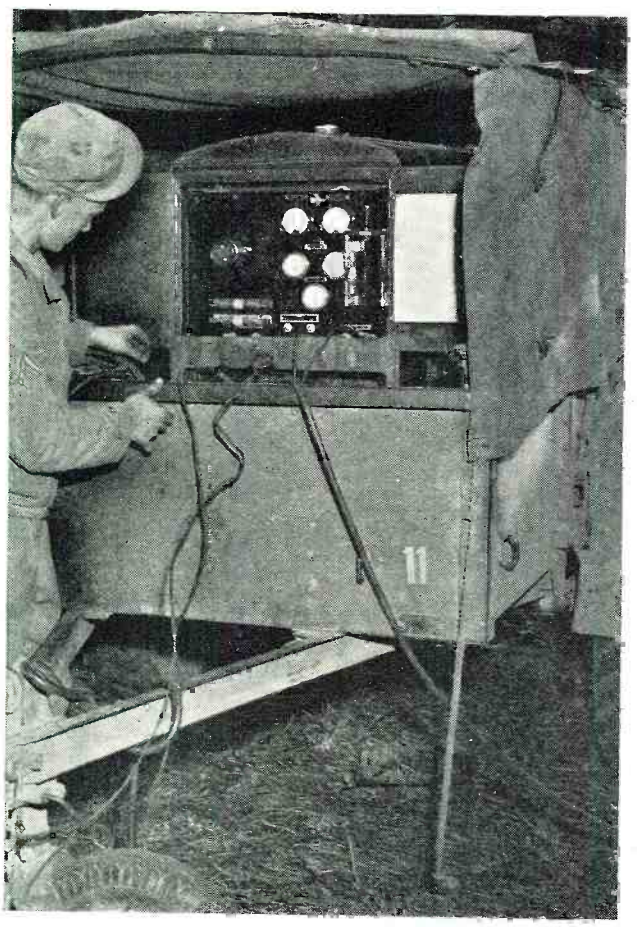
PEACETIME research by the communications manufacturers is contributing very materially to the success of our fighting forces. Years of laboratory work coupled with the latest production methods have made possible the splendid equipment available to our armed forces. The examples of communications equipment shown here reveal the wide range and the multiplicity of units necessary to maintain accurate, dependable contact between men in the field and various headquarters. No small part of the credit for providing this material is due to the efforts of the men and women on our many production lines.

Operator using a field telephone at one of our many fronts. It is compact and readily portable.

Crew of an advanced mortar brigade with portable communications system. Direct contact with other troops is vital for effective operations.



Native workers aiding in the installation of a submarine cable which will be used for military communications.



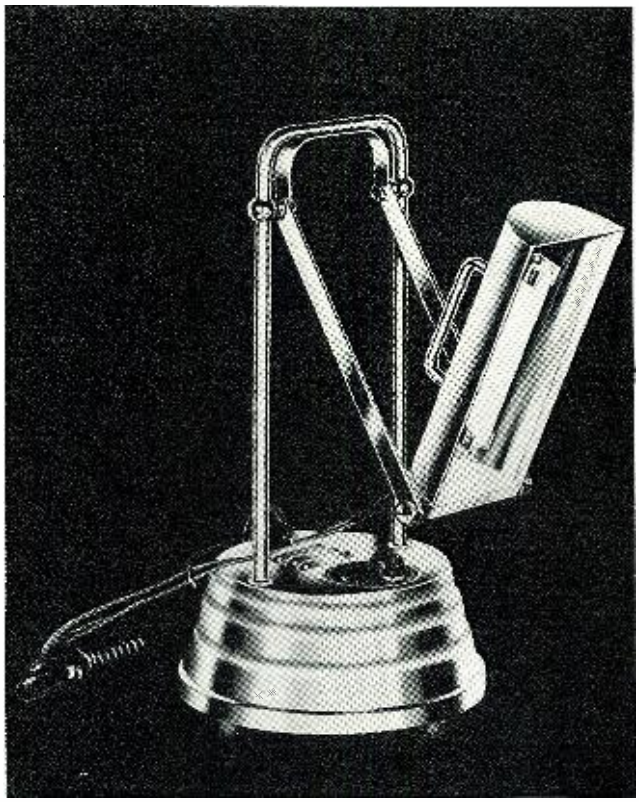
Military technician preparing a mobile gasoline-driven power-supply unit used with communications truck.

Telephone operators completing calls coming in over a portable switchboard. This particular unit has a 60 local station capacity with 135 lines.

EFFICIENT ULTRA-VIOLET GENERATOR

by S. W. EDWARDS

A high-frequency oscillator circuit used in conjunction with a unique electrodeless quartz tube to produce ultra-violet rays.



The completed unit—producing ultra-violet rays used in industrial applications and as a therapeutic agent in the medical profession.

ONE of the interesting applications of radionics is that developed by Mr. Frank Furedy (U. S. Patent No. 2,300,916). By utilizing radio-frequencies (R.F.) energy to excite the discharge in a mercury-filled quartz tube some unique results are achieved. The internal electrodes usually employed in devices of this kind can be dispensed with. Electrode sputtering and excessive heat, due to the power-loss at the electrode, is not present with r.f. excitation, and consequently the life-span for such a tube is almost limitless. The high r.f. voltage gradient together with the relative absence of heat in the quartz and the low gas pressure combine to radiate rich actinic rays in the high-frequency portion of the ultra-violet spectrum.

Fig. 1 shows the energy distribution of the radiation from the quartz tube. It will be noticed that the preponderance of energy is in the region of 2,537 angstrom units, a ray which medical authorities state has great germicidal power. The angstrom unit is a measure of wave-length and is equal to 10^{-8} cm., approximately or .1 mu (millimicrons). In terms of the system of measurement most radio men are familiar with, this corresponds to a frequency of 3,000,000,000,000 megacycles, which is quite a few vibrations per second. The frequency range of this optical spectrum is thus from 857 to 1200 millions of megacycles. It is interesting to note that measured this way the high-frequency limit of vision is approximately 750 million megacycles, red light approximately 350 million megacycles, heat-rays in the neighborhood of 150 million megacycles, while the infra-red threshold is in the order of twenty million megacycles.

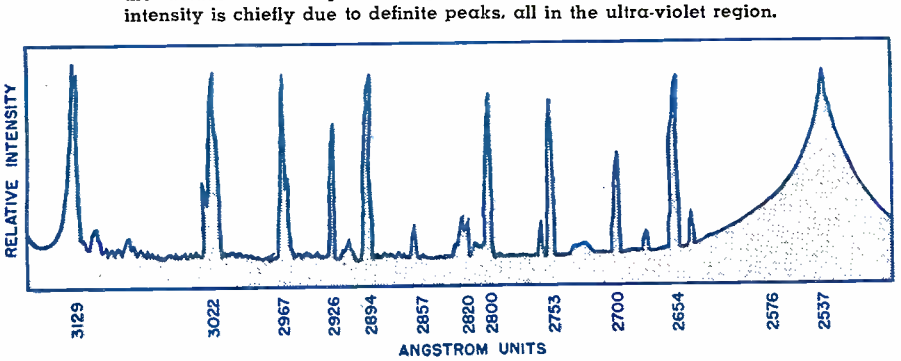
A simple circuit for utilizing this principle is shown in Fig. 2. A device of this kind has been manufactured commercially as a therapeutic sun-lamp. A 117L7GT serves as rectifier and oscillator in the Furedy circuit operating in the neighborhood of 20 megacycles. Radio-frequency energy is applied to the quartz tube through blocking condensers C_1, C_2 and a short transmission line. The tube itself is about 6 inches long and is held by fuse clips in a suitable reflector.

Quartz is employed because of its excellent transmission characteristics in the ultra-violet region. Its high frequency transparency remains undiminished after long use. The tube is first exhausted to a high vacuum, and then filled to a suitable pressure with argon, neon, helium, or krypton together with a droplet of mercury, some of which becomes vaporized during use.

If more ultra-violet intensity is required, the circuit of Fig. 3, which is still relatively simple, will provide it. A valuable advantage comes from using the 35L6's in push-pull as the r.f. voltage available for application to the quartz tube is double what it would be with one tube or parallel connection of two tubes. This is because in an r.f. oscillator the voltage at the plate is of the same order of magnitude as the polarizing potential and cannot very well exceed it no matter how much power is being developed. When the tubes are used in push-pull, however, the two voltages are connected effectively in series, so far as their application to the discharge tube is concerned.

—30—

Fig. 1. Curve showing the intensity of the output ray plotted against the actual wave-length in angstrum units. Note that the output intensity is chiefly due to definite peaks, all in the ultra-violet region.



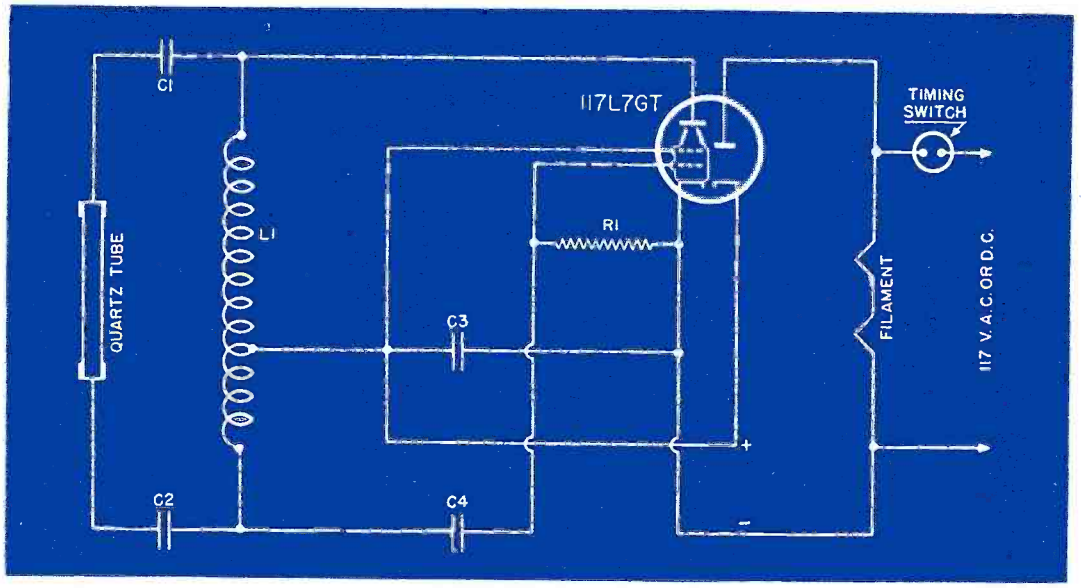


Fig. 2. A single tube oscillator circuit used for excitation of the quartz, ultra-violet producing, tube.

C_1, C_2, C_4—250 μμfd mica cond.
C_3—4μfd Electrolytic cond.
R_1—10,000 ohm ½ watt resistor.
L_1—Tank coil; 12 turns # 18 d.c.c. wire on ⅞" o.d. bakelite tube; tap 4 turns from grid end.

USES OF ULTRA-VIOLET RAYS

AS a therapeutic agent ultra-violet light is used for germicidal purposes and in the production of Vitamin-D in the skin. The radiation at 2537 angstroms is a strong germicidal ray while that at 2967 angstroms is most efficacious for Vitamin-D.

The industrial applications are numerous. Ultra-violet is used in the processing of foods (for Vitamin-D) and serves to insure sterility in many manufacturing operations. When the visible light is filtered out the high-frequency rays which are invisible can be employed in conjunction with special inks likewise invisible, or at least unnoticeable, under ordinary light. This combination can be used to effect many secrecy and signalling systems. Furthermore all sorts of marks, flaws, etc. not visible with daylight show up under ultra-violet. This results in many uses in crime detection and industrial inspection.

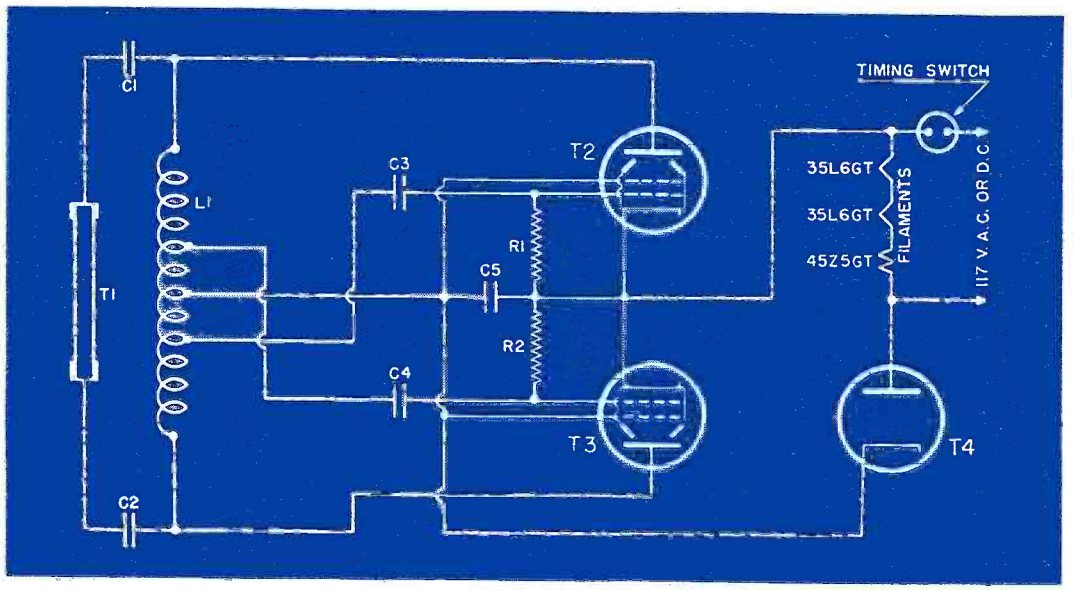


Fig. 3. Push-pull oscillator circuit using 3 tubes for the generation of additional r.f. power.

C_1, C_2—250 μμfd mica cond.
C_3, C_4—8μfd. Electrolytic cond.
R_1, R_2—20,000 ohm, ½ watt resistor.
L_1—Tank coil; 11 turns # 18 bare tinned copper wire on a ⅞" o.d. bakelite tube; winding length 1⅜"; grid taps two turns each side of center.
T_1—Quartz tube.
T_2, T_3—35L6GT.
T_4—45Z5GT.

Manufacturers' Literature

Our readers are asked to write directly to the manufacturer for this literature. By mentioning RADIO NEWS and the issue and page, we are sure the reader will get fine service. Enclose the proper sum requested when it is indicated. This will prevent delay.

SOUND EQUIPMENT

The *Bell Sound Systems Inc.* have just published a new catalogue announcing the type of sound equipment available. The apparatus described meets the most stringent requirements, offering the ideal combination of high efficiency, compactness, self-contained design, light weight, and smart appearance.

The listings of equipment include Amplifiers of 10—100 watts, Industrial Broadcasting Apparatus, Intercommunicators, Loudspeakers, Loudspeaker Horns, Loudspeaker Housings, Microphones, Phono Amplifiers, Microphone Stands, Mobile Systems of 15—30 watts, Preamplifiers, Public Address Systems of 6—50 watts, Recording Equipment, Portable Record Players, Remote Control Units, School Systems, Volume Expanders, and Voice Paging Systems.

These items are well illustrated and the descriptive data gives the interested party a well rounded verbal picture of the instruments.

These catalogues are available upon request from the *Bell Sound Systems Inc.*, 1183 Essex Ave., Columbus, Ohio.

FLEXIBLE SHAFTING

A new Flexible Shafting Manual illustrates and describes the many newly developed uses for flexible shafting. War orders for tanks, airplanes, aircorps equipment and other war units indicates a tremendous use of remote-control equipment. After the war this will develop still more as industry has found many new possibilities for flexible shafting.

Copy of manual N (Flexible Shafting) may be had by addressing the *F. W. Stewart Co.*, 4311 N. Ravenswood, Chicago, Ill.

FROSTRODE COOLER

A two page, illustrated technical Bulletin No. 75-AC describing the new FROSTRODE coolant cooler has just been released by *FROSTRODE PRODUCTS CO.* Designed for accurate temperature control of coolants and lubricants in machine processing, these portable compact, durable units complete the equipment needed for many present day precision production requirements. Minimum work distortion due to heating in grinding, cutting, turning and other operations is now possible for the first time, it is claimed.

(*Continued on page* 118)

S'W... J-...F

A resumé of the applications of ultra-high frequencies in the postwar period.

ULTRA-short radio waves which today are beamed like light and perform miracles of war, will be used in the postwar period to perform equally amazing feats in the home, on the highways and high seas, and in the factory, according to I. E. Mouromtseff, electronics engineer at the *Westinghouse Electric and Manufacturing Co.*

Radio may be used for treating human disease, cooking without external heat, guiding ships into fog-bound harbors automatically and many industrial applications.

We may reasonably expect that the vast development of the last few years in tube and equipment design and manufacture will help reduce the cost of such radio projects to a practical level. In addition, the many elaborate and well developed military radio systems now being used will not go into oblivion with the end of the war, but will find application in peacetime projects.

Guide Autos Through Fog

Small ultra-short wave radio sets, similar to military equipment, might be installed in automobiles. When these radio beams strike rows of overhead or roadside reflectors, the driver would be warned of danger spots or could be guided along the road despite the densest fog.

No longer will one train crash into the back of another on the same track nor will ships have difficulty finding the way into and out of harbors in fog and rain. Long wave radio gave us sound at a distance; the very short waves now give us vision at a distance.

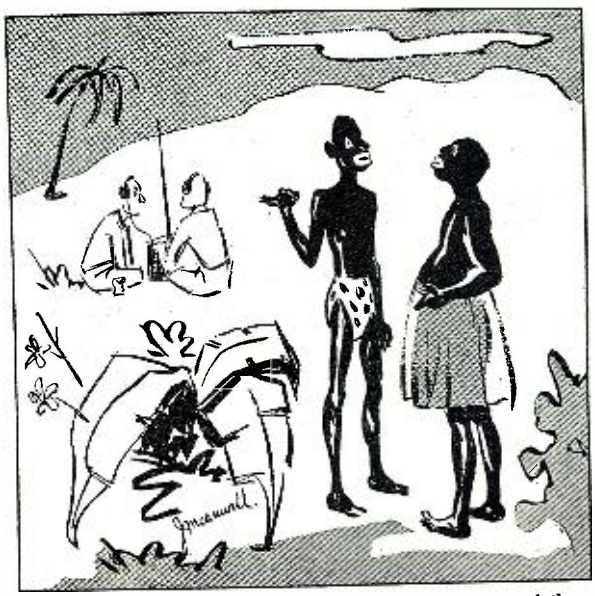
Long waves, like those used in standard broadcasting, radiate from a sending antenna like ripples when a pebble is dropped into a pool of water. They travel in all directions and use the earth's surface as a guide, thus following a slightly curved path. Ultra-short waves, on the other hand, are "channelized" into a narrow path and travel through the air in a straight line. Like light, these short radio waves can be projected in a beam and reflected. Thus they can be harnessed to accomplish many tasks.

Industrial Applications

Among the "feasible applications" in industry for this newest form of radio, Mr. Mouromtseff listed such jobs as helping convert chemicals into cloth, aiding in the manufacture of safety glass and treating preserved foods after they already are in the jars or packages.

One of the first industrial experiments with ultra-high frequency radio which produces ultra-short waves was for the de-infestation of wheat in grain elevators, contaminated with rice weevil. Laboratory experiments were successful and stirred up a tremendous interest both in this country and abroad.

Vacuum packers were interested in the possibility of pre-cooking hams and similar products by high-frequency radio. Restaurants investigated the future of large "radio cookers" which might be installed in dining rooms for grilling steaks, hot dogs or toasting bread in front of the customer. Heat would be generated only in the food itself and the food would be cooked from the inside out, giving it a different flavor.

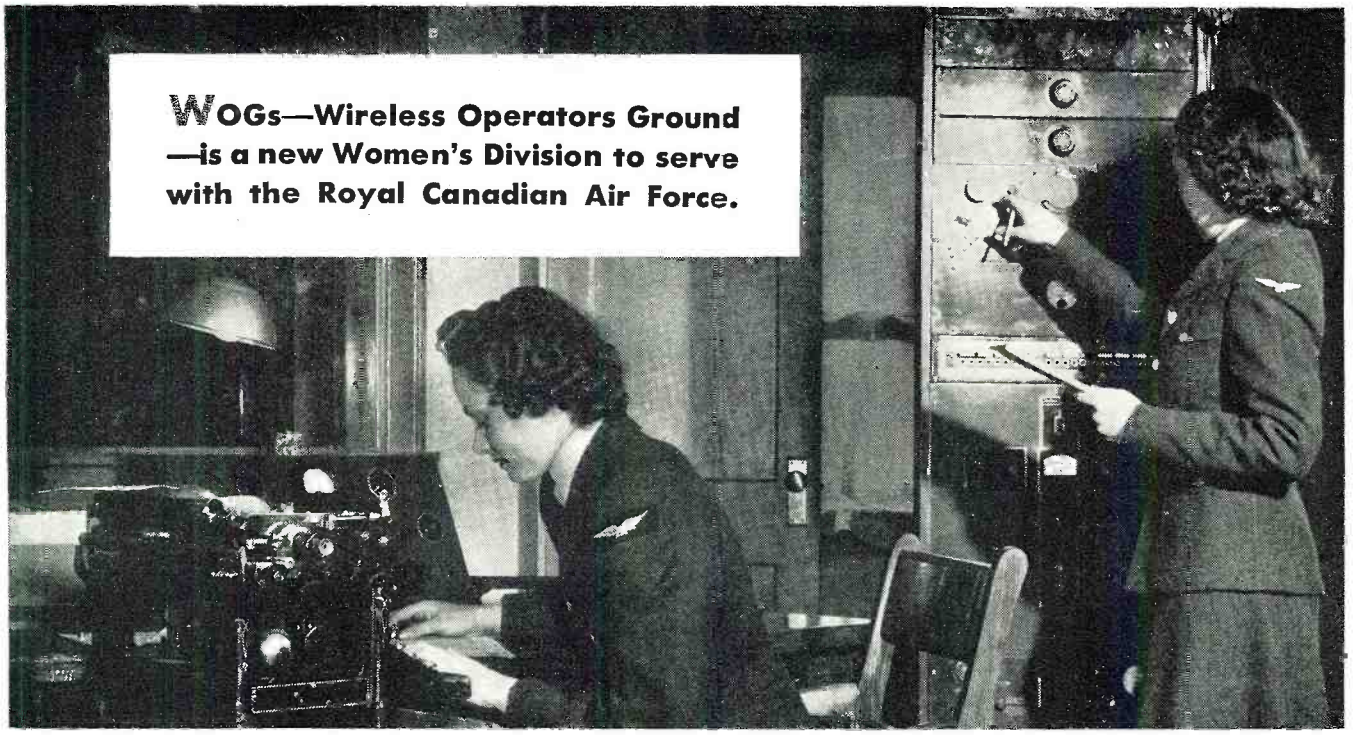


"Their transmitter utilizes the grid-plate capacity of the tube to provide feedback coupling in the grid circuit!"

Research Opens New Markets

Two factors cooperated in the past to frustrate the initially successful effort to apply ultra-high frequency radio to industry. First, the great economic depression killed all development projects in their early stages and, second, the cost of equipment was too high for practical applications. That cost will be reduced by virtue of ceaseless war research, however, and a vast new market, in the design of future ultra-high frequency equipment, lies ahead.

(*Continued on page* 127)



Radio operators shown recording data in a transmitter control room.

WOGS—CANADIAN AIRWOMEN

NO matter how high they fly these days, or even if the flip is a solo, Royal Canadian Air Force pilots must submit to sweet, gentle, but firm reminders of the fact that there is a Women's Division of their service. Reason: Lady-WOGs.

WOGs are Wireless Operators Ground, and recently the first batch of Airwomen to undergo the six-months training course were graduated from No. 1 Wireless School, Montreal, Quebec, and posted at various stations. Now when a pilot goes aloft, he can forget about those harsh bass voices, and concentrate on soft sopranos, for when he flips his radio switch, it is a Lady-WOG who gives him his orders.

WOGs have also been chosen to instruct aircraftsmen in Morse, signalling procedure, aldis lamp, and semaphore. Of these, Wing Commander K. R. Kirkpatrick says they are "convincing, combatible, and entirely firm in discipline."

Proof of Lady-WOGs' competence lies in the fact that not so long ago a group of them assumed full control of radio station CFAC in Calgary, for a whole day, and carried out in full all the detailed jobs of radio station operation, including sportscasts, newscasts. Even a network appearance (unscheduled and by accident) with the current grain prices was handled with dignity and aplomb that drew congratulations.

The men, who instructed the first group of Lady-WOGs, were surprised at the way in which the girls mastered the arrangements for the letter "Q", usually a difficult one for men. On inquiry, they were reminded by the girls that the Morse for "Q" is "dah-dah-dit-dah", or the refrain from Lohengrin's Wedding March.

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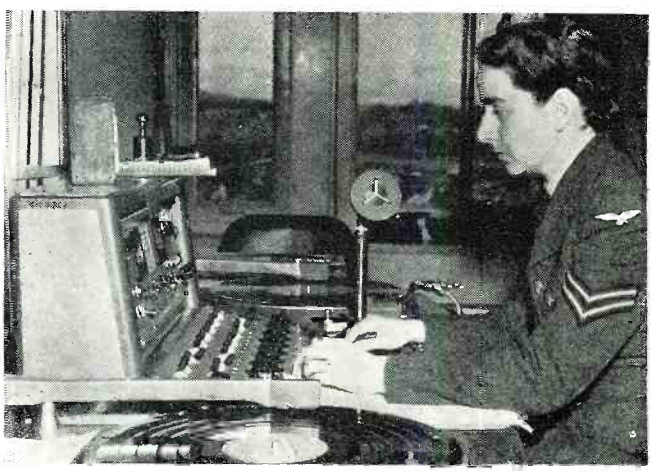
A full-fledged operator with "Sparks' Badge," at controls.

Corporal C. Ascah at control board of Canadian station CFAC.



FUNDAMENTAL BASS BOOST CIRCUITS

By WILLARD MOODY

Fundamental bass boost circuits for the experimenter, illustrating the many possible circuit designs that may be used.

MANY set owners like plenty of "boom" in their radio reproduction, and a deep bass being something that is not afforded by the average set, the serviceman may add the feature by using junk parts taken from old and discarded radios. For example, old choke coils can be used, and

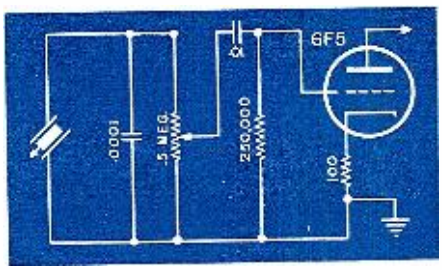


Fig. 1.

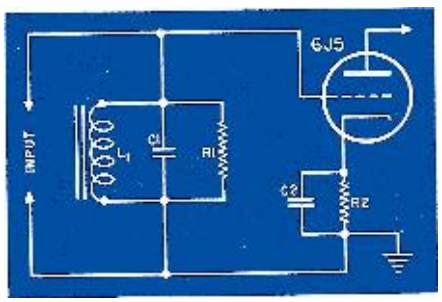


Fig. 2.

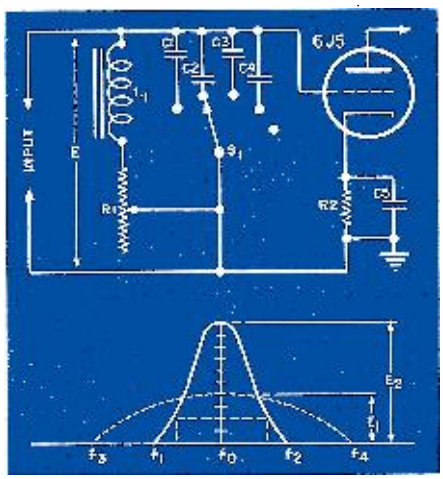
in some cases discarded field coils can be employed.

An improvement in the bass response can often be made by using the same radio chassis but hooking a different speaker to the set, one having a large diameter cone. This speaker is mounted in a solid cabinet of good construction. The wood of the cabinet will have an effect on the tone just as it will in the case of a violin or a piano. If loose, flimsy hinges are used, they may vibrate and produce a rattling sound or tinny clatter. For this reason, if possible, avoid cabinets having metal parts. This is easy to do, if the set does not have an automatic or manual record changer built in, and there is no cabinet top to be raised and lowered. Another point to keep in mind is that considerable back pressure is built up when reproducing low notes and the inside of the cabinet can be acoustically treated by simply adding some soft material to the inside of it. Even an old wool blanket will help, but any sound absorbent material may be used. An old rug, cut to about the dimensions of the back of the cabinet and tacked against the wall, will absorb back end radiation and reduce barrel-like tone effects. Usually the set may be placed four or five inches distant from a wall without having it vibrate and rattle on low bass notes.

The chassis should be mounted on rubber cushions, but an old rubber mat placed between the chassis and the cabinet will help dampen the vibrations and prevent acoustic feedback to the tuning condensers and tubes. Other soft material can be used.

In some sets the dial drive may rattle. It can be dampened against vibration by simply attaching a small piece of cord which will put tension on the metal drive rod (if one is used), or the dial cord tension can be increased slightly by stretching the spring. If an automatic record changer is in the same cabinet, the screws of the unit can be loosened and removed. Then soft leather or felt washers can be placed underneath the heads of the screws, the latter being replaced. Not too much pressure should be exerted against the springs, and the screws are not to be turned tightly. Enough tension, however, is used to hold them in place without allowing the transmission of vibrations from the cabinet to reach the record changer, in any appreciable magnitude.

Fig. 3.



A simple way of apparently boosting the bass, on a phono pickup of the crystal type, is to use the arrangement as shown in Fig. 1. The high frequency currents go through the easy path in the .0001 condenser rather than through the high opposition path in the .5 megohm ohm control. Because this circuit attenuates the highs, it is not truly a bass boost form, however, it does give an apparent bass boost effect.

In Fig. 2 we have a more authentic

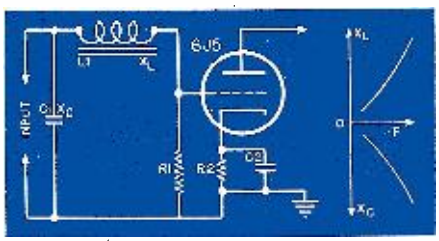


Fig. 4.

bass boost. If C_1 has a small value and R_1 is small, there will be little shunting effect of C at very high frequencies, and therefore there should be no appreciable loss at the high end. However, the bass and lower frequency notes will be brought up by resonance in L_1 & C_1. A disadvantage of this circuit is that selection of the resonant frequency is fixed and no control of the bass boost is afforded. R_1 is usually large enough to prevent great broadening of the tuned peak or resonant effect, although the lower R is made the less selective will be the tuned circuit and the lower the voltage across R. The selectivity effect of the resistance present is much the same as in a series circuit. This is illustrated by the curve in Fig. 3. If R_1 is made small, the voltage, across the grid and ground, at resonance rises. Increasing R_1 increases the circuit losses, broadens the tuning, and drops the voltage E. Selection of resonant frequencies is possible by means of S_1 and associated condensers, while control of the effect is obtained with R_1.

In Fig. 4, series inductance L_1 offers low opposition to low frequencies and

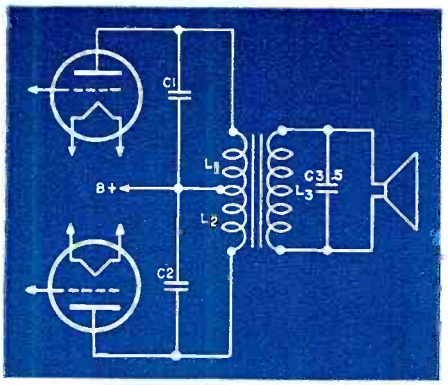


Fig. 5.

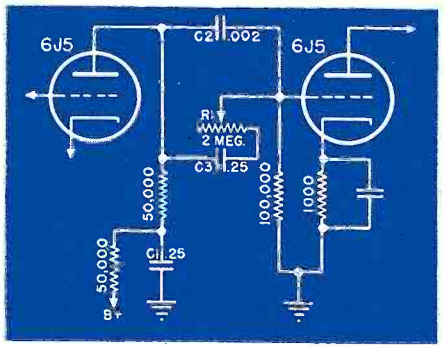


Fig. 6.

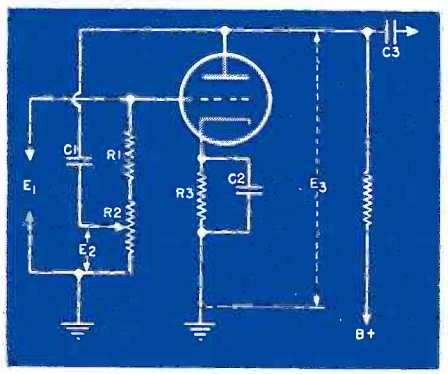


Fig. 7.

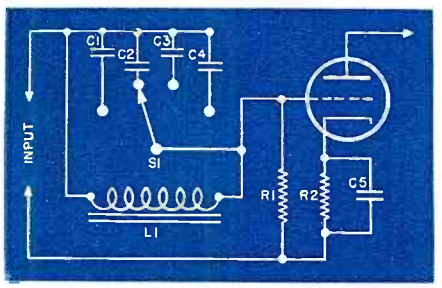


Fig. 8.

great opposition to highs, while C_1 bypasses the highs and does not pass the lows to any extent. This is a dividing network, or simple filter. The curve shows how the element reactances vary as the frequency is changed. Resonance is not used here, or is not noticed because of the high value of R_1 in series with L_1 and C_1. This circuit can be used advantageously in some sets, but has the disadvantage of putting the inductance coil in the grid circuit. There it may have appreciable capacitance to ground, which tends to cause leakage and losses at high frequencies, unless a triode with a low input impedance is used.

A means of obtaining low frequency apparent boost is to use a shunt condenser across the voice coil as shown in Fig. 5. This, however, will take out some of the highs and may cause peculiar resonant effects. Although it isn't generally recommended, this circuit, with some experimentation, can be employed.

The circuit of Fig. 6 gives good results. Decreasing the value of R_1 brings up the bass, and increases the series capacitance to a large value when R_1 is zero. Still another means of obtaining bass improvement, although it is not a real bass boost, is illustrated in Fig. 7. The gain of the circuit at high frequencies is cut down due to negative feedback. The amount of feedback is controlled by R_2. Since condenser C_1 is chosen to have a low value of about .0005 μfd. and does not pass the lows. E_3, due to lowered gain in the tube, drops as E_2 is made greater by raising the arm of R_2 above ground.

Referring to Fig. 8, a parallel resonant circuit develops a high impedance at resonance in series with the grid, attentuating signals at or near resonance. In this way, by rejecting the highs, the lows will be accentuated. The loss of volume, however, is high and the circuit does not offer much.

Series resonance is used in Fig. 9. There is opposition to the flow of current at frequencies away from resonance, and low opposition at resonance which is the exact opposite to the situation illustrated in Fig. 8.

In Fig. 10, a unique action occurs. R_3 controls the d.c. current in the winding L_2. If this current is made high, the core saturates and the inductance of L_1 is varied since the flux density changes and the flux divided by the current is a measure of the inductance. The variation of the reactance of L_1 changes the resonant frequency and the bass boost action. When C_1-L_1 are resonant, the plate load impedance of the tube rises and so does the gain at the resonant frequency.

The circuit of Fig. 11 shows a resonant circuit across which there is a potentiometer for picking off a part of the resonant voltage. In this way, the frequency of boost remains almost constant and the amplitude or gain is controlled by the pot.

Fig. 12 involves regeneration at the peak resonant frequency. L_3 & C_1 are chosen to resonate on the low end of the band. Feedback current, in the proper phase, is fed to L_1 through R_1

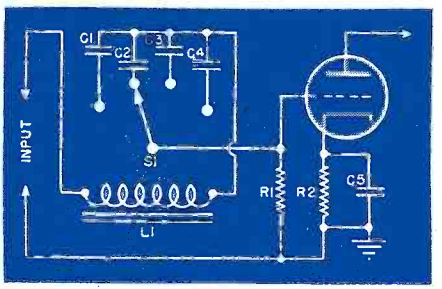


Fig. 9

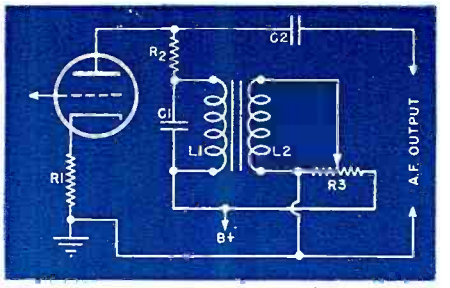


Fig. 10.

and R_3. The resistors R_1 and R_2 form a voltage divider for cutting down the feedback and establishing the limits of the circuit. This circuit is critical and regeneration cannot be brought up too high or it will spill over into oscillation and distortion. The feedback voltage across L_1 induces a secondary voltage in L_2, and this voltage is amplified by the tube.

Formulas and calculations do not mean much when working out these circuits. Every case is individual. Try

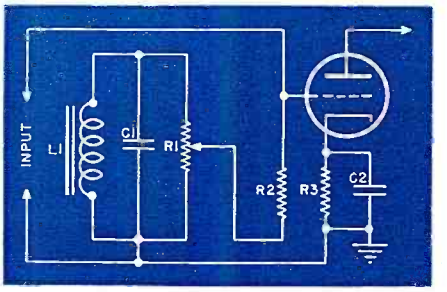


Fig. 11.

different values of L, C & R until the desired effect is secured, preferably with the receiver speaker in the cabinet and in the home.

The foregoing circuit diagrams provide numerous applications of funda-

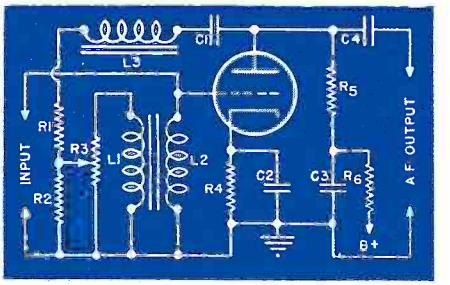


Fig. 12.

mental principles of vacuum tube circuits in order to emphasize the bass frequencies in the average home radio. Those circuits which provide a manual control of the bass frequencies are most practical since the amount of bass desired by an individual is determined by the acoustical characteristics of his ear. Here characteristics vary from person to person and therefore cannot be compensated by a fixed circuit. The particular circuit used may be one of those shown in this article or may be a combination of several circuits to give the desired results. Sufficient variety has been included in order to suggest original thinking on the subject thereby devising methods using available equipment.

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★ ★ ELECTRON TUBES ★ ★

By W. C. WHITE
Engineer, General Electric Co.

A review of electron tubes, and the part they are playing in electrifying present day industry.

WITH all the glamour currently associated with electronics, it is well to get back to the simple fundamentals. This is advisable because, in spite of all the publicity on secret electronic war developments, there are really no new basic principles employed. These basic principles have been in the literature for years.

What has happened is that these principles have been combined to form the basis of new devices and perfected in a shorter time and to an extent that could not have been done in peacetime.

Variety in tubes and versatility in their application is one of the outstanding characteristics in this field. Tubes are available that will detect and measure currents far less than a billionth of an ampere. Others will carry thousands of amperes. Similarly, voltages of a millionth of a volt can be detected and amplified and rectification up to one hundred thousand volts provided for.

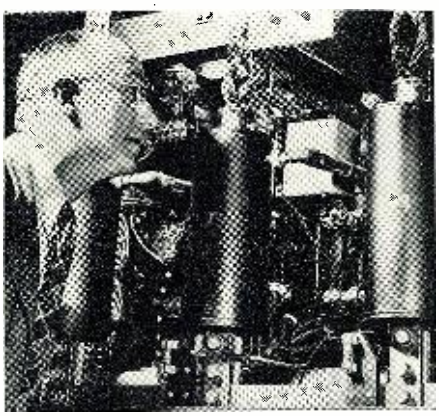
On the frequency scale, tubes are available to provide frequencies up to about a billion cycles. Physically, some tubes are so small that they will fit into a thimble; others are bigger than a man.

This variety plus the common use of such coined words as pliotron, kenotron, ignitron, and magnetron has made the understanding of what's what in tubes seem very complicated.

This need not be so because the fundamental classification of tubes is really quite simple.

There are only four basic component variables:

(1) The nature of the cathode that emits the electrons which is the basis of operation of the tube. There are several kinds of cathodes commonly employed. The red-hot metal cathode, the arc spot on the surface of a pool of mercury, a light-sensitive surface, or a cold-metal surface.



Engineer inspects sealed ignitrons installed in mercury arc rectifier unit.

(2) The nature of the content of the envelope. This may be a very high vacuum or a low pressure of an inert gas or vapor.

(3) The number of electrodes. Every tube has at least two but the pentagrid converter tube has, as its name implies, five grids and some recent tubes have thirteen external base pins or connections.

(4) A special feature is sometimes added to the basic components listed above to adapt a tube to some particular use. Examples of this are the fluorescent coating in a cathode-ray tube and the magnetic field for the magnetron.

On the basis of this simple form of classification, a Tungar bulb, for instance, is a hot-cathode, gas-content, two-element tube. An ignitron is a pool-cathode, vapor-content, three-element tube.

In this way any tube may be identified in terms of its fundamentals.

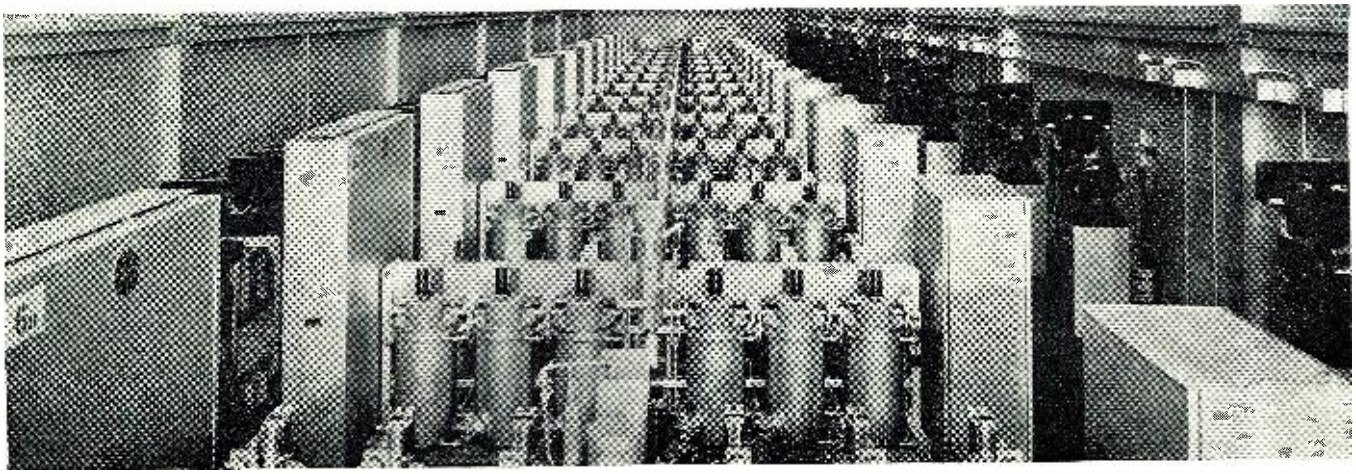
As a circuit element, the tube simply fills a gap where an electrical circuit has been cut and the tube inserted to re-establish this circuit. Here in this space between two electrodes the current is conducted by a cloud of many billions of electrons and, in some cases, aided and abetted by positive ions. Here we have electrical conduction simplified to its fundamentals.

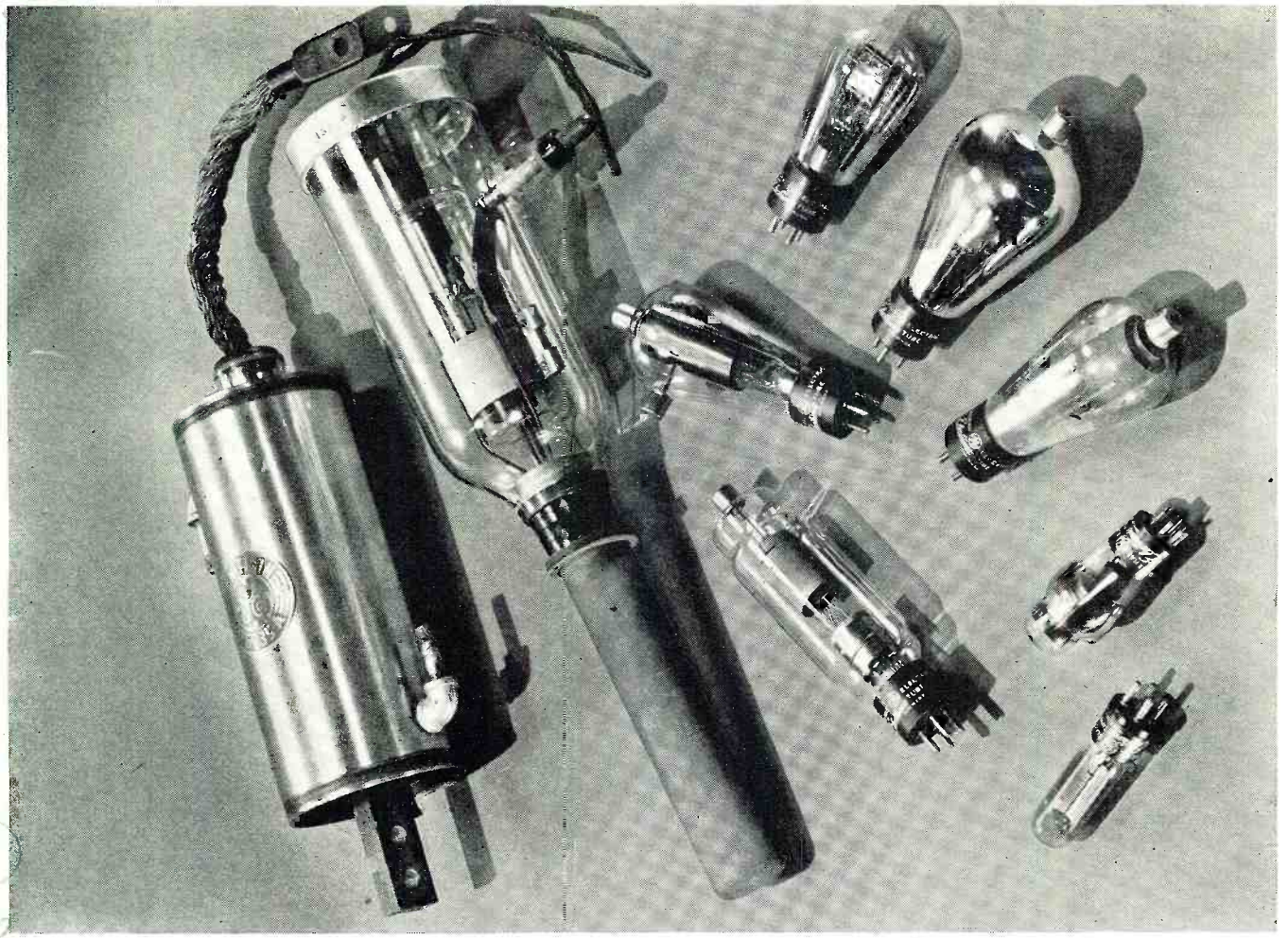
Thus, this little gap of a few mils to a few inches in length in a high vacuum or in a low-pressure atmosphere of some gas or vapor offers several possibilities for unique circuit control operations.

The usefulness of the electron tube as a circuit element is based upon many characteristics but in general these can be reduced to certain rather simple fundamentals.

The first of these fundamentals is their almost complete independence of action as regards the frequency of the circuit. As you well know, many electrical devices are suitable only for use on direct current or only the one frequency of 60-cycle alternating current. However, a vacuum tube can function at millions of cycles a second just as well as at 60 cycles. It can do this because the myriad of electrons in the

Twelve-unit ignitron mercury-arc rectifier installation in a large electrochemical plant.





A group of interesting tubes. They are all of recent design, and have aided materially in our war production.

evacuated space inside the bulb move at such enormous velocities that the frequency range mentioned above is slow compared to the time required for them to move from one electrode to another.

The second reason that electron tubes are unique is their ability to control electrical currents smoothly. Most devices that are used to vary an electric current do it step-by-step. The charge carried by each electron is so exceedingly small that the rhythmic increases and decreases of current to follow, for instance, music or the human voice, are easily, accurately, and smoothly accomplished.

The third feature is their ability to control the movement and velocity of the speeding electrons by merely changing the electrical potential of one of the electrodes inside the tube. This requires only a very small amount of electrical power. This is just another way of expressing the well known fact that vacuum tubes are amplifiers and can reproduce, at a greatly increased power level, the impulses fed to them.

The fourth feature is their ability to pass current only in one direction or, as it is often expressed, to act as a rectifier.

If one considers vacuum tubes in the light of these four unique characteristics, it is easy to see why they are so absolutely essential to modern radio. It is because these tubes possess and can utilize simultaneously some or all of these properties. In turn, modern radio needs, of course, just these properties. Radio is inherently a science of very high electrical frequencies, requires complicated wave forms, and the receiver must pick up the very minute amount of power received from space by a few inches of wire and amplify it to a point where the reproduced sound is at a relatively high power level or, as we say, has been greatly amplified.

The various applications of tubes in the industrial fields are also based upon the utilization of one or more of these unique characteristics. It is often useful to apply them as criteria to get a quick over-all viewpoint as to whether a particular suggested tube application is sound technically.

For instance, their use in welding control as circuit-closing elements is based upon their ability to amplify and operate accurately at high speed and for very short periods of time. In high-frequency heating, the ability to operate at very high frequencies and over a wide range of frequencies is of primary importance. In connection with a phototube, the ability of another tube to act as an amplifier responding to extremely small electrical impulses is the important factor in making the photo-electric relay a practical device.

Many think of the electron tube as having introduced a new era into the electrification of industry. For many years, electric equipment was applied to labor saving in industry, to remove one by one the many jobs requiring hard physical effort. The workman pulling, hauling, and lifting heavy objects has been replaced by one before whom is a series of buttons or levers by which he can quickly and accurately accomplish the desired result, with a minimum of physical exertion. This trend has continued until there are now but few of the old-time, back-breaking jobs left in industry. Industry is pretty thoroughly electrified in this respect.

The present trend is toward "routine saving" and here electron tubes are sure to play an important part. By "routine saving," is meant the ability of a piece of equipment to do something that one of the human senses plus certain muscles of the body do—without the aid of the thinking brain. For example, a person can watch a production line of manufactured objects pass by and note whether a certain part has been included or properly located. To do this only requires looking at the object and, when a certain difference in appearance is noted, operating a lever or responding in some

(*Continued on page* 102)

TECHNICAL BOOK & BULLETIN REVIEW

"ELEMENTARY ELECTRICITY FOR RADIO STUDENTS," by W. E. Flood, M.A. Published by *Longmans, Green and Co. Inc.*, 55 Fifth Avenue, New York City. 62 pp. plus index. Price 40c.

All who study wireless must know something about Electricity. This book presents the subject in such a way that those with no previous knowledge of electrical theory can acquire a sound background of accurate facts. When necessary more advanced textbooks can be tackled with confidence. Resistances, batteries, coils, condensers, and the properties of alternating current circuits are among the topics discussed. The text is fully illustrated by line diagrams, and ample exercises with answers are included for practice at the end of each chapter.

"SIMPLIFIED RADIO SERVICING BY COMPARISON METHOD," by M. N. Beitman. Published by *Supreme Publications*, Chicago. 107 pp. plus index. Price $1.50.

The contents of this manual have been used for lectures in a number of practical radio shop classes and proved very successful in application. Only practical and required data for actual radio work is included. Theory is kept to a very low minimum. Sufficient introductory material has been included to acquaint the beginner with essential radio facts. This same information will serve as an excellent review for others. You only need to be mechanically inclined to be able to follow these simplified instructions. The COMPARISON technique of radio servicing tells you what simple tests may be made to obtain electrical, visual, and other reactions from radio parts and circuits, and how to determine if the indications secured are what is to be expected from a properly functioning circuit, or what parts or stage to suspect. This method is a great simplification of servicing and calls for less knowledge, less time spent, and fewer instruments.

"ELECTRONIC PHYSICS," by L. Grant Hector, National Union Radio Corporation; Herbert S. Lein and Clifford E. Scouten of the University of Buffalo. Published by *The Blakiston Company*, Philadelphia. 346 pp. plus index. Price $3.75.

This text was written to meet today's urgent need for a beginner's text with a new approach to the subject. It presents a well integrated, modern study of the principles of electronic physics. All electrical phenomena are studied from the electron-proton point of view. Even magnetism is described in terms of moving electric charges. The electrical nature of atoms of all elements is constantly used in the ex-

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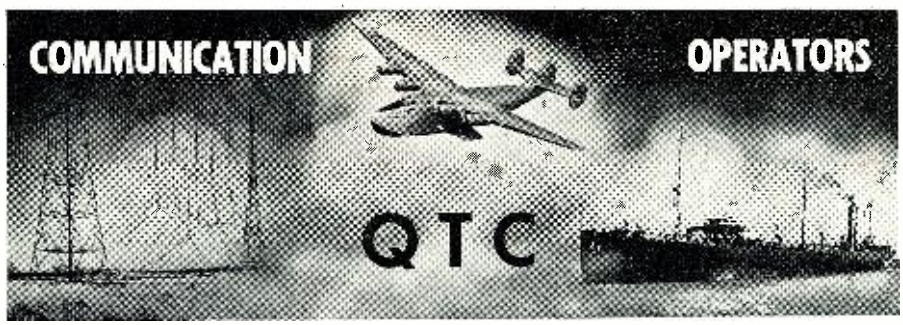

By CARL COLEMAN

WITH the advent of cooler weather and the end of vacations, the gang seems to have recovered some of the old time pep and things are really looking up a bit. Have heard from quite a few of the old timers, among them H. Meyerhoff, who was in New York recently on a vacation from his berth on the west coast run. Dave Grossett was also in not so long ago. Winiker has recently taken out a Liberty ship. E. Quick is back from WAX, where he has been pounding brass for several months. He is going back to sail the briny deep once more. Crosby of UFCO is expected to return to that outfit after an extended leave in beantown. Gjeruldsen also shipped out on a Liberty recently. Those "C" type of boats certainly make a nice berth. There are a goodly number of the boys, who would like to travel around on 'em. The new Victory ships are also going to be nice going for some of the gang lucky enough to connect with one. They will be coming through sometime early this spring. The boys, who are on a "C" ship now, are sticking to them—well, one can't blame them, for they are nice jobs. There is a lot of new equipment on them, including Scott receivers which are also being installed on the Liberty ships. The newer Libertys, incidentally, will be a big improvement over the earlier types. And, of course, if you're not satisfied with these new cargo crafts, you can always join the Navy.

Recently had a nice letter from C. E. Williams, president of C.R.O.A., who sent information regarding some of the members. R.O.U. gave us also a lot of information on the gang, including Edward Baxter, who recently was associated with the Chicago and Southern Airlines. He has terminated his employment there to return to sea. J. H. Pierce, former third mate of Waterman Lines, has obtained a radiotelegraph license and shipped out. D. F. Merritt is to make a maiden voyage on one of the new Waterman Line ships. Paul Brown and E. J. Olsen recently accepted new assignments. William Alexander has taken out a Liberty and so has Warshore.

A. A. Mansfield recently enjoyed a brief vacation in Miami between assignments. Michael Lucia was also in for vacation a short time ago. Frank Flack returned to New Orleans a while back, after having been away for nearly a year. C.T.U. Mar-Div in New York reports that Lt. Karl Baarslag, noted author of "S O S to the Rescue" and many other well known books which have always been of intense interest to the marine radio officers, has won a promotion to Lt. Commander. It's also Lt. Commander Fuld now; congratulations to both these men who so well deserve these advances. John Breaux and Peter Scott both announced, on their return to New Orleans, that they were made members of the Torpedo Club a while ago. Peter took out a Liberty shortly after his arrival. E. Emile Rackle, for many years Superintendent of Communications for the Waterman Line, has terminated his services with that company to accept a position with the Higgins Industries at New Orleans. He has been replaced by the equally capable David R. Hoy, a recent employee in the Waterman Shipyard.

The U. S. Maritime Commission in New York is continuing with the installation of Scott receivers aboard ships as they arrive; both the broadcast and communications models will soon be on the great majority of ves-

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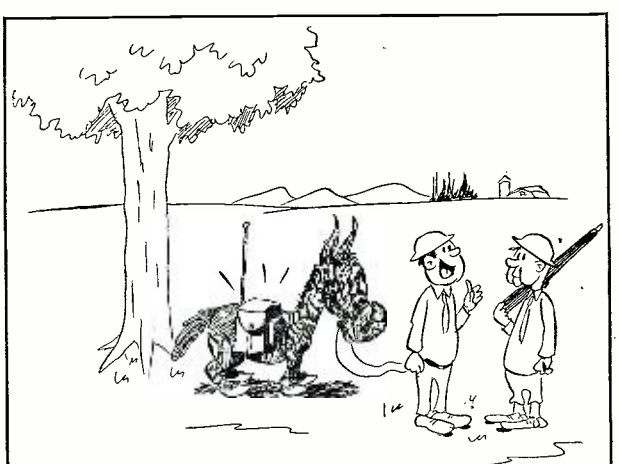


"Taking orders like this is almost like having the Sarg. himself standing there!"

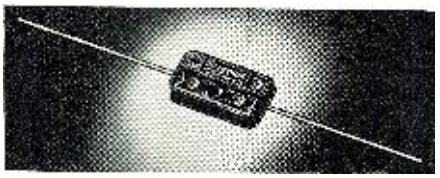
WHAT'S NEW IN RADIO

New products for military and civilian use.

CAPACITOR

Keeping steady pace with the increased tempo of war and the subsequent need for new improvements, the *Micamold Radio Corporation,* now announces the perfection of a small-size capacitor.

It will find widespread application in compact radio, sound and electronic equipment. This newly developed, small paper capacitor, molded in bake-



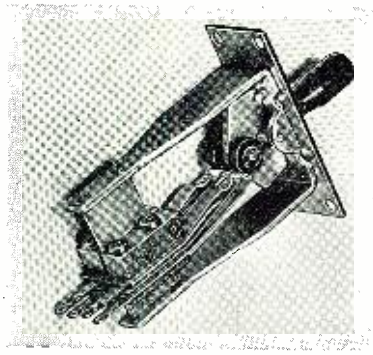
lite, known as the Type 338, has body dimensions ¾" long by 7/16" wide and 7/32" thick, and is available in capacities up to 0.1 μfd., with a rating of 120 w.v. d.c. Because it is hermetically sealed, the 338 will operate satisfactorily under highly humid conditions. It has been approved in a series of tests, including immersions tests, meeting rigid government specifications. For further information, write to the *Micamold Radio Corporation,* 1087 Flushing Avenue, Brooklyn, New York.

KEY SWITCHES—JACKS

Key switches, designed for quiet, dependable operation in vital communications circuits are now available for immediate delivery from the *Audio Development Company.*

Allowing for a maximum of seven springs in each quadrant of the switch, they provide a wide variety of locking and non-locking switching combinations. Silver alloy contacts are standard. Special contact materials can be supplied when desirable. Key switches are supplied with or without mounting plates.

A new telephone type of jack is



available. It features welded box construction assuring rigid alignment of all parts. Non-aging springs provide permanent tension. Additional springs allow for the switching of auxiliary circuits as desired. They can be supplied for all standard two and three circuit telephone type plugs.

Manufactured by the *Audio Development Co.,* 2833 Thirteenth Ave South, Minneapolis, Minn.

INSTRUMENTS

A new line of small, thin, d.c. panel instruments featuring a revolutionary internal-pivot construction is announced by the *General Electric Company* for use in aircraft, and radio and communications equipment, and for application on various types of machinery. Available with either brass or molded Textolite dustproof and moisture-resisting cases in 2½-inch sizes, the line consists of d.c. voltmeters, ammeters, milliammeters, microammeters, radio-frequency ammeters and milliammeters, and d.c. volt-ammeters. The volt-ammeter, one of the group designed for naval aircraft, has a push-button-operated switch to change the reading from "amperes" to "volts."

In the new instruments, the pivots are solidly mounted on the inside of the armature shell instead of being secured to the outside of the armature winding in the conventional manner. One jewel bearing is mounted rigidly on top of the core-and-frame assem-

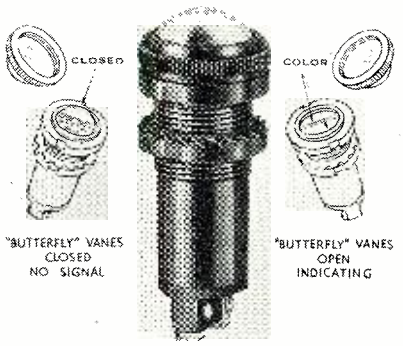
bly, and the other is mounted in an adjustable sleeve fitted into the lower part of the soft-iron core. Thus the element assembly is a single, self-contained unit, all parts of which are supported by a high-coercive cast magnet, and it can be removed easily for inspection or repair in the field.

Two publications available on request to the *General Electric Co.* at Schenectady describe the new instruments in detail. Publication GEA-4117 covers the 2½-inch panel instruments designated Type DW-53 for Naval Aircraft. Publication GEA-4064 covers the 2½-inch diameter panel-type electric indicating instruments, designated Types DW-51 and DW-52.

SIGNAL INDICATOR

The new *Littelfuse* No. 1534 Signalette is used extensively as a signal indicator in aircraft and has many possible applications in other fields.

It operates by reflected light and radio activity. This serves to make it useful under a variety of conditions—such as daylight, "black light," and to-



tal darkness. A radium active fluorescent paint used on the indicator shows signals in total darkness. The Signalette makes the signals correspondingly brighter, thus there is no dimout in sunlight.

There are some other important advantages. It does away with the blur usually occasioned by transmitted light. The pilot's eyes do not have to adjust themselves to the reflected light, which gives better vision in night flying. The indicator is also free from glare in the daylight. Not being disturbed by glare, the pilot does not have to dim his Signalette, and there are no burn-outs as with other similar type lamps.

The Signalette is shatter-proofed by a transparent plastic cap, which withstands severe tests of shock and explosion, and permits free penetration by ultra-violet rays. Its overall length is 2 5/32-in. and it is constructed for mounting in panels up to ⅜-in. thickness.

Test samples are available to government agencies and to companies who will outline their applications so that engineering test data can be secured. The applications should be sent to the manufacturer—*Littelfuse Incorporated,* 4757 Ravenswood Ave., Chicago, Illinois.

TEST INSTRUMENTS

R. C. P. has just introduced three new test instruments designed to fill industry's war-time need for compactness, simplicity, flexibility, and accuracy in test equipment.

The first one is an Output Meter—Model 471—which has a constant impedance of 4,000 ohms. All resistors are precision wire wound, and are accurate within 1%. 471 is a rectifier type a.c. voltmeter. Five voltage ranges are available by turning a se-

(*Continued on page* 100)

WARTIME PROGRESS

THIS is the new bomber nose test chamber which takes aircraft and electronic equipment seven and one-half miles up into the stratosphere without leaving the ground. Developed by engineers of the RCA Victor Division of Radio Corporation of America, two are now in operation at the Camden plant, speeding radio equipment to the air services. An actual nose for a famous bombing plane, it is made of pleniglas, a plastic, and permits engineers to see the entire apparatus in operation. Photo shows RCA engineer checking equipment under stratospheric conditions it will encounter in high-altitude flying.

PRACTICAL RADIO COURSE

by ALFRED A. GHIRARDI

Part 19. Covering the causes of harmonic and frequency distortion produced by power pentode tubes and methods of minimizing them.

COMPARED with the power amplifier triode, the power amplifier pentode offers several important advantages for use as a power tube. It is more *effieient,* in the sense that a greater proportion of the power drawn by its plate circuit from the plate voltage supply is converted into a.c. signal power for operating the loudspeaker. Also, it has higher *power sensitivity,* in that a volt of alternating signal applied to its grid produces a larger output; and this larger output can be obtained with reasonably low distortion. Its high power sensitivity makes it widely used as a power-output tube for radio receiving sets, because it usually can be driven directly from the detector or demodulator without the necessity for an intervening a.f. voltage-amplifying stage. This is especially important in small low-priced receivers where compactness and low cost are considered more important than superior tone quality.

Since the efficiency, power sensitivity, and output power of power pentodes exceed the corresponding quantities for power triodes, they are widely used as the output tubes in home radio receivers, public address amplifiers, and similar apparatus. The power pentode plate characteristics, however, differ so markedly from those of triodes, that many of the deductions arrived at in the previous two lessons concerning triodes are not valid for pentodes.

Harmonic Distortion of Power Pentodes

With power triodes, as we have seen, most of the distortion produced by the tubes is *second-harmonic* distortion, caused by the curvature of the dynamic characteristic, which has the general shape illustrated in Fig. 1A. Notice that the curvature here is single, which is typical for second harmonic distortion. The amount of distortion depends upon the amount of divergence M-N between the actual curved dynamic characteristic and the straight-line ideal characteristic C-D.

In the case of the power pentode the dynamic plate-current grid-voltage characteristic has the peculiar double-curve S-shape illustrated in Fig. 1B. This particular type of divergence from linearity usually implies both second harmonic and third harmonic distortion.

A graphical analysis of the distortion resulting in a power pentode tube is presented in Fig. 2. Here both the resultant distorted plate current wave and its components consisting of the *fundamental, second* and *third* harmonic sine-waves are clearly shown. This analysis can be reasoned out in a manner similar to that we employed for second harmonic distortion in a triode (see Part 17 of this series in the September, 1943, issue of RADIO NEWS).

Where both second and third harmonic distortion are present, the total distortion is equal to:

$$\%\ \text{total (2nd \& 3rd) harmonic dist.} = \sqrt{(\%\ \text{2nd har. dist.})^2 + (\%\ \text{3rd har. dist.})^2}$$

This in accordance with the usual method of adding two alternating values of differing frequencies.

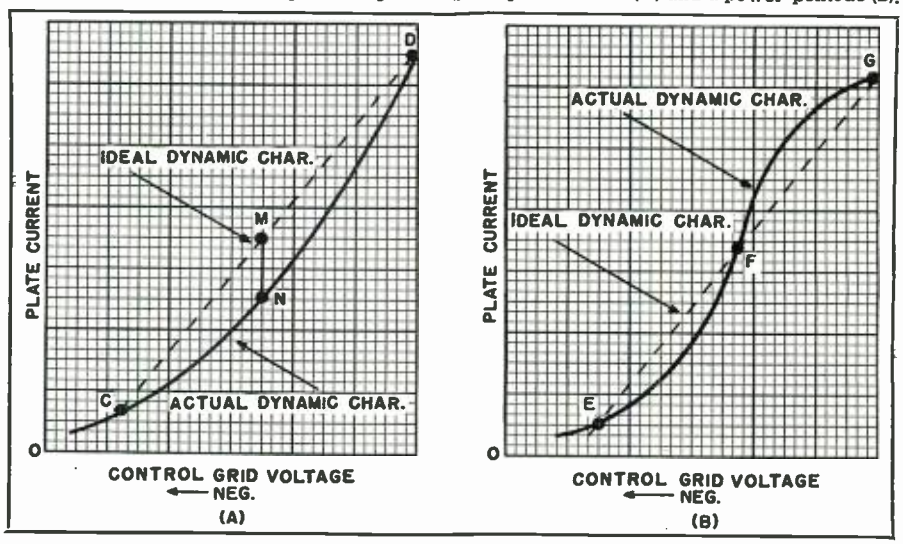
Plate Load Effect on Harmonic Distortion

Since the dynamic characteristic of a triode power tube becomes more nearly linear as the load resistance is increased, the distortion caused by these tubes (mainly second harmonic) *decreases* as the magnitude of the load resistance is *increased.* This is illustrated in the typical triode load-versus-distortion characteristic shown in Fig. 3A. Inspection of this illustration shows also that as the load resistance is increased (past the value where the load resistance equals the a.c. plate resistance) the power output also decreases (as shown). Maximum *undistorted* power output (total harmonic distortion within 5%) is obtained when the load resistance is equal to about *twice* the a.c. plate resistance of the tube.

In contrast to this, since the load-versus-distortion, and the power output, the characteristics of power pentodes are more nearly as indicated in Fig 3B, it makes the selection of the proper value of plate load resistance for power pentodes much more critical than for triodes. As the load resistance is increased, the upper bend of the plate-current grid-voltage characteristics (see Fig. 1) becomes more and more curved, and the *third* harmonic distortion therefore *increases* steadily. The *second* harmonic distortion is high for low loads, but drops away to zero as the load is increased. Still higher loads above this reintroduce second harmonic distortion, which then rises rapidly with increasing load, as shown. This makes the selection of the proper value of plate load resistance for power pentodes much more critical than is necessary for triodes. However the power delivered to the speaker increases at a diminishing rate as the load is increased.

Comparison of the typical characteristics of power triodes with those of power pentodes (Fig. 3) will quickly show why power pentode loading involves some special considerations which make the problem different from that encountered with power triodes. It will be seen from Fig. 3B that from the standpoint of distortion, power pentode operation with a fairly low plate load is much to be preferred (even though this means a reduced power output). Thus third harmonic distortion is rather low at low loads. Although the percentage of second harmonic distortion for single-tube operation is rather large for low loads, it is much less objectionable than a considerably smaller percentage of third har-

Fig. 1. Plate current—control grid voltage curves of α power triode (A) and α power pentode (B).



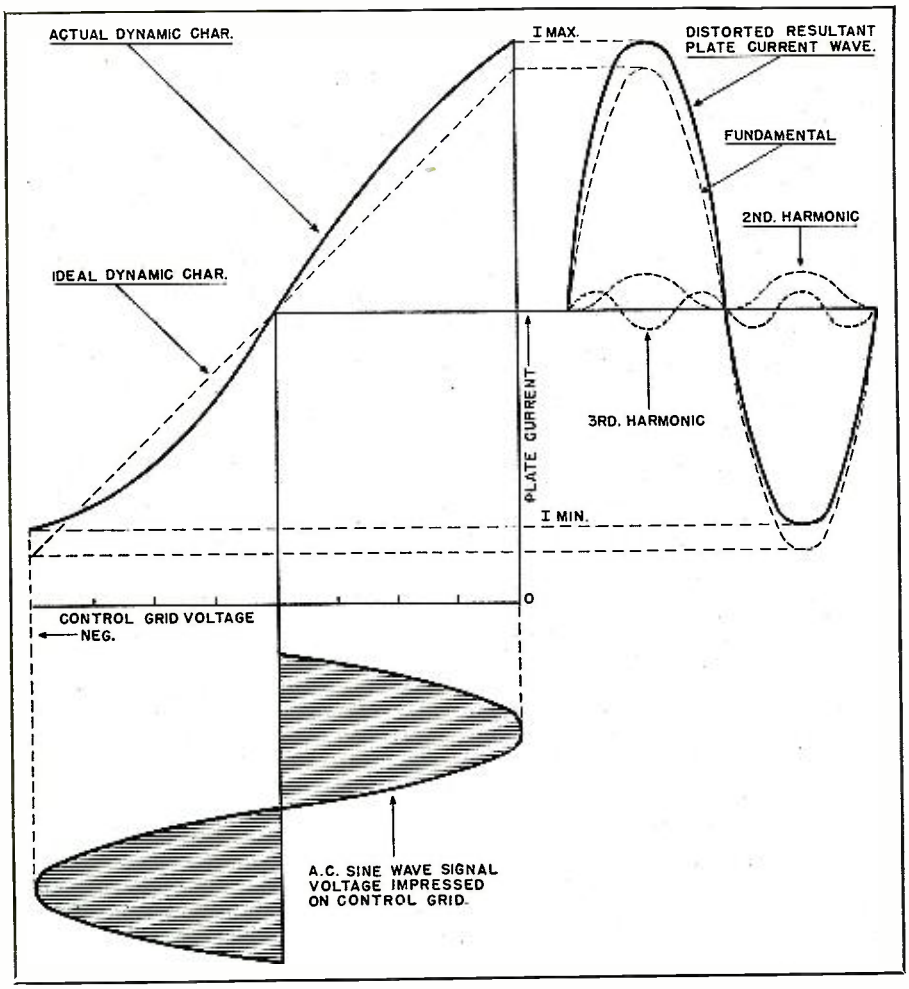


Fig. 2. Power pentode plate current—control grid voltage curve, illustrating the output distortion made up of second and third harmonics.

monic distortion would be (since third and other odd-order harmonics are more noticeable and contribute far more unpleasantness in the reproduced sound than the same total percentage of second harmonic distortion).

As a result of these peculiar harmonic distortion characteristics, maximum undistorted output is *not* obtained from a power pentode when the plate load is made equal to *twice* the a.c. plate resistance (as is the case for power triodes), for if a load resistance as high as this is used for a pentode, excessive distortion (especially third harmonic) will result. For this reason, a load resistance very much lower than the plate resistance is usually employed with these tubes. For example, for a typical power pentode (6F6) having an a.c. plate resistance of 80,000 ohms, a load resistance of only 7000 ohms must be used. This is less than 1/10 of the value of the a.c. plate resistance. Of course, with such a large mismatch, much of the available signal power is lost within the tube. Power pentodes, however, have such high amplification factors that even under such unfavorable operating amplification conditions a comparatively large amount of signal power output can be obtained with a low grid signal voltage and at values of load resistance for which the total distortion is fairly low.

The optimum load for a power pentode in a given application is, therefore, that which provides the largest output power without more than the allowable value of distortion.

Power Pentodes in Push-Pull

Owing to the fact that in properly designed single-tube power pentode circuits the dominant harmonic distortion produced by the tubes is the *third,* very little reduction of total harmonic distortion can be effected by operating pentodes in push-pull since, as explained in Part 17, of this series, the push-pull connection removes only *second* and other even-order harmonics. Pentodes, however, are often operated in push-pull under special loading conditions in order to obtain improved fidelity at the expense of power output. If the two power pentode tubes are operated in push-pull with a fairly low value of load resistance per tube, the *second* harmonic distortion produced by each tube will be *high,* see Fig. 3B, and the *third* harmonic distortion will be *low.* Since the high second harmonic distortion will be eliminated from the output by the push-pull connection, a net overall improvement in the fidelity is obtained because of the lower-than-usual third harmonic distortion which results from the operation with low plate load.

Of course, all of the other advantages of push-pull operation, which were outlined in Lesson 18, (such as hum reduction, less filtering required in power supply, etc.) are obtained when power pentodes are operated in push-pull. Some of these may be important enough in themselves to dictate the use of push-pull pentodes in some applications.

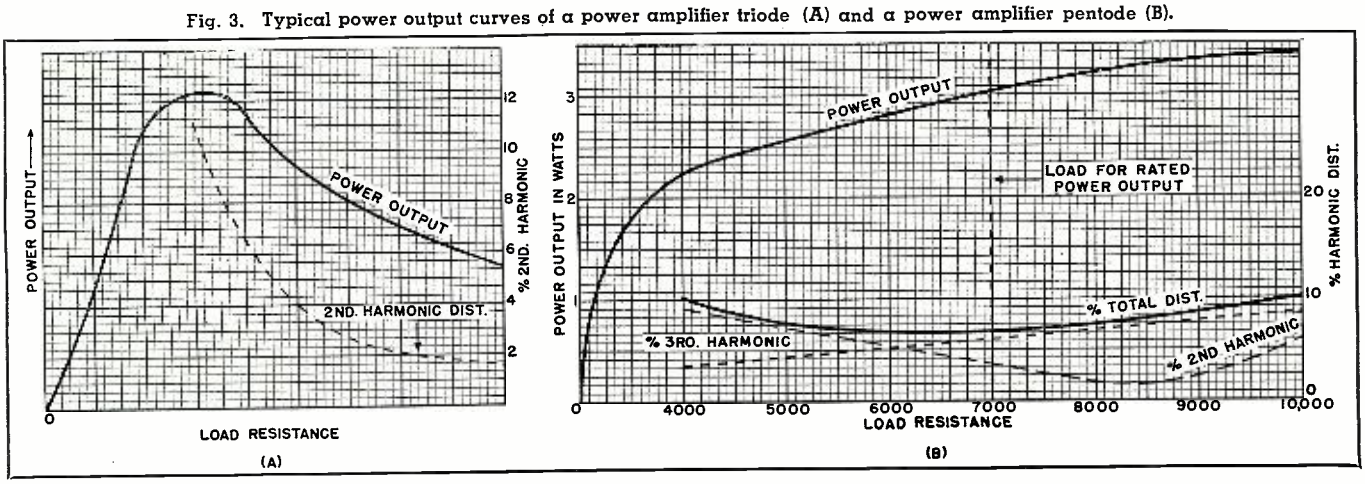
The odd-order harmonics generated by power pentodes may also be reduced by the loading conditions made possible in Class AB operation, or by employing negative feedback as we shall see later.

Causes and Effects of Loudspeaker Impedance Variation

For simplicity in our discussion of

(*Continued on page* 104)

Fig. 3. Typical power output curves of a power amplifier triode (A) and a power amplifier pentode (B).



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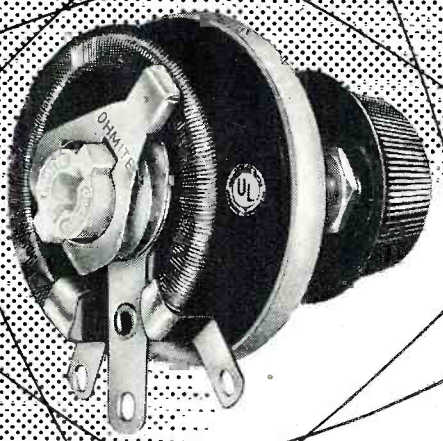

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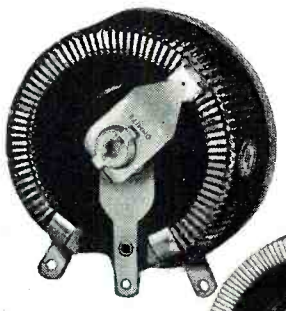

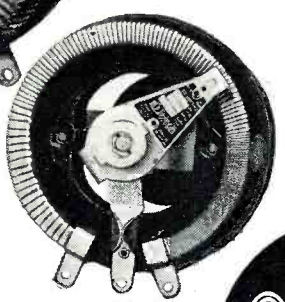

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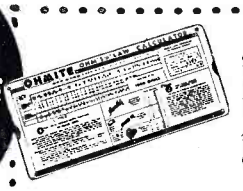

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Saga of Vacuum Tube
(*Continued from page* 28)

amplifying properties of the Audion. As has been noted in a previous article, de Forest had not up to this time succeeded in utilizing the Audion for this purpose. This may possibly have been due to the use of improper coupling impedances, the use of radio frequency coils and condensers, in trying to make it operate as a low frequency amplifier.

Otto von Bronk, a Telefunken engineer, was more successful in this respect, and in 1911 obtained a German patent (D.R.P. No. 271059)[151] on the use of the de Forest "hot cathode tube" as a *high frequency* amplifier. The arrangement used by von Bronk is shown in Figure 54. He also obtained French, United States, Austrian, and British patents for the arrangement.[152]

The final form of the von Lieben tube, which in time came to be known as the "LRS Relay" or "LRS Repeater", is shown in German patent D.R.P. No. 264554,[153] the application date of which is October 15, 1912. This patent was issued to the Allegemeine Elektricitäts Gesellschaft in Berlin, which had with the Telefunken Company acquired the rights to the inventions of von Lieben and his associates a short time before.

The story of the development of this Repeater was told by Reisz in an article published in 1913,[148] and his description of the device, which is shown diagrammatically in Figure 55, is as follows:

> *"g is the evacuated glass tube in which the three electrodes (cathode k, auxiliary electrode h, and anode a) are mounted. The auxiliary electrode extends over the entire cross-section of the tube and permits of current flow between the main electrodes through small openings, the main electrodes being connected to a direct current source. The cathode k consists of a thin platinum strip, wound in a zig-zag fashion upon a glass rod, the metal surfaces being covered with a thin layer of barium and calcium oxides. The cathode is brought to a bright red heat (1000° C) by means of the battery of 30 volts."*

Further details from other sources are as follows.[154] The cathode consists of a strip of platinum about 1 meter in length, 1 mm. wide, and 0.02 mm. thick. The apertures in the auxiliary electrode (grid), which is an aluminum disc, are 3.5 mm. in diameter. An amalgam of mercury is contained in the small side tube. This is used to enable the operator to maintain the pressure in the main tube at the proper level (about 0.01 mm. mercury). Mercury vapor could be introduced, when needed, by heating the amalgam in the side tube. The anode was a spiral of aluminum wire 2 mm. in diameter. The anode battery was 220 volts, the

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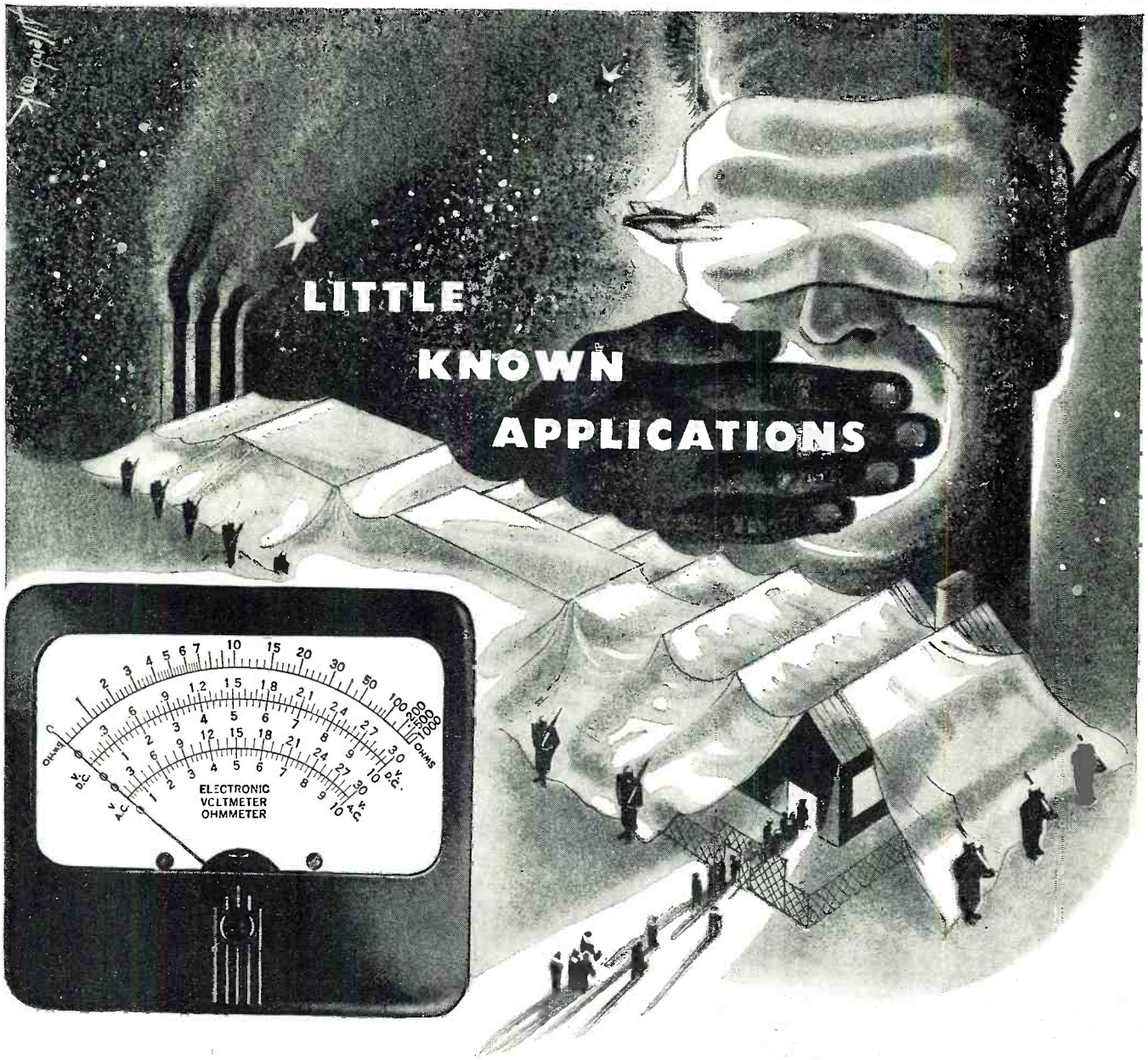

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anode current 10-15 milliamperes, and the cathode heating current was about 2 amperes. The amplification factor was approximately 33, and a useful life of 1000-3000 hours was claimed.

In the earlier LRS Relays the bulb was about 18 inches high and had a maximum diameter of about 4 inches. Later a smaller bulb about 8 inches high, with corresponding reductions in the other dimensions, was made.[155] There were two types of bases. In one of these all connections were made through bayonet pins which were so arranged that the tube would not be inserted in an incorrect manner into the socket used. Figure 56 shows a specimen of the larger LRS Relay, with a base of this type. Figure 57 shows the same type of tube but with a different base.

The LRS Relay was used for a time as a telephone repeater in Germany, but was never satisfactory. It had several disadvantages. It was, like all ionization devices, undesirably noisy. The filament was subject to bombardment by the positive ions of the mercury vapor, which tended to knock off the oxide coating. Variations in the operating characteristics caused by external influences, such as temperature changes, were excessive. It was very sensitive to extraneous voltages which, if very great, caused paralysis of the tube. Most of these disadvantages are, however, common to all devices which employ mercury vapor. The introduction of this vapor had the effect of reducing the internal impedance of the device, and permitting the use of larger anode currents than had previously been obtained in vacuum tubes. It also simplified the design of the necessary auxiliary apparatus, such as input and output transformers.

When the LRS Relay was in operation the upper portion of the bulb, above the perforated intermediate electrode (grid), was filled with the blue glow of the ionized mercury vapor, except for a dark space just above the grid. This tube was usually operated with a positive potential on the grid, which was adjusted by means of a potentiometer. The most satisfactory functioning was usually obtained when the grid potential was adjusted so that the dark space extended from 1 to 2 cm. above the grid.[156] Some of these tubes had a graduated scale etched on the side of the glass bulb, extending upward from the grid. This was probably used as a guide in adjusting the height of the dark space.

The LRS Relay was made in two sizes, as has been noted before, and also in two types. One type had the electrode construction described above, the other was similar except that the perforated aluminum disc used as a control element was replaced by a fine wire-mesh grid.[157] It is not known to the author whether both types were made in both sizes or not. The tube with the fine mesh grid was intended for use as a "weak current" amplifier, and the other type, although similar, as a "strong current" amplifier.

Some of the difficulties which were experienced in the use of this amplifier in practice were overcome by enclosing the tube in a temperature regulator, as shown in Figure 58. This arrangement was made the subject of a German patent in 1914.[158] It was a makeshift solution, however, which only partially overcame the difficul-

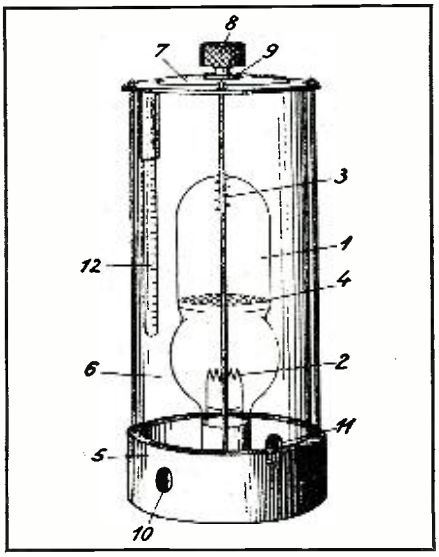

Fig. 58.

ties. A short time later the Telefunken Company abandoned the gaseous tube and brought out a smaller tube with a tungsten filament, and a high vacuum.[159] This and later German high vacuum tubes will be treated in a subsequent article.

It is interesting to note, in passing, that von Lieben and his gaseous ionization tube have been honored by the Austrian Government by being pictured on a postage stamp. The stamp is one of the Charity Series of Commemorative Semi-Postals, issued in 1936. (Scott No. B131)

Concerning the work done in thermionics in other parts of Europe, the author has been able to find record of only two cases of such activity. The first is that of Eric Magnus Tigerstedt of Copenhagen, who, in 1914, obtained a German patent (D.R.P. No. 314085)[160] for a "relay for undulatory currents." A United States Patent covering the same device, and bearing the application date October 19, 1916, was issued

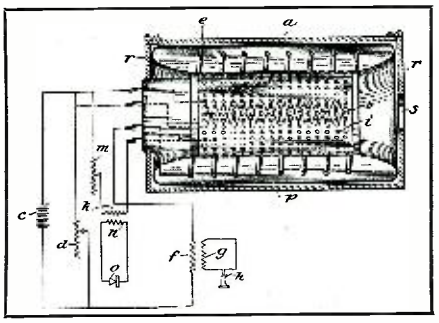

Fig. 59.

to Tigerstedt in 1917.[161] The invention was described as "a relay for undulatory currents comprising an airtight evacuated container, an anode mounted

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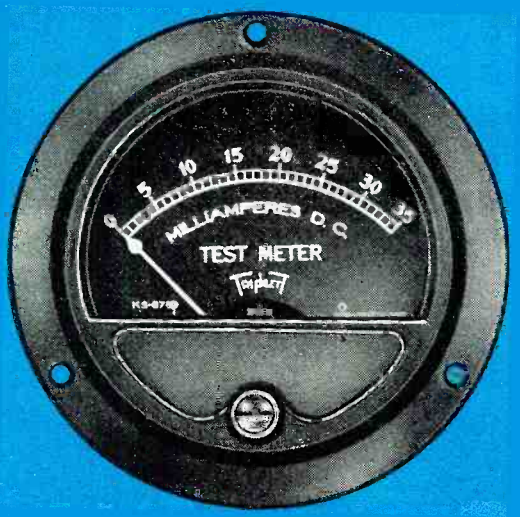

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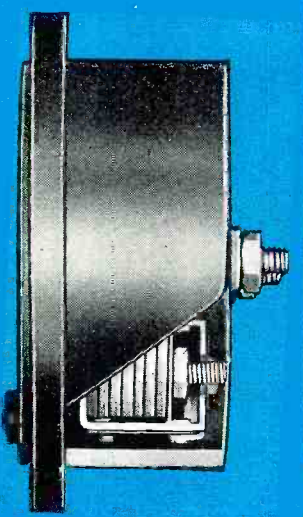

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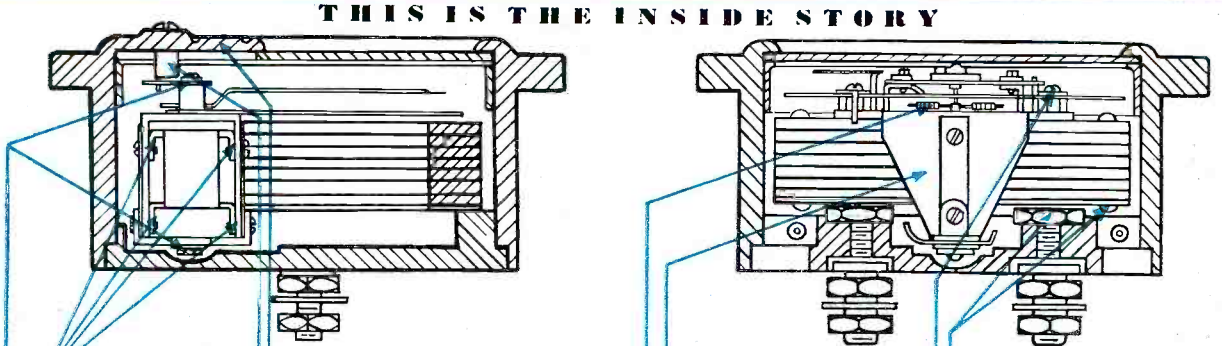

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therein, a perforated auxiliary electrode arranged inside said anode, a cathode arranged inside said auxiliary electrode and adapted to be heated by an electric current, and a *mantle* consisting of a magnetically and electrically conducting substance surrounding said container."

Figure 59, which is reproduced from this U. S. Patent, shows the Tigerstedt tube in a circuit arranged for telephone amplification. The spiral wire "*e*" is the anode, the perforated cylinder "*i*" is the grid, and the zig-zag element "*b*" is the cathode. The effect of the external electrostatic and electromagnetic influences was said to be reduced by the concentric element structure, and by the enclosing "mantle." This is the first instance the author has been able to find of the use of a shield on the tube itself.

The other activity was that of Quirino Majorana of Rome, who devised a modification of the de Forest Audion, which he described as an "Electronic Deviator." He obtained a German patent (D.R.P. No. 281014)[162] on this device, which he described in a note to the Accademia dei Lincei in 1912.[163]

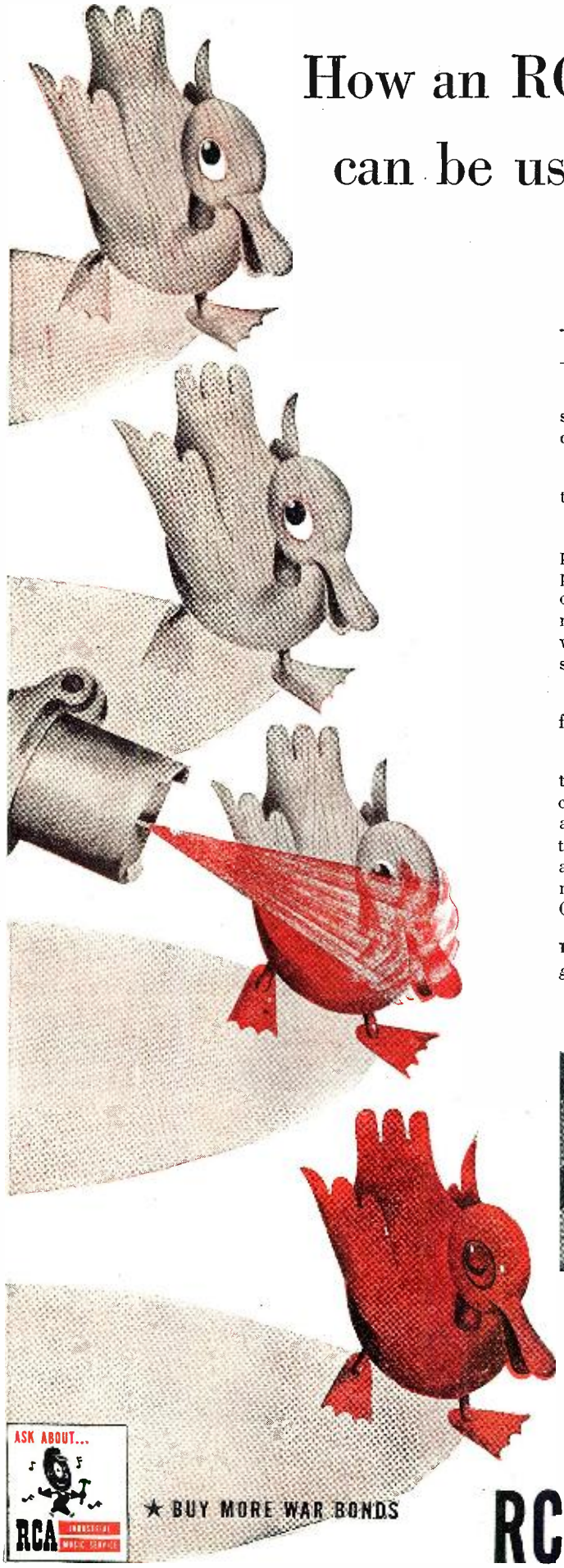
The Majorana Electronic Deviator is shown in Figure 60. It is similar in construction and dimensions to the de Forest Audion, except for the grid. The de Forest grid was replaced by two comb-shaped electrodes with their prongs alternating in the same plane. This was the first use of co-planar grids, as far as the author has been able to determine, and we do not find it again for twenty years. Majorana's device was intended for use as a wireless detector, but its possible use as a telephone relay was suggested by Max Ikle.[164]

While we are concerned only with factual material on the evolution of the vacuum tube, at this point an observation might be made, in passing, on the difference between the approach to the work done in America, and the approach to the work done abroad during this period.

The inventors in America, de Forest and his associates, struggling to make and use vacuum tubes, did not actually understand the theory of such devices. They were trying out gadgets to solve their problems with wireless, and by the process of elimination were turning out truly remarkable devices which, when perfected by our applied scientists, opened the door to modern communications.

In contrast to this we have seen how abroad the pure scientists had worked for many years on the mechanism of electrical conduction through gases, and had built up a background of vacuum tube information and technique. Then the inventors stepped into the picture, and by adapting certain laboratory techniques, produced a cathode-ray type of amplifier tube. This line of development eventually produced not only a telephone amplifier, but the cathode-ray tube so essential to the television of today.

We have also seen how confused was the picture, both in Europe and in



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The principle behind this device can be used by any manufacturer who is interested in paint-spraying economies.

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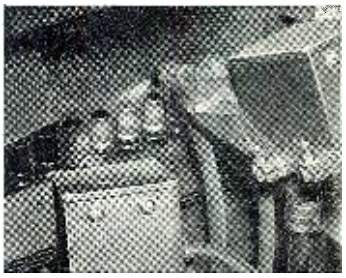

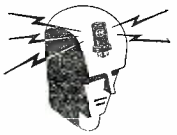

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America, on the question of gaseous conduction versus pure electron discharge operation. This condition existed until the accumulated scientific knowledge of electronics was brought to bear directly and to the fullest extent on the practical problems of the utilization of these inventive advances.

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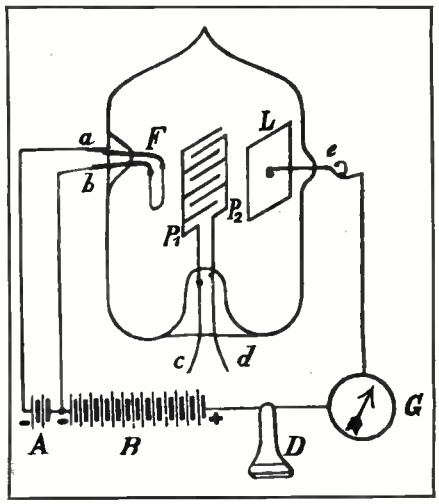

Fig. 60.

vacuum tube advanced from the invention stage to that of industrial development. In the succeeding article we shall show how this development progressed in the largest communication laboratory in America, that of the Bell System.

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Captions for Illustrations

Figure 49. Von Lieben high vacuum cathode ray relay of 1906, using magnetic field for beam defocussing. Reproduced from *D.R.P.* Nr. 179807.

Figure 50. Dieckmann and Glage cathode ray relay of 1906, using magnetic deflection of cathode rays. Reproduced from *D.R.P.* Nr. 184710.

Figure 51. Von Lieben gaseous cathode ray relay of 1910, using magnetic deflection of cathode rays acting as "ionizer." Reproduced from *D.R.P.* Nr. 236716.

Figure 52. Von Lieben gaseous cathode ray relay of 1910, using electrostatic control of cathode rays. Reproduced from *D.R.P.* Nr. 249142.

Figure 53. Photograph of Von Lieben gaseous cathode ray relay made in 1911. Reproduced from *Archiv fur Geschichte der Mathematik,* 1931.

Figure 54. Von Bronk arrangement for using the de Forest Audion as a high frequency amplifier. Reproduced from *D.R.P.* Nr. 271059.

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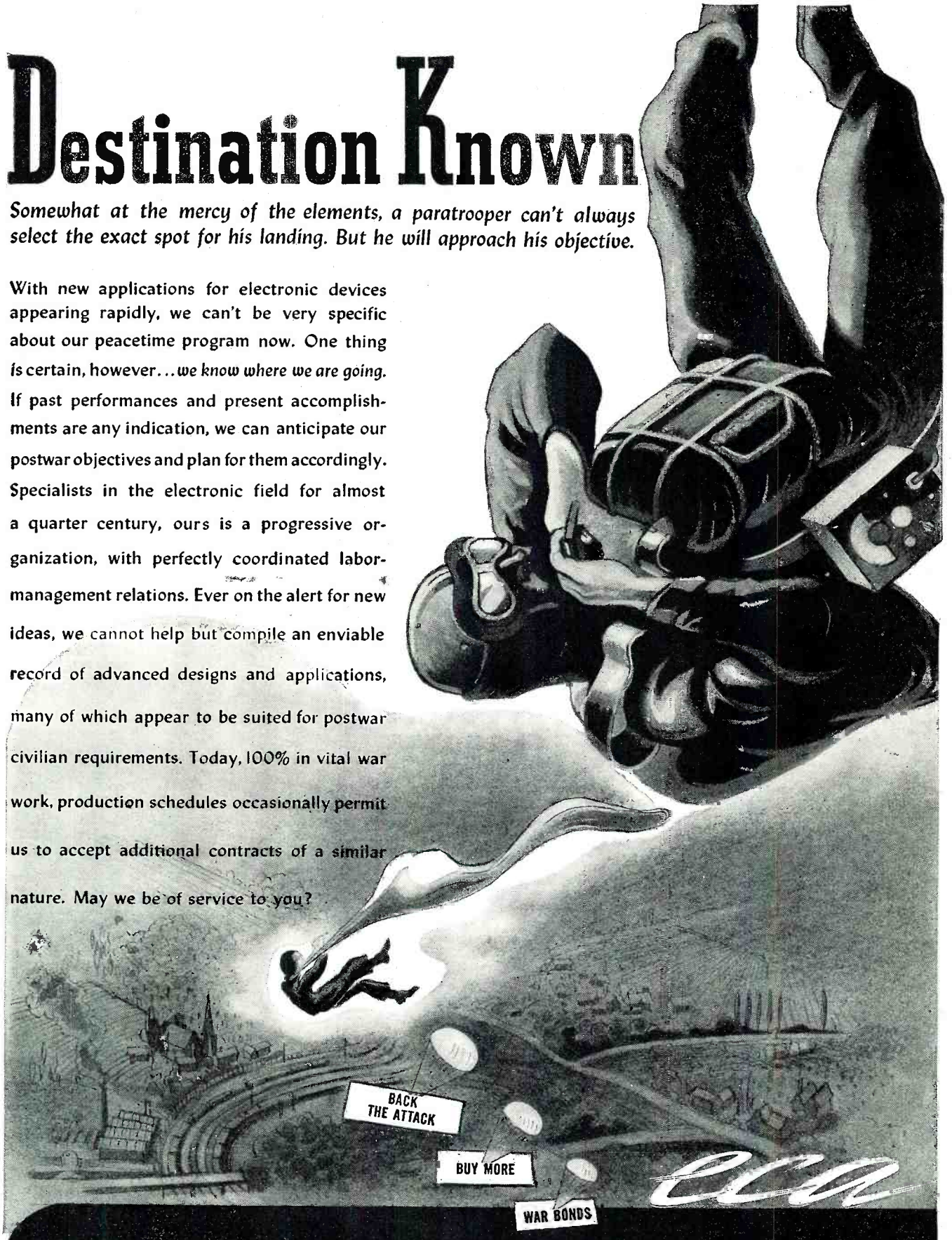

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Figure 55. Von Lieben mercury vapor repeater tube in final form. Reproduced from *D.R.P.* Nr. 264554.

Figure 56. Large size LRS Repeater, with perforated sheet aluminum grid and pin type base. Photograph courtesy *Bell Telephone Laboratories.*

Figure 57. LRS Repeater with cylindrical base. Reproduced from *Archiv fur Geschichte der Mathematik,* 1931.

Figure 58. Temperature regulator for LRS Repeater. Reproduced from *D.R.P.* Nr. 293460.

Figure 59. Tigerstedt telephone relay arrangement using magnetically shielded and concentric electrode structure. Reproduced from *U.S.P.* 1,212,163.

Figure 60. Majorana's Electronic Deviator. Reproduced from *Jahrbuch der drahtlosen Telegraphie und Telephonie,* 1913.

—30—

Oscilloscope Applications

(*Continued from page* 41)

In addition to providing hitherto unobtained speed, the oscillographic method of obtaining tube characteristics permits, at the same time, the use of higher electrode voltages than would be possible in taking such data by other means. This is because the various instantaneous values of voltage are maintained for too short a time to produce any injurious effects upon the electrodes. A peak value of plate voltage may thus attain a value which, under conditions of observation, by means of meters, would result in certain damage to the tested tube.

In testing tubes, *any* current characteristic may be plotted on the oscilloscope screen by employing the voltage drop produced by the current flowing through a small resistance. Rectifiers and other diodes may be tested as well as multielectrode types.

Indication of Gas Engine Cylinder Pressure

In investigations of internal-combustion engine operation, cylinder pressures can be measured by means of pressure gages similar to the familiar steam gages. This system possesses numerous limitations. Recent methods make use of electromechanical-pressure kickup devices which are fastened to the outside of cylinder walls and record internal pressure during the various cycles of engine operation. This apparatus is susceptible to great vibrations of the motor and does not possess the required sensitivity for investigating action of anti-knock gasolines.

Engine cylinder pressure is recorded in modern motor laboratories by means of radionic equipment which employs the oscilloscope as an indicator. In this system, virbrational impulses are transmitted from the *inner* wall of the cylinder by a light beam.

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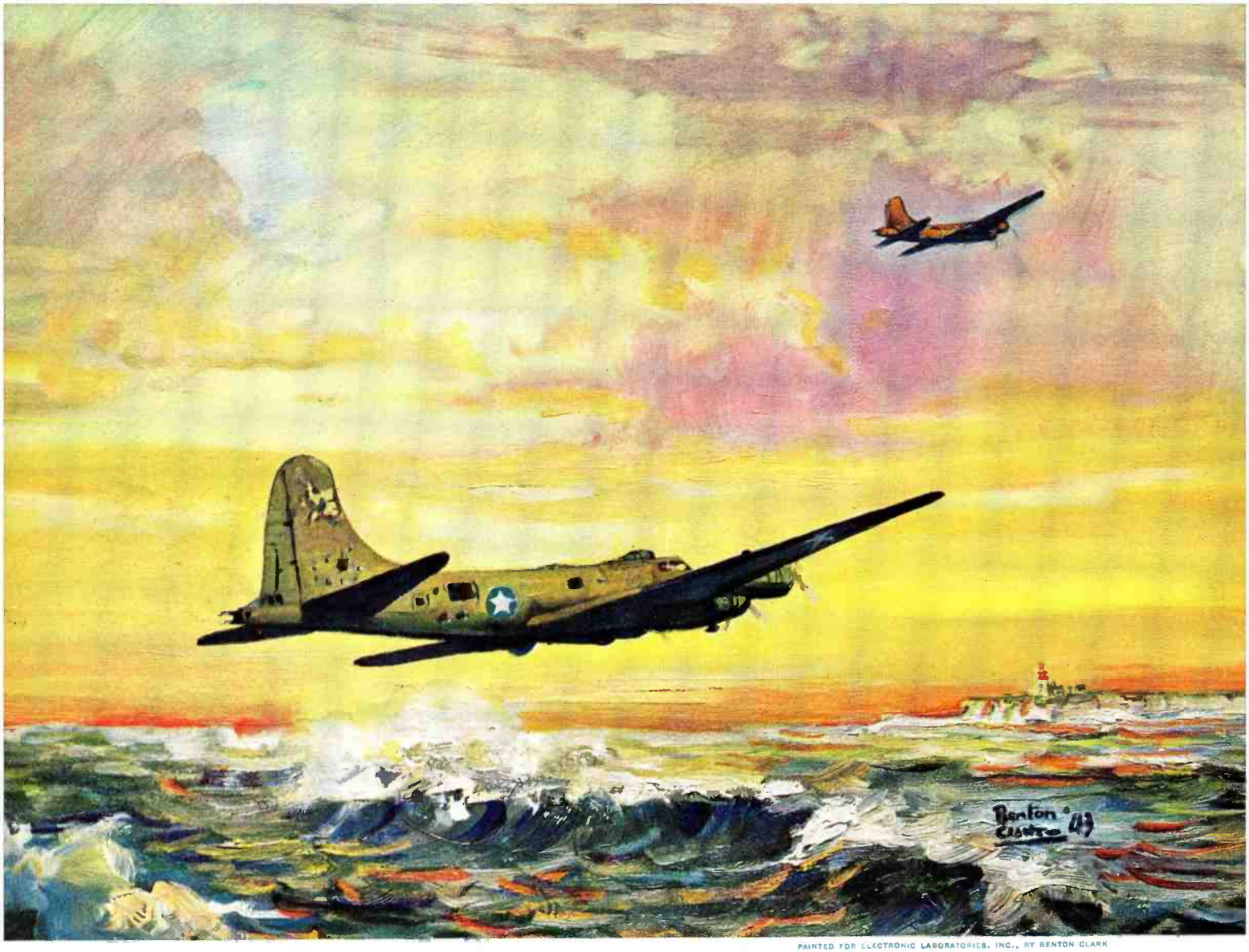

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The measuring equipment thus does not present a load to the engine, and the system is not subject to large vibrations. The oscilloscope gives in a single glance the entire cylinder pressure diagram in which pressures are "plotted" against operational cycles.

Several different systems have been devised for studying engine pressure conditions oscillographically. One such system is illustrated basically in Figure 4. Here, a polished metal diaphragm, D, is placed in a pressure fitting so as to coincide as nearly as possible with the inner surface of the cylinder. This diaphragm is made of flexible material and as it yields under internal pressure, tends to assume a shape corresponding to a section of a sphere.

Light from a masked lamp house passes through a lens, and is reflected to the pressure diaphragm by the partially-silvered plain mirror, M. Due to the partially-applied reflecting surface, this mirror may also pass light rays. The reflected rays then impinge upon the pressure diaphragm, and are reflected through the mirror to the photocell. The amount of light thus reflected to the photocell will depend upon the diaphragm curvature which, in turn, will be due to the internal cylinder pressure. Robertson[1] has shown that the light reaching the cell is inversely proportional to the pressure difference across the pressure diaphragm.

Photocell pulses are amplified by a special isolated, high-gain amplifier and are applied to the vertical plates of the oscilloscope. A horizontal sweep voltage, synchronized with the operational cycles of the engine, is obtained from a battery by means of a contactor or commutator actuated by the engine-drift shaft, or by means of a small generator driven from the engine shaft.

The type of pressure-rotation pattern obtained is shown in Figure 5. This curve is from a Diesel engine and depicts variation in pressure during compression and expansion. The horizontal trace indicates 720-degree rotation of the drive shaft.

Inaccuracies of indication due to vibration of the pressure diaphragm may be minimized by choosing a diaphragm of such thickness that the natural resonant frequency will be quite high. The insertion plug or other device for retaining the diaphragm within the cylinder wall is purposely made thick in order to remove heat rapidly from the diaphragm.

Success in studying combustion pressures within engine cylinders, by means of the oscilloscope, point to similar applications of these electro-optical equipments for studying various other kinds of vibrational or pressure phenomena; such as movements of building walls, expansion or contraction of numerous types of chambers, etc.

[1] A. F. Robertson. *Electro-Optic Pressure Indicator.* Review of Scientific Instruments. March, 1941, p. 142.

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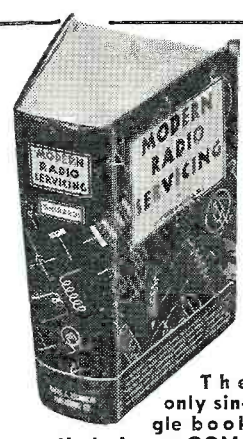

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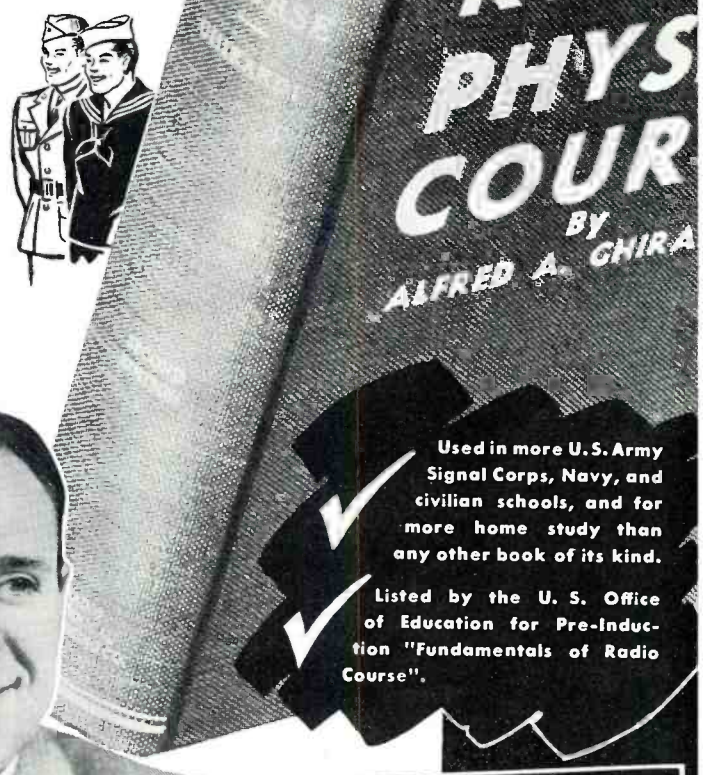

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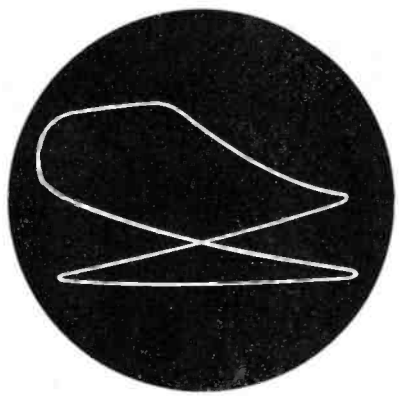

Fig. 5. Method used to study engine pressure conditions oscillographically.

Common applications of the oscilloscope as a rate setter are adjustment of auto radio vibrator units, setting of buzzers and hummers, adjustment of "time-on" periods in electronic welders, and adjustment of impulse duration in certain contactors and signal devices. The latter two applications, involving the simultaneous tracing of two different waves on the oscilloscope screen will require that an electronic switch be employed in conjunction with the oscilloscope.

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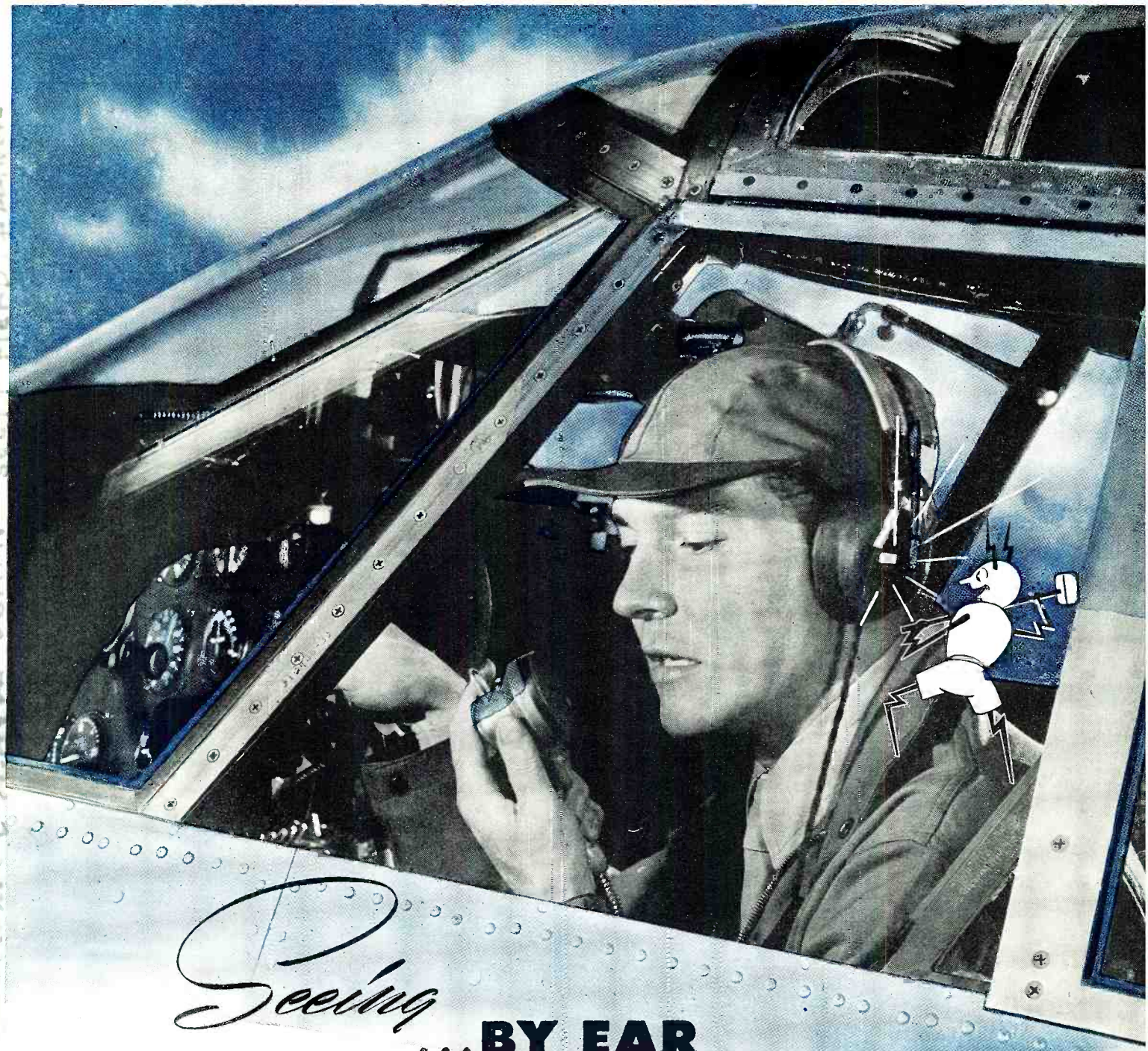

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TEST EQUIPMENT NEEDED—Will pay cash for sig. gen., Voltohmmeter, etc., also recorder. L. E. Posey, Jr., Box 225, La Porte, Texas.

WANTED—V-O-M, signal generator, D-C voltmeter, ohmmeter, and tube tester (preferably mutual conductance). Perry Radio Shop, 5529 5th Ave., Pittsburgh 6, Pa.

WANTED—50L6 and 35Z5 tubes to service soldier's radios. Will pay list. Cpl. R. L. Wenk, Smyrna Air Base, 45th Hq. & Hq. Sq., Smyrna, Tenn.

WANTED—V-O-M, signal generator, tube tester, tubes, and parts for cash. W. Wagner, 3814 Faversham, Cleveland Heights, Ohio.

MANUALS WANTED—Will pay cash for Rider's Manuals. Nicholas Groskinsky, 49-10 69th St., Woodside, N. Y.

TUBE TESTERS FOR SALE—Jackson, RCA, Supreme, Precision, and Superior. Good condition. $35 each. The Radio Man, 1724 Central Ave., Middletown, Ohio.

CHANNEL ANALYZER WANTED—Will pay cash for good make. Also want Alden universal socket adaptors, dual connector cord and plug. Denzel Summers, Box 193, Augusta, Mich.

WANTED—1 D.C. Ma. or V-T-V-M or what have you? John Walsh, 122 4th Ave., San Francisco, Calif.

MULTITESTER FOR SALE—Weston, in good condition; also two DB meters. Want sig. generator, 'scope, and tube tester. E. H. Wright, Jr., c/o W. P. Kann Radio Service, 45 Linden Place, Summit, N. J.

WANTED—Tubes for ultra highs, below 5-watts, incl. acorns and sockets. Also dry disc rectifiers; units from old type speaker field exciters, etc., satisfactory; ¼" Masonite or tempered ⅛" black or brown up to 24"x48". Sterling, Hoyt, etc. D.C. MA meters 15, 25, 50, 100, 150, 200, 250 M.A. Will buy or swap. Send your want list. Richmond Radio Club, 1227 Windsor Ave., Richmond 22, Va.

TELEVISION DEMONSTRATION EQPT. FOR SALE—Built by engineer following plans in 1940 QST. Consists of camera and modulator unit with external power supply and crown view tripod; extra new Iconoscope tube; 112 MC television Xmitter and power supply; 112 MC 3" receiver; full set of tubes for all units—$350. Unexcelled for class work. Myron E. Kluge, 1913 Montrose St., Los Angeles 26, Calif.

MANUALS FOR SALE—Riders Vols. 1 to 13 incl., $128 cash with order or will ship on $25 deposit. Frank M. Kelly, 949½ West Jefferson St., Los Angeles 7, Calif.

WANTED—V-O-M, late tube tester, and sig. generator for cash. Richard Flottman, R.R. 1, Box 268, Chanute, Kansas.

TESTER FOR SALE—Supreme Model 85L tube tester, good cond., $15 f.o.b. Meginniss Electrical Corp., 368-370 Broadway, Albany, N. Y.

WILL TRADE—Will swap 5 new G-E Type 83 tubes for an equal no. of following types: 80, 24A, 47, 45 or 3525GT. Thomas C. Stokert, 215 North Plum St., Havana, Illinois.

VOM WANTED—Will pay cash. Send full details. George Murakami, 3303 B, Newell, Calif. (Modoc County).

URGENTLY NEEDED—Combination tube checker and multimeter, or multimeter only. Will pay cash. I have 35Z5, 6K7, 6Q7, and 6A8 tubes. Send offer. Daniel Fliderblum, 55 Morris St., Yonkers 5. N. Y.

WANTED—Hickok RFO-5 oscillograph, 177-X or 188-Z oscillator, and Jumbo V-O-M tester. Condition immaterial. Will pay cash. Hunt Radio, Liberty, Mo.

MULTITESTER WANTED—Will pay cash for Hickok 202, Radio City 662, or RCA 165 or similar. Wayne Fernyhough, KCRJ, Jerome, Arizona.

FOR SALE OR TRADE—Shure microphones, models 70H and 55C, perfect condition; Weston No. 528 15-150 V. a-c voltmeter; elec. phono unit in hardwood cabinet; phono-recorder unit in portable case; complete 10-Watt high fidelity portable unit. Want late signal gen., V-T voltmeter. H. Tanaka, 600 W. 187 St., New York 33, N. Y.

WANTED—UX 874 or CX 374 voltage regulator glow tubes for use in war plant. Beutel, 827 East 79th St., Chicago 19, Ill.

V-O-M WANTED—Will pay cash. Describe fully. Albert Eatherly, Route #5, Lebanon, Tenn.

WANTED—0-1 Ma meter, late model Weston or similar make in 3½" round or square case. J. M. Brandvig, Gross, Nebr.

FOR SALE—Hallicrafters S-29 Sky Traveller, A-1 condition, used approx. 3 months. What do you offer? Want Hallicrafters S-31 FM-AM tuner. A. M. Stump, 15 Niagara Ave., Dayton, Ohio.

SIGNAL GENERATOR WANTED—Late model, also VOM and tube analyzer. Richard Knoff, 8901 Connecticut Ave., Cleveland 5, Ohio.

EQUIPMENT FOR SALE—Clough-Brengle multitester AC-DC resistance and millmeter, $25; brand new Philco signal tracer, $25; new Jackson 640 oscillator, $40. Nick Shuler Radio Service, Gonzales, Texas.

WILL TRADE—Zenith auto radio; RCA ditto; 0-200 micrometer (Weston); 8" PM speaker (Magnavox). Want signal tracer and condenser checker. W. Tieman, 4425 Redmont Ave., Deer Park, Ohio.

TUBES TO SWAP—Will swap following types: 1-12Q7; 1-35L6GT; 1-12K7; 1-12A8; 3-6D6; 4-43; 1-25Z5; 2-27; 1-6K7; 1-85. Will trade for 12SA7; 50L6GT; 12SQ7; 35Z5. Henry Skoritowsk, 1903 Pittston Ave., Scranton, Pa.

WANTED—3 trumpets with units. Will trade Jackson model 637 set tester. Wm. Macres, 64 Van Buren Ave., Campbell, Ohio.

WANTED—Communication receiver, 220 V. 60 cycles in good condition with speaker. Give full details and price. Cpl. Jos. J. Miller, H.Q.Co., 959th ABS Bn., APO 860, c/o Postmaster, New York, N. Y.

FOR SALE—Triumph #500 condenser bridge-analyzer, only used 2 weeks. Want octal tube test data for model 400 Triumph tube tester using special Triumph octal adapter. 1st money order for $20 gets the analyzer. Victor G. Purcell, High Falls, N. Y.

WANTED FOR CASH—Hickok universal signal generator, 188x FM-AM. Supreme portable Lab. 504-A. Give details. O'Brien's Radio Service, 609 W. 1st St., Fulton, N. Y.

URGENTLY NEEDED—AC-DC tester, preferably Readrite #860 VOM. Also want Cornell-Dublier capacitor analyzer. Model BN bridge. Blaney's Radio Shop, 202 Troy St., Canton, Pa.

WANTED—Rec-O-Cut recording mechanisms and dual-speed motor for 12" or 16" recording, or what have you? Raymond Spejna, 351 Holford St., River Rouge 18, Mich.

WANTED—Volt-ohm-milliammeter; gas engine driven AC-DC generator, 300 or 450 watts; also capacitor analyzer. A Saulwater, 820 State St., Schenectady 7, N. Y.

WANTED—Will pay cash for the following tubes: 4-12SA7GT; 2-35Z5; 1-12B8GT; 1-32L7GT; 1-6SS7; and 1-12SG7. Write! Reaves Electric Service, Box 246, Bishopville, S. C.

Obviously, Sprague cannot assume any responsibility for, or guarantee goods, etc., which might be sold or exchanged through above classified advertisements

TRADING POST

SERVICE FOR RADIO MEN

FOR SALE—Converters, 6-volt DC to 110-volt AC. 100-watts, new (vibrator type), $25. Cornell Radio Service, 10 N. W. 23rd St., Portland, Oregon.

FOR SALE OR TRADE—Supreme No. 339 analyzer in good condition. Want signal generator. Chakeres Radio Service, 1115 Walnut St., McKeesport, Pa.

FOR SALE OR SWAP—Commercial type photographic enlarger (American Camera Co.) 35mm to 4"x5", lens and compl. dark room eqpt. Want communications receiver, oscilloscope, or test eqpt. Ben L. Sandberg, Washington Village, Apt. 36, Asbury Park, N. J.

FOR SALE—E-200 Precision Apparatus Co. signal generator, like new in original carton. First money order for $49 takes it. Also have misc. tubes and other eqpt. Quitting radio business. Hlawati Radio & Ref. Service, 1434 W. 1st St., Oil City, Pa.

WILL TRADE—Have Weston VTVM #669-2, practically new; eight new vibrators; Superior Instruments utility tester (up to 5000 watts, 1000 volts, and 3000 ohms AC or DC. Will trade for Hickok trace-o-meter, Meissner analyst, or portable recorder and playback. Packerene Radio Service, RD#2, Latrobe, Pa.

FONE XMITTER FOR SALE—Complete, 350 watts input; PP 35T's final; 250-watt 838's class B modulator. Freq. range to 40 mcs. Ideal for hi-freq. police work. Mtd. on std. relay rack, separate power supplies, 500 ohm audio output. Also offer RME DB20 pre-selector, RME DM36 and RME 510X band expanders. Leroy May, 9428 Hobart St., Dallas 18, Texas.

URGENTLY NEEDED—0-1 milliammeter; 0-10 voltmeter, both AC-DC, any good makes. Also need test eqpt., multitester or VOM, also good signal generator (not bat. operated), Rider's manuals, and 6E5 electron ray tubes in original cartons. Give details. Modern Radio Service, 2834 Howell St., Camden, N. J.

WANTED—All-wave signal generator; multimeter; high-resistance voltmeter, and tube tester. Late models only. Describe fully and name cash price. Julian Garcia, P. O. Box 107, Mosquero, New Mexico.

FOR SALE—Have hundreds of used pre-tested tubes: 80—45—26—27—71A—24A at 30c ea. J. H. Schwerin, 8321 Kraay Ave., Munster, Ind.

TUBE TESTER WANTED—Will pay cash for Radio City 312-C tube tester, or Triplett model 1612 in good cond. J. B. Patrizi, 115 W. Sherman Ave., Newark, N. Y

FOR SALE—Rebuilt and adjusted meters. Enclosed rectifiers, AC-DC. 1500 and 2000 ohms per volt. Write for details. Edmund McD. Bendheim, 22-33 31st St., Long Island City 5, N. Y.

TESTER FOR SALE—Precision Electronometer tube tester pattern #500-B, complete, $35. Recently remodelled. Morris Wiener, 914 42nd St., Brooklyn, N. Y.

WANTED—Recording eqpt. magnetic head; 12" turntable; crossfeed 2 mike amplifier input. Fairchild or Presto preferred. Will pay cash. Ideal Radio & Appliance Service, 112 Glen St., New Britain, Conn.

FOR SALE—RCA metal service tip file and cards, $3.50. Write for details. Will trade for rifle or revolver. W. O. Smitha Radio Service, 4002 E. 10th St., Indianapolis, Ind.

FOR SALE—Hickok signal generator, model 0S7B, in good condition, $20; also Hickok tube tester, model AC49, $15. Want Voltohmyst, Jr., Ruben Enmark, c/o Burt Radio Service, 622 E. Second St., Jamestown, N. Y.

RECEIVER WANTED by 18 ex "hams" now in service for use during leisure hours. Prefer small Ecophone (EC1 or 2) or any comparable A-C receiver in good condition. Pay cash. Pvt. Charles Brownell, 12142776, Co. A, 38 Signal Cons. Bn., Camp Toccoa, Georgia.

WILL SWAP two new RCA 8005 tubes for four RCA 809's, or two 809's and two Taylor TZ20's; or two TZ20's and two T20's, or what have you? Have Sylvania 860 tube which will sell for best cash offer or parts. Can use power supply eqpt. Fred Craven, W3ERV, 2216 S. Seventh St., Philadelphia, Pa.

TUBES TO SELL OR SWAP—27's, 30's, 99's, 45's, 26's, 24A's, etc. Good condition. Write for prices. Ronald Johnston, 424 N. Work St., Falconer, N. Y.

FOR SALE OR TRADE—Shop stock of new parts incl. by-pass conds., i-f coils; r-f coils; volume controls and switches; output trans.; AC-DC choke, etc. Write for list. Want Television receiver with at least 5" tube for cash or trade. S. H. Smith, 6601 Kimbark, Chicago, Ill.

WANTED—Tube chart for Simpson #333 tube tester. Also need AF-RF osc. and manuals. Bert Price, Lewis, Ind.

WILL PAY CASH for late model tube and set tester or V-O-M in good cond. Also need 0-1 ma. meter. W. T. Harless, 1101 Niagara St., Houston 4, Texas.

TUBES TO SELL—3-35L6GT tubes to swap or sell for 3-12SA7GT. Chas. A. Smith, 198 Main St., Hornell, N. Y.

WANTED—All types of receivers, tubes, and test eqpt. for cash. Describe fully. H. Boford, 6221 Vernon, Chicago 37, Ill.

URGENTLY NEEDED—Any out-of-date set tester, analyzer, or V-O-M. Must have ohms scale and DC volt scale. Pay cash. Austin English, 308 Wood St., Loogootee, Indiana.

WANTED—V-O-M, also 12SK7 tubes or satisfactory substitutes. Clyde Culp, Box 88, New Rockford, N. Dak.

TEST EQUIPMENT FOR QUICK CASH SALE—Will sell for a fellow serviceman who is ill, for cash: One Supreme signal generator #189, ranges 100-3, 400 kc. and 3.3-30 mc. in 6 bands, built in modulator and audio signal output plus one Supreme #385 set analyzer and tube tester to test all regular receiving tubes, analyzing ranges 0-15, 25, 125, 250, 500 and 1250 (6 ranges) in DC volts, AC volts, DC ma's., output volts. Ohmmeter 0-.25 ohms to 0-20 megohms in 6 ranges. Capacity analyzer .001 to 12.5 mfd. in 6 ranges. Free-point analyzer, cable and plugs. A real "one piece lab" in excellent condition, almost new. Both for $100. Write to Askin Radio Service, 1107 South Main St., Paris, Illinois.

FOR SALE OR TRADE—We offer long list of items including amplifiers (also theatre types); intercom systems; juke box; Tungar chargers and bulbs; trickle charger; motion picture projectors, misc. speakers, etc., etc. Write for complete list. Will sell for cash or trade for high-wattage amplifier equipment, mikes. recorders, speakers, and other PA equipment. Nightingale Sound Service, 434 Westminster Ave., Greensburg, Pa.

EQUIPMENT FOR SALE—One Clough-Brengle CRA 3" scope, used about week, $85; one Supreme 561 AF-RF signal generator (metered) push button frequency selector. A-1 condition. $90 (late 1942); one Supreme Audolyzer #562 with vacuum tube voltmeter and ohmmeter, uses single probe line, A-1 condition, $85 (late 1942). Will ship C. O. D. express. D. A. Dargie, P. O. Box 35, Joseph City, Ariz.

to a flat-response audio amplifier which in turn energizes the vertical plates of the oscilloscope. A portion of the amplifier output voltage is also applied to the synchronization input circuit of the instrument. Horizontal deflection is obtained from the internal saw-tooth sweep oscillator.

Examinations may be made of speech waveforms in voice training and in the course of diagnosis of laryngological diagnosis, or of music waveforms in the testing of musical instruments, bells, chimes, trumpets, and the like.

—30—

Radio in Warfare

(*Continued from page* 29)

The main disadvantage of such arrangements is that once an enemy discovers the wavelength, or wavelengths, upon which such signals are sent they could readily jam them. Such a procedure could cause a whole fleet to crash without warning, perhaps on the territory from which they were sent.

But there are other possibilities. The different noises by which the various operations controlling the plane were carried out might be picked up and deciphered in a very short time. Unfortunately, or perhaps fortunately, codes (of which this would be a type) are of necessity, of such construction that cipher experts can invariably decipher any code within a very short time. It is for this reason that military and other authorities frequently vary the codes they employ.

Assuming that the noises directing the planes are discovered, what can prevent the country which is to be raided from swamping the enemy signals and sending out others to counteract them. The raiding fleet may then arrive at the intended victims aerodromes intact, but rendered impotent.

Relay Circuit

Perhaps some readers will be interested in a circuit of the relay arrangement which makes possible the control of apparatus by radio.

A perusal of the circuit shown (Figure 1) will emphasize how the relay works. In the circuit shown the relay is incorporated in the plate circuit, using a type 30 tube. The tube acts more as a detector than an audio amplifier, giving sharp impulses to trip the relay. A Morse sounder, for example, may be connected to the relay contacts or the relay used to permit the setting into operation by radio of many electrical devices.

If you wish to try out the idea why not attempt operating your electric-lighting system by means of your voice? A small oscillator equipped with a microphone would provide sufficient signal to do this, and once you have started experimenting with the equipment innumerable possibilities will become apparent.

There is little need to emphasize that it might endanger the lives of the fighting forces and civilians, if the details of secret apparatus in use at present were described. Although such secrets are generally very short lived, they are valuable as long as they remain unrevealed to the enemy.

The author does not intend to describe anything which might be of use to the enemy, but contents himself with discussing known apparatus that is useful in warfare.

As you undoubtedly know, electrical equipment, particularly where sparks are concerned, throws out radiations into the ether. If you operate a short wave radio, you are painfully aware of this fact, for every time a car passes a "click, click, click" is audible in your loud speaker.

Aeroplanes, like cars, have electrical equipment and consequently, radiations from their engines could be picked up by a radio set. At first this appears of little interest, but when one considers that such radiations become louder when approached, the significance of the fact becomes evident. A fighter aircraft equipped with sensitive short wave apparatus could, by picking up noises created by the engine of an enemy bomber, travel towards that bomber in the dark even though it be invisible to the pilot.

Some years ago in California experiments were conducted with apparatus constructed to enable planes to land at aerodromes in a fog. The Bureau of Air Commerce installed a station at Oakland which operated on 3.3 metres. It was modulated with a 60-cycle tone. The aerial was arranged so that an egg-shaped field was radiated into the air. When an aeroplane, equipped with a special receiver incorporating a neon indicator, picked up the signals, its pilot reacted according to the position of the plane as indicated upon the neon dial.

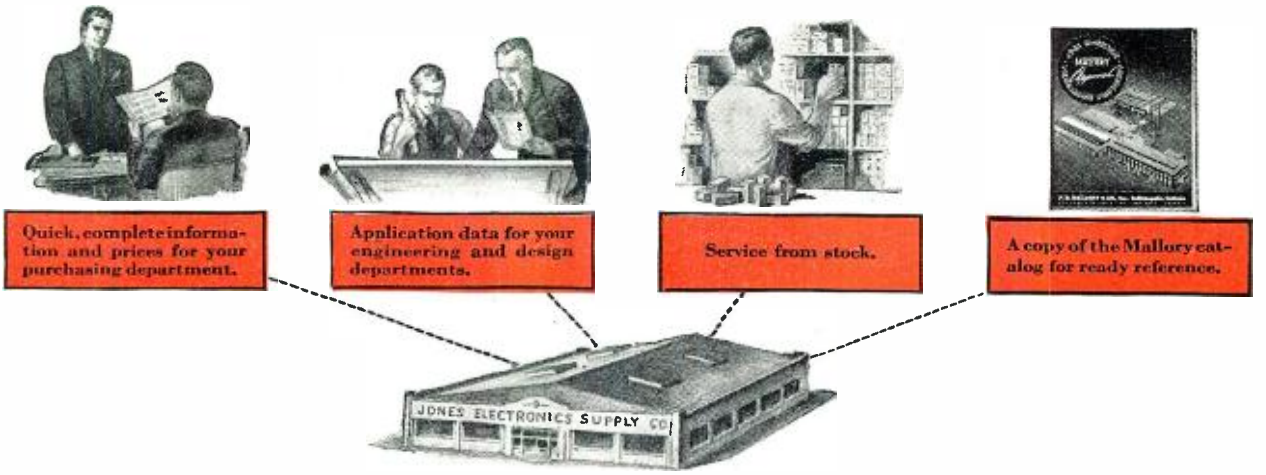
If the machine arrived to the left of the correct landing ground and above the proper landing path, the indicator clearly showed the fact (Fig. 2A). If it arrived to the right of the runway and below the proper landing path, the effect was equally clear (Fig. 2B).

It remained only for the pilot to maneuver his plane so that the indicator showed his position to be correct for landing (Fig. 2C) and to maintain that position in order to arrive safely and without much difficulty.

If such equipment were fittted to a night fighter it would be possible, by using the radiations from the spark plugs as a beam, to travel with accuracy to an invisible bomber and to effectively attack it.

There are many other ways in which radio and kindred sciences can be used in warfare. At one time it was rumored that German bombers were equipped with apparatus which enabled their pilots and bombardiers to see targets on the ground no matter how dark the night.

At first sight this might appear an absurd claim. In reality it is quite possible. Many years ago Baird, the television pioneer, constructed apparatus which, employing infra-red rays, if



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fitted to a ship, would enable the pilot to see through a fog just as well as if it were absent. The only difference would be that instead of looking ahead into the darkness he would look down onto a special screen and see what was ahead of him. In just the same way, similar apparatus could enable a pilot to clearly see on a screen the ground below him.

And so we see that the possibilities to which science can be put in wartime are innumerable. Some of them sound a trifle alarming, however, the author would like to remind readers that it is an invariable rule that as soon as some new machine has been constructed to do a certain task, other machinery will almost immediately be built to counteract its actions!

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Book Review

(*Continued from page* 52)

planations throughout the text, thus enabling the student to promptly follow the phenomena of the radioactivity and modern transmutation presented in the closing chapters of the book. An outstanding feature of the volume is the 289 illustrations, most of them in color. Contents include: Discovery and Nature of Electricity; Some Single Characteristics of Electricity; Volts, Amperes and Ohms; Electric Power and Energy; Electrolysis; Batteries; Magnetism; Electric Motors and Meters; Induced Electric Currents; Inductance and Alternating Current; Condensers and Alternating Current; Wireless; Electron Tubes; X-Rays; Nature of Light; Illumination; Reflection of Light; Refraction of Light; Some Applications of Mirrors and Lenses; Infra-red and Ultra-violet; Photoelectricity; More about Waves; Natural Radioactivity and Transmutation of Elements; Transmuting the Elements.

"PRACTICAL RADIO COMMUNICATIONS," Revised Second Edition, by Lt. Arthur R. Nilson, U.S.N.R. (Retired) and J. L. Hornung, formerly Radio Instructor, Guggenheim School of Aeronautics, New York University. Published by the *McGraw-Hill Book Company,* New York City. 905 pp. plus index. Price $6.00.

This is a handbook for both student and experienced radio operators. It fuses theoretical radio principles and practical radio operating into a well-balanced radio source of instruction material for home study and radio school purposes. The student will find this book to be a complete course in radio operating, and thorough preparation for all operator's license examinations. The experienced radio operator will find the information on advances in radio technology necessary to prepare him for progress and a better job. Rapid and extensive advances in the science of radio communication make this second edition necessary. Ohm's Law problems and explanations, prin-

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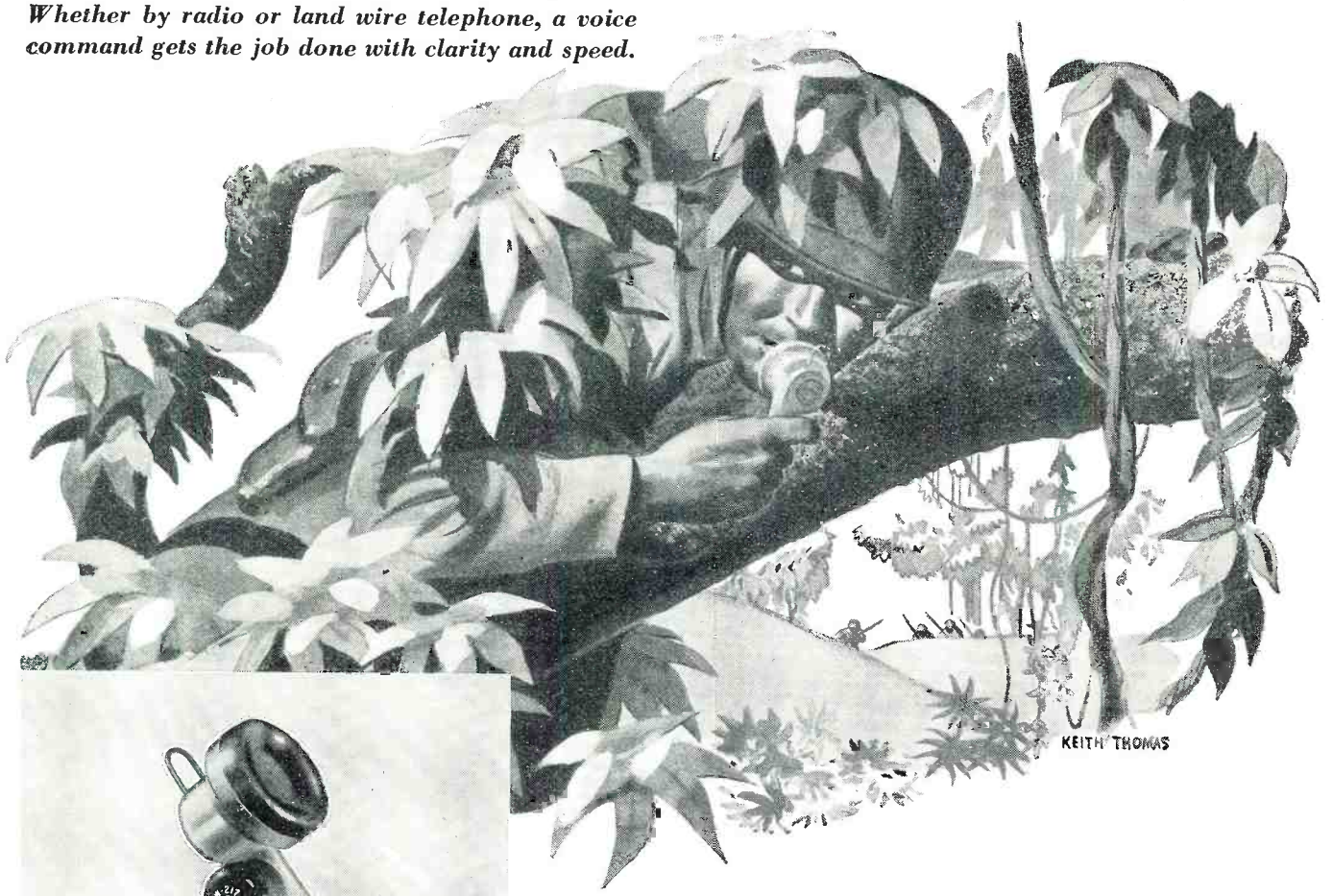

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ciples of high-efficiency radio-frequency amplifiers, receiver-circuit design, the cathode-ray oscilloscope, antenna arrays, ultra-high-frequency theory and practice, frequency modulation, aviation radio, latest broadcast equipment, and four complete chapters on marine radio, including automatic alarms and modern direction finders, are important additions in this second edition. This book will be particularly valuable to students as a basic source of information underlying the questions and answers covered in its companion volume *Radio Operating Questions and Answers.*

"SUCCESSFUL RADIO REPAIRING WITH AVAILABLE SUBSTITUTE PARTS," by M. N. Beitman. Published by *Supreme Publications,* Chicago. Price 25c.

This booklet is presented at a timely moment. The substitution of parts and the altering of component values has offered the radio technician and serviceman innumerable problems when servicing home radios. The author includes typical examples to illustrate the method of substituting for unavailable parts. The last three pages contain a listing of about 450 tube types with a corresponding list of similar tubes. This tabulation should prove helpful when making tube replacements.

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Q T C

(*Continued from page* 52)

sels. F.C.C. is strongly recommending that certain items be supplied to U.S. Merchant Marine ships.

They suggested in a release, some time ago, the use of a small soldering iron, and a flashlight with a case made from insulating material instead of metal. The sooner these become requirements of F.C.C. regulations rather than just recommendations, the sooner they will be provided aboard ship. There are still many individuals in charge of furnishing tools and supplies to vessels, who will supply only the bare necessities actually demanded by laws and regulations. It's, however, a step in the right direction to have them "approved." They suggest "one electric soldering iron having a rated power in the range 85 to 125 watts, and one-half pound of wire solder with a suitable amount of NON-CORROSIVE FLUX."

The boys are beginning to pile up complaints against the Liberty ships, the main one appearing to be from those in the northern latitudes that the steam radiator in the ship's radio room is too small and that they actually suffer from the cold while on watch. At the same time those on the runs in the tropics say that they are hotter than blazes. The Radio Officers Union has recommended to the War Shipping Administration that a larger radiator be installed, but maybe it would be a better idea to install an air conditioning system. It certainly isn't any fun to have to stand watch closed up in either a cold or hot room. If anything can be done to relieve this condition, it should be attended to immediately, because the men of our Merchant Marine must be given the best equipment with which to carry on our fight against the axis. Don't forget that the more we all invest in war bonds, the more equipment we will be able to throw into the battle, and incidentally, at the same time, pile up a savings accumulation which will come in handy in the future.

Lloyd Mackay, ex WSC WSBN WMCM, has taken a Liberty assignment with the Waterman Line. Bob Small, for some time past a radio material man in the pacific area, has been transferred to the West Coast. Bob has been in the Navy for several years. Leif Hvidsten former marine service man in New York, was married September 25th. Leif is at radio officer's training school since joining the Army. Another former marine serviceman, H. L. Messinger, is studying navigation in the Army Air Force. Harold says he is learning the shortest routes to Berlin and Tokio from practically everywhere else! He is also to be a "yes" man soon—was recently engaged to a gal from back home in Flushing.

The following bit of helpful information comes from R.O.U. If you have a commission in the Maritime Service, be sure and carry your commission with you at all times. Don't go ashore in a haphazard arrangement of uniform and insignia, and don't wear the Maritime Service insignia if you are not authorized to wear it. Graduates of government schools have the right to wear their uniforms until they have served six months as a radio operator; after serving six months, they are eligible for the rank of Ensign. Old timers, returning to the sea after a spell ashore, are given commissions as soon as they are assigned to a vessel, unless they have been away from the sea for 15 years or more. Consideration for higher rank, regardless of ship tonnage, is being studied by the War Shipping Administration. Uniform regulations and other pertinent literature for Maritime Service officers are in the process of preparation, and will be given wide dissemination when completed. Misunderstanding has also existed regarding the wearing of campaign ribbons by merchant seamen. Congress recently authorized the War Shipping Administration to issue campaign ribbons to merchant seamen. These are made especially for them and differ from the others. It is forbidden by law for anyone not a member of the military forces to wear Army or Navy campaign ribbons. The design of a ribbon for merchant seamen is under discussion at WSA, and a public announcement will be made when arrangements have been completed. Don't wear military ribbons and thus avoid the possibility of getting into trouble.

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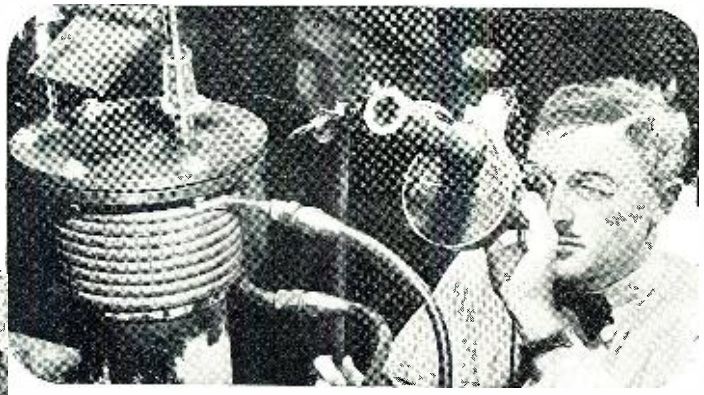

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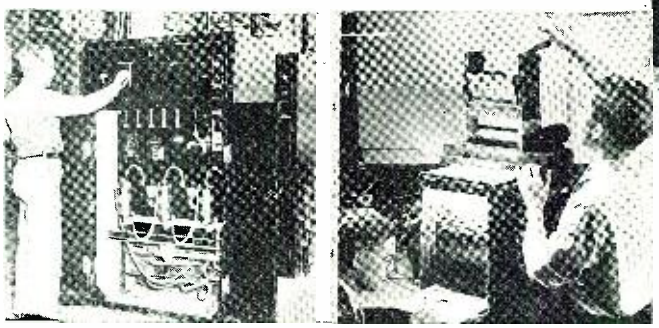

Out of the War is emerging the Age of Electronics, with immediate opportunity for you to enter America's new Industry

★ Radionics is a general term embracing Industrial Electronics, Television and Radio. Electronics for harnessing the forces of Industry, Television to bring the world's sights into the home, Radio with revolutionary improvements—these are developments that constitute a tremendous field. You can project yourself into this mighty field. You can become part of it. You can earn good pay as a Radionics expert, with independence insured during and after the war. When the war ends, Radionics will boom even faster than now. But you can't successfully enter this field unless you have TRAINING. Let's speak plainly. You have the desire and you realize the tremendous future of Radionics. But you lack training. So here's the way to get into Radionics. Have National Schools train you right in your home.

National is always in the lead. As industry advances, National offers training to fit. This was never more true than today. National's training covers all phases of Radionics. You learn by following fascinating lesson assignments, based on practical shop-laboratory methods. Instructors give you the same fundamental training that you would receive if you were actually in the school. It's an amazing extension of resident school training.

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For more than 38 years National Schools has trained thousands of men. Many graduates hold top positions in hundreds of leading industries. Unlike ordinary correspondent courses, National's Radionics Course is based on shop-practice, shop-tested, shop-routine training, adapted to *Home Study*. Replacing dry text books, fascinating Lesson and Experimental Assignments are provided. Instructors counsel with you. After the first few Lessons, you are qualified to repair Home Radio Sets. Soon you master Communications and Sound Systems. Before you realize it you have practical knowledge of the "workings" of countless Electronics Controls and how Electronics is applied to Industry. When you graduate you are qualified to accept a job that should pay substantially more than you are now earning. This is a real opportunity for you.

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CITY_____ STATE_____

other complaint from the boys on the Liberty ships. It is expected that the typewriter will be moved to the left side of the operating position, and the spot it now occupies will be filled with a new Scott communications type receiver. In the design of the radio room, plans were originally made for this receiver to be placed on the aft bulkhead, but this position has been found unsatisfactory. The old position of having the "mill" on the operator's right must have been designed by a left handed gentleman.

We understand, that attempts are being made to obtain deferrment from the draft for men engaged in marine radio repair and service of ship radio station equipment by a government department interested in this work. This is, it seems, a rather important contribution in war time towards keeping 'em sailing. Men and materials must get through to the various fronts. Another man engaged in this important work, Carl Amato, is scheduled to join the Army in November, unless the above plans are carried out. Licensed men with any amount of experience in this work are apparently just not to be had, according to reports from the various organizations engaged in the marine service field.

Not all the men who decided to help their country by sailing ships of the Merchant Marine, will continue to work radio permanently. A large percentage will return to their former pursuits when the war is over. Whether they will be able to obtain their old jobs, after the conflict is over, is a question which no one can answer. This hasn't prevented these men from taking a chance on losing their lives by going down to the sea in ships. A law has been passed by Congress and signed by the President, giving the men in the Merchant Marine the same rights, in reference to postwar reemployment, as have already been granted to men of the armed forces. Your boss must give you back your old job when the war is over. In case your old boss isn't in business any longer, you will have to find a job somewhere else. The Office of War Information recently announced that even Nazi Propaganda Minister Goebbels admitted that the Americans and British have enough shipping and fighting men to land anywhere on the continent. That means each and everyone of us has to hit them harder when they start to stagger—so don't let up until the Nazis and Japs holler "uncle." Buy all the bonds you possibly can.

—30—

Test Unit

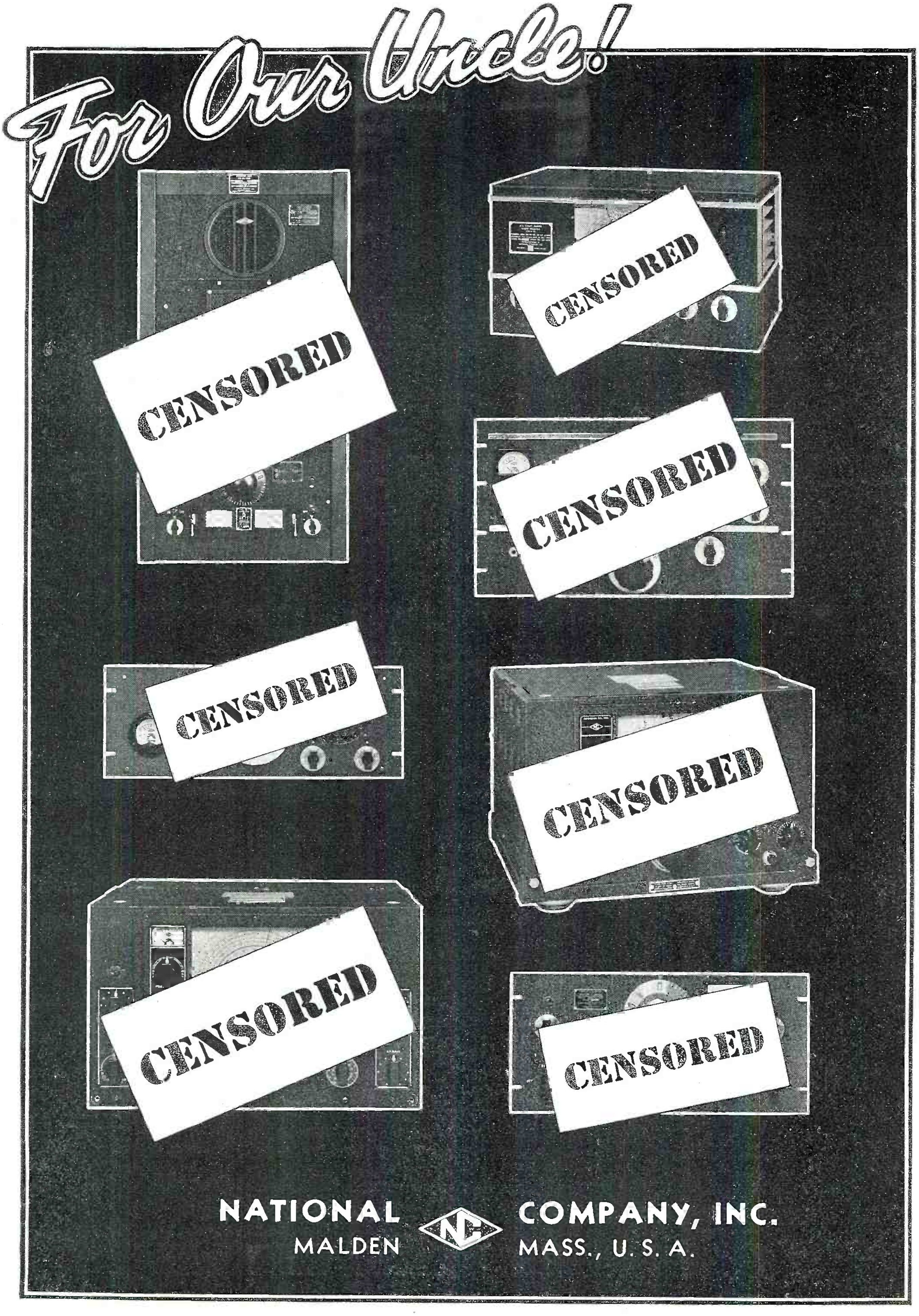
(*Continued from page* 37)

self marking types, like National ACN, on which frequencies may be marked directly.

Inductance Calibration: The inductance values of the coils L1, L2, L3, and L4 may be measured by switching these coils successively to the output terminals T7 and T8 (S2 at 6, 7, 8, and 9 respectively) and measuring their values directly by means of an inductance bridge or inductance test oscillator connected to T7 and T8. Or these values may be calculated sufficiently accurately for most practical purposes by means of resonance tests. These coils are switched into the circuit successively by setting S2 at 1, 2, 3, and 4. A test oscillator is connected to T4 and T5 and is set to give any signal within a particular coil frequency range. The condenser C9 is then adjusted for resonance, and from the capacitance at this setting and the value of the input frequency, the inductance may be calculated by applying equation (2).

Capacitance Calibration: The capacitance settings of variable condenser C9 are determined in the following manner: S2 is set to position 5, connecting C9 directly to output terminals T7 and T8. A reliable capacitance bridge or capacitance test oscillator is then connected to T7 and T8. Starting at the maximum setting of C9, each setting is identified in $\mu\mu$fds. by means of the capacitance checker and marked directly on the C9 dial or on the tuning chart. A number of points, evenly spaced, are so located between maximum and minimum settings of C9.

An alternative method would consist of making resonant frequency measurements at various settings of C9, with a known inductance connected to T7 and T8, and calculating the capacitance values by means of equation



(1). Connect the test oscillator to T4 and T5. Set S2 to position 5, and connect the known inductance to T7 and T8. Set C9 at its maximum capacitance and adjust the input frequency until resonance is obtained. Assume another setting of C9, close to the first, and locate the new resonant frequency. Locate a number of such points between maximum and minimum capacitance settings and calculate the corresponding capacitances from equation (1).

Setting One Radio Frequency to Another: Connect standard-frequency oscillator to T3 and T5. Connect experimental oscillator to T4 and T5. Set S2 at 10 and close S1 & S3. Adjust frequency of experimental oscillator until v.t. voltmeter ceases pulsing and returns to zero, indicating the zero beat.

Setting One Audio Frequency to Another: Connect standard a.f. oscillator to T1 and T5. Connect experimental oscillator to T2 and T5. Set S2 at 10, close S1 and close S3. Adjust frequency of experimental oscillator until permanent deflection of v.t. voltmeter becomes steady, rather than pulsating.

In each of the above adjustments, if the signal voltage is too large or too small for purposes of indication, the gain controls R1 and R2 may be adjusted.

Measuring an Unknown Radio Frequency: Connect source of unknown frequency to T4 and T5. Set S2 to position 1 and close S3. Tune condenser C9, watching for a deflection of the v.t. voltmeter. If a deflection is not obtained, move S2 to position 2 and again tune through the range of C9, switching to other bands until the signal is located. When the resonant deflection is obtained, the frequency is read from the C9 calibration. When identifying an unknown frequency in the above manner, it is advisable to start tuning in the lowest-frequency band, progressing through the higher-frequency ranges.

Checking R. F. Frequency Deviation: Set S2 to position 10. Open S3. Connect the standard frequency oscillator to T4 and T5 and the source of the checked frequency to T3 and T5. (If the checked source is a transmitter, the signal may be picked up with a short length of wire connected to T3. If the pickup from the transmitter is excessive, even with the short antenna, R1 may be turned down. A direct-reading audio-frequency meter connected to T7 and T8 will then indicate the frequency deviation directly in cycles-per-second when S1 is closed.

Capacitance and Inductance Measurements: Both condenser and coil measurements are made as indicated earlier in the text. When *large* capacitances and inductances are to be measured, audio frequencies must be employed. Connect the variable-frequency audio oscillator to T1 and T5, close S1 and S3, and set S2 to position 10. Connect the unknown coil in parallel with a known large capacitor (0.1 μfd. or higher) and connect the combination to T7 and T8; or connect the unknown capacitor to a large coil (1 henry or higher), and connect this combination to T7 and T8. Adjust the frequency of the audio oscillator until resonance is obtained, and note the resonant frequency. The unknown large capacitance or inductance value may then be determined from Equation (1) or (2).

Measurement of Series or Parallel Resonant Circuits: Connect the series resonant circuit to T6 and T8. Connect the parallel resonant circuit to T7 and T8. If the parallel resonant frequency is expected to be in the a.f. range, close S1, otherwise leave this switch open. Close S3 and set S2 to position 10. Connect the variable r.f. or a.f. test oscillator to T4 and T5 (r.f.) or to T2 and T5 (a.f.), and adjust the oscillator for resonance as indicated by voltmeter deflection. The resonant frequency of the L-C combination under test may then be read directly.

Signal Tracing: The comparator unit may be used directly for tracing signals in radio receivers or in audio amplifiers, although its sensitivity will not be as great as the channel analyzer with amplifier stages. R. F. test prods may be connected directly to T4 and T5, with S1 open, S3 closed, and S2 set to the band in which the r.f. signal appears. C9 is adjusted for the signal frequency. A. F. test prods are connected to T2 and T5, S1 closed, S2 set to position 10, and S3 closed. The v.t. voltmeter will then read the relative strength of the audio voltage at any point to which the T2 prod is touched.

—30—

Check these needed items you didn't expect to get for the duration!

AMPLIFIERS
COMMUNICATIONS EQUIPMENT
RADIO TUBES
TESTERS

Lafayette also offers: Latest developments in inter-communications equipment . . . Advance listing of 1944 Radio and Electronic books . . . Expanded list of tools, particularly suited for assembly and factory use . . . Complete list of Victory lines for repair and replacement . . . Bargain Section of Special Values.

New!

Just off the press! The new Lafayette Radio Corporation Catalog 94 is now ready for you! It presents hundreds of new listings of radio and electronic parts and equipment. Many items shown were merely designs on the drafting board a short while ago.

Lafayette Radio Catalog 94 lists the most complete stock of radio and electronic products available today for industrials, the armed forces, government agencies, schools, etc., on priority. *For civilian maintenance and repair items,* your order will bring quick delivery *without priority.*

This catalog is a *must* for all procurement men and expediters – for industrial, civilian and military needs. Write *today* for *your* FREE copy of this complete, up-to-the-minute Lafayette Radio Catalog 94.

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Spot News
(*Continued from page* 14)

his beautiful "cover" girls as announcers and demonstrators.

Television does seem to be going places.

WEATHER FORECASTING ON TELEPHONE CIRCUITS with magnetized steel tape carrying the message, was quite a business with telephone companies in many areas before the war. Because of the vital information supplied on these weather forecasts, it was necessary, however, to curtail the distribution of most of the detailed information. Now, however, this mode of transmission has swung back into popularity again with the government as a prime factor in this reestablishment. For now the weather announcements are supplemented by such phrases as "The wounded can't wait, give to the Red Cross"; this is followed by the weather report. Pleas for more Bonds, Navy Cadets, etc., are common advertising messages used on the steel tape today.

In Chicago, this type of service has received its greatest application. Approximately 34,000 calls are made daily. These weather reports and announcements are recorded on a tape every hour and run some 27 seconds. There are times when the calls begin to average about 14,000 an hour or near capacity. When this occurs, usually in the winter time when storm information is requested often, the supplemental messages are of course shortened or deleted.

Transmission of messages over the telephone circuit was used commercially by one organization for quite a while. This company located in Atlanta, Georgia, conceived of the method of renting transmission units using film on mirror-coated drums, actuated by photoelectric cells. Close to 50 installations had been made throughout the East and South, for the purpose of selling "time on the line." National advertisers included Coca-Cola, Wheaties, and local banks.

There are many plans afoot to introduce this form of service on a national scale in the postwar period.

TWENTY-EIGHT YEARS AGO the vacuum tube entered one of its most important phases of application. In 1915, the first vacuum tube modulator was used in an experimental test of radio transmission from Arlington to Paris. And in 1927, two way transatlantic radiotelephony became commercially possible.

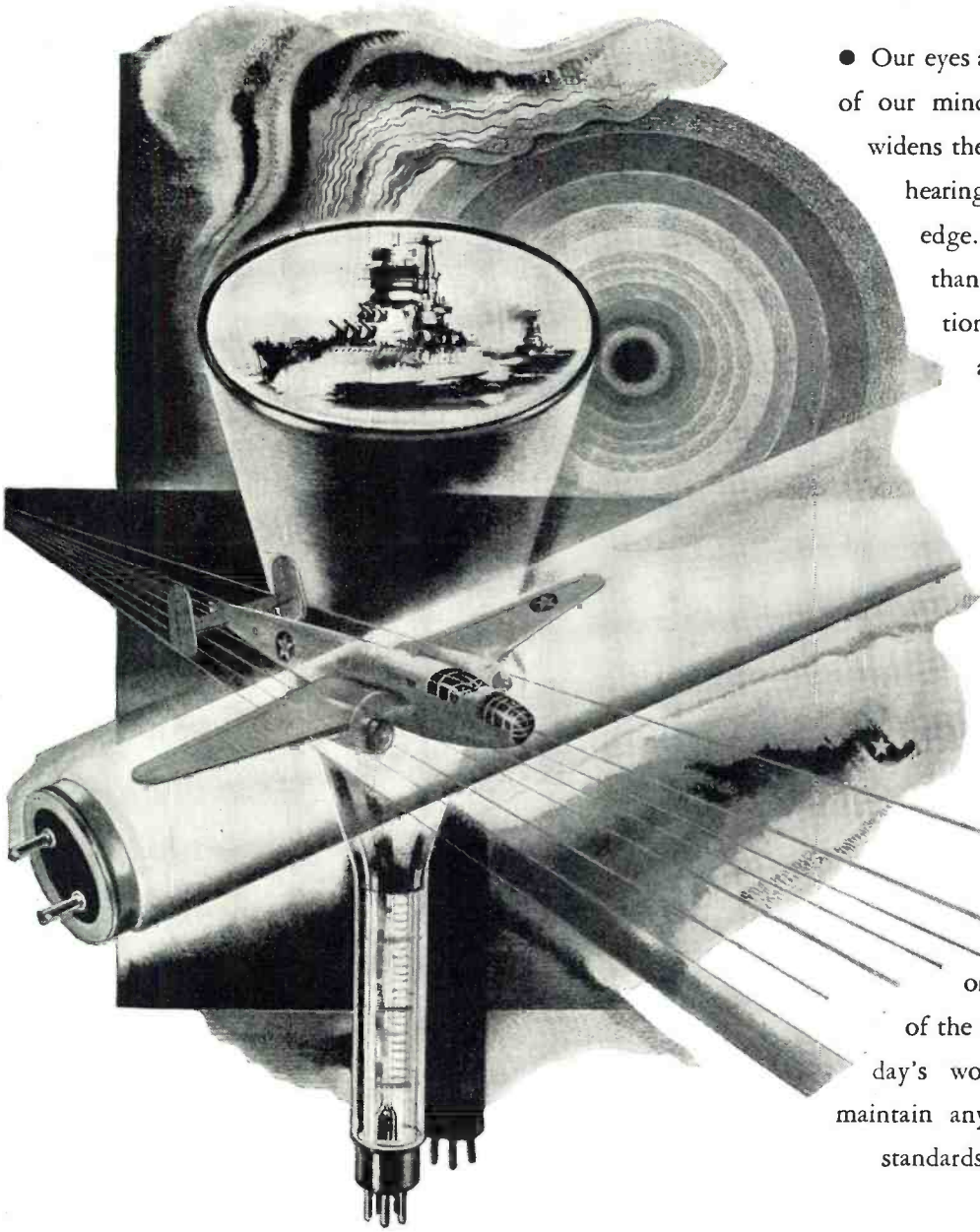
Talking about vacuum tube "firsts" reminds us of the first attempts made to improve the efficiency of the old De Forest tubes. So that gasses in the tubes could be released, and thus tuning and signal strength improved, many resorted to the use of a glowing match to fan the glass envelope. This was known as "flame tuning" and provided some unique results. Old timers will remember that familiar glow of blue which followed the application of "flame tuning." How times change!

SHOCK TESTING for electrical indicating instruments to insure satisfactory performance under battlefield conditions, is now among the new war standards adopted by the American Standards Association.

Another important standards contribution to the war program has been the glass-bonded mica radio insulator standard. The chief feature of this standard is that it provides engineers and draftsmen with specific information on the machining of glass-bonded mica items. That is, engineers and draftsmen are told how holes are to be tapped, how corners are to be cut, and what thicknesses are available, etc. It differs from others in that there are no standard shape or type designations. Only procedure and recommended practice is provided for in this standard. Many important specialists appeared on the committee to develop it. Included were L. J. Cavanaugh of General Electric, who was chairman of the committee, B. R. Boymel of the Navy, T. N. Caven and G. M. Heckel of Camp Evans, W. A. Evans of Bell Laboratories and H. R. Terhune of RCA.

Standards have been a vital wartime contribution towards expediting production. Accordingly, every effort has been made by the Standards Association, WPB and industrial groups to

To see and hear beyond the beyond

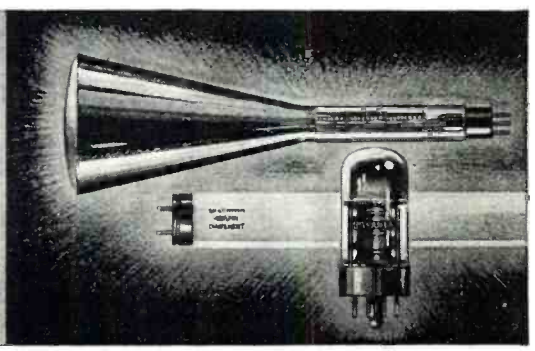


● Our eyes and ears are the advance guards of our mind's march forward. Whatever widens the horizons of human vision and hearing, reveals new vistas of knowledge. So our chosen work for more than forty years has been exploration of uncharted realms of sight and sound. Starting with the humble incandescent lamp, progressing to radio and electronic tubes, fluorescent lamps and equipment, we are today busy with ventures which are contributing vitally to the winning of the war. And important as these may be to Victory, their full flower will come as enduring boons to better living in the years beyond. How could anyone, glimpsing the rich promise of the future, be content to do each day's work with a firm resolve to maintain anything less than the highest standards known!

SYLVANIA ELECTRIC PRODUCTS INC., EMPORIUM, PA.

MAKERS OF INCANDESCENT LAMPS, FLUORESCENT LAMPS, FIXTURES AND ACCESSORIES, RADIO TUBES, CATHODE RAY TUBES AND ELECTRONIC DEVICES

VITAL TO VICTORY is the ever-increasing number of electronic devices that miraculously bridge the gap between man and the machine tool in war industry. Electronic contributions to technology make inspection and processing more automatic and foolproof. From long experience, Sylvania has developed and applied electronic tubes to industrial as well as military uses.



effect an accelerated program for standard procedure. As a result, American production has broken all records.

IN A STIRRING ADDRESS BEFORE THE RADIO INDUSTRIES CLUB in London recently, G. M. Garro-Jones, MP, Parliamentary Secretary to the Ministry of Production, and Deputy Chairman of the Radio Board, told of the prewar, present day, and postwar status of radio in England. He pointed out that in the prewar days, the annual turnover of the British radio industry was about one billion dollars, and that approximately eighty manufacturers were engaged in producing radio receivers. Their output, he said, was about one and one-quarter million sets a year, with about eighty per-cent of the industry devoted to such production. The production of transmitters and other similar types of equipment concerned the other twenty per-cent.

According to Mr. Jones, over eight million owned receivers in England when war began. Today, he said, the radio industry is entirely engaged in the manufacturing of war equipment, and hundreds of companies are now engaged in such production. The war seems to have brought out an important trend in the development and production of small and sturdy apparatus. This will undoubtedly be an important guide in civilian production when such manufacturing is resumed.

As a result of progress on very short wavelengths, the possibility of new national broadcasting company services has been increased. The tremendous possibilities in the field of television have also mounted because of this improvement. In addition, there are many wartime developments that will contribute towards the improvement of television equipment.

The postwar picture, according to Mr. Jones, is a good one. He emphasized that the radio industry is more assured of a successful outlook than many other wartime industries. He stressed the fact, though, that government control of industry will probably be necessary for some years to come, because of the unavailability of some raw materials. He said in conclusion, such control will be helpful to the industry and will serve to build a sound basis for improved business.

THAT POPULAR NEW YORK STATION WMCA owned by Edward J. Noble, who recently purchased the Blue Network, has been sold to Nathan Straus, former administrator of the United States Housing Authority. Mr. Straus paid $1,255,000. This is $400,000 more than Mr. Noble paid, when he bought the station from Donald Flamm in 1941.

It will be recalled that Mr. Flamm entered an injunction attempting to halt this sale. A ruling, however, of Judge Albert Cohn of the Appellate Division of the New York Supreme Court denied an interim stay to prohibit the sale of this station. According to Mr. Flamm's attorney, attempts to halt the sale are still in progress with action now pending in the New York State Supreme Court.

In the meanwhile, some interesting plans for the Blue Network are being made by Mr. Noble. There has been discussion of a network using FM. Already applications have been filed for FM transmitters in New York, Chicago, Washington, San Francisco, Los Angeles. According to Mark Woods, president of the Blue network, as soon as FCC sanction is given, network plans will be discussed. Looks like FM will become quite a project with the Blue.

THAT GRAND OLD MAN OF RADIO W. D. Terrell, who recently retired as chief of the field division, FCC Engineering Department, was given a magnificent dinner in his honor at the Lee-Sheraton Hotel in Washington. Sixty-eight of his associates were present. These included all of the FCC commissioners, with the exception of Chairman Fly who was out of town and Governor Case who had another engagement.

Highlighting the dinner, which was presided over by FCC chief engineer Jett, was a tribute from the President of the United States in the form of a letter expressing thanks and gratitude for Mr. Terrell's many years of service to radio.

The ex-colleagues of Mr. Terrell presented him with a gold chain and watch and a silver tray. The chain and watch were presented by Charles C. Kolster,

DELCO RADIO PRODUCTION METHODS

represent the practical application of research and invention

The products of research and invention become factors of Victory only after methods are developed for mass-producing them.

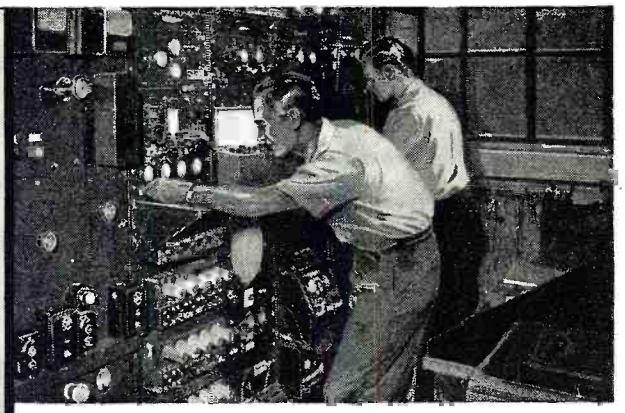
This is a skill which Delco Radio has acquired through years of automotive radio manufacturing for millions of cars. It is serving wartime needs through the volume production of highly intricate radio communication parts and equipment . . . push-button tuning for tank radio receivers . . . parts for air-borne communication equipment . . . complete transmitters and receivers for artillery equipment . . . and many other products.

Yesterday, Delco Radio's ability to combine research with production worked for higher entertainment value. Today it works in Victory's cause. Delco Radio Division, General Motors Corporation, Kokomo, Indiana.

• • • *Back the Attack*

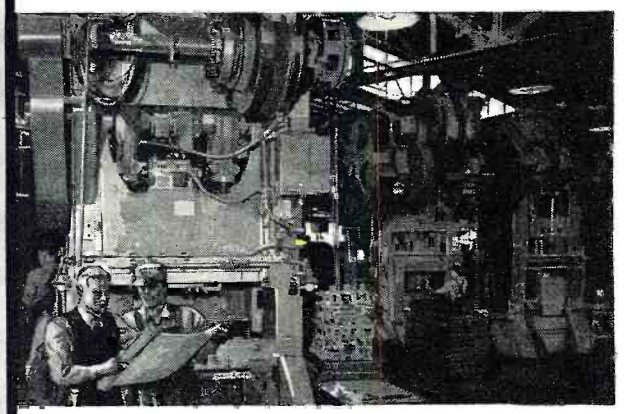
WITH WAR BONDS

★ ★ ★ ★ ★ ★ ★ ★ ★



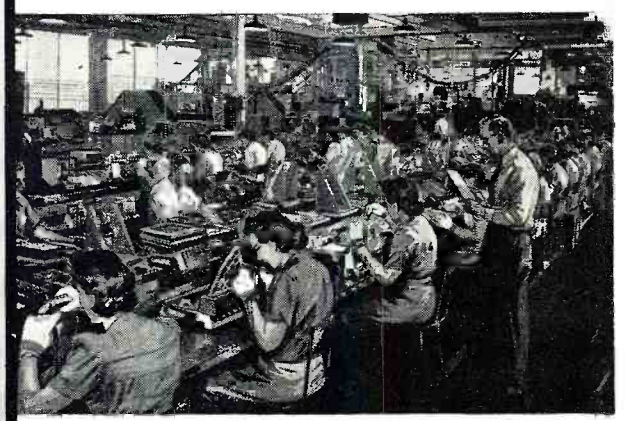
ELECTRONICS RESEARCH

Technicians of Delco Radio are carrying forward pioneer research in the field of radio and electronics.



PROCESS ENGINEERING

Delco engineers are equipped through years of experience to translate swiftly the product of research and design into practical, useful products.



PRECISION ON A PRODUCTION BASIS

Delco specializes in the ability to mass-produce highly intricate products. Years of experience in the automotive radio field qualify Delco for vehicular radio production for war.

Delco Radio

DIVISION OF

GENERAL MOTORS

FCC chief inspector at Boston and the oldest man in the service, while the silver tray was presented by Mr. Sterling, assistant chief engineer of FCC. George S. Turner, who succeeds Mr. Terrell, presented a scroll with the names of everyone at the dinner.

It was a proud night indeed for Mr. Terrell and Mrs. Terrell, who was also present.

Our best wishes to you, Bill Terrell!

FOR THE FIRST TIME boys and girls between the ages of 16 and 17 have been awarded first and second class radiotelephone licenses. As a result of special training in the Benson Polytechnic Training School, a division of the Portland Public Schools in Portland, Oregon, these youngsters have qualified for posts formerly held by experienced adults. In the group that completed the training were nine, three of whom were awarded first class licenses, while six were awarded second class licenses.

Undoubtedly stations in and around the Portland area will employ these operators. William E. Richardson, the head instructor of war production training at the school is handling the employment details.

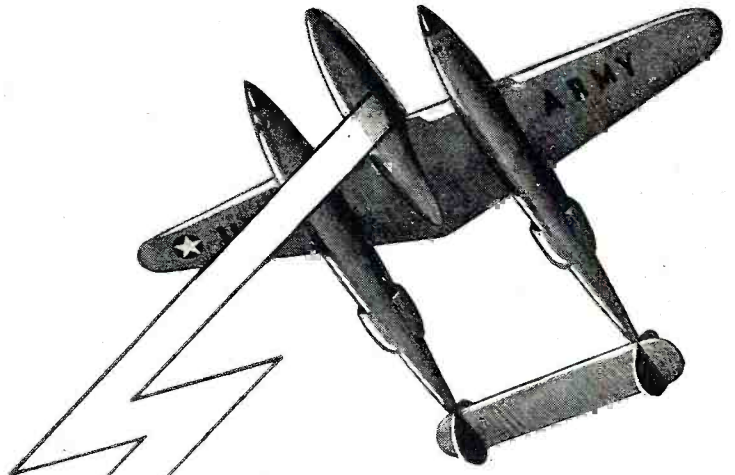
Youth seems to be having its day!

ONE OF THE PROUDEST MEN IN THE INDUSTRY TODAY is our good friend Bill Halligan, president of the Hallicrafters of Chicago, for, a few weeks ago, Bill's uncle, the late Rear Admiral John Halligan, was honored by the launching of a new warship, the U.S.S. Halligan. It was launched in the Boston Navy Yard with Mrs. John Halligan, widow of the late Admiral, as its sponsor.

As a tribute to the memory of his uncle, Bill Halligan presented the ship's crew with a phonograph and some 250 records.

ON TUESDAY, SEPTEMBER 14TH some 3000 employees and guests witnessed the presentation of the Army-Navy "E" burgee and pins to S. W. Muldowny representing the *National Union Radio Corporation,* Newark Divisions.

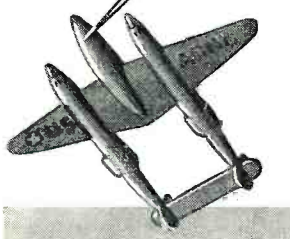
Lt. Col. Kenneth D. Johnson of the Office of the Chief Signal Officer, Washington, D. C., in making the presentation noted, *"National Union* has increased production six times with four times the floor space, three times the engineering staff and three times the total personnel." He stated, "That is indeed an excellent record of achievement, one that stands high in the official records of this war."

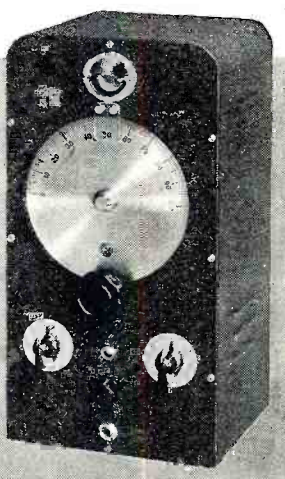


"ORANGE LEADER CALLING . . ." "ROGER!"

Pre-operational checking of transmitters helps make sure that messages will be received. Browning Frequency Meters (types S1 and S2) have for some years provided simple, comparatively inexpensive means for such checking. Type S2 is accurate to within .005%. They are easy to operate. They stand up under hard use. Full details are given in literature available upon request.

The balanced-capacitance Browning Signal System for plant protection without guard patrols is another product of Browning Laboratories research. A descriptive folder will be mailed when requested.





BROWNING

LABORATORIES, INCORPORATED

WINCHESTER, MASSACHUSETTS

ONE OF THE MOST ENERGETIC MEN IN WASHINGTON is Arthur T. Whiteside, WPB vice chairman for civilian requirements. He has been extremely active in correlating facts and figures to provide means of supplying Mr. and Mrs. Public with many essential civilian items. He has asked Congressmen to keep him posted on all civilian problems so that he may gauge the situation fluently. To assist in this fact-finding program, Arthur Stringer of NAB sent out a request to all NAB members asking them to communicate with their Congressmen. The tube problem was the featured topic in Mr. Stringer's bulletin to the NAB members. In Mr. Whiteside's letter to Congressmen he cited that a 20% reduction in dollar value of civilian business was to be expected during the last half of the year.

While it is too early to completely evaluate the Congressional response to Mr. Whiteside's letter, comment on Capitol Hill indicates that he has already received helpful information that will bring a few more choice smiles to Mr. and Mrs. Public.

PERSONALS . . .
The industry lost several of its outstanding specialists during the past month. The director of the U. S. Army Signal Corps laboratory at Camp Evans, **Lt. Col. Paul E. Watson** died at the Fort Monmouth post hospital of a cerebral hemorrhage. Colonel Watson was associated with Westinghouse before joining the laboratory. . . . In Canada, **E. C. Grimley,** president of the RCA Victor Company, and past president and director of the Canadian RMA, lost his life when he fell from a sailboat at his summer home. . . . And in Northern Ireland, **David Grimes,** vice president in charge of engineering of Philco, was killed in an airplane crash, while on an assignment for the Navy. . . . **J. J. Nance,** vice president of Zenith has been appointed to the new committee of postwar planning of the RMA. . . . The vice president of the Yankee network of New England, **Robert T. Bartley** has joined the National Association of Broadcasters as a coordinator of war activities. . . . **Clyde M. Hunt,** chief engineer of WTOP, Washington, D. C., has accepted the chairmanship of the engineering committee for the fourth district of the NAB. . . . **Eugene H. Fisher,** the manufacturing engineer in charge of ceramics in the porcelain department of Westinghouse who developed that new type of porcelain Prestite, was awarded the Westinghouse *Order of Merit*. . . . **James Quam,** president and general manager of Quam-Nichols Company, Chicago, has been elected a director of the Nichols Steel and Wire Company.

Quite a few "E" awards were given out during the month to those in radio. Winners included *Hazeltine Electronics Corporation, Webster Electric Company, United Electronics* and *Cannon Electric Development Company.* The *Scott Radio Labs* were presented with the U. S. Maritime Commission "M." According to the officials, this is the first "M" awarded in Illinois. Scott won the "E" a short time ago.

—30—

Electronics in Chemistry

(*Continued from page* 25)

tween the two dial settings is then the capacitance of the empty cell. The cell is then filled with the test solution and the variable oscillator reset to zero beat, calling the dial reading at this point C3. C3-C1 is then the capacitance of the filled cell. The dielectric constant is equal to C3-C1 divided by C2-C1.

The power factor, dielectric resistance, and Q in addition to the dielectric constant are measured to determine quality and general characteristics of various non-electric solutions. Low-frequency power factor is measured by means of bridges operated usually at 1000 cycles-per-second. Dielectric resistance is in the vicinity of thousands of megohms and is determined by means of sensitive meggers, megohm bridges, electronic ohmmeters, or sensitive galvanometers. Q is measured by means of Q-Meters, adaptations of the efficient radio-frequency oscillator and high-impedance vacuum-tube volt-meter. The construction of these devices has been discussed in earlier issues of RADIO NEWS.

—30—

You boys in the services are getting the "feel" of these RCA instruments

Plenty of old-timers at home would like to buy these instruments. But all we can make go to war plants and the services.

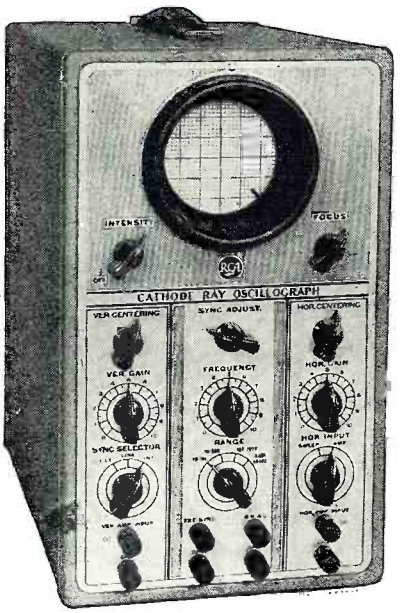
You are using these instruments —getting the "feel" of them— learning how efficient, how handy they are, how they simplify and speed up every kind of radio installation, testing, trouble-shooting, repair, or rebuilding job.

These are the instruments you will want to OWN when the war is over.

These are tools you will want to *own* when the war is won, and you come back—keen to get ahead, in the post-war world—the new world of electronics.

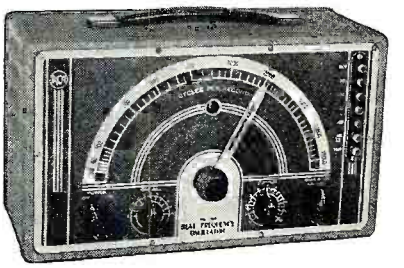
RCA RIDER CHANALYST—TYPE 162-C

Most complete signal-tracing instrument of its type. Contains five channels (RF-IF, OSCILLATOR, AUDIO FREQUENCY, ELECTRONIC VOLTMETER, WATTAGE INDICATING); enables you to check practically every circuit in a radio receiver without interfering with its operation.



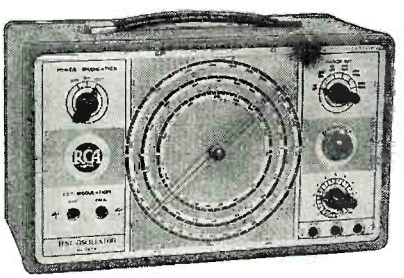
RCA 3-INCH CATHODE-RAY OSCILLOSCOPE—TYPE 155-C

Thoroughly reliable for study of wave shapes and transients, modulation measurements, radio receiver and transmitter adjustments, and peak voltage determinations. Portable, rugged, versatile. A timing axis oscillator circuit giving 10 c.p.s. to 60 KC. range is an important feature. Others are deep light-shield, removable graph screen, directly accessible deflection plates, and new "binding jack," exclusive with RCA—instantly adaptable to either binding post or pin plug—extremely handy for quick connections.



RCA BEAT-FREQUENCY AUDIO OSCILLATOR—TYPE 154

A self-contained A-C operated BFO with an AF range providing continuous coverage from 30 to 15,000 cycles. Useful signal source for testing loud-speakers, audio amplifiers, and for cathode-ray oscillograph studies. Has convenient, accurate means of calibrating against power supply frequency.



RCA A-C OPERATED TEST OSCILLATOR—TYPE 167-A

Generates signal voltages at 100 to 30,000 KC. Delivers two microvolts to one volt output in three ranges. Internal (400 cycle) or external modulation, with jack for latter.

RCA JUNIOR VOLTOHMYST—TYPE 165-A

Measures D-C and A-C voltages and resistances over very wide range. High input resistance. Easy to operate; foolproof D-C voltmeter, protected against burnout. Voltage and resistance scales need no resetting when ranges are changed. Design permits dynamic voltage measurements in signal-carrying circuits without interfering with their action.

RCA

TEST AND MEASURING EQUIPMENT

Engineering Products Department • RADIO CORPORATION OF AMERICA • Camden, N. J.

BUY WAR BONDS

Sound Recording

(*Continued from page* 23)

tual recording and play-back elements. The recordings are not interchangeable in themselves, though at least two modern professional play-back units are universal, being designed to reproduce both vertical and lateral recordings with the same tone arm.

Recording discs are usually of plastic or of some foundation material coated with plastic or plastic-like lacquer, and the "sound-trace" is either engraved or embossed directly thereon, or pressed in by a master mold. In the engraving process, a sharp stylus, usually a sapphire, cuts out the "sound-trace," this stylus being actuated by an electromagnetic driving unit. A piezoelectric crystal is sometimes used as the motor element to drive the cutting stylus. The chip or shaving which is removed from the record is disposed of by suction or brushing, in order to prevent its interference with the cutting stylus.

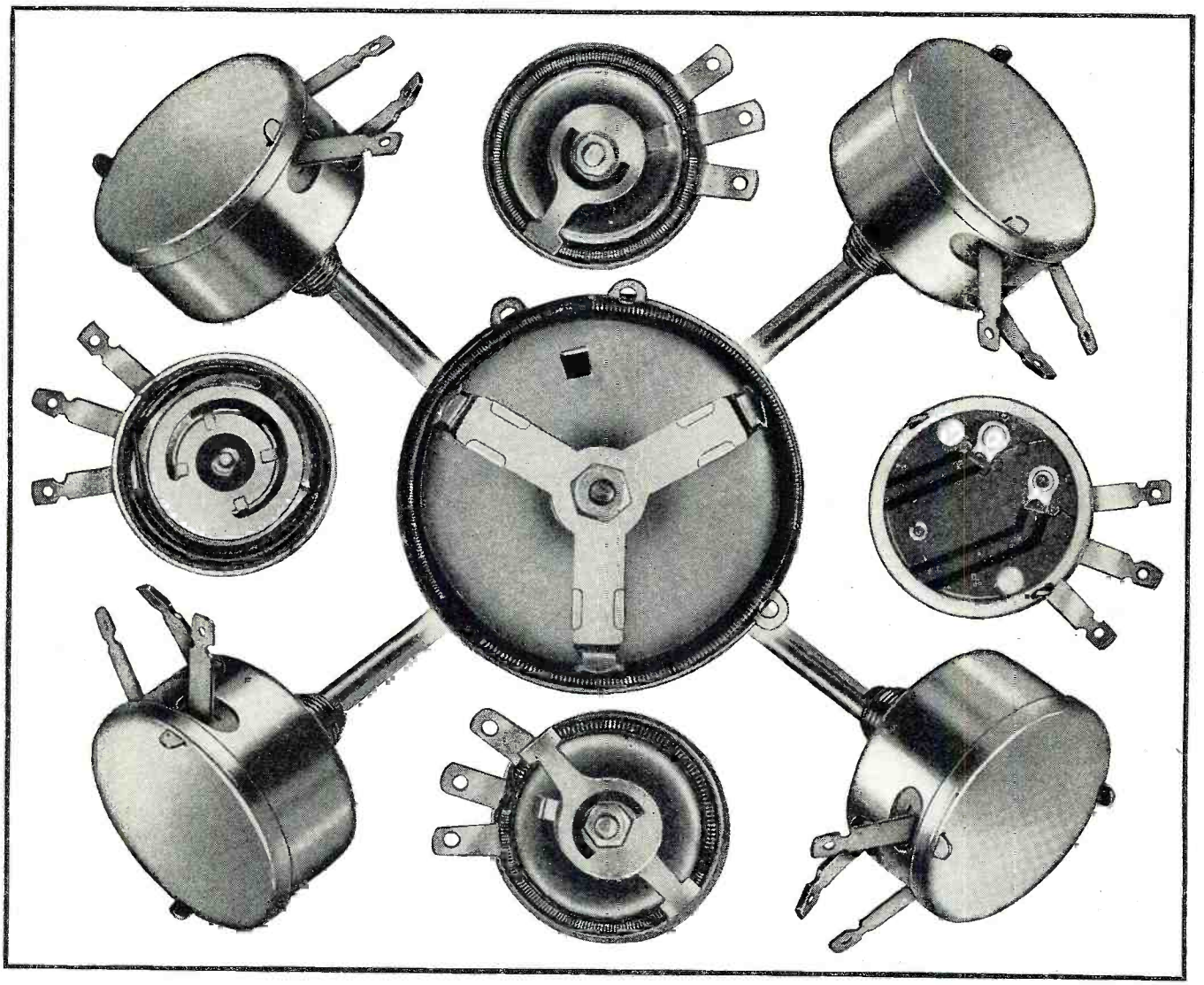
Records made exclusively for reference files are usually produced by a direct embossing method, using a stylus with a blunted and polished point, operating on a semi-soft plastic sheet in which no supporting or stiffening material is used. The "sound-trace" is thus produced by sheer pressure, which displaces the soft material without rupturing it. Use of the thin sheets combines economy of material cost, with the advantage of file space saving, since they stock approximately 75 to the inch compared with 16 for the coated records used in high fidelity technique. Moreover, file recordings using slower recording speeds and finer, more closely-spaced grooves, play one hour on each side, whereas the high fidelity type play but fifteen minutes. The embossing method produces no chip and therefore such records can operate without attention since there is no danger of fouling the stylus.

If the engraved or embossed material is sufficiently firm, the recording can be played back immediately. Soft waxy materials are often used when the record is intended to serve only as a master from which a hard mold is made. This mold is then used to press out duplicate records in a material hard enough to permit play-back. This method is the one used commercially to produce large numbers of duplicates, as in the case of the current releases of records sold to the general public for home use. Incidentally, direct play-back type records, as well as the softer "wax," may be processed to make duplicating molds, the choice depending upon the commercial and technical factors involved.

Direct play-back is a great convenience where duplicates are not a problem, and it is natural therefore that broadcasters have adopted that system almost exclusively. Old experiments and developments therein date back to the time when the only direct play-back material available was soft aluminum. The process involved embossing the "sound-trace" on a disc, but the metal proved insufficiently plastic to enable production of a smooth groove. For this reason, though reasonably accurate reproduction was achieved, the needle scratch produced in play-back was excessive and objectionable.

Direct play-back recording received a tremendous stimulus upon the introduction several years ago of the lacquer coated aluminum disc and subsequent development of this portion of the art has been almost exclusively on that basis. These discs are made by applying a coating of plastic or plastic lacquer on a smooth aluminum base, the coating being sufficiently thick so that the groove can be cut thereon without touching the supporting metal. Various types of coating are used, all of them essentially of a cellulose base, each manufacturer having his own semi-secret formula and method of application. At present, due to shortage of aluminum, the discs have a glass base which has proven a satisfactory substitute, but which requires greater care in handling.

The key stations of the several networks maintain in constant operation a battery of recording discs and one or more can reproduce simultaneously whatever is desired to record. Each



THESE VETERANS ARE SERVING ...WHERE RESISTANCE IS IMPORTANT!

IN MANY a war product—on land, at sea and in the air—Utah engineering and precision manufacturing safeguard the successful performance of many types of equipment. Indispensable to wartime service, Utah Wirewound Controls are passing the tough test of combat with flying colors.

Available in rheostats, potentiometers and attenuators, Utah Wirewound Controls are supplied in five sizes—3, 4, 9, 15 and 25 watts—with total resistances from 0.5 ohm to 25,000 ohms.

In all types of applications, under all kinds of operating conditions, Utah construction and design have proved their worth. In Utah Controls, high quality resistance wire is evenly wound on a substantial core, clamped tightly to the control housing. The result is a rugged and dependable variable resistor.

Typical of the Utah line is Utah Potentiometer Type 4-P. This rugged control dissipates 4 watts over the entire resistance element. Resistance elements are clamped in place in a cadmium-plated, all-metal frame, resulting in maximum heat dissipation for its size.

Find out if Utah controls can solve your electrical control problems. It costs nothing to get the facts—and may save you a great deal of time and money. Write today for full engineering data on Utah Wirewound Controls.

UTAH RADIO PRODUCTS COMPANY, 824 Orleans St., Chicago, Ill. Canadian Office: 560 King St. W., Toronto. In Argentina: UCOA Radio Products Co., S.R.L. Buenos Aires.

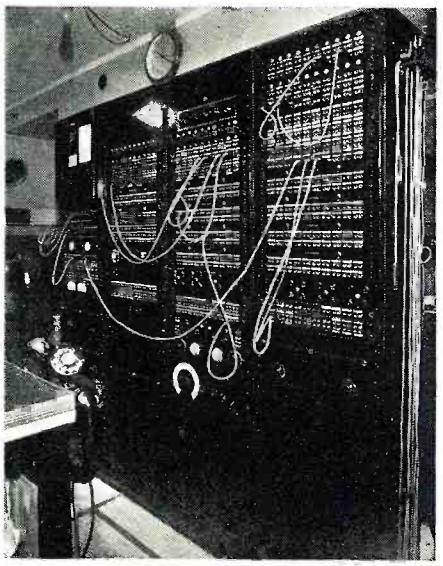
PARTS FOR RADIO, ELECTRICAL AND ELECTRONIC DEVICES, INCLUDING SPEAKERS, TRANSFORMERS, VIBRATORS, VITREOUS ENAMELED RESISTORS, WIREWOUND CONTROLS, PLUGS, JACKS, SWITCHES, ELECTRIC MOTORS

CABLE ADDRESS: UTARADIO, CHICAGO

utah

single high-quality recording channel as installed, for instance, at The National Broadcasting Company in their various major studios, consists of six technical systems of operation.

First . . . a program selecting method whereby a means is provided so the output of any studio incoming program line, or other source may be conveniently connected to a recording channel. This is accomplished either by remotely-controlled relays or by manually-operated rotary switches.



Recording control panel at Radio City.

Second . . . a special type of electronically limiting amplifier designed to automatically reduce the occasional program "peaks," or sudden bursts of high volume, to a pre-determined maximum value. This prevents "cutting-over" from one groove to the next, while at the same time maintaining maximum average groove amplitude, which in turn provides a high average volume of reproduction.

Third . . . an orthocoustic recording transmission filter or program modifier which accentuates the higher and lower frequencies of the program being recorded, in accordance with certain established standards. This feature, together with the corresponding play-back filter, produces superior overall quality of reproduction and materially reduces needle scratch and other recorded noises of an objectionable nature. These transmission filters are of great importance in the field of electrical communications since they permit modification of the sound material, being either transmitted or received, to compensate for deficiencies in the medium through which the transmission is taking place. The frequency band producing needle scratch is largely in the region upwards of 1,000 cycles per second and one of the functions of the orthocoustic filter is to increase the volume recorded above this frequency. On effect, this function overrides the factors causing the needle scratch. On play-back, the reverse is required, and a filter is used which reduces to normal the frequencies which were accentuated in recording, the overall result

BZZZ . . . BZZZ . . . ugly rumors work their way from mouth-to-mouth. **YOU HEAR** that our best grades of food are sent overseas and we are given the leavings. **YOU HEAR** that the need for purchasing war bonds is just so much talk. **YOU HEAR** that inferior implements are given our soldiers.

THE truth of the matter is that these rumors are bare-faced lies . . . spread around to cause fear and confusion. America is still the best-fed nation in the world . . . it's more important than ever that you keep buying war bonds . . . and, as for inferior war materials, you know, and we know, that American equipment is the best. Speaking solely for ourselves, Kenyon Transformers have been put to any number of gruelling tests . . . and they've emerged with flying colors.

Yes, you hear all sorts of rumors these days. They're inspired to set Americans against each other . . . management against labor, color against color, race against race. Do your part to stamp out this evil practice. **Investigate before you believe!** Remember, united we stand, divided we fall.

BUY WAR BONDS—10% is only a start. Every dollar invested in war bonds is a vote for victory. Keep on backing the attack.

THE MARK OF *EXCELLENCE*

KENYON TRANSFORMER CO., inc.

840 BARRY STREET
NEW YORK, U. S. A.

then being "flat" or natural reproduction.

Fourth . . . a high-fidelity amplifier of sufficient power output (usually 50 watts) is used to handle maximum program peaks as well as to make it unnecessary to impose power efficiency as a requirement in design of high quality cutter heads and their corrective networks.

Fifth . . . a recording cutter head which transforms input electrical energy to mechanical energy in order to actuate the stylus which engraves the record. This is a precision instrument requiring construction standards approximately equivalent to those used in watch-making.

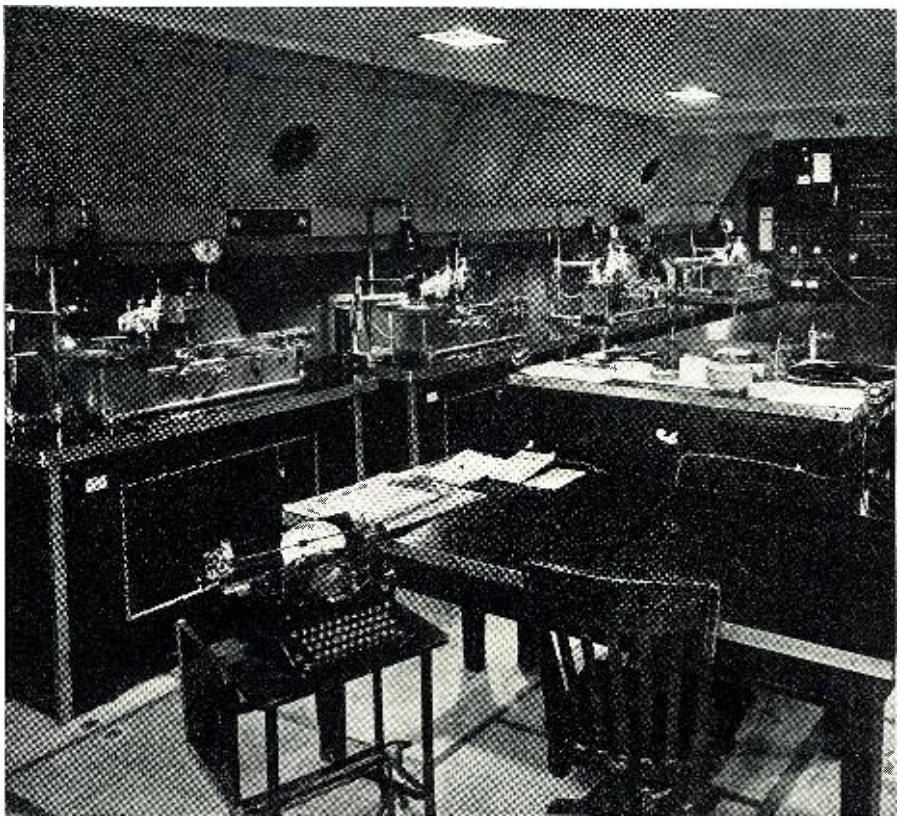
Sixth . . . the final, and equally important element, employed is the turntable which is a lathe-like device that rotates the polished, clear blank disc under the cutting stylus and also moves the latter transversely across the record. This machine also requires a high quality of workmanship since speed regulation of the rotating record must be of a high order. Even slight variations in the rotational speed of the record, either during the recording process or in the play-back will cause variations in pitch of the reproduced sound. This accounts for the objectionable quavers or "wows" heard on some recordings, particularly noticeable on sustained tones such as bells, chimes, piano chords, etc. The turntable must be exceptionally smooth and quiet in operation since any mechanical rumble or vibration will be impressed on the record together with the program material. A microscope is usually provided at each turntable to enable the operator to examine the groove during and after the recording process.

When duplicate records are necessary the required number of recording channels are connected together to operate simultaneously from the program source. Records may also be duplicated by "dubbing" or copying. In this process, the record to be duplicated is played back upon a turntable which can reproduce all the sounds contained on the record in their true relations.

Quite often a program is put together by combining parts of several different recordings. In this case the "dubbing" technique is used, requiring the simultaneous operation of several play-back turntables, the operator switching from one to the other, at the required moment, and synthesizing the result into a single new recording. This obviously requires much skill and experience on the part of the operator to avoid program gaps or clipping of syllables.

If large quantities of records are required, two original or "master" recordings are made in duplicate, one to be sent to a processing plant and the other to be stored as a protection copy in case of loss or damage to the processed copy. The processing plant then reproduces the original in the form of a metal "stamper" which in turn is used to mold, in plastic, the required number of copies.

This article is based on technical data and photographs supplied by Mr. C. A. Rackey, Audio and Video Facilities Engineer of N.B.C. Engineering Department, Radio City, New York.



N.B.C.'s largest and busiest recording installation totalling 20 separate channels.

—30—

BATTLE STATIONS -on the double

There goes the air raid alarm. And here they come, the fighter pilots . . . scrambling madly for their waiting planes. You'd hurry too if you were in their shoes, because time grows mighty important right then. Only a split second can make all the difference between getting upstairs in time, and maybe not getting off at all.

Speed is vital, too, in the building of all the tools and weapons our fighting men need. Speed, that is, consistent with good workmanship.

The young lady pictured at left is helping to send electrical instruments to battle stations faster, and in greater volume, than ever before. Hers is the delicate task of fastening the top hair spring to the armature. Note how the specially designed jigs not only speed her work, but insure accurate, precise assembly.

This single operation, all by itself, can not materially reduce the time required to build an instrument. It does serve, however, as a small indication of the many new ideas and refinements that have enabled Simpson to make such great strides in instrument manufacture.

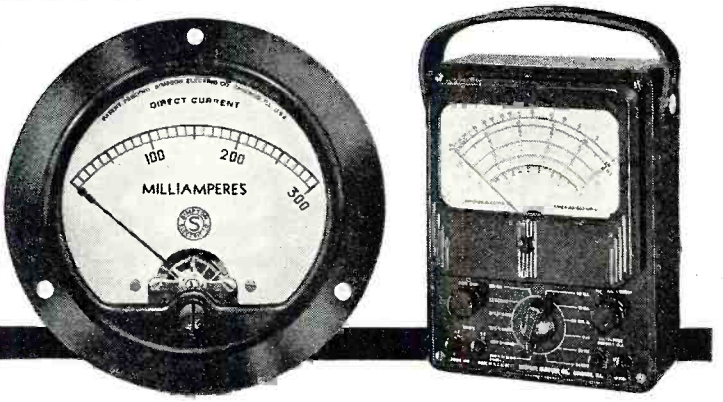
In all Simpson instruments and testing equipment you will find a basically superior type of movement which required a slow and costly method of construction only a few years ago. Today, in the Simpson plant, this greater accuracy and stamina is a matter of mass production.

SIMPSON ELECTRIC CO.
5200-5218 W. Kinzie Street
Chicago 44, Illinois

Simpson

INSTRUMENTS THAT STAY ACCURATE

Buy War Bonds and Stamps for Victory

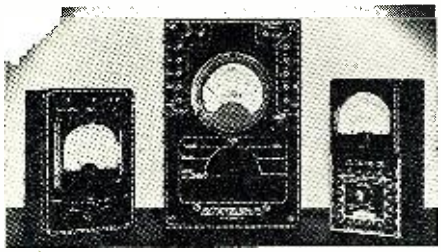


What's New

(*Continued from page* 53)

lector switch: 0-1.5/6/15/60/150. A self-contained condenser for blocking any d.c. components is connected to separate terminals.

The second is a Volt-Ohmmeter—



Model 481—which has a meter sensitivity of 50 microamperes. Equipped with precision wire-wound resistors accurate to 1%. D.c. voltmeter readings from 0.1 to 1000 volts. D.c. milliammeter readings from 0 to 100 milliamperes. Resistance measurements from 0.1 ohms to 10 megohms. Energy for resistance measurements is supplied from self-contained batteries.

The third of these is a Pocket-size Multimeter—Model 442. It is a compact multitester with a 200-microampere movement and a sensitivity of 5,000 ohms per volt. Four d.c. milliammeter ranges: 0-0.3/6/30/150 (with a first scale division of 5 microamperes). Four d.c. voltmeter ranges: 0-6/150/300/1,500 (with a first scale division of 0.1 volt). Four a.c. voltmeter ranges: 0-6/30/150/600 (with a first scale division of 0.1 volt). Four output voltmeter ranges: 0-6/30/60/150/600. Four decibel ranges from — 6 to + 50 db.

Catalogs and further descriptive information regarding these instruments can be had upon application at the main office of the *Radio City Products Co., Inc.,* 127 West 26th Street, New York City.

PLUGS AND SOCKETS

By increasing the leakage path and incorporating a new type of contact, the current characteristics of a new series of multi-contact plugs and sockets, de-

signed by *Howard B. Jones,* has been materially improved. This new No. 2400 series is interchangeable with their present No. 400 series.

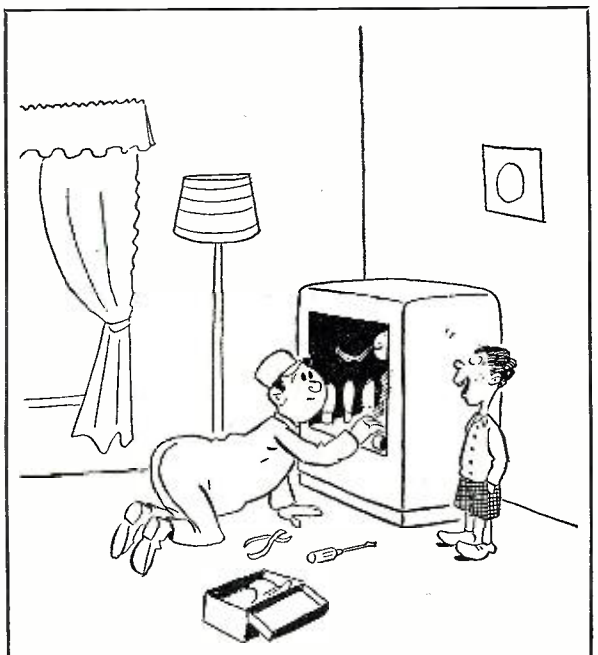
The plug and socket bodies are of BM120 formula bakelite moulded according to Navy specification 17P4, having high insulating qualities with maximum strength.

A new type of socket contact has been developed. Four individual flexing surfaces make contact with each plug prong, each segment making positive contact over its entire surface, and providing increased contact area and smoother action. Projections on all four sides of the socket contact lock it into position when forced into the contact pocket, and prevent any up and down movement whatever.

Both plug and socket contacts are mounted into recessed pockets. Barriers surrounding the contacts greatly increase the contact to contact and contact to ground distance thereby increasing the voltage rating.

The socket contacts are of phosphor bronze, silver plated. The plug contacts are of brass ¼ x 1/16" silver plated.

Further information can be obtained by writing *Howard B. Jones,* 2460 W. George Street, Chicago 18, Illinois.

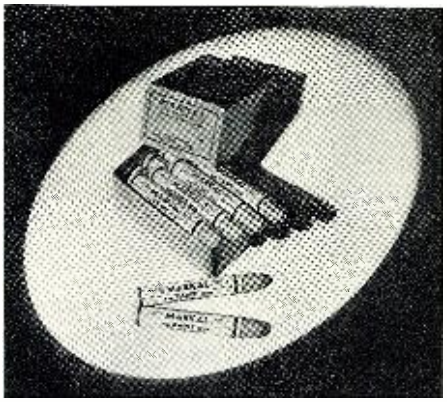


"Maybe the trouble is in the high impedance at frequencies off resonance in the audio range!"

PAINT STICK MARKER

A new Markal paint stick marker for use on all cold surfaces is announced by the *Markal Company.*

This marker designated as Markal



"N" makes a wide, highly legible mark and was developed especially for use in shipyards, steel mills, railroad shops, foundries, etc. It is a real paint in stick form and produces permanent, fade-proof, weather-proof markings on metal, lumber, rubber, stone, marble, hard polished plate glass, porcelain, vitrolite, plastics, cellophane and other surfaces. It is fast drying.

Markal "N" is made in red, white, blue, green, yellow and black; so that each color may be used for easy identification purposes as well as for piece work marking.

Literature and free samples on Markal "N" and other Markal paint sticks for hot and cold surfaces may be obtained by addressing the manufacturer, the *Markal Co.,* 6 East Lake St., Chicago.

JUNCTION BOX SET

A new CD-874 cord set, with plug and junction box assembled, has been announced by the *Trav-Ler Karenola Radio and Television Corp.* The junction box has a two-piece bakelite plastic case. The lower section of this case has two silver-plated, copper terminal jumpers, and four terminal binding posts for the necessary connections. Sturdy, rigid cord clamps are molded into both sections of the case,

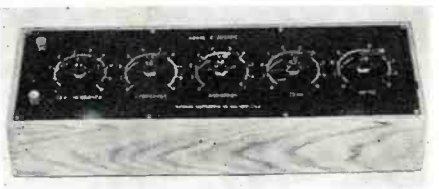
to firmly hold the cordage in place and prevent slipping. A tight-fitting Neoprene jacket sleeve makes a close seal over the end of the P1-55 plug, which is connected to the cordage.

It is guaranteed to withstand all U. S. Army Signal Corps tests.

Inquiries should be referred to the *Trav-Ler Karnola Radio and Television Corp.,* Dept. RN 25, 1030-2 W. Van Buren Street, Chicago, Illinois.

DECADE BOX

Model 5 decade is a precise decade box providing a choice of any resistance from 1 ohm to 99,999 ohms in steps of 1 ohm. All decades are adjusted to an accuracy of 1/10th of 1% and the resistors are all non-inductively wound with wire which has a temperature co-efficient of plus minus .00002 between 20° and 100° Centigrade. Low resistance switches are used throughout. The bakelite panel is engraved by the new "cut-in" process which eliminates the possibility of letters ever being scratched off. The instrument is housed in a rugged oak cabinet. Size 18½" x 6½" x 3½".



Manufactured by the *Superior Instruments Co.*, 227 Fulton St., New York 7, N. Y.

—30—

Electron Tubes

(*Continued from page* 51)

other way. After a time, this is easy to accomplish while thinking of something else. Also this is a job easy to accomplish by means of electronics because a phototube may be substituted for the eye so that a beam of light shining past the object to the phototube is affected when the part in question is missing or improperly placed. When the phototube is thus actuated, electrical relays plus solenoids or motors can follow up with the desired action.

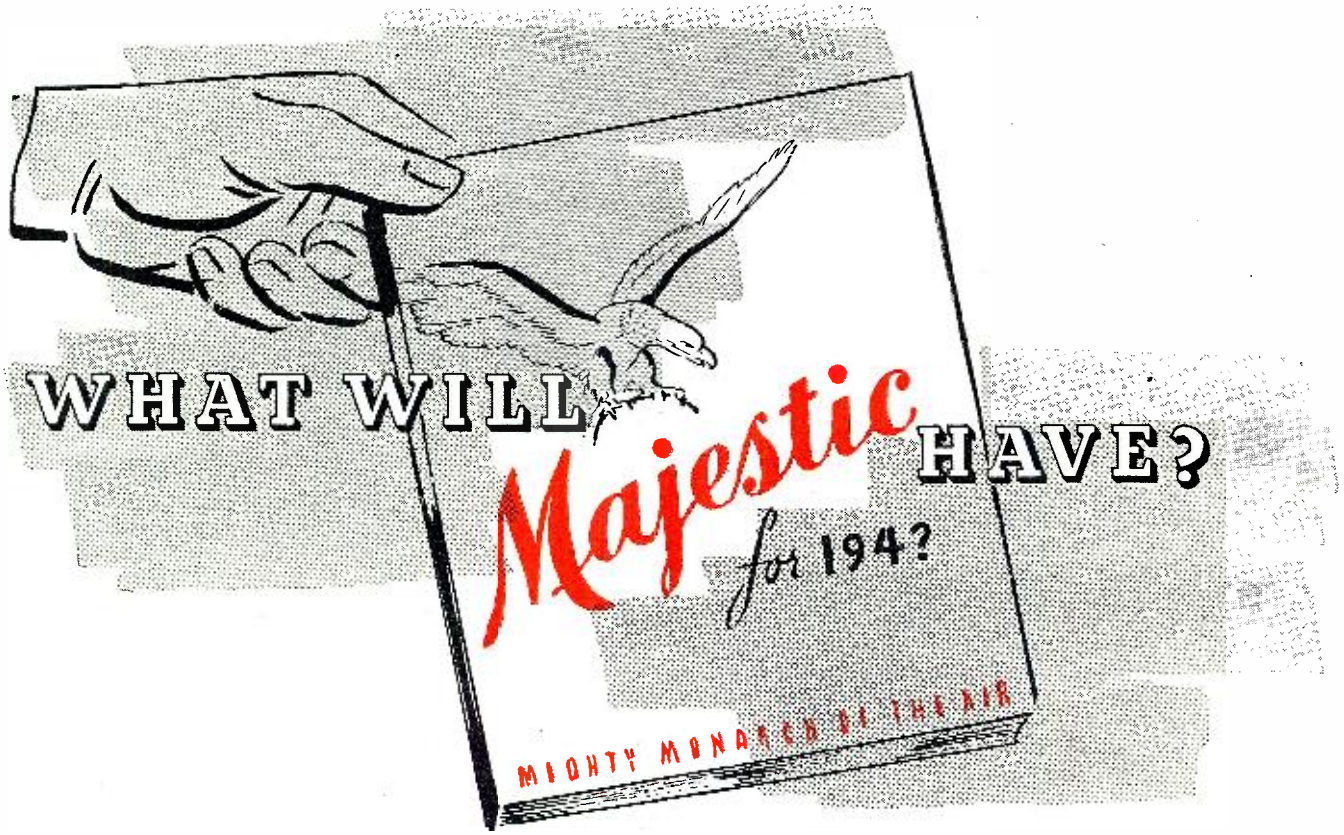
Extending this idea, the electrical microphone will respond to sound and the thermocouple to temperature. Other combinations incorporating vacuum tubes can be made to respond to a slight movement of an object. Many of the modern applications of electron tubes in industry are based on this fundamental idea that has been aptly termed "extending the senses."

The present trend in tube development appears to be along the line of stepping up their characteristics over a several-fold range. This means, for instance, that tubes and their associated circuits will be able to handle currents several times as heavy as present tubes now handle. It will mean that frequencies ten times as high as those in common use can be generated.

Working in the opposite direction, there will be a trend toward tubes that fundamentally respond to weaker impulses, that is, have a higher degree of amplification or that will time electrical circuit operation for much shorter periods and with much greater accuracy than we now enjoy. Whenever it becomes possible to do something ten times faster, slower, bigger, or smaller than previously, one can be sure that some new development of value will result. Therefore, there is every reason to believe that as time goes on we can do not only some *new* things with tubes but we can do some of the things we now do, better, more accurately, or at a lower cost.

—30—

Commander Charles F. Greene, U.S.N., former Assistant Chief of the 5th Naval District, Norfolk, Va., and new Commanding Officer of Naval Training Schools at the University of Wisconsin, watching noncommissioned Waves try their hands at typewriters and earphones in the radio classroom. They are receiving a three month course in radio communications.



Majestic has been a good soldier in the great production army. Walkie-Talkies, Crystals, and other types of military electronic equipment are flowing from its production lines in a never ending stream.

But, Majestic is looking forward impatiently to the day when it can again build receivers for radio hungry American citizens. Already post-war price ranges, types of receivers and cabinet styles are being discussed with dealers and distributors, and plans for the post-war Majestic are being made.

When that day comes, Majestic will have a line tailored to public demand!

$1000 PRIZES IN WAR BONDS

For Most Helpful Answers to These Three Questions

1st Prize, $500 maturity value; 2nd Prize, $250 maturity value; 3rd to 13th $25 maturity values. Every one is eligible. Contest ends December 31, 1943. To stimulate YOUR post-war thinking, and to check OUR post-war plans, Majestic offers prizes for the most helpful answers to these questions:

(1) What types of radios will be in large demand in YOUR locality immediately following Victory?

(2) In what new features or new merchandising policies are you most interested at present?

(3) What kind of advertising support do you believe will be most helpful to you?

Competent judges will read your answers. It's facts and ideas, not rhetoric, that will count. If any two prize winning letters are considered by the judges to have equal merit, duplicate awards will be made. Write your answers to these three questions—mail them to me personally, today!

E. A. Tracey, President

Majestic MIGHTY MONARCH OF THE AIR-IN WAR AS IN PEACE

Builders of the Walkie-Talkie—"Radio of the Firing Line"

MAJESTIC RADIO & TELEVISION CORPORATION

2600 West 50th Street • Chicago, Illinois

Practical Radio Course
(*Continued from page* 56)

power tubes, thus far, we have assumed that a certain value of load resistance was provided for the tube to work into, and that whatever value was provided remained *constant* during the tube's operation. When, however, the power tube of an audio amplifier feeds the usual complex audio signal of varying frequencies into a loudspeaker load, this ideal operating condition does not exist. Actually, a dynamic speaker (including its impedance - coupling transformer) does not act as a pure resistance, and does not present the same impedance to the output tube at all audio frequencies. In the first place, the loudspeaker, being a complex electro-mechanical system, is subject to some sort of resonance at one or more definite frequencies. Usually, the most serious, and the one we need consider here, is that which occurs in the bass region below 100 cycles. The impedance characteristic of a typical dynamic speaker is illustrated in Fig. 4. Bass resonance for this speaker occurs at about 70 cycles (point *A*). At this frequency (which is usually less than 100 cycles in most speakers) the impedance of the speaker is high (80 ohms), and *resistive*. Immediately above (and below) the resonance frequency the impedance drops to a much lower value; it is only about 15 ohms at

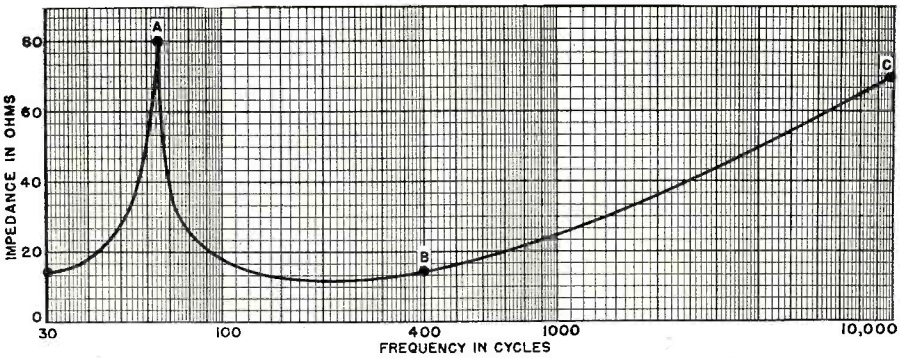


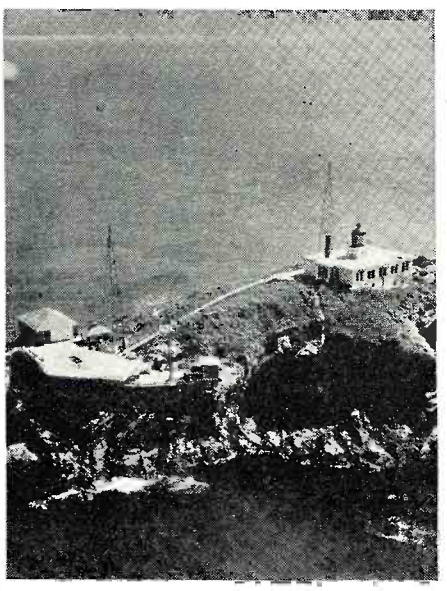
Fig. 4. Speaker impedance variations due to variable frequency response.

400 cycles (point *B*). Because the voice coil contains turns of wire over a highly magnetic core, it has inductance. Since the effect of the loudspeaker inductance *increases* with the frequency, the impedance of the speaker increases with frequency. This is shown in Fig. 4 by the fact that increase in frequency above 400 cycles causes the impedance to rise steadily, until it reaches almost the same high level at 10,000 cycles (point *C*) that it had at the resonance frequency (point *A*). In fact, at frequencies higher than the resonant frequency, the load impedence of a dynamic speaker acts like an inductance in series with a resistance.

If constant electrical signal power were applied to this loudspeaker at all frequencies, the *acoustic* (sound) output from it would be very much greater at all other frequencies than in the region around 400 cycles. Low frequencies would "hang-over" when reproduced, and would be accentuated by the resonance effects in the speaker. High frequencies would be accentuated by the rising impedance characteristic and would, therefore, be reproduced at excessively high levels. The overall reproduction might be, therefore, most unnatural.

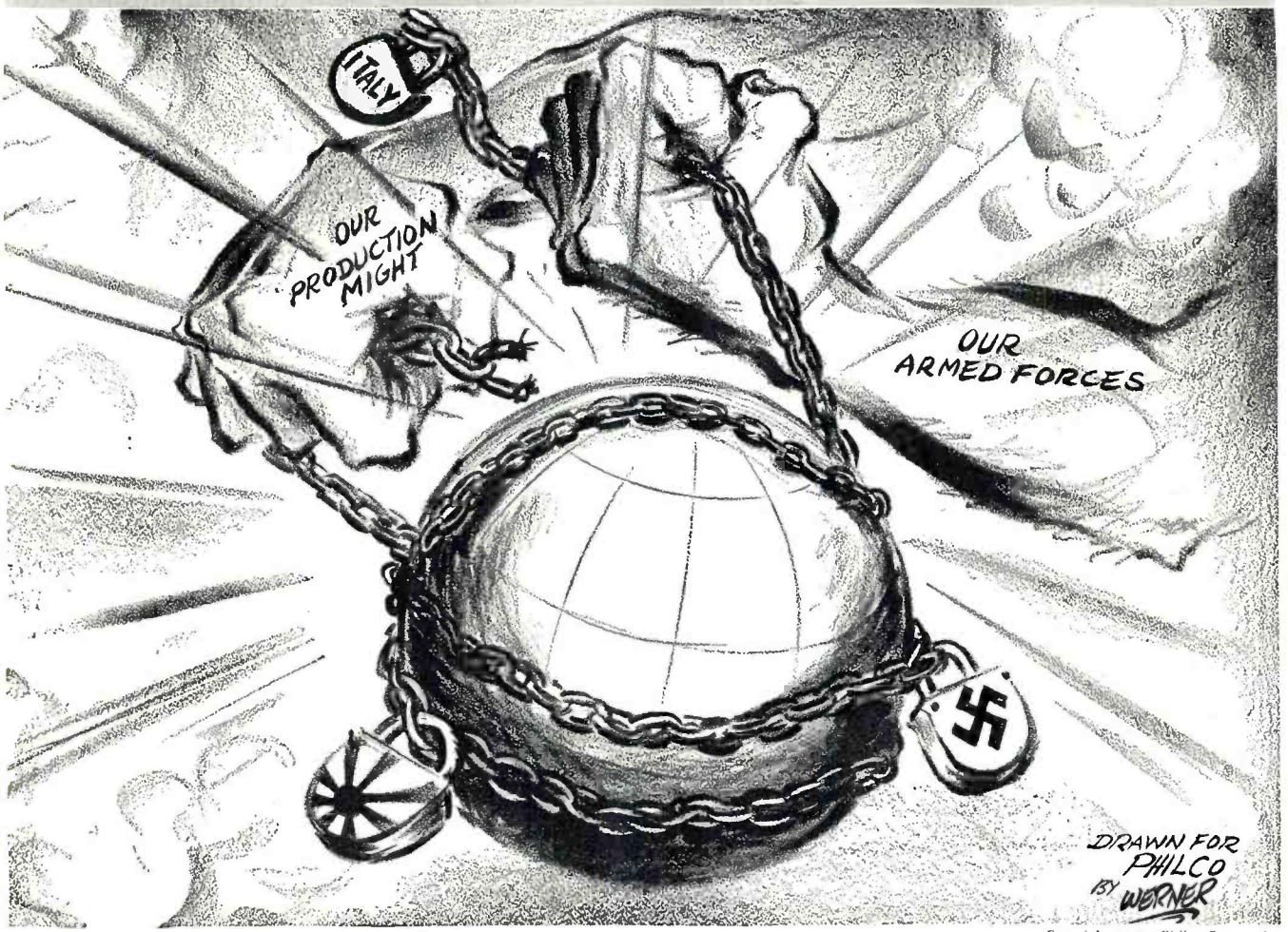
Frequency Distortion Effects

Now when a power *triode* output tube is used to feed a loudspeaker, the speaker impedance (including the output transformer) is chosen so that the *lowest* value it will have over the audio frequency range is at least equal to the optimum value required by the tube. Hence, any increase in speaker impedance that occurs at other working frequencies will increase the tube plate load and therefore *decrease* the output power of the tube available in the load at these frequencies, as is illustrated in Fig. 3A. This has the effect of automatically damping out any



Airplane view of Coast Guard Light Station, Cape Spencer, Alaska. The cage antenna between the steel masts is for the radio beacon. The radio communication antenna (not visible in the picture) is strung from the mast at the left to pole atop the light tower.

And Then there were Two!



This is another of the series of cartoon advertisements appearing in the national magazines depicting the might of industrial America. It tells the story of Philco at war and the peacetime promise of Philco war research and production for the homes and industries of America.

AS OUR fighting forces move to the attack, there is one assurance that the home front may safely draw from the news. No power on earth can match the productive might of an aroused industrial America! That is the faith that gave us the courage to go forward during the darkest days of the Axis advance. And that is the calm conviction that leads us today to bend our full strength to the task until total victory is won.

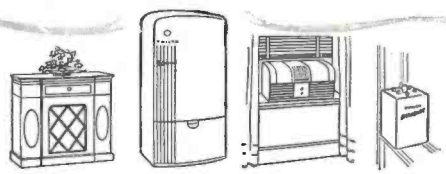
The men and women of Philco know that whatever toil and sweat it has taken to win the initiative, it will take more of the same to win the Victory. All they have learned in their laboratories and production lines during twelve straight years of radio leadership is devoted now to making radios, communications and electronic equipment that will give our soldiers and sailors superiority in the attack.

On some tomorrow, they will be back at their peacetime tasks, bringing you the fruits of their new knowledge and skill in radio, television, refrigeration, air conditioning and industrial electronics . . . under the famous Philco name.

PHILCO CORPORATION

In time of War

BUY BONDS FOR VICTORY



PHILCO—the Quality Name in Millions of American Homes.

In time of Peace

BUY PHILCO FOR QUALITY

"low-frequency boom," or shrillness due to over-accentuated high-frequency reproduction, that might otherwise result from this cause.

On the other hand, just the opposite effect is produced when power pentodes (or beam tetrodes) are employed. Since the power output of these tubes *increases* with increased load impedance, see Fig 3B, at the bass resonance point, and for the higher audio frequencies, the power output tends to rise, often producing very serious frequency distortion (unequal amplification of all frequencies) unless some corrective measure, such as inverse feedback, or a corrective filter, (both to be explained later) is employed.

Harmonic Distortion

The variation of loudspeaker (including the output transformer) impedance over the audio frequency range also effects the harmonic (waveform) distortion produced by the output tube. In the case of a *triode* power tube, the second harmonic distortion will *decrease* at those frequencies for which the loudspeaker impedance increases—see Fig. 3A.

In the case of pentode or beam power output tubes, variation of loudspeaker impedance with frequency is much more serious. Change of load resistance either side of optimum load value causes a comparatively rapid change in harmonic distortion—see Fig. 3B. Furthermore, with a load of varying impedance, there is a *selective* effect on the harmonic distortion. For example, if the impedance of the load is greater to a harmonic than it is to the funda-

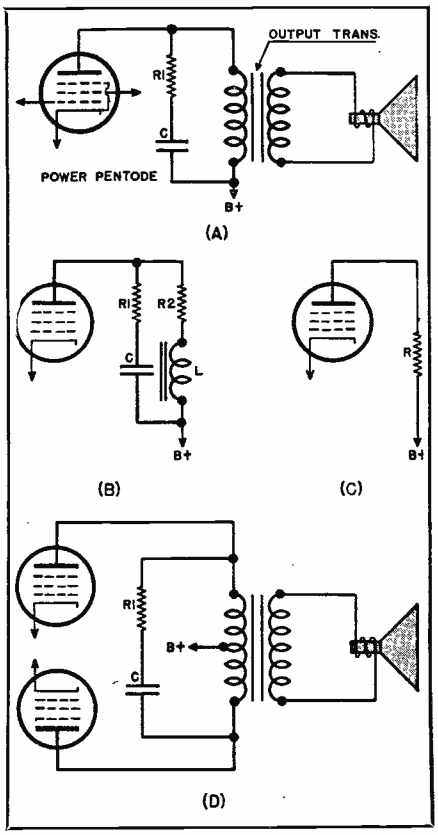
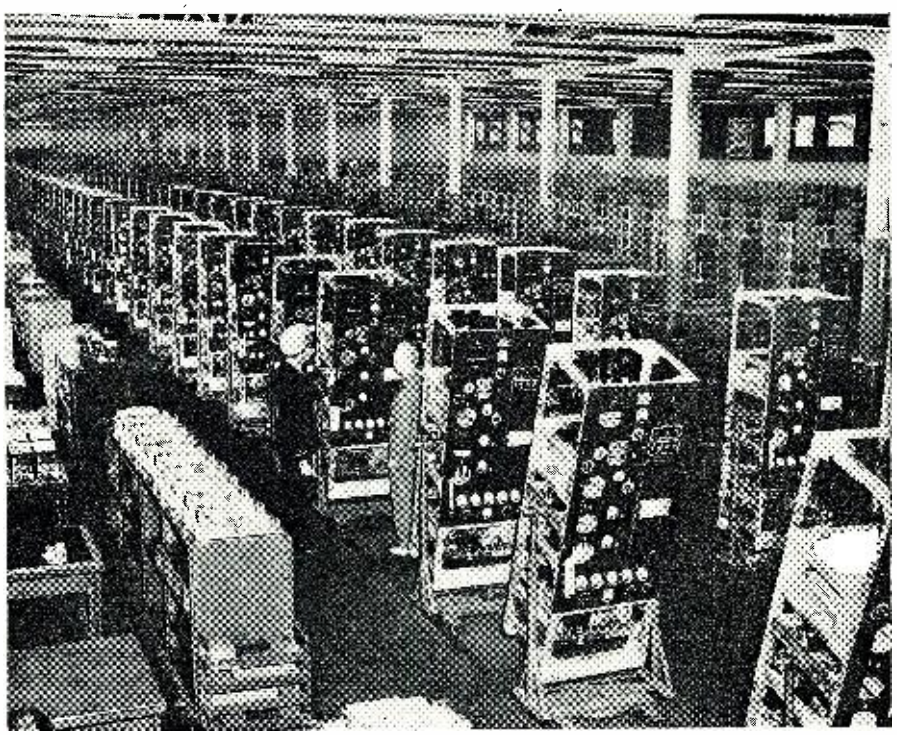


Fig. 5. (A) Compensating network for speaker impedance variations. (B) The equivalent circuit of (A). (C) The equivalent circuit of (B) as a pure resistive load. (D) Compensating network added to a push-pull output stage.



Long rows of radio transmitting equipment for the Navy are shown in one of the many large General Electric factories. Many warships have not one, but a number of transmitters and receivers of various frequencies and power ratings, also equipment for detecting planes and other ships as well as portable radio apparatus for a variety of applications.

Remember Uncle Joe?

Perhaps to you his name was not Uncle Joe. Maybe it was Dad—possibly it was the man-down-the-street. But, as youngsters, most all of us were fortunate enough to know someone with whom we could talk over our problems—someone who always seemed to have an answer for the questions that stumped us.

We want to be your "Uncle Joe" for perplexing radio service problems. We want you to make use of our services established to provide technical information, suggestions on replacements, recommendations on substitutes for hard-to-get items, solutions to circuit problems . . . all the questions you ask in practical wartime servicing of home sets to "Keep 'Em Listening."

No one person in the Mallory organization is a "know-it-all." But many competent radio engineers are on our staff. Men experienced in servicing problems. They are at your service . . . along with plenty of down-to-earth technical data that will help mightily in these busy days. Tell us your problems in detail. Just address—Technical Information Service, P. R. Mallory & Co., Inc., Indianapolis, Ind. You will hear from us promptly.

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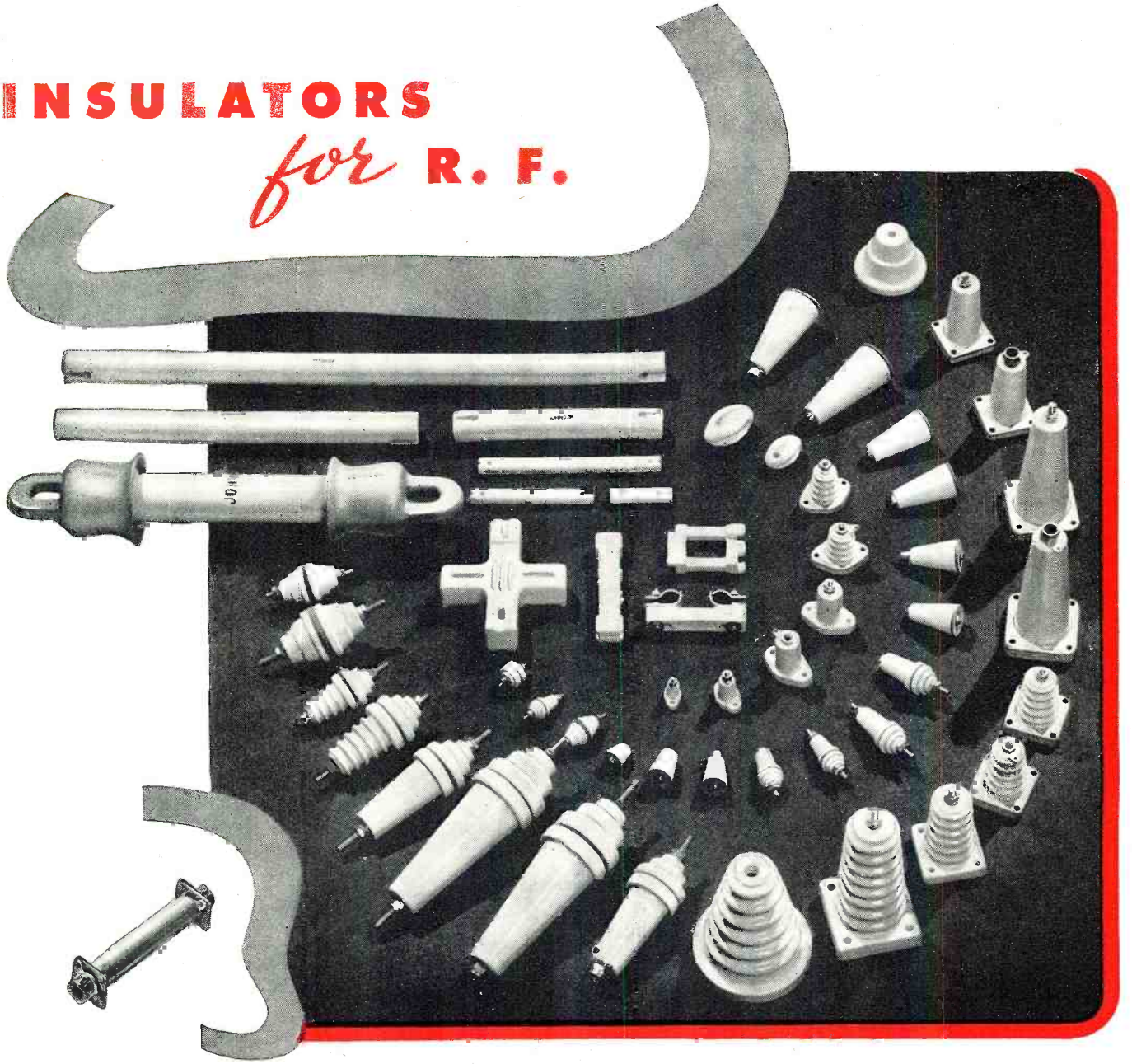
mental (as is the case when the load impedance is predominantly *inductive*) the harmonic percentage will be greater than with constant load resistance equal to that offered by the fundamental. Also, as can be seen from Fig. 3B, when the load impedance increases, the output *rises,* so that even if the percentage of harmonics remained steady instead of rising steeply as it actually does, the *amount* of harmonics present would tend to increase. Harmonic distortion, by its very nature, causes shrillness in the reproduction. This is objectionable and often actually annoying.

Corrective Filter

There are two ways in which the objectionable effects of speaker impedance increase with signal frequency increase (frequency distortion and excessive harmonic distortion) can be reduced so as to improve the frequency characteristic of an output stage using a beam power tube or a pentode. One is by using inverse feedback (to be discussed later). When this is not applicable or convenient for some reason (as is frequently the case in amplifiers with pentode output tubes), a simple resistance-capacitance *corrective filter* is employed. This usually consists of a condenser C and a resistor R_1 in series, connected across the primary of the output transformer as illustrated in Fig. 5A. Connected in this way, the filter is in parallel with the plate-load impedance reflected from the speaker voice coil by the output transformer. The magnitude of this reflected imped-

Cadet Strathmore K. McMurdo, of Augusta, Ga., keeps in touch with patrols by radio during the Maneuvers of West Point Cadets at Pine Camp, N. Y. Cadet McMurdo of the Red Force, is chief of the radio and visual section.

INSULATORS *for* R. F.



Many commonly used insulating materials function perfectly in low frequency circuits such as audio, 60 cycle power or even the lower radio frequencies. These same materials at medium or high radio frequencies act as high resistances to waste precious R. F. Many porcelains, steatites, glasses and similar materials have this fault and only tests under laboratory conditions will detect it. Johnson insulators were not only designed for high R. F. but the materials were selected only after exhaustive tests to determine the best. Can you afford to take chances? Demand the best—they cost no more—specify Johnson.

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ance increases with increasing frequency in the middle and upper audio range, and also at the lower bass resonance point. The equivalent electrical circuit is shown at (*B*) in which *L* and R_2 are the inductance and resistance of the loudspeaker load. A tone correction filter *could* be connected across the secondary of the transformer instead, thereby putting it directly across the speaker voice coil itself, but that would necessitate an excessively large capacitance to do the job.

Due to the capacitance *C*, the impedance of the corrective filter *decreases* as the frequency increases, so its action is just opposite to that of the inductive load. Therefore, by proper selection of values for the resistance and the capacitance in the filter, the combined actions of the inductive load and the filter can be made to produce an effective load impedance on the output tube (or tubes) that is practically constant for all frequencies in the middle and upper audio range. The reason for including the resistor R_1 in series with the condenser is to form a high-resistance circuit with *L* and R_2 at all frequencies so that the condenser *C* does not resonate with inductance *L* at some particular frequency. This would cause excessive amplification at this resonant frequency. The resulting circuit containing an inductance (*L*) and resistance (R_2) in one branch, and a capacitance (*C*) and high resistance (R_1) in the other acts practically as a non-resonant circuit equivalent to a pure *resistance R*, shown in Fig. 5C, which is *constant at all frequencies*. By using such a tone-correction circuit, then, the frequency and harmonic distortion that would arise from change of plate load (loudspeaker impedance) with frequency is materially reduced.

Design of the Corrective Filter

The resistance, R_1, to be used in the corrective filter for a push-pull pentode or beam power stage is about 1.3 times the recommended plate-to-plate load resistance; or for a single-tube stage, is about 1.3 times the recommended plate load resistance. The capacitance *C* should have such a value that the voltage gain of the output stage at a frequency of 1,000 cycles or higher (depending upon the frequency range over which a flat characteristic is desired) is equal to the voltage gain at around 400 cycles. A simple method of determining the proper value of capacitance for the filter in any case is to make two measurements on the output voltage across the output transformer primary: first, when a 400-cycle signal from an audio oscillator is applied to the input, and, second, when a 1,000-cycle (or higher frequency) signal of the same strength is applied to the input. The correct value of capacitance is the one which gives equal output voltages for both of these signal inputs. In practice, this value is usually found to be of the order of 0.05 μfd.

When R_1 and *C* are determined in this manner, considerable power may be dissipated in R_1, especially at the high audio frequencies. For this reason, it may be desirable to increase R_1 and *C* until a suitable balance between high - frequency compensation and power loss is obtained.

The effects of speaker resonance are NOT reduced by this filter method of compensation. Inverse feedback must be employed for that.

The connections for applying the filter to a push-pull pentode output stage are shown in Fig. 5D.

—30—

For the Record

(*Continued from page* 4)

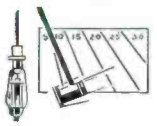
In most cases the equipment is quite crude in comparison to ours. Each has its own peculiar characteristics. For example, Italian radio sets appear to be very hay-wire and built of inexpensive material. Wiring is done carelessly and flops around within the various units where it is subject to breakage. Light weight panels are used and there seems to be a general lack of engineering skill throughout the design of their units.

German equipment, as a rule, is designed to give long life and trouble-free service. Elaborate castings are employed for various units of their assemblies. They have some highly efficient tubes and socket assemblies. Maximum protection is afforded the various tubes, particularly those designed for use in aircraft. Cabling is done neatly and silver soldered connections are to be seen in many German transmitters and receivers. Late German sets, however, are lighter in weight and less carefully assembled.

Japanese equipment smacks of being copied. A large Japanese direction finder for field use was displayed which had never seen combat service. It was a maze of cabinets and other accessories, most of which could well be eliminated. Copies of American made tubes were found within Japanese tube cartons. Several of those that we saw actually had our Navy anchor embossed on the glass. The dry batteries furnished with the set were almost identical in appearance to the well-known Burgess batteries made in this country. Other Japanese units resemble to a great extent those made in the United States. You may be sure, however, that even though these units are copies, they do not compare favorably in performance to our domestic units.

At the time of this writing there is considerable speculation in Washington that at least a part of this huge display may be taken on the road to visit some of our larger cities. We hope that our readers who have the occasion to see this Signal Corps equipment on display will not fail to take advantage of this excellent opportunity to see for themselves how the American radio industry has responded to the demands of the Signal Corps for the best made radio and telephone equipment in all the world. 73 . . . OR

"How would you like to be hit several times with a hammer?"



Pity the Hytron tubes struck several sharp blows by a heavy, swinging hammer during the Bump Test. Only by such rough treatment, can rugged Hytron tubes suitable for the shocks of mechanized warfare be selected.

Even this trial is not enough. These quality tubes must withstand many other mechanical shock tests during which the stability of electrical characteristics is carefully measured while the tubes are tortured by scientifically simulated jolts and vibrations which might occur in actual combat.

Hytron engineers are quality conscious. Whether the test be mechanical or electrical, their purpose is the same—to supply our boys with tubes fit for service in bouncing jeeps, rattling tanks, shell-belching battleships, and darting, twisting, roaring fighter planes. Wherever Hytron tubes may be called upon to act as the dependable hearts of radio and electronic fighting equipment, they must be the best that can be made.

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TELEVISION PRODUCTION

By AUSTIN C. LESCARBOURA

Telecasting—and its many production problems, affecting entertainers and engineers.

EVER since King Solomon's famed parties, there rarely has been such high-price-per-capita talent as that cooped up in a dazzling studio on the 42nd floor of a New York skyscraper. Several evenings per week you can meet up with costly entertainment talent here on display, not to mention less glamorous but most impressive engineering skill, executive ability and advertising brains bubbling with enthusiasm and steaming from exertion—all for a mere handful of seen and unseen spectators. The cost per capita is truly appalling. But fortunately it's strictly on the cuff. The audience pays nothing. The sponsors pay nothing. Yet everybody hopes to cash in, some day. Meanwhile, it's just the television kindergarten in session.

For several years past Du Mont television station W2XWV in midtown Manhattan has been on the air on a strictly engineering basis. And now, despite the war, it provides scheduled entertainment programs for the several thousand television receivers in the metropolitan area, and strictly trade shows for those interested in the dollars-and-cents possibilities of the next step in home entertainment.

Television to be commercially successful—to make good on the lavish promises made in its name for years past—must first round out a three-point development program. First, it must be properly engineered. Second, the programs must possess genuine entertainment value. Third, the economies must be worked out, so that it will be on a self-supporting basis once the initial novelty has worn off and Santa Claus departs from the scene. Utilizing television station W2XWV as a laboratory, a three-point development program is being developed and the foundation of post-war commercialized television built.

First in importance is engineering! Television must be capable of flashing sharp, clear, action images to hundreds of thousands of television receivers in a given metropolitan area. This it can already do, thanks to tremendous engineering strides these past few years, further augmented by certain military developments and requirements in the cathode-ray field, fortunately applicable to television technique.

Today's television images are comparable with the pictorial quality of average home movies, or adequate for satisfactory entertainment. Definition is really good. Images are clear, bright, crisp. Subject matter is no longer limited to closeups of one or two individuals. Nor is there any guessing as to what is really taking place on the screen.

Neophytes sometimes expect too much of television at this early stage, just as photo amateurs expect too much from those tremendous blownup enlargements. A director of a recent telecast presentation went to great pains to avoid exposing his left profile to the television camera. He happened to have a slight scar! No doubt the camera did record his self-consciousness, whereas it might fail to pick up the negligible facial blemish.

Television now takes in a full studio setting with several performers. It follows the fastest action such as dancing, ping pong, fencing. Definition is sufficient to enable the reading of charts, simple maps, labels, titles. Movies can be nicely reproduced with the necessary pictorial quality for real enjoyment.

If a mobile pickup is available, whereby to take the television camera to remote locations from which signals are flashed back to station headquarters by ultra-short-wave radio link, excellent outdoor scenes can be handled, such as street scenes, news events, baseball or football games, track meets and parades. In short, the engineering end of television is now at par, all set to go commercial, but. . . .

There is more to television than good images. They must be interesting pictures—with sound. Engineering is the means rather than the end. The end spells entertainment pure and simple. And that means programming.

It so happens that telecasting or the actual practice of television is unique unto itself. There is nothing else just like it. It isn't broadcasting: some broadcast stars have already flopped miserably on television programs. It isn't the movies: some screen headliners have scored perfect flops before the television camera. Television is simply television, and that is what is causing considerable consternation in entertainment circles.

Television is somewhat like the movies because it takes in sight and sound. But it is quite different because it is spontaneous. In other words, it picks up and transmits what is happening at the moment. There is no such thing as "shooting" the scene several times and picking out the best "shot." Television is a one-shot proposition. The performance stands or falls on that one attempt. Of course there are re-

THE French have a proverb—"The more things change, the more they are the same." How true that is of Midwest Radios! Once we counted satisfied Midwest Radio owners in hundreds of thousands . . . in every part of the globe. Today, we have only one customer—America's fighting man. But you'll find him, too, in every corner of the world—and, by his side, radio or electronic equipment, built by Midwest, giving him the same dependable performance that for 22 years has made Midwest Radios an international favorite.

When Victory is won, a new era in radio and electronics will open for you who have been forced to stand by while a greater need was being served. What this new era will bring, it would be foolish to conjecture. But, of this you can be certain—Midwest will be back again with highest quality radio receivers, and with Factory-To-You savings of up to 50%—*as always!*

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hearsals, but when the performer steps before camera and microphone it is his one chance.

Furthermore, unlike the stage, you can't repeat the same thing over and over again, night after night, week after week. Television, like broadcasting, calls for an endless flow of fresh material. "What, do you mean to say your station is on the air only five hours a week!" exclaims the impatient prospect for a home television receiver. Well, my dear Mr. Prospect, to provide even those few hours of entertainment means the endless corralling of hard-to-get talent, many hours of rehearsing, and a big fat money bag.

Ah! A big fat money bag. And where does that come from?

Until now, television has been one of Santa Claus' hobbies. Something new, something different, something thrilling, it has been sustained by several large and small organizations just as broadcasting was carried along for about five years before hard-boiled accountants had a chance to add up long columns of cost figures and scare earlier Santa Clauses into a sense of realities. Ultimately broadcasting went commercial. Program sponsors were invited to help themselves to publicity and advertising, at so-much-per-hour to 1 charges, plus the cost of programs.

Du Mont believes that, as with broadcasting, the manufacture of television receivers and the telecasting of programs will probably be thoroughly divorced so far as most participants are concerned. Hence telecasting will have to pay its own way. Program sponsorship must be the answer to the economic riddle.

Thus station W2XWV's latest activities in the television kindergarten covers program sponsorship. But more about this later.

The television studio in midtown Manhattan makes up in ingenuity what it may lack in size. Television studios heretofore have been massive. One of them could actually house a full-sized circus. Equipment for television has been impressive, and so costly as to be limited strictly to a handful of leading metropolitan areas, leaving secondary communities of the nation pretty much in the lurch so far as television is concerned. This unit is built from a different slant. The designer believed that he could make a mole hill out of the television mountain. Station W2XWV is out to prove this.

In a studio space measuring approximately 30x30 feet, some of television's outstanding programs have already been presented. Two studio cameras handle the scenes. The adjacent control room is simplicity itself, with "chains" or groups of metal-cased units on wheeled racks providing all necessary controls, amplifiers, synchronous-signal generators, monitors, and other technical gadgets in place of those huge power-house switchboards usually associated with television.

It is claimed that a start can be made in television for a hundred thousand dollars. That is about the price of a purely local broadcast setup. Certainly it is well within reach of the average secondary community; likewise a welcome relief from the vast sums heretofore associated with commercialized television.

Much the same shrinkage applies to television station personnel. Heretofore such establishments have been staffed by several dozen engineers, studio hands, program directors and so on. At Station W2XWV the activities are handled by one program director who can also double as stage manager, two cameramen and one microphone man, in the studio. The control room has a couple of engineers. A third engineer operates the transmitter. That may sound like a lot of personnel. Actually, it is only two or three more than required by a small broadcasting station.

Another mole-hill-out-of-a-mountain feature of W2XWV is the lighting. Television studios have heretofore gone in for a terrific amount of illumination. One typical studio consumes as much electricity as a "city" in the Middle West or a sizable village here in the East. This station has simplified its general illumination to several dozen standard fluorescent lamps in polished aluminum reflectors, accentuated by a few bird's-eye bulbs, and then a couple of spotlights for dramatic effects. At the same time the studio is kept considerable cooler. Yet....

Recently Sam Taub, well-known radio sports announcer, was interviewing Jack Lavelle, former Notre Dame football star. Jack must weigh around 250 on the hoof. It was a terrifically hot evening. Cameramen, director, engineers and others out of camera range, were in shirt sleeves. Perspiration poured out of Jack, fully attired in a business suit, and in lesser measure out of Sam who wore a sport suit and sport shirt. Following his telecast Sam mopped his wet brow and exclaimed that he was parboiled. We consoled him by explaining that it might have been a thorough and permanent baking job if the usual incandescent lamps were being used instead of these relatively cool fluorescents.

As for backgrounds or scenery, just a few painted panels do the trick. A set of panels represents the New York skyscraper skyline. Others are neutral gray.

The cameras are mounted on tilting and pan heads which in turn are bolted on rubber wheeled carts serving as dollies. A recent addition to camera equipment is a red signal light which flashes on just below the lens as that camera is cut in by the control room and is therefore "on" so far as the performers are concerned. During telecasting the two cameras are alternately used so as to present interesting long shots and close-ups and varying angles.

Telecasting is different, as we said before. The coordination of the actual telecast is far more elaborate than in the case of sound broadcasting. Whereas broadcast performers stand or sit in one position convenient to the microphone, television performers are

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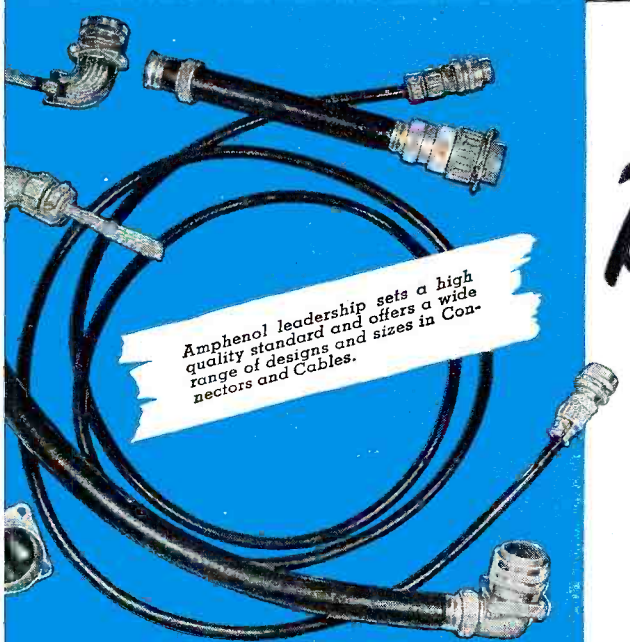

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free to move about within the limits set by cameramen. They can be followed about by the cameras, not to mention the microphone swinging immediately above them and outside the camera range.

To direct the cameramen, the studio director speaks over a telephone system. Cameramen wear earphones connected with studio director and control room operator. Thus all parties concerned are in touch with each other. Cameramen are instructed where to move their cameras, what to take in, when they are "on," and so on. Performers out front can tell by the red light which camera is "on" and therefore direct their acting to that particular lens, which means the audience.

Speaking of performers, television is quite exacting in the matter of make-up. Sulphur-yellow face, purple lips, blackened eyelids and bushy eyebrows certainly destroy the last vestige of feminine beauty so far as the naked eye is concerned. But since we are seeing the performers through electronic eyes, all is well and television beauty is definitely enhanced by such make-up.

Another thing is the confusion that attends a television show. Prior to the starting time, which is 8:30 for most programs, there is confusion plus in the tiny studio, control room, powder room, offices, and reception room. Operators are running through a film which will be included in the program, so as to know how to "shade" or monitor for satisfactory telecasting. An operator is trying out a new electrical transcription over the studio sound system. Out in the studio a pianist in shirt sleeves is coordinating his playing with the comedienne who is headlining the evening program. The program director is dictating a few notes to be memorized by the announcer—you can't read a script in television, please notice. The girl announcer—she won the popularity contest in the plant where she works—is doing her memorizing under considerable stress and strain; audibly so. Confusion plus. Yet a few minutes later, everything clicks with clockwork precision. Such is the show business of which telecasting necessarily partakes for better or for worse.

The Wednesday evening program at W2XWV is the real television kindergarten. There is a regular scheduled program every Sunday evening, intended as true entertainment for the several thousand television receivers in the New York area while serving as a programming laboratory. But the Wednesday evening show is "for the trade" only. That is to say, it is intended for advertisers, advertising men, agencies, would-be telecasters and others interested in television as a business proposition. They are invited to come, see, try. They can kibitz to their heart's content. They can look through the camera electronic finders —actually television receivers showing actual telecast pictures. They can go in the control room. They can watch audience reactions in the reception room where a giant 20-inch tube receiver presents the sight-and-sound programs just as they are being picked up outside. And when the kibitzing stage leads to the itch to try telecasting on one's own, the facilities are available at no cost whatsoever. The would-be telecaster can bring in his own program. The would-be telecast advertiser or sponsor can try his own ideas. Hence the telecast business laboratory at work.

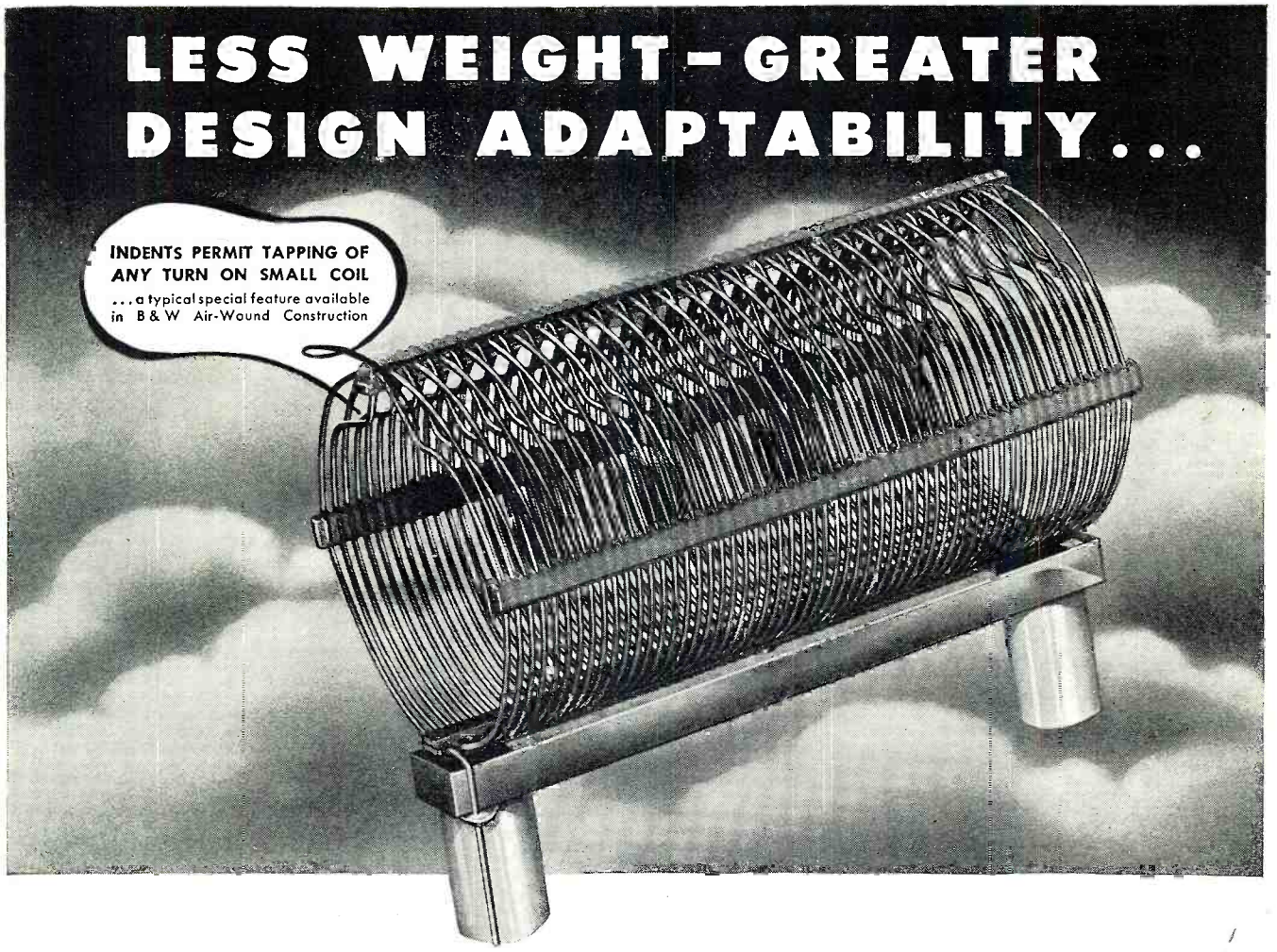
Recently Mutual's Station WOR staff has undertaken telecast experiments. The Station W2XWV is being used once a week, on Tuesday evening, for a series of experimental casts. Artists associated with WOR now have the opportunity of trying telecast delivery, make-up and other facets of the new field. Jack Poppele, WOR's chief engineer, is following the technical angle personally, while J. F. Seeback, Vice-President in Charge of Programs, and his staff of program executives, are programming via the new medium.

It is a television kindergarten indeed. Here telecast youngsters, though they be oldsters in broadcasting, advertising, movies, stage or other fields are mastering the rudiments of this new art. Many an outstanding television executive, engineer, director or performer of the postwar era is learning to crawl right now in that blazing television kindergarten. Infants today; television giants tomorrow.

It's this sort of thing—bubbling en-

Working a two-way radio set, Corp. Priscilla Wilson, USMCWR, contacts a plane at the marine air station, Braintree, Mass. A graduate of the Control Tower Operators' School at Atlanta, Ga., Corp. Wilson is one of the first women Marines to handle the work of directing planes about to land or take off. Standing is Sgt. Marvin H. Silas of Jacksonville, Fla.

LESS WEIGHT-GREATER DESIGN ADAPTABILITY...



...with B & W "Air-Wound" Construction

Air-Wound coil construction—pioneered by B & W—holds many advantages:

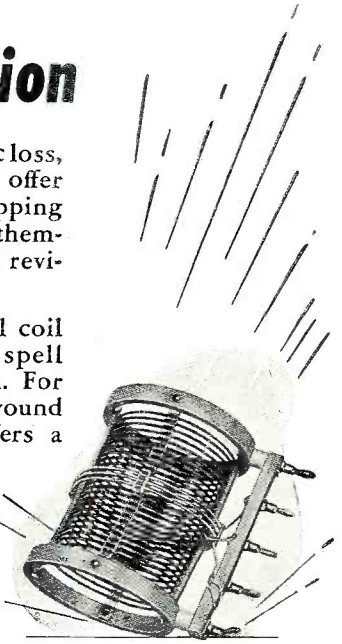
Air-Wound coils weigh less because no conventional winding form is required.

Air-Wound coils are adaptable to almost any mounting arrangement.

Air-Wound coils are ideal for plug-in services. They are not likely to be damaged if dropped—but, even if bent completely out of shape, can easily be repaired. For rough service, they can be further protected with "bumper" rings.

Air-Wound coils have low dielectric loss, can be wound to uniform pitch, offer greater design adaptability (note tapping indents in illustration) and lend themselves to mechanical and electrical revisions in the circuit.

Thus, while not a panacea for all coil problems, B & W Air Inductors spell greater efficiency for most of them. For other applications where form-wound units prove preferable, B & W offers a variety of types.



HOW'S THIS FOR A "DROP" TEST!

There's nothing scientific about it, but when a B & W Inductor is dropped three stories (as illustrated) on to a cement sidewalk without being put out of commission, it at least proves the practical nature of Air-Wound construction. Actually, the only damage was a bent plug-in prong and a cracked ceramic support. The Coil was immediately "repaired" without tools of any kind, and operated perfectly!

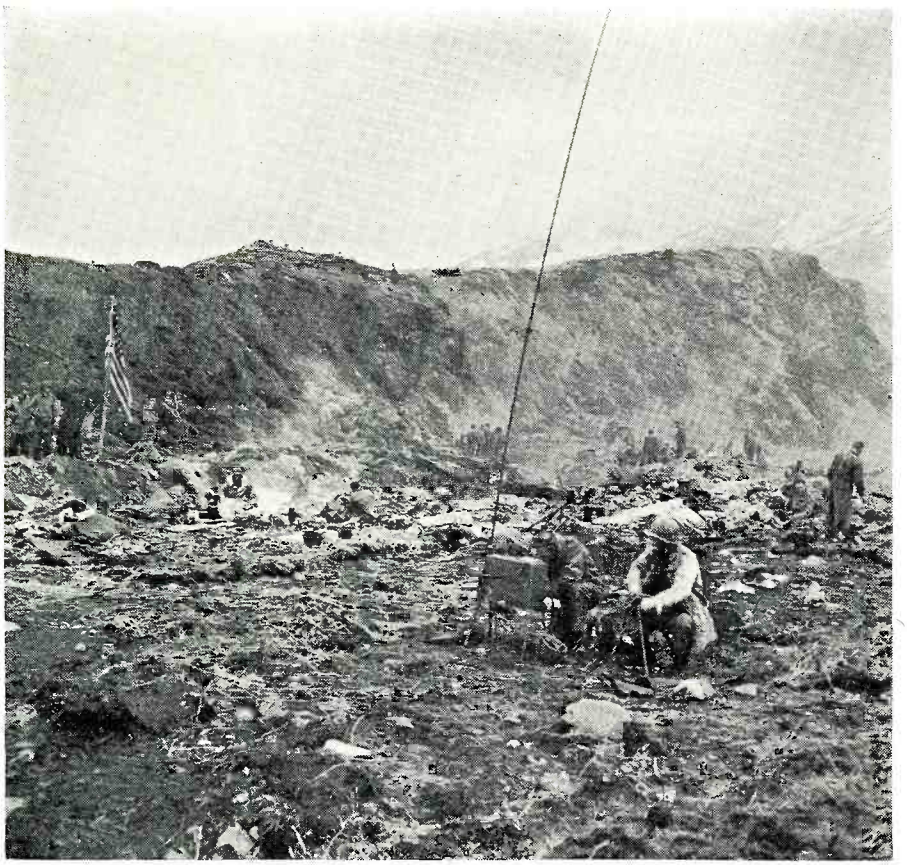
B&W

BARKER & WILLIAMSON
235 Fairfield Ave., Upper Darby, Pa.

AIR INDUCTORS

"BABIES" AND "JUNIORS" (25 to 75 watts) • STANDARD TYPES (100 watts to 1 KW.) • SPECIAL HIGH-POWER TYPES (to 10 KW. and above) • TURRETS—"BAND HOPPERS"—SWINGING LINK ASSEMBLIES, ETC. • SPECIAL RADIO AND ELECTRONIC EQUIPMENT ASSEMBLIES

Soldiers who took part in a recent large scale maneuver under war conditions somewhere in the Southern Command, shown with a telephone set by which orders are received and transmitted.



Attu Island—when American forces landed north of Holtz Bay and then clawed their way up and over precipitous cliffs under heavy sniper, machine gun and anti-aircraft fire, to smash and capture the Japanese base at Holtz Bay. Within one week, forces under Col. Frank Culin and Maj. Albert V. Hartl advanced over the difficult terrain to capture the well-stocked and well-fortified Japanese base. In the foreground are shown Signalmen testing their newly erected equipment.

thusiasm, real sweat, overtime work, personal sacrifice, sheer experimentation—which is paving the way for truly commercialized television. And likewise reaffirming the saying of that famous Chinese sage about a picture being worth ten thousand words. Similarly a telecast program, no matter how experimental, is worth far more than thousands of words of loose talk regarding television's future promise.

-30-

Mfrs.' Lit.

(*Continued from page* 46)

Automatic maintenance of the coolant at the temperature differential below room temperature selected by the operator, assures more consistent accuracy in heavy grinding and intermittent operations. Uninterrupted streamline flow of coolant obtained by the use of a single steel tube evaporator coil eliminates the frequent shut down for cleaning coils often required by multi-passage evaporators.

Operating independent of water supply, mounted on 2½ inch casters, furnished with "RH.," "L.H." or "straight-thru" coolant line connections.

Complete specifications and an illustration of a typical installation are included in the Bulletin, which may be had from the *Frostrode Products Co.*, 19003 John R St., Detroit 3, Mich.

-30-

Radio in Its Infancy

(*Continued from page* 39)

read: "Two tons blutwurst; four tons wienerwurst; two tons liverwurst; one-half ton limburger; fourteen kegs pilsner." It sounded pretty good at that, although I couldn't conceive of a half-ton of limburger cheese.

We old-timers, who pioneered radio, had our fun. But it wasn't all fun. Sometimes we found plenty of grief awaiting us. As, for example, the time when I copied erroneously one word of a coded cablegram from the Navy Department, relayed out to our commanding officer from that same Cavite wireless station.

The captain, fortunately, caught the mistake. I caught something else, when he called me down to his cabin. "Do you know what this message says the way you took it down?" he shouted at me. I shook my head.

"It orders us to proceed to Yokohama and open fire on the Japanese!" he roared.

Well, maybe it would have been a good idea at that. But I shudder to think what would have happened to me if the skipper hadn't figured out that I had copied "fishes" for "dishes."

In conclusion, let me say that there is no finer avocation for young men than amateur radio. It is a hobby which gives both pleasure and useful training in a field of ever growing importance.

-30-

Seven things you should do:

1. Buy only what you really need	2. Pay no more than ceiling prices... buy rationed goods only with stamps	3. Pay off old debts and avoid making new ones	4. Support higher taxes ...pay them willingly	5. Provide for the future with adequate life insurance and savings	6. Don't ask more money for goods you sell or work you do	7. Buy all the War Bonds you can afford – and keep them

Keep prices down...use it up, wear it out, make it do, or do without

THE WRITTEN WORD

By JOHN D. GOODELL

The fundamental considerations in conveying technical intelligence in writing.

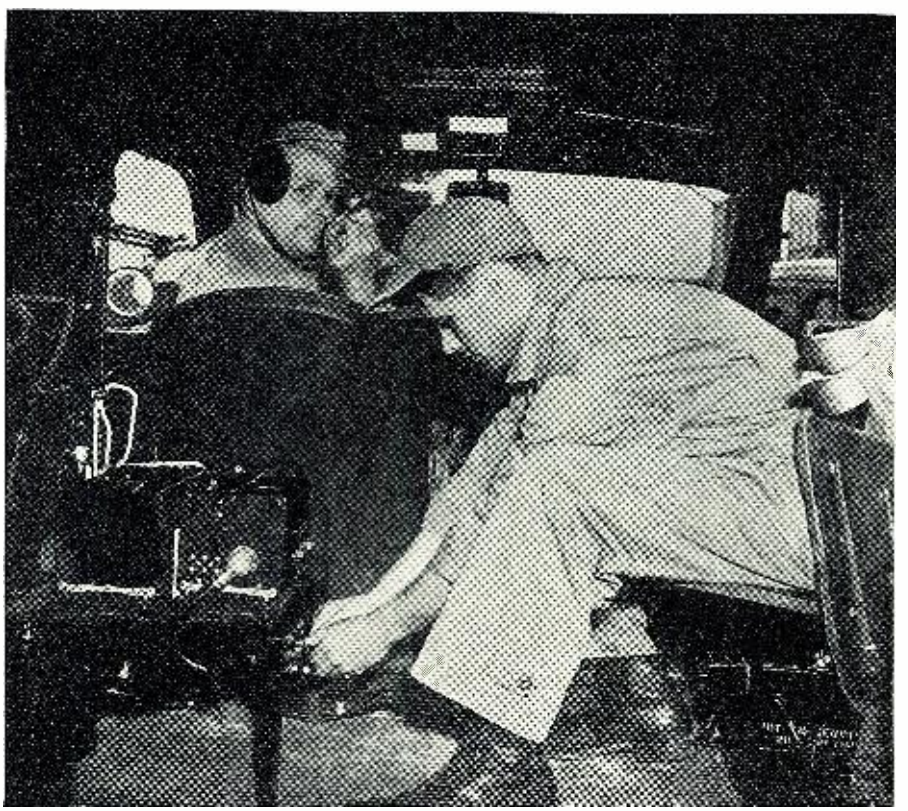
IF the knowledge available to the most brilliant brain of any human being was limited to the observations of his own neurosensual system, his progress would be relatively meager. Fortunately it is possible for every man to enjoy the advantages of the cumulative observations made by millions of similar organisms—because human beings, uniquely, have the ability to communicate with abstract symbols. Rapid progress is fundamentally based on semantic agreement. The man is selfish indeed who is unwilling to add his own observations to the flow of knowledge. He is to be even more seriously condemned if his contribution pollutes the stream with confusion because of incompetent or careless writing.

This article was originally written for technicians in radio communication activities. In the process of the first revision, it was noted that the principles were applicable to the broad field of engineering associated with radionics. A further extension of this thought brought realization that the "Radionic Art" has established its roots in the fundamental structure of science; hence, revision included a generalization of the original concepts.

It is not intended to detail English usage in engineering writings, or to enter into an intricate discussion of semantics, but rather to recapitulate the fundamental considerations of greatest importance in conveying technical intelligence with words on paper. Much of the material which follows may be considered too obvious to warrant mention. The writer's apology for this is qualified by the conviction that a periodic review of the canons of any art is a healthy exercise.

This article doubtless contains errors of the kind it condemns. Writing about writing is an inherently vulnerable activity, somewhat analogous to drawing a map of a map, thinking about thinking, defining the meaning of meanings.

As a result of increased activity in technical fields, and the scarcity of



In the driver's seat, Staff Sgt. C. D. Goodhouse and at the radio controls, Private D. E. Smith, operating the new two-way radio equipped ambulance which recently was put into operation at Kelly Field, Texas, the Air Corps Advanced Flying School.

qualified personnel, many men are now engaged in research and development projects with organizations that require paper work procedures new in their experience.

Too many technical workers fail to keep adequate records and many valuable contributions have been lost thereby. Too large a percentage of graduate engineers are incapable of accurately reporting their findings, evidencing incomplete training in most colleges. Men whose workmanship in the laboratory is impessable, strew careless verbiage through their writings with complete abandon. Those who do know how to write accurately often underestimate the importance of using this knowledge.

Inability to organize reports is often interpreted as indicative of loose thinking. Words are not only a means of transmitting thought, but can also be applied as valuable reasoning tools. It is almost axiomatic that logical writing denotes lucid thinking. Inability to present ideas convincingly is costly; the life income of an engineer who writes effectively is likely to be $30,000 greater than his otherwise equally capable colleagues.

Certain terminologies are uniquely used in connection with specific trades. It is apparent that such words are applicable only to reports intended for the information of persons qualified to understand them, and not in communications written for purposes of administrative control.

The introduction to the unabridged second edition of Webster's New International Dictionary, contains the following: " . . . it must be realized that certain sciences have levels in which are used terms that cannot be adequately explained except to persons who have passed through preliminary stages of initiation." It is evident that the layman may be stymied by a technical term even after recourse to a standard definitive source.

Words are arbitrary symbols, labels with no inherent meaning. Dots and dashes, spoken sounds, or pencil marks are successful in communicating intelligence only when all concerned are familiar with the code. Obviously, the use of an uncommon word forces many readers to refer to the code book (the dictionary) in an attempt to understand the full import of the message. It is an imposition to use an unusual word if there exists a well known, *equally adequate* synonym.

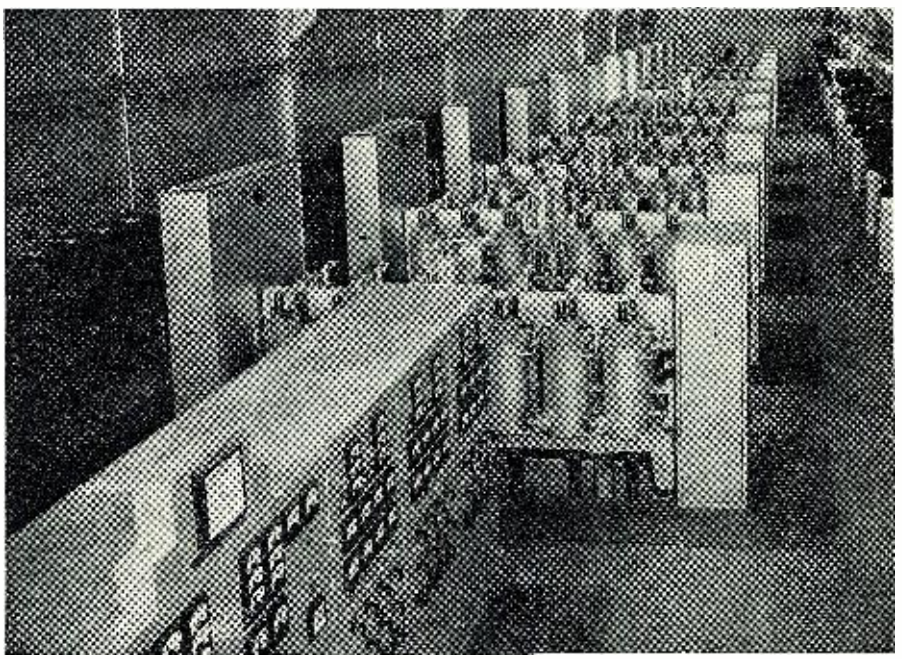
An engineering report recently reviewed, contained the following:

"It will be noted that in all four cases supra—"

There appears no possible excuse for not using the word "above" or, still better, "preceding." Even though the meaning is clear to a specific reader, the unnecessary use of obscurities is irritating rather than impressive.

The effort to achieve simplicity in writing can also be carried to an undesirable extreme. Some mutual understanding between the writer and reader must be assumed. Technical writing must be quantitative as well as qualitative; mathematical symbols, graphs, and drawings are a better quantitative code than words and should be used freely.

Even a relatively uncomplicated object becomes difficult to describe if you do not assume some associative experience in the mind of the reader. Try



A 12 unit ignitron mercury-arc-rectifier installation. Rectifier units are rated 12-anode, 5000 amperes, 645 volts. (3225 kw.). View showing master duplex control panel (left foreground), 6-pole high-speed anode breakers (along left wall), rectifier excitation cubicles, ignitron rectifiers, rectifier auxiliary control panels (left center), and cathode breakers (along right wall).

IRC Answers Your Questions

ON TODAY'S

VOLUME CONTROL and RESISTOR PROBLEMS

"HERE'S HOW"—IRC's new, free booklet—just off the press, is chock-full of tested ideas and information to help Service Men keep home radio sets functioning satisfactorily. Well illustrated and written in simple, understandable language, it should prove a real time and money saver. Included in its contents are the latest facts on ½, 1 and 2 Watt Resistors, an up-to-the-minute listing of Preferred Number Ranges, an easy to read and complete Resistor Determination Chart as well as other important data.

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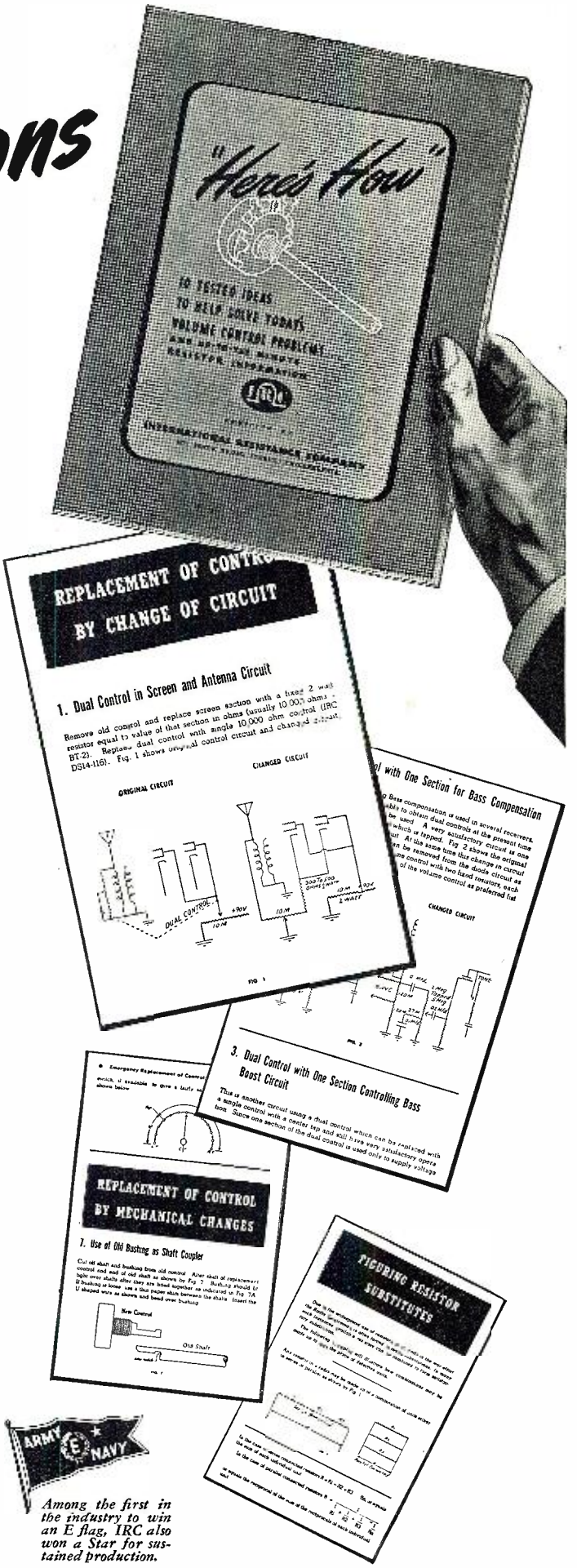
IRC
FIXED & VARIABLE RESISTORS

INTERNATIONAL RESISTANCE COMPANY

Dept. O • 401 N. BROAD STREET
PHILADELPHIA 8, PA.



ARMY (E) NAVY

Among the first in the industry to win an E flag, IRC also won a Star for sustained production.

to describe a bolt and nut so clearly that a "man from Mars" could make one.

No one actively engaged in technical work would likely be guilty of the following quotation:

"A bolt is a thing like a stick of hard metal, such as iron, with a square bunch on one end and a lot of scratches going round and round the other end. A nut is similar to the bolt only just the opposite, being a hole in a little square of iron sawed off short with rings also around the inside of the hole."

Almost everyone has experienced difficulty in drawing word pictures. Often such efforts are wasted and recourse to marginal sketches is indicated.

The preface to Webster's New International Dictionary includes the following:

"In the actual definition of words and senses, as well as in the selection of the vocabulary, the editors have had available as a most important source of information a storehouse of citations specially gathered for this revision . . . They have been collected from a vast number of sources, contemporary authors particularly having been widely read for new words and for new meanings of older words."

It is apparent that definitions are interpreted from the usage of a wide variety of writers and are not static. When it is realized that each application of a word in written form may have a powerful influence on the meaning of that word, carelessness appears increasingly inexcusable.

Many people accept a single instance of usage as an adequate definition so that one mistake may generate an infinite series of similar errors. Reading, supplemented by constant reference to a good dictionary, greatly aids vocabulary growth. A satisfactory understanding of an unfamiliar word is not obtained until it has been encountered in a variety of contexts.

The style of engineering memoranda should be crisp, clear and concise. Rambling, slovenly sentence structure must be avoided, but this does not mean that the statements need be staccato. Short sentences are best used for stating facts. Expressions *about* facts (e.g., in discussions, conclusions, and recommendations) often require relatively long sentences in order to clarify the relationship between various thoughts. Literary beauty may sometimes be achieved, but it should be comparable to an explicitly accurate formula rather than surrealistic free verse. Abstractions have little place in technical vocabularies.

Most organizations have developed standard forms for reports which include paragraph headings adapted to specific requirements. During the present period there has been a mushroom growth of technical activities both in Government agencies and private industry which necessitate standardization of many new types of engineering report forms. In many cases, the pressure for actual accomplishment has minimized effort to develop proper forms. In other instances, the personnel available are not sufficiently experienced along these lines. The outline principles are substantially the same in all engineering memoranda.

With slight alteration, elimination or addition, the following sequence of suggested paragraphs will provide a satisfactory report form for most technical operations. The subject matter used has been chosen in order to pre-

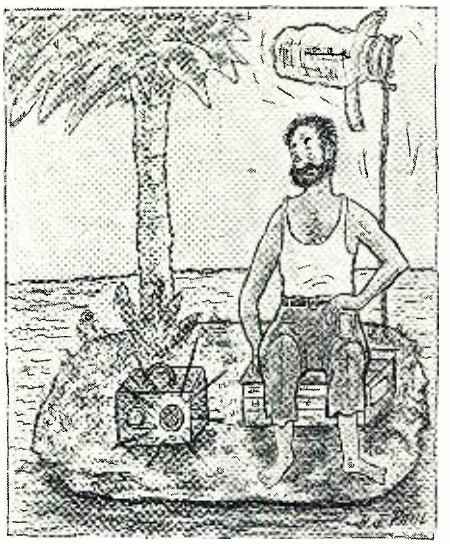
Research scientist studying electric high current arcing in gases at low gas pressure at the Westinghouse Research Lab's.

vent any factual considerations that might interfere with an objective evaluation. A further reason is concerned with the belief that a memory trace is more definitely established by an unusual combination of stimuli.

1. Authority
   a. This work was accomplished in accordance with a memorandum from Mr. J. Smith, dated 1 July 1943.
2. Location and Date of Tests
   a. Experiments were conducted in the Smith Laboratory from 4 July through 6 August 1943.
3. Objective
   a. To determine whether a 4h. r.f. choke tied around a carbon resistor will change the resistance.
4. General Information
   a. Earlier this year similar experiments were made with an a.f. choke and a 2h. r.f. choke. The only data indicating a change in resistance were obtained with the 2h. r.f. choke. Mr. Smith believes a 4h. r.f. choke might have greater effect.
5. Equipment

Quantity	Item
1.....	4h. r.f. choke
1.....	Carbon Resistor (color coded as 500 ohms)
1.....	Ohmmeter, Model 37, Serial No. 6422-A, Manufactured by Fancy Radio Products Corporation.

6. Procedure
   a. The carbon resistor was connected between the Ohmmeter probes. The resistance measurement reading was observed and recorded.
   b. A 4h. r.f. choke was tied around the carbon resistor, and the procedure outlined in a of this paragraph was repeated.
7. Results
   Resistance Readings
   Carbon Resistor Alone—Carbon with 4h. r.f. choke tied around it 523 ohms.
8. Discussion
   a. No change in resistance was observed in the tests conducted. It is believed that the results mentioned in paragraph 4 of this memorandum, where a 2h. r.f. choke was used, were probably caused by some factor or factors other than the r.f. choke.
9. Conclusions
   a. A 4h. r.f. choke tied around a carbon resistor has no effect on the resistance.
10. Recommendations
    a. It is recommended that the test with the 2h. r.f. choke be repeated under controlled conditions to determine whether the observed change in resistance readings was actually caused by the r.f. choke.



"And now we'll hear the story of Robinson Crusoe!"

If an experiment has been conducted properly and described accurately the paragraph titled "Conclusions" should state the conviction already implanted in the mind of the reader.

Argument has no place in technical reporting and usually represents an effort to make a square fact fit a round theory. The validity of engineering depends on operations and not on verbal extrapolation.

A great deal of blundering can be avoided if certain portions of a report are compiled in written form *before* a project is undertaken. This should include the information indicated under such paragraph headings as Authority, Objective, Equipment, Background Information, Procedure. All the knowledge necessary to write these paragraphs is available before any of the work is done. If anything is lacking (a proper understanding of the objective, the necessary equipment, a clear conception of allied previous activity or a definitely determined procedure), then certainly it is important to fill the gaps in advance.

It is a curious fact that many persons who would never undertake construction of an amplifier without first sketching the circuit will unhesitatingly venture a complex experiment without drawing a verbal schematic diagram. As a consequence, a great deal of effort is expended later in attempting to fit unrelated data into a coherent report.

Carelessness in selecting an exact word may mislead innumerable investigators, causing the conduct of faulty experiments and the waste of an indefinitely large quantity of time, energy, and material. It is always important not to impede progress by wasting time, but when we are fighting desperately to preserve the progress we have already made, such carelessness becomes criminal.

Typical of the words which are often erroneously interchanged are the following: rotate—revolve, electric—electrical, benzene—benzine, etc.

Practitioners of the electron art find themselves increasingly associated with a wider field of engineering. It behooves them to become familiar with at least the commoner terms of all the sciences.

Brevity is obtained by using the explicit words instead of roundabout, detailed descriptions:

Service conditions requiring operation at a substantially constant load for an indefinitely long time..... = Continuous duty.
An abnormal connection of relatively low resistance between two points of different potential ..... = Short-circuit.

In expressing subjective opinions, avoidance of positive affirmation is often desirable. Conclusions may be qualified by such phrases as, "It appears that . . . ", "The data indicates . . . ", and "It is believed that . . . ".

Statements specifying the results of operations should be unequivocal. It is rarely advisable to use such qualifying words as "very", "slightly", "large", or "small" in quantative communications.

In using pair words, that are meaningless unless their antonym be assumed, a reference level must be stated. The least precision normally allowable in quantative statements is contained in such phrases as "greater than . . .", or "less than . . .".

A majority of the suggestions in this article contain ideas with which most readers are in full agreement. Unfortunately, understanding does not always imply action, and knowledge must be applied to have any real value. It is "easy to give advice" but training one's self in good habits of thought, action, and writing requires rigorous and difficult self discipline. Fortunately, after the initial inertia has been overcome, a good habit operates like an ideal flywheel.

Professional men do not attempt to memorize the total fund of available knowledge applicable to their work, but rely greatly on written records, reference manuals, and text books. Education consists largely of learning where to seek and how to interpret.

When a technician expresses his thoughts in written form, he is working in a field which is not his specialty. Professional writers use the text books and manuals of their art in the same manner that an electrical engineer uses a handbook. Few men who write for a living would attempt to solve a problem involving Ohm's law without looking up the equation in a textbook. Yet many engineers attempt to solve problems of definition, grammar, and verbal expression without using a dictionary, a handbook of English usage, and a thesaurus. These three volumes should be a minimum reference library for every person required to apply the difficult, complex, and often controversial science of written communication.

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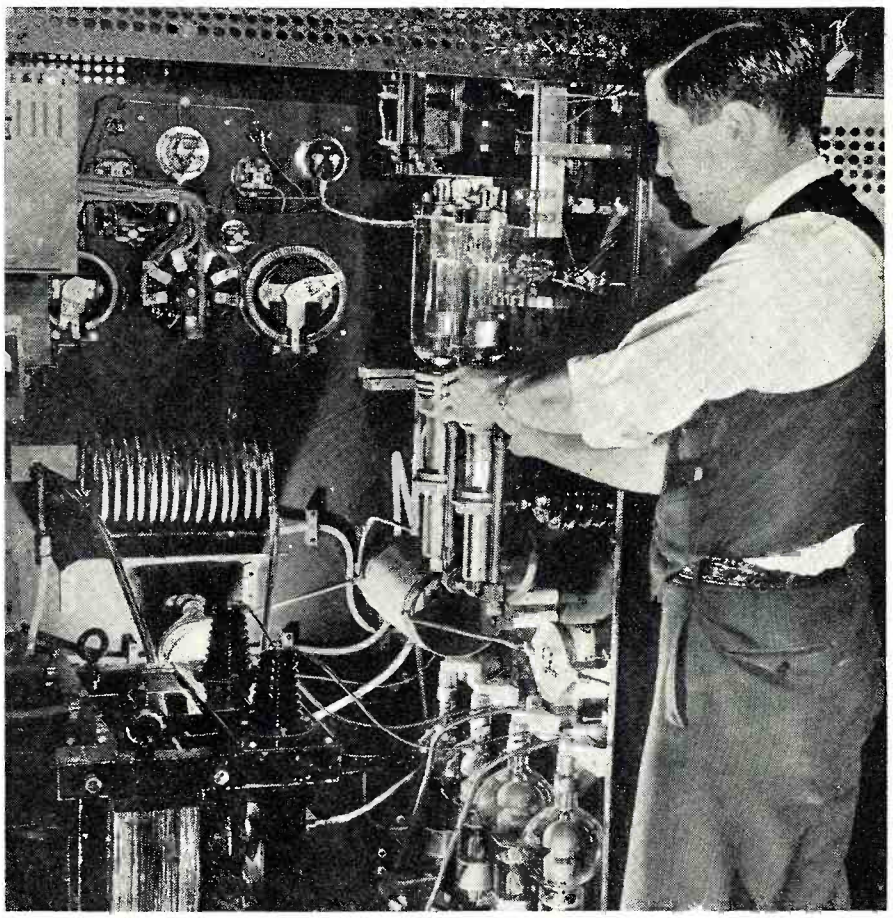

Performing hundreds of hardening, brazing, and soldering operations in seconds instead of minutes is the job which General Electric's electronic heater is now performing in war industry. The unit converts ordinary 60-cycle electric current into high-frequency 500,000-cycle current. Here R. D. Frazier of G.E.'s industrial heating and welding engineering division installs one of the high-frequency tubes which are part of the electronic heater equipment for heat-treating metal parts to desired temperatures in a few seconds' time.

Postwar U-H-F

(*Continued from page* 46)

The field of short-wave radio seems almost limitless. In the field of medicine it has been found that various sicknesses can be treated by irradiating the body with radio waves. Very short waves can be focused into narrow beams—narrowcast instead of broadcast—and applied to the body for therapeutic treatment at sharply defined places. Radio, for example, can be used for irradiation of kidneys, lungs, stomach and other areas. It also is the most convenient method of heating the entire body. The doctor can administer such a "Turkish bath" right in his office.

The future usefulness of the ultra-high frequencies will depend upon the type of circuit used as well as the particular application. At present, primary UHF development is investigating the possibilities of the Barkhausen, the Magnetron, and the Klystron oscillators. The Barkhausen generator has never become particularly popular in radio applications, as it has a very low efficiency. The magnetron invented by Dr. Hull in 1920 was originally designed for low frequencies but its utility for generating microwaves was discovered a few years later. It now plays a very important part in the microwave development program.

—30—

Ammunition for industry—the "ammunition being turned out by this workman are electronic tubes produced by the Westinghouse Lamp Division. Ignitrons, like these metal-encased devices, convert alternating current into direct current needed to make aluminum for American fighting planes. The workman is shown seam-welding the metal jacket in which tube mechanism is enclosed.

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NATIONAL UNION OFFERS A GREAT OPPORTUNITY

National Union Radio Corporation, long acknowledged as a national leader in vacuum tube manufacture, is building a greater research and engineering staff. Our contribution to the war effort has been substantial; our plan for the future knows no bounds. If you get into this electronic tube picture now, you have a brilliant future, unlimited horizons ahead.

Our laboratories are in Newark, New Jersey.

We prefer men with a degree in electrical engineering, physics or mathematics and a knowledge of vacuum tubes; however, if your experience warrants, a degree is not absolutely essential. You must be draft exempt and not now employed full time at highest skill in a war industry.

CAN YOU QUALIFY AS:

- **Electronic tube engineer**
- **Metallurgist**
- **Production engineer**
- **Development engineer**
- **Measurement engineer**
- **Physicist**
- **Electrical engineer**

Write at once and tell us your experience, education, draft status, salary requirements.

NATIONAL UNION RADIO CORPORATION

48 Spring St., Newark, New Jersey

★ INDUSTRIAL ★ MAN-POWER BUREAU

RADIO TESTERS *for* Westinghouse

We can place in our Test Department at Baltimore, Maryland, men or women with training and experience in Radio theory and practice. The work will provide experience with the latest electronic equipment. A high school education or equivalent, including courses in mathematics and physics, is required and, in addition, at least one of the following qualifications:

1. **Completion of a course in fundamental radio transmitter or receiver theory (preferably a resident course, in a recognized radio school).**
2. **One year's experience as a radio amateur during the last five years, plus at least one year's recent experience in radio testing.**
3. **Two year's recent experience in radio service work.**

Employment depends on satisfactory personal interview and a physical examination.

No one employed at his highest skill in essential industry should apply. Applicants living outside the Baltimore area must obtain a "Statement of Availability" from their nearest United States Employment Service office.

Apply in person or by Letter to

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WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY
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RADIO STATION TECHNICIANS

TRANSMITTING OR RECEIVING

For Point-to-Point International Radiocommunications Stations.

Applicants possessing at least SECOND CLASS Radiotelegraph Licenses Preferred.

Code speed at least 18 WPM

Assignment outside New York City.

Do not apply if utilizing full skill on other war work.

Apply weekdays except Saturdays, between 10 A. M. and 3 P. M., personnel dept., or write

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PHYSICIST

For war and post-war development work with major manufacturer in the field of electronics.

Write, stating education, experience, and salary requirements.

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Persons in war or essential activity not considered without availability statement.

Radio and Electronics ENGINEERS PHYSICISTS

A progressive electrical concern now producing products that are playing a vital role in hastening Victory, as well as pioneering in the birth of new post-war electronic devices has several excellent openings for men with experience on the design, development and production of electronic tubes and equipment.

Write concisely giving age, education, experience and present salary to Box No. 323, % RADIO NEWS, 540 North Michigan, Chicago 11, Illinois.

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TIN PLATIN

In answer to the problem of boosting output of tin plate to keep pace with the rapidly-growing requirements of our armed forces, high-frequency heating equipment is being designed to operate at speeds up to 1000 feet per minute while gas furnaces are limited to 150 f.p.m. and hot oil to 200 f.p.m. At present electrolytic plating is operated at a maximum of 500 feet per minute, but in the near future this speed will be doubled and full advantage made of the high speed operation of induction heating.

Only tin plate with high corrosion resistance can be used to pack foods containing acids, such as tomatoes. To provide the steel strip with adequate protection, the tin must be heated to the fusion point so as to flow into a smooth, homogeneous texture. Electrolytically deposited tin forms a granular dull grey surface which is not not highly corrosion resistant. With the corrosion dependent on the thinner spots, the overall effectiveness of the tin plate deposited is not high, until it is fused and a uniform thickness obtained by the peaks filling the valleys.

Great care must be used in handling the tinned strip as the tin is a very soft material and is easily scratched. The rehandling problem is avoided with induction heating as sufficient power can be generated in the sheet to heat the strip to the fusion point of tin, immediately after it passes from the plating tank. Within .7 of a second after the strip enters the coil, the temperature is brought up to 450° F, where the tin melts and starts to flow into a smooth, even surface. Only a few feet of line-travel is required to produce sufficient heat when the strip is passing through the inductor coil at 1000 feet per minute. This flowing operation becomes an integral part of the tinning line, instead of a separate operation requiring an additional handling of the strip.

With induction heating, the power input may be adjusted rapidly to accommodate changes in the speed of the line, as during periods of acceleration or deceleration when two coils are welded end to end. A speed change simply means a corresponding change in the power input to the heater coil.

It was first believed that the flowing operation was necessary only to provide greater corrosion resistance. In addition, it was found that this smooth coating is essential for the sheet-by-sheet suction cup feed on the high-speed can making machines. The rough surface on the coating lets air creep in under the cups and causes sheets to stick together when lifted.

—30—

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Many other high-voltage applications

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● Charged in parallel, discharged in series, these capacitors provide for voltages up to ten million and over for certain deep-penetration X-ray and impulse generator applications. For usual X-ray work, single units operate up to 150,000 volts.

Aerovox Type '26 capacitors are designed for just such service. Multi-layer paper sections, oil-impregnated, oil-filled, housed in sturdy tubular bakelite cases. Choice of metal cap terminals facilitates stack mounting and connections. Sections of matched capacitance insuring uniform voltage gradient throughout length of capacitor.

Behind these capacitors stand those giant Aerovox winding machines handling dozens of "papers" at a time for highest-voltage paper sections. Likewise batteries of Aerovox vacuum tanks insuring thorough impregnation even to the last paper fibre. Such facilities spell Aerovox—the last word in oil capacitors—safeguarded by thorough inspection and testing from raw materials to finished units.

● Aerovox capacitors, from these tall X-ray units to the tiniest paper tubular, are made with utmost care and are *individually tested*. You can always depend on Aerovox quality and performance. Consult the local Aerovox jobber regarding your needs and our latest catalog.

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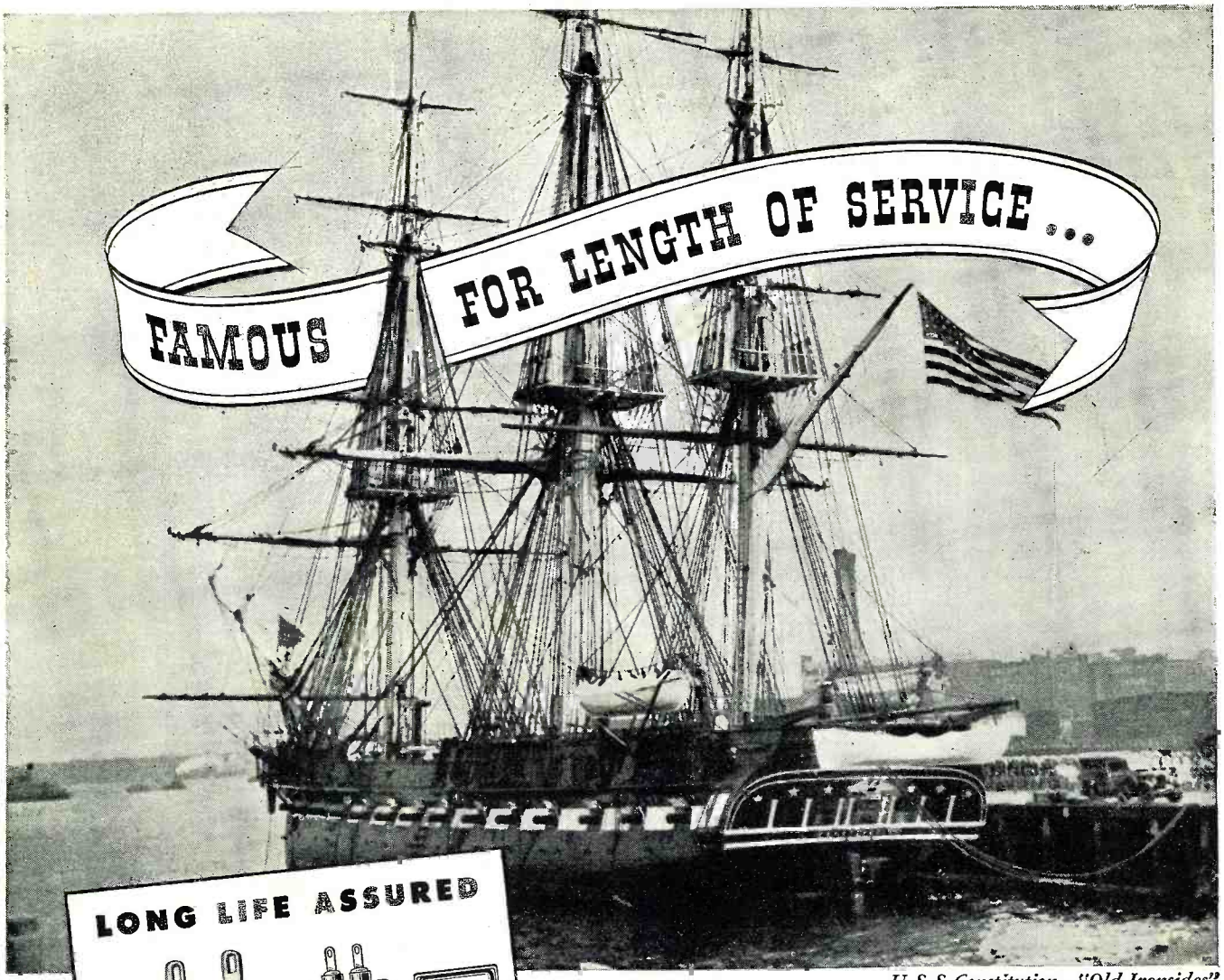

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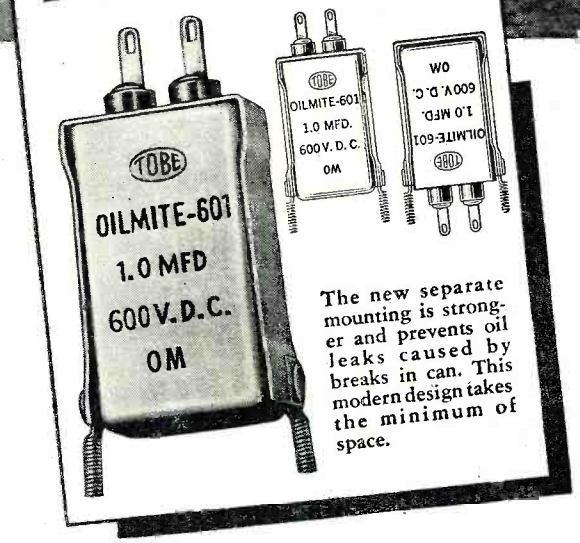

TYPE	OM
RATINGS	.05 to 2.0 mfd. 600 V.D.C. .05 mfd. to 1.0 mfd. 1,000 V.D.C.
STANDARD CAPACITY TOLERANCE.	±10%
TEST VOLTAGE	Twice D.C. rating
GROUND TEST	2,500 Volts, D.C.
SHUNT RESISTANCE	.05 to 0.1 mfd. 20,000 megohms. .25 to 0.5 mfd. 12,000 megohms. 1.0 to 2.0 mfd. 12,000 megohms.
POWER FACTOR	At 1,000 cycles—.002 to .005
CONTAINER SIZE	Width 5/8", length 1-5/16", height 2¼"
MOUNTING HOLE CENTERS	1½"

YOU WANT capacitors that can stand up and take it. The well-nigh flawless record of Tobe Capacitors as to "returns" proves they have that outstanding requirement of durability.

This quality is built into each and every Tobe Capacitor by advanced engineering practices and production methods. And their rating is always an "understatement".

Shown here is the Tobe Oilmite Capacitor. Filled and impregnated with mineral oil it is used as a filter condenser in war equipment. The new hold-down bracket permits inverted or upright terminals, with wiring either underneath or on top of chassis.

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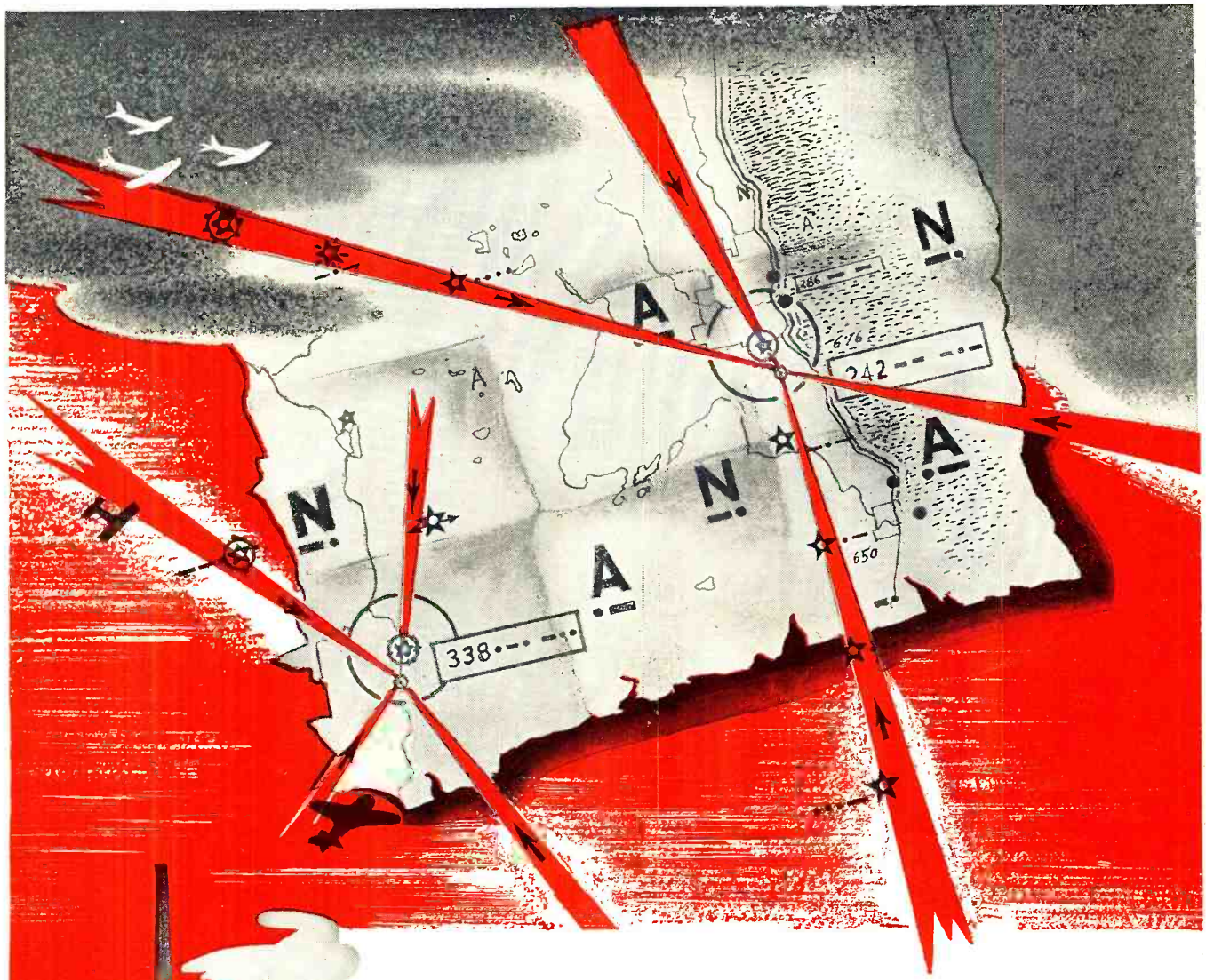

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