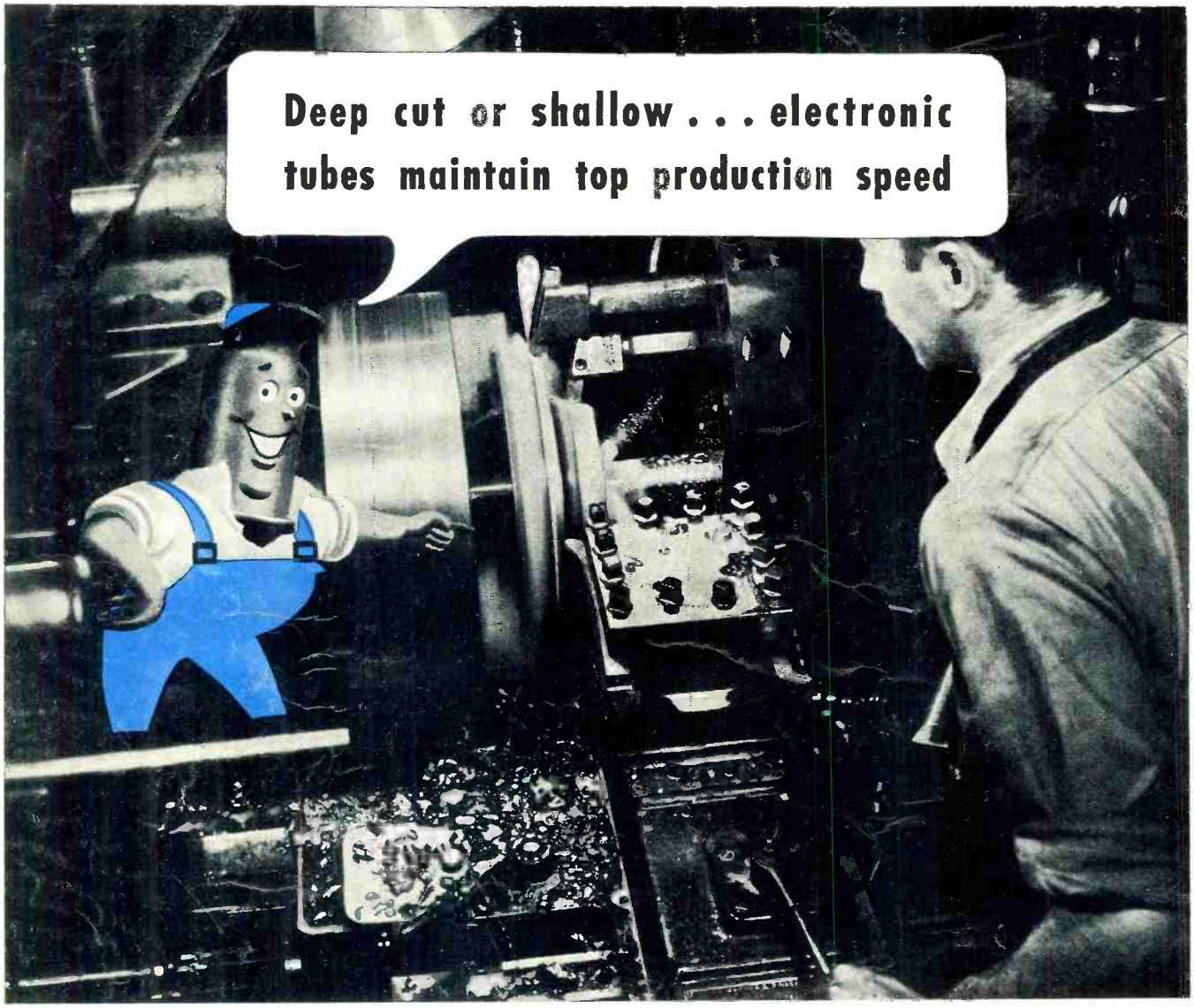
RADIO NEWS

SEPTEMBER
1943
25c
In Canada 30c

No. 5 OF A SERIES EXPLAINING THE USES OF ELECTRONIC TUBES IN INDUSTRY



How the General Electric thyratron tube makes possible the simple and accurate control of motors

LIKE some silent guiding hand, a G-E electronic tube is busy at the benches and lathes of industry — cutting production costs and speeding war output.

This tube is the thyratron, a lightning-fast automatic switch. Its job is to keep machine speed constant regardless of variations in load so that production continues without interruption.

Thus, on the cutting lathe, in turning steel parts where depth of cut varies from deep to shallow, the thyratron automatically supplies the right amount of power to hold the speed of turning exactly constant, whatever the load.

On textile looms where variation of driving speed may result in imperfect cloth, the thyratron assures a uniform motor speed for perfect weaving.

Fast to a split cycle, accurate to a hair, the thyratron is at once a synchronous switch and a rectifier that enables DC motors to operate from an AC power supply.

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

FREE BOOKLET ON ELECTRONIC TUBES

Send us the names of interested men in your plant and we will keep them informed of electronic developments. For example, we would like to mail 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, New York.*

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

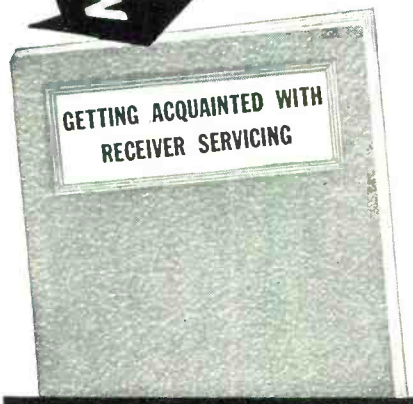
GENERAL ELECTRIC

162-B11-8850

GET BOTH FREE

SAMPLE LESSON

64 PAGE BOOK



I will send you this FREE Lesson, "Getting Acquainted With Receiver Servicing," to show you how practical it is to train for Radio in spare time. It's a valuable lesson. Study it—keep it—use it—without obligation! Tells how "Superhet" Receivers work, gives hints on Receiver Servicing, Locating Defects, Repair of Loudspeaker, I. F. Transformer, Gang Tuning Condenser, etc. 31 illustrations. And with it I'll send my FREE 64-page book, "Win Rich Rewards in Radio." It describes many fascinating jobs Radio offers, explains how N.R.I. trains you for good pay in Radio!

See How I Train You at Home in Spare Time to BE A RADIO TECHNICIAN

J. E. SMITH
President
National Radio Institute
Established 28 Years

I Trained These Men

$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 Kalamath St., Denver, Colo.

$200 a Month in Own Business

"For several years I have been in business for myself making around $200 a month. Business has steadily increased. I have N.R.I. to thank for my start in this field." ARLIE J. FROEHNER, 300 W. Texas Ave., Goose Creek, Texas.

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 certainly coming in mighty handy these days." (Name and address omitted for military reasons.)

EXTRA PAY IN ARMY, NAVY, TOO

Men likely to go into military service, soldiers, sailors, marines, should mail the coupon now! Learning Radio helps 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.

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 my FREE Lesson and 64-page, illustrated book, "Win Rich Rewards in Radio." See for yourself how *you* can train for Radio at home in spare time!

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

There's a big shortage of capable Radio Technicians and Operators because so many have joined the Army and Navy. Fixing Radios pays better now than for years. 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, Ship Radio and other communications branches are scrambling for Operators and Technicians to replace men who are leaving. You may never see a time again when it will be so easy to get started in this fascinating field. The Government too needs hundreds of competent civilian and enlisted Radio men and women. Radio factories, now working on Government orders for radio equipment, employ trained men. And think of the NEW jobs Television, Frequency Modulation, Electronics and other Radio developments will open after the war! This is the sort of opportunity you shouldn't pass up.

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

There's probably an opportunity right in your neighborhood to make money in spare time fixing Radios. I'll give you the training that has started hundreds of N.R.I. students making $5, $10 a week extra within a few months after enrolling. The N.R.I. Course isn't something just prepared to take advantage of the present market for technical books and courses. It has been tried, tested, developed, perfected during the 28 years we have been teaching Radio.

Start Now Toward Radio's Rich Rewards!

MAIL THE COUPON! I'll send you the FREE Lesson and 64-page, illustrated book. No obligation. You'll see what Radio offers YOU. You'll read more than 100 letters from men I trained telling what they are doing, earning. And you'll have my FREE lesson to keep. No salesman will call. Mail the Coupon NOW in envelope or pasted on penny postcard!—**J. E. SMITH, President, Dept. 3JR, National Radio Institute, Washington-9, D.C.**

TRAINING MEN FOR VITAL RADIO JOBS

GOOD FOR BOTH 64 PAGE BOOK SAMPLE LESSON **FREE**

Mr. J. E. Smith, President, Dept. 3JR
NATIONAL RADIO INSTITUTE, Washington-9, D. C.

Mail me FREE, without obligation, your Sample Lesson and 64-page book, "Win Rich Rewards in Radio." (No Salesman will call. Please write plainly.)

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

Address .....

City ..... State 4FR

RADIO NEWS

SEPTEMBER, 1943 Vol. 30, No. 3

CONTENTS

FEATURES

DEPARTMENTS

Cover Photo by U. S. Army Signal Corps Laboratories

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 demands upon radio for post-war aviation will reach huge proportions just as soon as peace is declared. With thousands of Air Force and other pilots returning to civilian life, there will be an ever increasing demand for small private planes by these men in order to satisfy their desire for fast transportation and to give them a chance to take full advantage of the skill that they have acquired in flying many types of military aircraft.

It appears that the most serious problem which will have to be solved will be that of providing highly efficient "policing" of the airways. Radio communications, together with radionic devices, will in large measure solve this particular problem. However, many violations are bound to creep in and it is reliably predicted that there will be many cases where former military pilots will be arrested for reckless flying, hedge-hopping, etc. Many of these pilots will fly for the mere thrill of traveling by air in a high-speed craft. It may be necessary to install a vast network of radio stations in order to report such violations by radio. Radio-equipped patrol planes will then be notified of such violations and they in turn will be able to communicate directly with the offending craft. These "radio cops" would operate in similar fashion to state police. They would be capable of overtaking the guilty fliers and directing them as they saw fit.

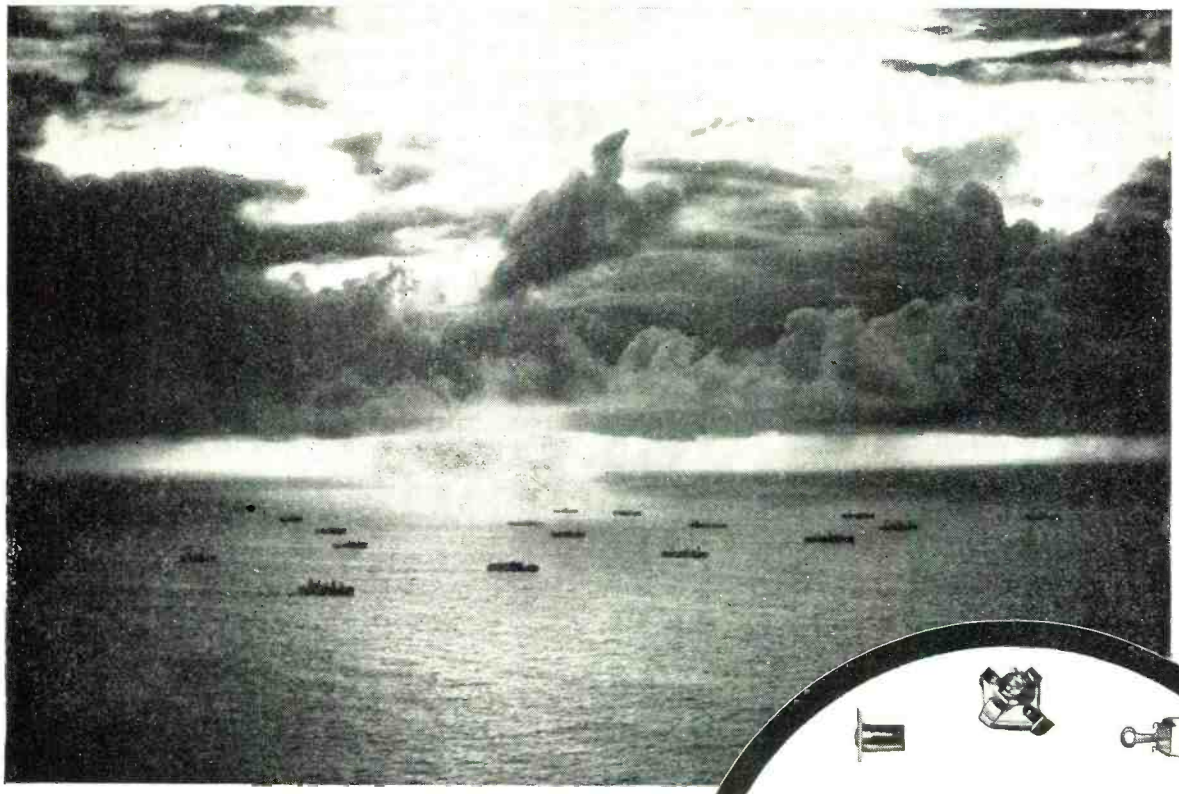
It will be a bit difficult for many of the new private fliers to become familiar with the lighter type of airplane. Many of them will not be satisfied to travel at 90 m.p.h. when they have been behind the stick in a 300 m.p.h. bomber.

Many other problems will have to be met and solved in order to keep our airways safe for all services. New radionic devices have already been developed which are fully capable of preventing collisions in mid-air and others make it possible for the pilot to fly "blind" by the use of new radionic instruments.

It is predicted that the heliocopter

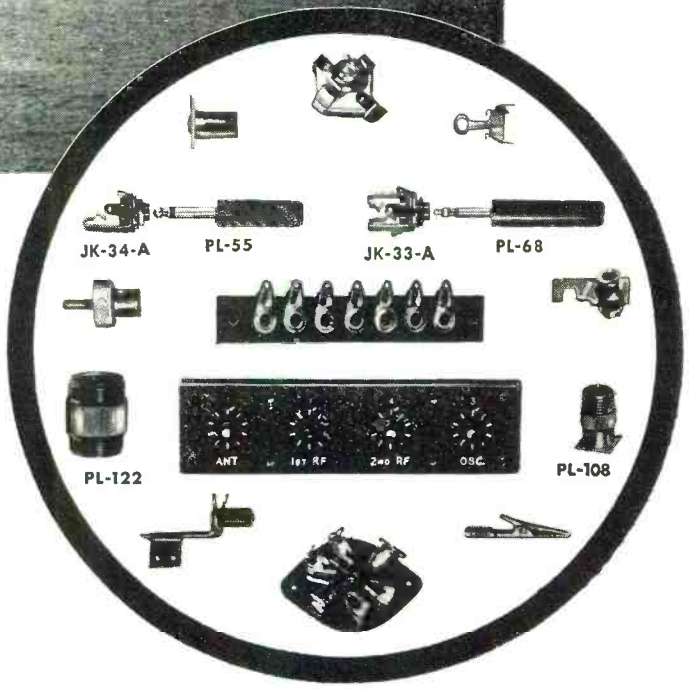
(*Continued on page* 90)

ELECTRONICS... A MIGHTY WEAPON



This is ELECTRONICS in operation . . . but not until the full facts are released will you be able to see all the technical developments.

ELECTRONIC DEVICES physically, are assemblies of components, each one contributing its share toward making the instrument function. Among the many activities of American Radio Hardware is the manufacture of over one hundred parts used in ELECTRONIC equipment and applications. That our components are used in the production of this mighty weapon is in itself a fine tribute to our skill and our facilities.



ELECTRONIC equipment is comprised of many individual components . . . plugs, jacks, insulators, etc.

With electrical and mechanical tolerances as critical as they are nowadays, all of our components have been improved to a commanding degree. When they are released for general use, they will be able to serve you better than ever before. Your inquiries regarding the entire ARHCO line are welcomed.

ARHCO RADIO PRODUCTS

American Radio Hardware Co., Inc.

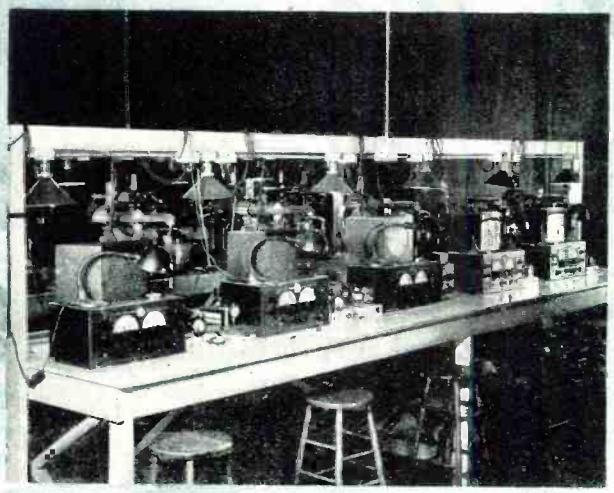
476 BROADWAY • NEW YORK 13, N. Y.

MANUFACTURERS OF SHORT WAVE • RADIO • TELEVISION • SOUND EQUIPMENT

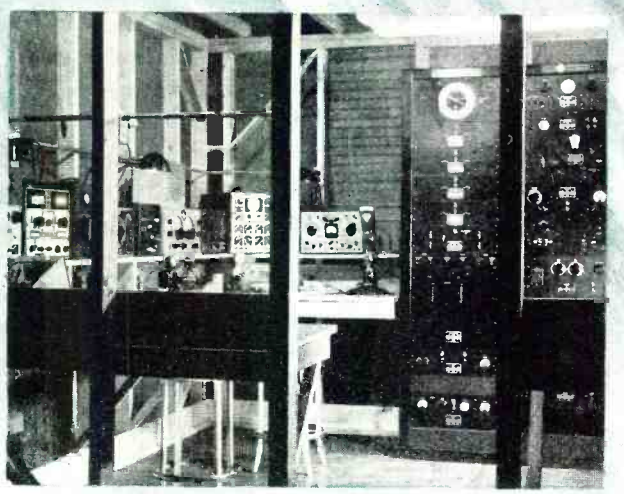
JAMES Crystals KNIGHTS

There's History Behind Every JAMES KNIGHTS CRYSTAL

For many years, key men of our carefully built organization have pioneered, "researched", and developed the manufacture and application of precision cut quartz crystals. As engineers, physicists and operators from American, Foreign and U.S. Government technical schools, they have consistently contributed history making graphs, inventions and methods to the Crystal industry in general and to James Knights Crystals in particular. With such a practical achievement background, it is understandable that James Knights Crystals meet and satisfy the most intricate specifications.



There's efficiency in concentration. We manufacture but one product—precision cut quartz crystals. All of the skill, experience and output of our staff is concentrated on crystals exclusively. Above is a corner of the lapping and calibrating department.



A section of the experimental and testing laboratory. Here is an important reason why we were one of the first manufacturers after Pearl Harbor in actual quantity production of quartz crystals meeting Governmental specifications. What are your requirements?

The JAMES KNIGHTS Company

SANDWICH, ILLINOIS PHONE 65

Spot Radio News IN DEFENSE AND INDUSTRY

by **LEWIS WINNER**
RADIO NEWS Washington Correspondent

Presenting latest information on the Radio Industry.

ASSEMBLERS OF THE DISTRIBUTOR and retailer type will hereafter have to abide by a price ceiling formula established by the OPA. This step was taken in view of the extended practice of dealers and distributors of assembling chassis into phono cabinets, and modernizing an assortment of equipment for general sale, not as custom built units but rather as production units.

The ruling, which became effective July 26, adjusts prices for the public on a more uniform scale. In many instances price levels will be scaled down. Heretofore price control has been subject to the general price regulation order of March, 1942. This regulation, however, did not cover units of the assembled type as a whole, but rather individually. The new regulation does not affect the receivers or phonographs that were made by standard manufacturers up to and including the summer of 1942.

There are two types of price ceilings. One covers equipment made by distributors and the other is for retailers. Maximum prices to be charged by distributors are to be determined by taking the unit direct cost of the model being priced, adding 122% to determine the dealer's retail price and subtracting 40% from the latter to arrive at a maximum selling price to retailers. If the distributor wishes to sell at retail, he will add 82% to the unit direct cost of the model. The retail ceiling is determined also by the 82% addition to the unit cost.

These unit direct costs are determined by taking either the invoice cost of the parts, or the ceiling prices for the chassis cabinet and other parts. All markups established are based on the average March, 1942, trade practices. After the ceiling prices have been determined they have to be submitted to the nearest regional office of OPA. The models must not be offered for sale until 15 days after the price ceiling data has been submitted and approved. And any change that might reduce the unit direct cost by more than a dollar must be subject to a new price ceiling.

So that the consumer will be completely familiar with the maximum price, tags will be attached to each of the assembled units.

A unique price ceiling schedule covering used and rebuilt receivers has been put into effect in Canada. The schedule of prices covers table and console receivers made previous to 1934 as well as from 1934 up to 1942. Included in the schedule are . . . table models made previous to 1934, $29.00; table models, 5-tube style, 1934 to 1937, $25.00; 5-tube consoles, 1934 to 1937, $35.00; console models, 8-tubes and up, 1934 to 1937, $65.00; consoles, long and short-wave, 8-tubes and up with push buttons, $89.00. On the newer type consoles and table models, prices ranging from 75% to 90% of the original list price are used as price guides. The schedule also includes combination units with list prices of $300.00 and up. The schedule is quite complete and has covered every possible type of receiver available. The order which was issued by the Wartime Prices and Trade Board has been accepted favorably by dealers. Washington has also shown a keen interest in the schedule, which although quite compact, seems to answer the price ceiling problem very effectively.

The subject of price control received an effective analysis in the current issue of Dunn's Review. Willard L. Thorp in this issue points out that price control enforcement depends upon the public. It is not enough merely to abide by the rules, he says. Every effort must be made to avoid cheating, he stresses.

Yes, every one, from consumer to manufacturer, must cooperate in price ceiling control. *We* can control its effectiveness.

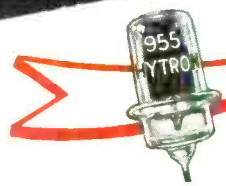
A REPORT THAT WPB HAS AUTHORIZED the conversion of one-half of the alleged existing one-million new auto sets, into home receivers, was emphatically denied by Frank McIntosh, chief of the Domestic and Foreign Radio Branch, Radio and Radar Division, WPB. Mr. McIntosh said that such wholesale conversion constitutes a violation of the old limitation orders L183 and L44, as well as the present order L265. Reported violators are being investigated immediately, according to Mr. McIntosh.

The WPB does not plan any program for conversion at the present time, since it does not feel that there is an urgent need for this equipment now. According to Mr. McIntosh, there is a

REPRINTED TO SHOW REVISED PRICES

SELECT for SERVICE

NEW HYTRON TUBES



Type	Description	Price
836	Half-wave, high-vacuum rectifier	$11.50
837	12-watt, r.f. pentode	2.80
954	Sharp cut-off, acorn pentode	4.50
955	Acorn triode	2.75
956	Remote cut-off, acorn pentode	4.50
1616	Half-wave, high-vacuum rectifier	5.75
1625	25-watt, r.f. tetrode (12-v. heater)	3.50
1626	5-watt, triode oscillator	2.50
E1148	3.5-watt, u-h-f triode	2.25
VR105-30	Gaseous voltage regulator	1.25
VR150-30	Gaseous voltage regulator	1.25

OTHER POPULAR HYTRON TUBES*

Type	Description†	Price
2C25	15-watt, medium-mu triode	$3.00
2C45	7.5-watt, triode (modulator)	2.50
10Y	15-watt, general-purpose triode†	1.50
801A/801	20-watt, general-purpose triode†	2.50
HY61/807	25-watt, r.f. beam tetrode	2.25
841	15-watt, high-mu triode	1.00
864	Non-microphonic voltage-amp. triode	1.50
HY24	2-watt, power triode†	3.50
HY31Z	30-watt, high-mu twin triode†	3.00
HY65	15-watt, r.f. beam tetrode†	3.95
HY69	40-watt, r.f. beam tetrode†	3.95
HY75	15-watt, u-h-f triode†	2.25
HY1148	(2C24) 1.8-watt, u-h-f triode	2.25
HY615	3.5-watt, u-h-f triode	

*This is not a complete list. Wattage ratings indicate instant-heating filament. maximum plate dissipation.
†For complete characteristics consult Government specifications.

On this list of tubes which have recently joined the growing legions of Hytron types already marching on to Victory, you may find just the ones you want for your War equipments. Whether you choose the tiny "acorns" or the husky 1616 rectifier, you will discover the same high quality and design refinements which have made other Hytron tubes famous. If you place your orders well in advance, you will also be pleased by Hytron's on-schedule deliveries. Not too infrequently, deliveries are made from stock.

HYTRON CORPORATION
SALEM AND NEWBURYPORT, MASS.
Since 1921 Manufacturers of Radio Tubes

decided difference between a *demand* and a *need* for receivers today. He said that surveys showed that 92% of the homes throughout the country are equipped with radios. This constitutes an effective percentage for the nation, said the WPB official.

ALTHOUGH DIMINISHED STOCKS OF ALL KINDS OF RECEIVERS have been reported by many stores, some retail establishments still seem to be able to gather enough receivers together to hold special sales. Recently, for instance, John Wanamaker in New York ran a large ad in a newspaper, advertising hundreds of receivers for sale. The display did not, of course, cover portable and table models, but there were plenty of consoles available in all price ranges. Receivers in the $59.00 to $129.00 category, of console structure, appear to be the most available type of receiver today, where receivers are available.

Radio departments in furniture and department stores report that there will be enough receivers available for the next few months. In anticipation of this sellout, many of the radio departments are being converted to record and cabinet departments.

The *black market* has become a strong factor in closing many departments. It has been impossible to date to trace the exact source of equipment being made along black market trends. However experts from the WPB and the industry itself, are conducting investigations daily, in an effort to destroy this evil.

The sale of reconditioned and second hand receivers originally believed to be a panacea for retailers, has not met with much success. Consumers have been reluctant to purchase such equipment unless a guarantee of servicing accompanies the sale, and many stores have hesitated to sell reconditioned equipment in view of the possible servicing problem. There is, of course, no denying that it is entirely possible to recondition receivers most effectively. However expert attention is essential in the initial operation. Many dealers claim that this exacting attention is not possible in all quarters because of time and manpower problems. Many in governmental and private industry circles still believe that reconditioning has possibilities, and accordingly are studying the procedure carefully. Time will tell.

PLANS FOR THE PRODUCTION OF ENGLISH UTILITY SETS have been shelved again. A statement from the Board of Trade in London indicates that there is no likelihood of utility radio sets being put on the market within the next few months. In fact, no decision has even been reached to make these sets. The statement emphasized the fact that radio equipment is too vital a necessity for the Services to permit production of civilian sets in any quantity at the present time. Of course, it must be remembered that in December there were still some 136,000 ordinary sets in the process of completion. At the present time, about 40,000 have been completed. Production of these receivers, known as domestic wireless sets, should be completed and released during this year.

At the present time, the engineering specifications on the utility model call for a battery and an a.c./d.c. three-tube model, capable of receiving about four or five stations.

Board of Trade president Dalton revealed in the House of Commons recently that he expects American receivers to be imported under the Lend Lease Act in the near future. The possible importing of these receivers plus the release of the domestic wireless units will be sufficient to care for present requirements.

INTENSIVE EFFORTS BY OCD CHIEF JAMES M. LANDIS have resulted in a major victory for the WERS. Hereafter the War Emergency Radio Service units will be able to go into action during emergencies endangering life, public safety or important property, for essential communications relating to civilian defense or national security. Under the new regulations WERS units will also be able to operate in the event of floods, fires, hurricanes, riots and other local emergencies, whether or not telephone and telegraph services are in operation.

This is quite a change from the original ruling which permitted WERS to operate only during or immediately following actual air raids, impending air raids or other enemy military operations or acts of sabotage to establish a center of communications for civilian defense.

WERS systems have been established in scores of communities throughout the nation to serve you and I, if and when emergency calls. Too much praise cannot be given to the volunteers of the WERS, for their outstanding work in developing this vital communications link.

THE TUBE SITUATION HAS FLARED INTO PROMINENCE AGAIN. A poignant letter from NAB president Neville Miller to the Honorable James F. Byrnes, director of War Mobilization, explaining the necessity for action *now*, in providing tubes for civilians, prompted Ray C. Ellis. director of the WPB Radio and Radar Division, to practically guarantee production of at least a minimum number of civilian tubes for the third quarter.

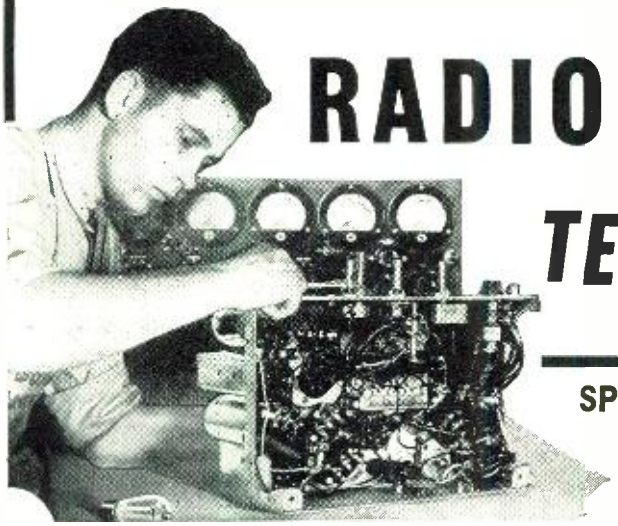
The letter from Mr. Miller said . . . "No directive is in effect to insure production of tubes in the quantity and of the type required to satisfy critical needs. But there exists in the WPB a program which should solve the problem immediately if put into operation."

Although in Mr. Ellis' reply to Mr. Byrnes, no specific quantities were mentioned, it has been assumed that between two- and three-million tubes a month will probably be made available. These figures were cited by Mr.

HERE IS 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. Be wise . . . look ahead! Plan now for a wonderful future in the swiftly expanding field of Radio-Electronics INCLUDING Radio, Television, Frequency Modulation, and Industrial Electronics. Then, 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 joint 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-J University Place, N. W.
Washington 9, D. C.

Please rush my FREE copy of "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

Miller in his letter to Mr. Byrnes. Incidentally the tube figures given by Mr. Miller were predicated on the maintenance of one set per home, excluding automobile and portable receivers.

Although there has been an improvement in the battery situation, many farmers are still complaining that they are not able to secure all the batteries they need. However, this problem will also receive instant attention by the Consumer Durable Goods Division, as well as Mr. Ellis' division as a result of the survey ordered by Mr. Byrnes.

Real action seems to be coming!

OWI AUTHORITIES have put their short-wave expansion program into high gear. In New York alone, five high-power transmitters will soon be on the air for OWI.

On the grounds formerly occupied by the transmitter of Columbia Broadcasting System's key station, WABC, construction of two 50-kilowatt short-wave transmitters, has already begun. In charge of the new undertaking is CBS engineer Henry O'Neil.

Four short-wave units will be installed in the former transmitter house of WJZ. Three of these new transmitters will be provided by OWI, while the fourth unit will be built by NBC of parts on hand. The standard broadcast transmitters of WJZ are being moved closer to New York in accordance with permission granted by the FCC. WJZ has a 50-kilowatt standard transmitter and a 25-kilowatt auxiliary transmitter. When the station moves, the auxiliary transmitter will be moved first.

According to James O. Weldon, acting chief of the Bureau of Communications Facilities of the OWI Overseas branch, American international broadcasting facilities will be expanded rapidly at many points during the next months.

THE NEW HELMETS OF THE ARMY have prompted the design of a new type of head set. It is a compact flat type unit which fits snugly under the helmet. To eliminate outside noises the new helmet employs a soft plug which fits into the orifice of the outer ear. This unique plug also has sanitation value, since with every head set issued, comes a new plug. According to tests made in laboratory and field, an extremely flat frequency response is available with this new headset.

A NEW SCIENCE, WITH A NEW NAME appears to have been added to the roster. It is known as Opti-onics. The term seems to have originated in optical circles where optical systems for television are being devised.

According to J. H. McNabe, president of Bell and Howell Company, the term Opti-onics appropriately describes the science in which the work of the optical engineer is predominant. We must remember too, he said, that in the physical world we reach a point where radio waves take on many of the characteristics of light waves. The need of optical science or Opti-onics is necessary to achieve satisfactory results, explained Mr. McNabe.

Welcome Opti-onics!

FEW VOLUNTARY GROUPS HAVE BEEN AS ACTIVE in defense work as the Civil Air Patrol or CAP. Organized a week before Pearl Harbor, CAP has grown to a force of 75,000 operating out of nearly a thousand airfields throughout the country. Now an auxiliary arm of the Army Air Force, it has become a vital unit of defense. And radio is playing its dominant role as usual.

So essential has radio proved itself that many States have conducted drives to purchase equipment. The legislative branches of States have also exhibited their interest in radio. The Virginia General Assembly appropriated $5,400 recently to install two-way radios in CAP planes. In Detroit, a contribution of $15,000 went into the construction of an operations office on wheels containing a portable transmitter that could be used on planes, too.

Local talent in the form of commercial pilots, instructors, electricians, and radio repair men have added their bit to the staffs of CAP. In some communities schools have been set up by flight communication officers to explain beacons, radio direction finders, flight theory and the mathematics of navigation. Many of these volunteer teachers are veteran professionals of worldwide fame.

Thus far, CAP pilots have flown over a total of 20 million miles. CAP pilots have spotted more than 140 submarines for the Army, Navy and Coast Guard. They have participated in the sinking of some submarines, and many off-shore patrol missions, which brought rescue to crews of torpedoed tankers.

Yes, the CAP is doing a real job. Our hats are off to them!

TELEVISION AFTER THE WAR is being discussed vigorously in England at engineering meetings. Comments made by such authorities as B. J. Edwards, O. S. Puckle and others indicate interesting postwar trends.

According to Mr. Edwards, for instance, a picture construction of approximately 800 lines interlaced to produce 25 complete pictures per second will require a video frequency of 20 mc. And, he explained, if we consider double side band transmissions, the transmitter will have to be modulated over a band width of 40 megacycles. This means that a minimum carrier frequency of 40 mc. will be necessary. Propagation difficulties which, of course, will prevail will have to be considered, explained Mr. Edwards. He pointed out that building reflection, offered great difficulties, too. However, he said, reflectors should offer a solution to this problem. A parab-

oloid not greater than two feet in diameter could be used. Mr. Edwards also described the use of a community antenna which could be elevated to the necessary height, connected to a suitable detector and amplifier that would provide distribution of a signal at video frequencies over a local coaxial cable network. Mr. Edwards stressed that such a system would eliminate the need for a signal frequency, i-f amplifier or detector. Such a method, he said, would be extremely practical in New York in view of all the high buildings.

According to Mr. Puckle a maximum frequency of 100 mc. is all that would be necessary for standard television transmission. For color or stereoscopic television, higher frequencies might be requisite, said Mr. Puckle.

L. H. Bedford provided some interesting data on the number of lines that offer the best results in television. He said that he had made repeated tests of viewing angles in motion picture theaters and found that an acceptable viewing distance was around six times the picture height. A wider viewing angle than this at home, would not, of course, be necessary. Therefore, he said, if we accept the fact that a 405-line scene can be seen from eight times the picture height without line resolution, the increased number of lines required to allow the viewing distance to be reduced to 6 times the picture height is $8/6 \times 405 = 540$. The nearest standard equivalent to that would be 525 lines. For such transmission he said, a 3.2 megacycle video band would be practical.

Interest in television in this country continues at a merry pace, too. Allen B. DuMont has just filed a request with the FCC for the reinstatement of a commercial television station application for Washington, D. C., to operate on channel 1, or 50 to 56 megacyles.

The New York television station of DuMont, W2XWV, is on the air every Sunday and Wednesday evenings. The Sunday evening programs transmitted from 8:30 to 10:30 are on a scheduled program basis, while the Wednesday evening programs are experimental.

Business groups, student bodies and lecture hall audiences are being told in no uncertain terms, of post-war television possibilities. The bills pending in Congress all have clauses on television control. This time it appears television will not be an experimental gesture, but a practical public project.

OUR OLD RELIABLE FRIEND, WWV, transmitting standard audio-frequency notes for frequency checks, is still very much on the job. Today, the 440-cycle note, which corresponds exactly to the tone *A*, above middle *C*, is being used to check the performance of transmitters, receivers, quartz crystal oscillators and other similar equipment.

The tone, which is accurate to within one part in ten million, is transmitted by the Bureau of Standards every day throughout the year on a special schedule. In the early days WWV was the pet of all amateurs. Today, it's one of Uncle Sam's best friends.

RADIO BROADCASTING played a stellar role recently out West, when two carloads of shells caught fire and rained shrapnel over miles of country. When the shells began to burst, the telephone lines became clogged with calls from every one in the area. However, timely broadcasts by local station KFXJ explaining the cause of the explosions and urging everyone to remain under shelter, not only stopped the deluge of calls, but prevented many fatalities as well. Hourly bulletins also disclosed areas in which shells had dropped, urging listeners not to pick them up as souvenirs. The station's activities were applauded by the police and military authorities.

A STATIC CONTROL that really works, is now available according to Gilbert J. C. Andresen, research physicist for the Goodyear Tire and Rubber Co. His device, known as a radio static neutralizer, subdues static to a point where it no longer interferes with reception, say the Goodyear officials. They admit that the device is not equal to f-m, but it can reduce or eliminate some kinds of static which baffle a-m, they say. Before a group of reporters, the device seemed to do its work well. However, the static produced was by artificial means and the instruments employed were of special construction. However, experts present did admit that the control was quite effective and had real commercial possibilities.

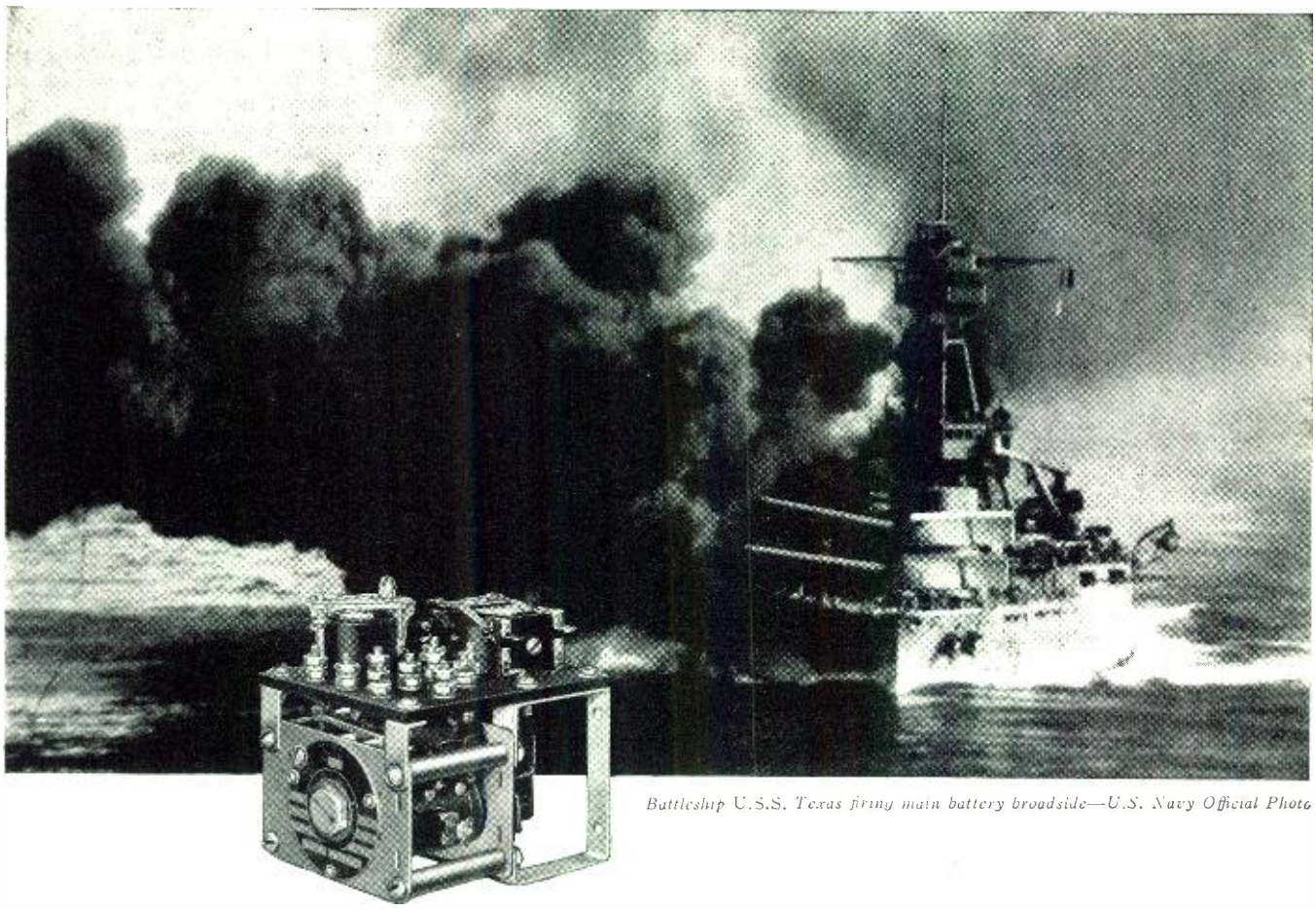
At the present time, this control is being employed by the military for special equipment. Incidentally, the entire device which is about 4″x2″x 2¼″, weighs less than six ounces.

THE FOUR FREEDOMS received a new series of definitions in London recently, when Sir Robert Watson Watt, addressed the Radio Industries Club on postwar problems. He said that the four freedoms necessary to the broadcast listener were freedom of choice, freedom from distraction, freedom from distortion and freedom from interference. Sir Robert claimed that six different programs were required to offer him freedom of choice. Interference from static and cross modulation were not beyond elimination, he said.

In commenting on piped radio, Sir Robert said it had its place as a supplement to radio. It could not, however, really take the place of radio, he explained, since it limited the four freedoms.

THE WHEATSTONE BRIDGE had a birthday recently . . . its hundredth. For on June 15, 1843, Charles Wheatstone presented his famous Bakerian lecture, describing among other notes, a "differential resistance measurer," or

(*Continued on page* 56)



Battleship U.S.S. Texas firing main battery broadside—U.S. Navy Official Photo

IT'S IN THE NAVY NOW

We can tell you about this motor driven, time delay relay because it has been used for years in peace time activities as a time control in drying systems, heat treating ovens, illumination and many other applications.

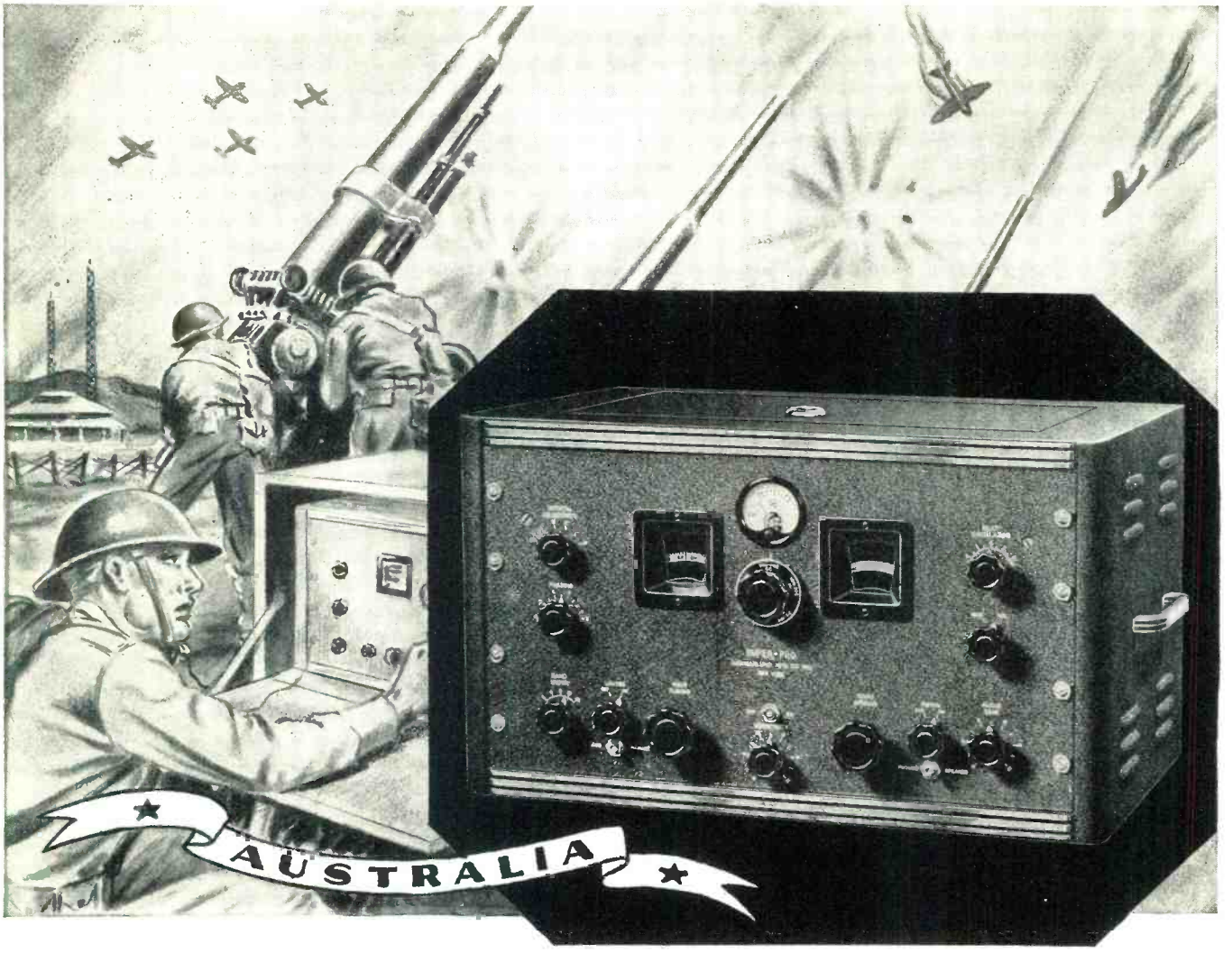
NOW IT'S IN THE NAVY. The positive action, ruggedness and resistance to shock and vibration of this relay, make it ideal for alarm control, communication circuits and for the protection and timing of many kinds of equipment. Manufacturers who are doing essential war production can often find items in the regular line of Ward Leonard Controls that will serve their needs without the delay of extensive redesigning.

WARD LEONARD

RELAYS • RESISTORS • RHEOSTATS

Electric control (WL) devices since 1892.

WARD LEONARD ELECTRIC CO., 47 SOUTH ST., MT. VERNON, NEW YORK



Twenty-four Hour Vigilance . . . the SUPER-PRO "SERIES · 200"

TWENTY-FOUR HOURS every day HAMMARLUND radio receivers aid in defending the United Nations against air attack. Sound electrical and mechanical design, together with accurate workmanship, make the "SUPER-PRO" superior in performance under the most adverse operating conditions.

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

THE SIGN OF QUALITY IN RADIO

HAMMARLUND

ARCTIC NETWORKS

Unloading radio equipment at an Arctic post, in July, from annual supply ship.

Erecting a wind-driven generator, used to obtain power for station operation.

by S. G. L. HORNER
Radio Division, Hudson's Bay Co.

Many adventures are encountered in the construction and operation of the Arctic Radio Network.

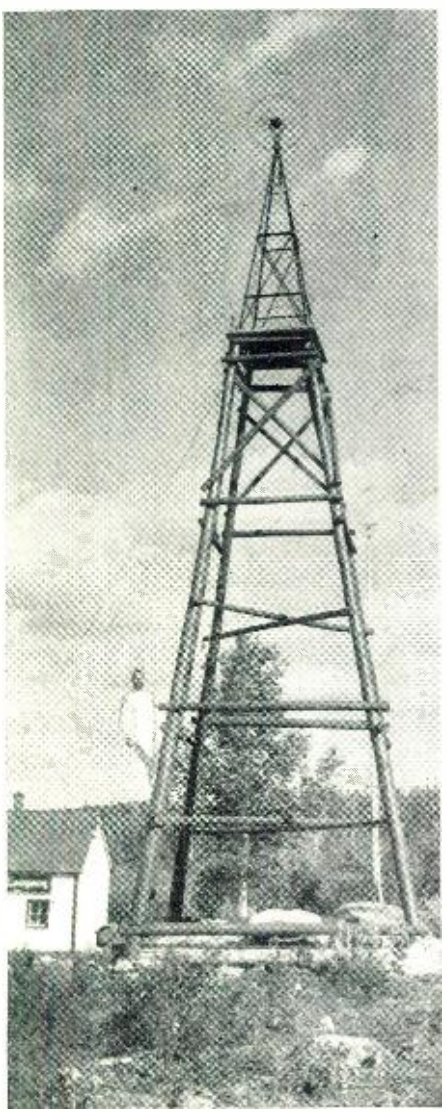
WITH the start of 1934, the Governor and Company of Adventurers of England, Trading into Hudson Bay, or as they are more commonly known in Canada and the United States, the Hudson's Bay Company, had completed 264 years of operating Fur Trade Posts throughout Canada's great north country. Due to the type of business engaged in and to the size of the country, with its very meagre white population, few of these trading posts or trading settlements had any form of modern communication between themselves, or with the nearest center of civilization. The odd post that had it, was generally a point at which there was a radio station operated by one of the Government services. In most of these instances, the bulk of the traffic was still handled on long wave only and short wave radio had not been developed to any great extent throughout this vast arctic and semi-arctic country.

The communication on the whole, between and with the 200-odd Hudson's Bay Company Fur Trade Posts, was therefore, by dog team in the winter and Indian canoe brigade in the summer, and in the case of the Posts definitely within the arctic, by supply ship once a year. The aeroplane was just starting to come into use in the more southern parts of this vast area of over 1,000,000 square miles, which stretched from latitude 45 degrees north to 500 miles north of the Arctic Circle, and from the Rocky Mountains in British Columbia and the Yukon to the jagged rock-bound coast of Labrador on the Atlantic.

At the majority of these trading posts, the Hudson's Bay Company employees consisted of a Post Manager and an apprentice clerk. In a few cases, there are additional white population at the trading centre and these are generally a Royal Canadian Mounted Police sergeant and constable, a missionary, or in rare cases, some other white trader. In a very few instances, there is a doctor stationed at the trading centre by the government. But at the majority of the Posts, the Company employees are the only white population and they have to act as trader, doctor, missionary, policeman, judge, etc., for the various bands of Eskimos and Indians who trap over the hundreds of square miles in the vicinity of the trading post. These Company employees are in no way technical in matters pertaining to ra-

A Hudson's Bay station with 50' towers situated on hill-top.

This arctic outpost uses steel towers for wind-driven generators.



Combination 35' wood tower and 10' steel tower used to support generator.

dio or mechanics, though they all are and have to be practical men, living as they do far from civilization.

Such then is a very brief picture of communication conditions between and with the 200-odd Fur Trade Posts of the Hudson's Bay Company at the start of 1934, when it was decided to go ahead and link up by means of short wave radio communication, 100 of the more isolated Posts, not only for business reasons, but as a service to all the white and native population of that vast area, which as stated before, consists of trappers, traders, missionaries, police, and the native population of Eskimo or Indian.

Naturally, in a communications project such as this, with practically no previous data to go on, not, of course, referring to the actual technical side of radio communication, it was impossible to draw up a blueprint of the final system such as it is today. The first step was to establish experimental stations in various parts of this large area and from there on expand. The plan worked well and after two years of being on an experimental basis, the plans were laid to develop the system over a four year period. The experimental period brought to light many problems that were not always technical. What was the final cost per station to be, the type of service required, both at the beginning and later when the system was finally completed, training problem of the Fur Trade staff for operating purposes—for the economic side and the amount of traffic at any one Post did not warrant purely radio operators at each Post—were just a few of the problems that had to be settled in the experimental years and later readjusted as the program was being carried out. However, the use of time for experimental purposes and the final decision to establish the system over a four-year period proved to be sound judgment, for it was found that the experience and data collected in one part of the area in one year was able to greatly benefit the work in another part the next year. The final result was that when the present war broke out in 1939, the Company not only had a communication system throughout the Arctic regions of the northern hemisphere that was able to be of immediate service to the United Nations, mainly at first from the communications end, but after Pearl Harbor, when the northern regions of the continent became of supreme importance, they became a source of much information for the various communication branches of the United Nations, who found it imperative to establish their own communication systems in certain parts of this vast northern country.

While the scope of this article, and in many instances for censorship reasons, does not permit a detailed account of the completed system, such as the location of the various stations throughout this vast area, the control system used, frequency, etc., it will try to give in a general way some of the problems that arose, and their solution and many other points that will be of interest to readers of RADIO NEWS.

As the economics of cost came in right from the start, since it was a private commercial undertaking, it was decided at the beginning to confine all activities to low power, and up until the outbreak of hostilities not one station of the 100 in operation had a

Maintenance work on the radio station must be done continuously. Note the snow-capped mountain peaks in the background.

power of more than 30 watts. Naturally, some of our readers will scoff at this idea of "flea power", especially when the distances to be covered ranged from 800 miles to 50 miles, though the average distance was 300 miles. Without a knowledge of the type of terrain to be covered, radio conditions as a whole in these northern areas, the pros and cons of the use of low power cannot be discussed at any great length, sufficient to say that over a period of seven years, satisfactory service has been maintained day in and day out (other than when normal radio reception was completely out for stations of all powers) and the type of traffic handled has varied from 2000 word commercial messages to ten word meteorological messages, though the average message has been of 200 words length.

Another type of problem which arose can be illustrated by discussing the question of the source of power for these 100 stations. This had to be considered from the economic side as well as the technical side. At first thought it would appear that gas-driven generators would be the simple solution to this problem, for, of course, the nearest power lines were anywhere from 500 to 1000 miles away. However, consideration of a few facts will show why gas-driven generators at the majority of the stations, was not the solution to the power question. Gasoline, when landed at many of these isolated trading posts, especially those in the Arctic regions, costs $2.00 a gallon, due of course, to the high freight and insurance rates. Therefore, from the economic point of view, the use of gasoline was to be avoided if possible. Again when gas-driven generators are used day in and day out throughout the year, they must have a certain amount of technical attention. As already explained, the men who were to operate these stations were in no way technical, other than being practical average men, therefore, a power source that could do with little or no care for a three- to five-year period, was what was needed, and gas-driven generators, therefore, did not fall in this category.

It was decided to pioneer in new fields, and for the first time, wind-driven generators were used in large numbers in Arctic regions, where the temperature ran to great extremes of cold and high wind velocities prevailed. Winter temperatures often reached 60 degrees below zero and the average winter temperature was around 30 degrees below zero. Wind velocities not infrequently touch 60 to 80 miles per hour at many of the places and 30 to 40 miles per hour were quite common velocities. The results more than justified the experiment, and now over more than 90 percent of the stations are powered by wind-driven generators, in conjunction, of course, with storage batteries. The first wind-driven generators used were not per-

(*Continued on page* 84)

Some of the earlier equipment used at Hudson's Bay posts in the Arctic regions.

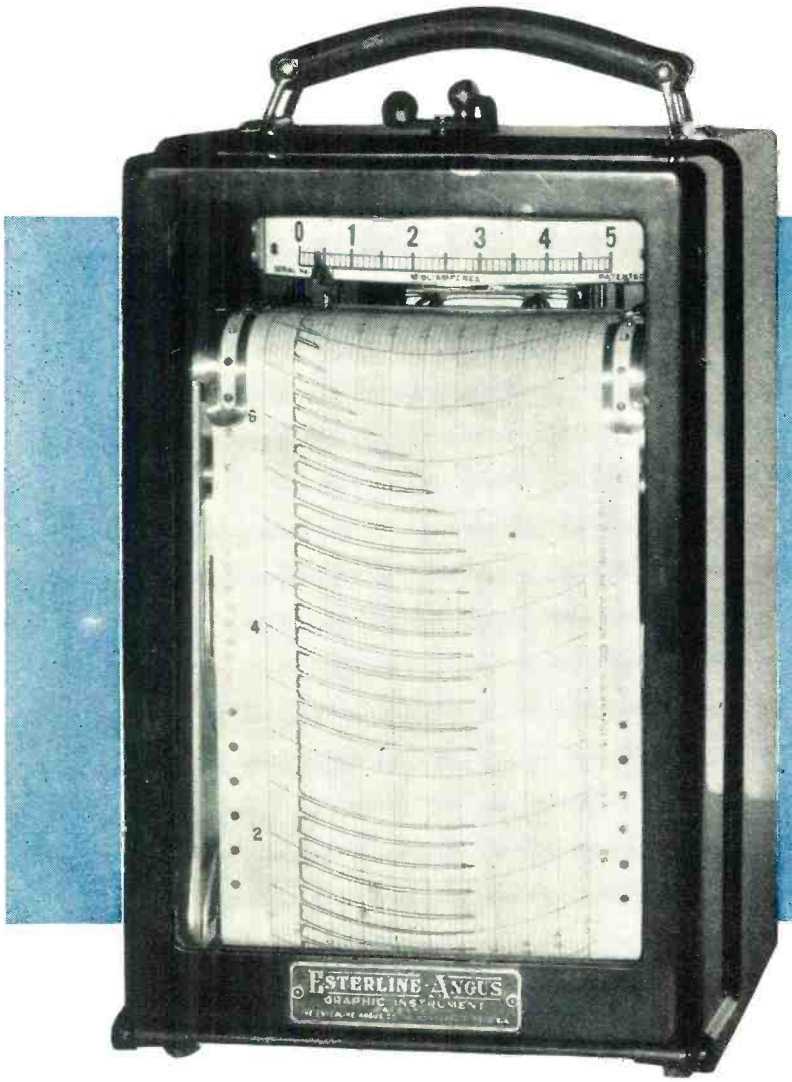


Fig. 1. Recorder employed in the Lie Detector used to plot variations in skin resistance and heart amplitude simultaneously.

CRIME DETECTION

by **RUFUS P. TURNER**
Consulting Engineer, RADIO NEWS

A review of electronic devices which are being employed for the detection and prevention of crime.

ELECTRONIC science does not step out of character when it assumes the role of a modern sleuth. Aside from the numerous well-known industrial applications which have distinguished this new branch of physics, there are applications to criminology which are not so well known to an otherwise electronics-conscious public. Modern crime detection is richly aided by the sharp eye and keen ear of electronic devices of one sort or another.

Electronic systems, insofar as they enable radio communication to be carried on, have served the police departments for a considerable period, so that today virtually no representative community is without police radio. Close to the turn of the Century, the City of New York was operating a police *radiotelegraph* transmitter. Police radio, both municipal and state-controlled is now so commonplace that many laymen cannot remember when it did not exist.

It is not the purpose of this article to review the police communication systems, since that subject has previously been fully covered on these pages. Rather, we will describe several of the electronic circuits and devices which are now being employed directly in detection of crime, in collection of criminal evidence, and in crime prevention. The number of these devices is steadily growing and the amount of serious research on the subject increases each year.

Most noteworthy of the devices in present use are (1) *detectaphones,* by means of which the conversations of criminal suspects may be monitored and recorded by authorized investigators collecting evidence or apprehending criminals, (2) *intrusion and theft alarms* for signalling watchmen or policemen in event of unlawful entry or attempted removal of valuable objects, (3) *metal detectors* for the spotting of stolen metal pieces in the pockets of outgoing employees, (4) *x-ray photo spoilers* for ruining negatives in cameras concealed on the person after taking unauthorized or prohibited pictures, and (5) *lie detectors* whereby deceptions in spoken testimony may be detected. These devices are only representative of the developments which have been made or which may suggest themselves to the reader who is investigating the future prospects of the art.

Some of the devices have not been universally accepted by criminologists, although their apparent utility is generally acclaimed. Likewise, several of the systems, although approved in regard to soundness of theory and practicability, have not been admitted in all States as legal gatherers of criminal evidence.

The Detectaphone

The detectaphone, also called "Dictograph," is one of the crime detective's oldest electrical aids. It is simply a highly-sensitive telephone with concealed pick-up device, which may be employed to eavesdrop on a criminal discussion. The simple detectaphone was first employed shortly after development of the telephone and enjoys a long record of service to detective agencies and police departments.

The first detectaphones which were most successfully employed were rudi-

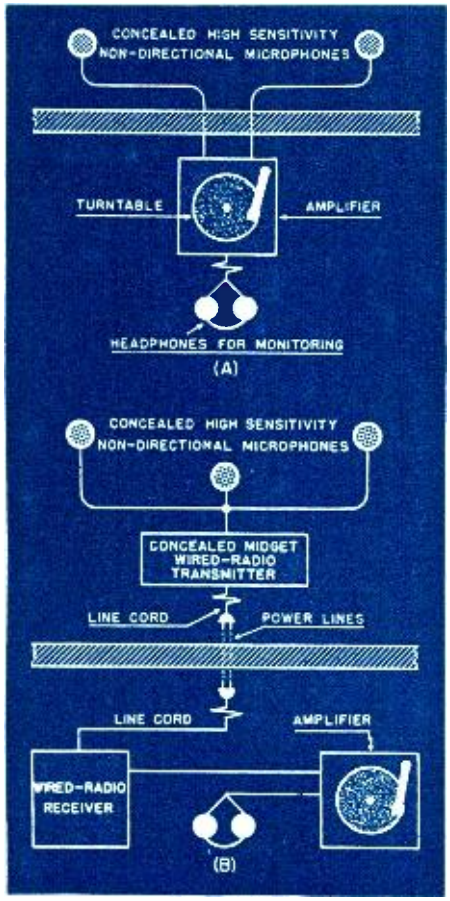
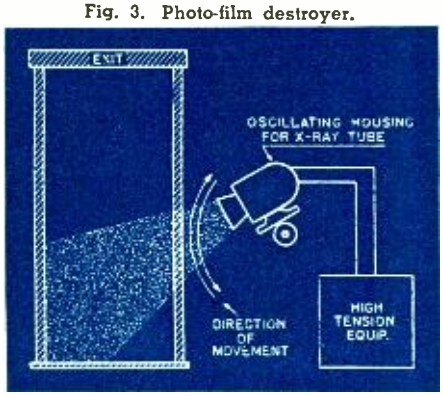


Fig. 2. Modern detectaphone systems.

mentary setups, consisting of a miniature, concealed microphone, placed in the room where the questionable conversation was carried on, and wired to a battery and headphones in a nearby room where investigators listened-in. In order to provide the largest amount of voice pickup, the microphone was generally of the carbon ball type which was the most sensitive form at the time. These microphones performed exceedingly well, when it is considered that they were required to operate behind pictures, in desk drawers, under furniture, and similarly concealed and that they were provided with no amplification!

The modern detectaphone receives the benefit of a long line of microphone and amplifier developments. It is now possible to place on the scene miniature, non-directional microphones with extreme sensitivity and to follow

Fig. 3. Photo-film destroyer.



these devices with amplifiers of sufficient gain to make even a low whisper audible to the investigator. Several microphones may be placed strategically about the room, and phonographic recordings may be made for future reference or for introduction as court evidence. By making use of the wired-wireless principle, an entire miniature amplifier-oscillator may be installed *on location* and the modulated r.f. signal from this unit piped over the power lines, thus making it unnecessary to string wires to the listening point. Detectaphone systems are shown in Figure 2.

The system shown in Figure 2-A is the conventional one requiring concealed wiring between the microphones in one room and the amplifier in the other. The amplifier may be used solely for eavesdropping with headphones, or it may be rigged up for recording as well. Usually, the running of wires for this system requires considerable careful planning and preliminary work in order to defy discovery. This system is accordingly not readily placed into operation when time is a factor.

Figure 2-B illustrates the wired-wireless system. The transmitter in the "hangout" and the receiver in the investigator's room resemble the well-known wired-radio intercommunicator systems which operate over the house wiring. The transmitter unit comprises a midget amplifier-oscillator operating directly into the line from which it obtains power. In the investigator's room, where space is not a factor, the receiver is augmented by an audio amplifier of sufficient gain for recording. Depending upon the type of microphones employed, the transmitter may be made quite small in size. High gain in the microphone amplifier may be obtained by employing pentode tubes in cascade. The entire unit may be constructed by any radio experimenter to fit into a desk drawer, china closet, or similar place of concealment. The entire unit need be no larger than the average battery-portable radio, and the line cord may usually be run, as under a carpet, so as not to be conspicuous.

An advantage of the wired-wireless detectaphone is the fact that the receiver need not necessarily be located in the same building. The investigators may be located at some distance away, depending upon the electric wiring of the community. And several listening points throughout the city may operate simultaneously for best coordination of effort.

Metal Spotters

Devices which will signal the presence of nearby concealed metallic objects have variously been termed *metal detectors or finders, metal spotters, gun finders, electric friskers,* and so on. Such instruments have been employed with varying degrees of success to spot concealed guns, knives, and similar weapons on the person of a prisoner marching in or out of quarters, weapons concealed by suspicious

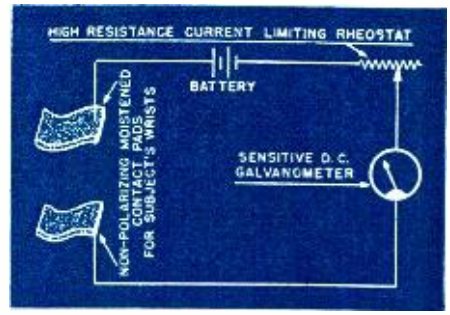


Fig. 4. Simplest form of Lie Detector.

persons entering courtrooms or important buildings, and stolen metal goods being carried in pockets or cases through pass gates by employees.

Rudimentary metal spotters make use of the properties of the magnetic field. They are simple in construction and theory, consisting of pole pieces or field coils set up in a passageway in such a manner that passers-through unconsciously cross a magnetic field, cutting lines of force. The presence of appreciable amounts of metal on the person of the passer changes the reluctance of the field and this condition is indicated by some appropriate current or voltage instrument. The leading disadvantage of the simple system is its dependence upon large metallic masses for most efficient operation. At the same time, the detected metal must almost always be magnetic in nature —either iron or steel; the sensitivity is largely impaired by the necessary length of the magnetic gap; and legitimate objects, such as watches or small tools, carried by the passer are apt to become magnetized in the field.

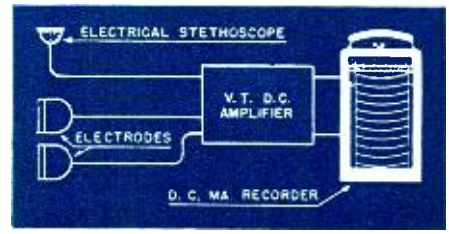


Fig. 5. Modern Lie Detector.

Another type of metal spotter utilizes r.f. energy, delivered by loop antennas placed in the passageway, and operating on the principle of the so-called treasure locaters. The sensitivity of this type of instrument may be made quite fine. In one version, an ultra-high-frequency wave is transmitted toward the point to be occupied by the passer-by, and another wave is transmitted to a receiver in a direction perpendicular to the first beam. The receiver is simultaneously responsive to both the direct beam and the beam which is reflected from an object in the passageway. The system is first "balanced" by making adjustments with a normal object (such as a person with a normal amount of metal in the form of watches, pocket-knives, etc.) until no indication is obtained as direct and reflected rays impinge upon the receiving loop. The instrument will then subsequently be

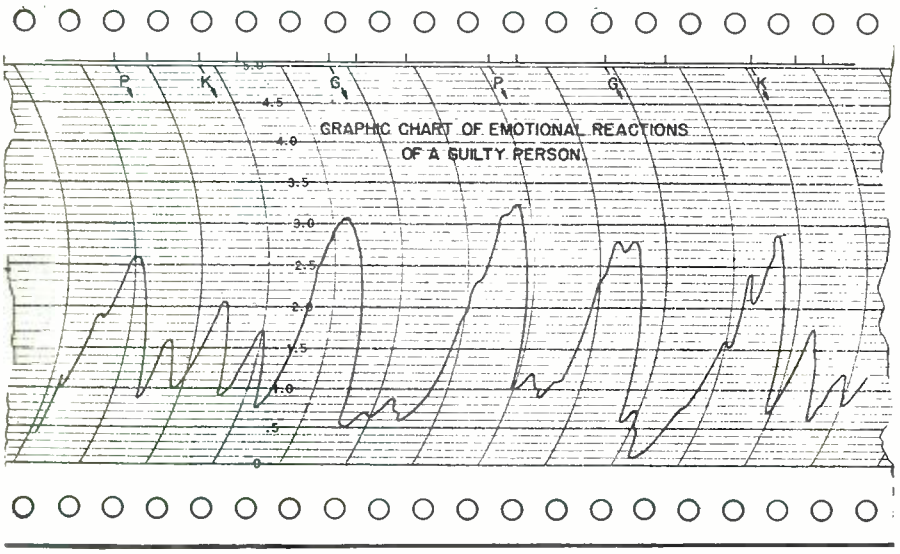


Fig. 6. Typical record sheet from the Lie Detector machine, showing response curve.

thrown off balance and will give a telltale indication when reflection occurs from a larger-than-normal object of metal. This version of metal spotter uses electronic parts entirely in its construction; and some models are highly advanced in design, employing ingenious electronic signal-relay circuits and delicate electronic balancing circuits.

A practical gun detector, which has been in use in some prisons, makes use of the electromagnetic principle. Employing a sensitive reluctance-change detector and amplifier, this device transmits a metal-detecting signal to a cathode ray oscilloscope to deflect the beam on the screen of that instrument. The gun detector is said to be extremely sensitive. However, its delicacy of adjustment and attendant vagaries require a skilled operator, and it is not suitable for the detection of small metallic objects. It likewise operates best on magnetic materials, such as iron and steel.

The metal spotter, although offering a number of possibilities in the field of crime detection, is not yet entirely foolproof in operation and simple in nature. The art of "gun spotting" may be said to be in a state of flux at this writing. Among the present problems are elimination of the magnetic field which might cause damage to a passer's watch and which does not afford most satisfactory operation; making the instrument equally sensitive to ferrous and non-ferrous metals, with some means of distinguishing between the two; simplifying the design in order to permit operation by any authorized employee who has no knowledge of electronics; and divorcing the response of the instrument from action resulting from small metallic objects, such as rings, watches, knives, pencils, etc., which are normally carried on the person. We believe that the electronic experimenter will find a fertile field in the development of practical "gun spotters."

Perhaps the greatest disadvantage of most metal spotters which have been tested up to this time is the inability of most of these instruments to spot *small* objects. In a number of factories, a large amount of stealing of small, but *expensive* devices goes on continually, producing an aggregate loss figure each year which is astonishing to read. These stolen goods may take the form of manufactured jewelry, timepieces, tiny electrical or mechanical parts, and so on. A boon to such manufacturers would undoubtedly be a metal spotter which might be "tuned" to the particular type of gadget produced in the plant and at the same time be made unresponsive to coins, metal buttons and other garment trappings, and other paraphernalia legitimately carried by the employee.

Intrusion and Theft Alarms

The science of electronics has been the number-one contributor of intrusion and theft alarms for many types of application. Starting with the rudimentary photocell type of burglar alarm, electronics has developed an imposing line of silent sentinels to watch over the home and factory. This includes many types with which the layman is already familiar in a general sort of way. Circuits and data for actual construction of these alarm devices were given in a recent RADIO NEWS article.

Ed. Note: see Intrusion Alarms, RADIO NEWS, *May, 1943.*

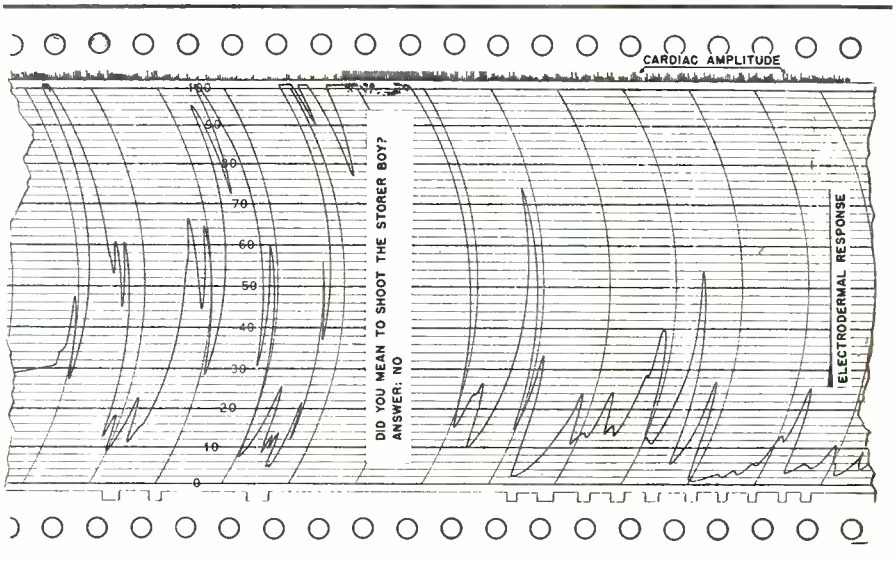
Prominent among the electronic intrusion and theft alarms are (1) photocell systems, (2) ultra-high-frequency beam systems, (3) capacity-controlled oscillators, and (4) light-contact switches in conjunction with wired-radio signals.

PHOTOCELL SYSTEMS. The photocell circuit is perhaps the oldest of the electronic burglar alarms. As an intrusion alarm, its operation depends upon interruption of a light beam which is continuously directed upon the light-sensitive surface of the cell. The system is very flexible in operation, in that a point of entry to a building may be criss-crossed by reflected light beams to cover all portions of the passage-way; invisible ultra-violet or infra-red rays may be utilized with special cells to foil the "educated" criminal; and an entire building or yard may be protected on all sides by reflecting *a single beam* around the area by means of mirrors placed at each corner. Photocell intrusion alarms of various types have been in use in many industries for a number of years, and have been installed by several detective bureaus.

U. H. F. BEAM SYSTEMS. Operation of this type of alarm depends upon a reflected or interrupted ultra-high-frequency radio beam for its operation. The apparatus and method are still experimental in nature and some research is being done along these lines. The fundamental units and system

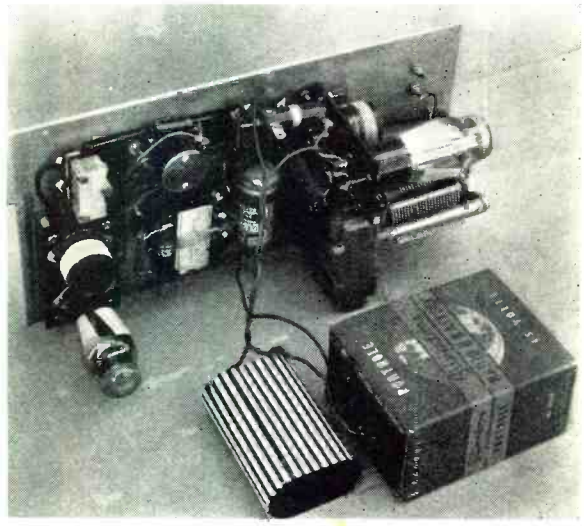
(*Continued on page* 78)

Fig. 7. Actual curves of the cardiac and electrodermal variations of guilty person.



RADIO—TO MEASURE MOISTURE CONTENT OF SOIL

The compact portable soil analyzer. The moisture content of soils must be known to determine reactions of ground waves accurately.



Interior view of chassis assembly showing location of various components. The unit is battery operated.

by S. R. WINTERS

A crystal-controlled oscillator unit used to determine the moisture content of soils.

WHEN the history of the Twentieth Century is finally compiled, a number of questions are going to be mulled over by future generations—especially such questions as whether man be controlled by radio or radio controlled by man. The answers will be about as easy to decide as the one concerning the hen and the egg.

The revolutionary powers of radio have now sunk their controls into a new field. Joel E. Fletcher of the Soil Conservation Service, United States Department of Agriculture, has recently experimented successfully with a dielectric method of determining the moisture content of soil—which means, in effect, that the business of sampling layers of the earth has made its debut in radio.

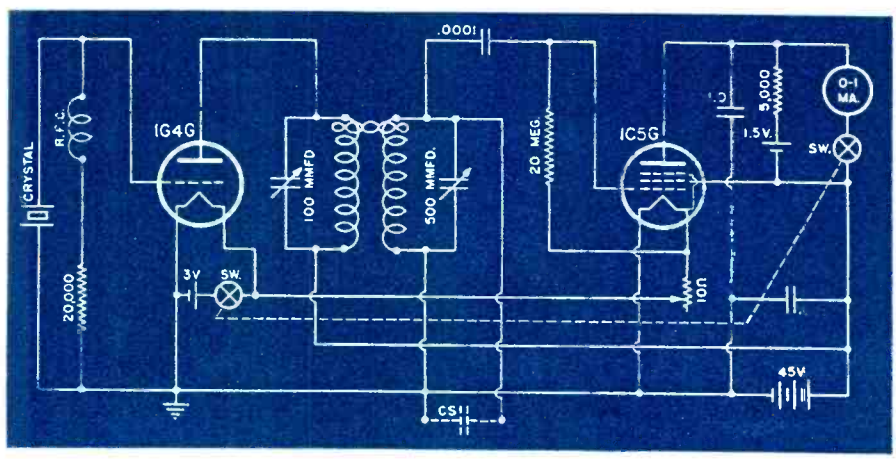
Experiments with electrical conductivity methods of determining soil moisture in certain sections of the United States, particularly in the Southwest, have not been successful due to the concentration of soluble salts in the soil. Tensiometer set-ups used in these experiments were not satisfactory in dry seasons since such conditions break the water columns and replacements must be made before further results can be obtained. A satisfactory method of determining soil moisture must be free of the effects of salt content of soil. In addition, equipment which is to be used over wide areas of the country should be easily portable and unaffected by changes in temperature.

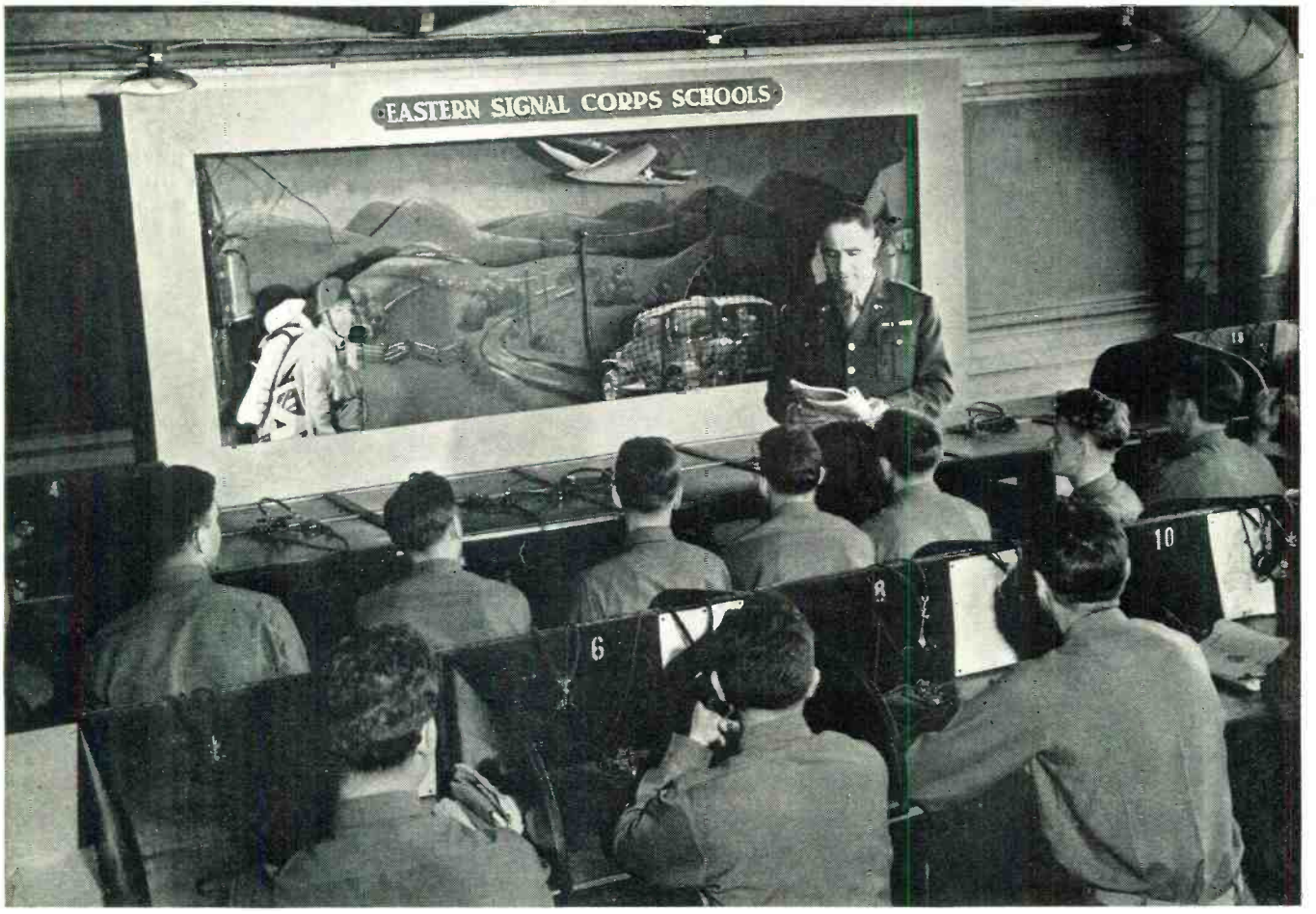
Investigations have been carried on for sometime to determine the relationship between soil and radio. These, for the most, were concerned in radio broadcasting and the two soil properties which had been found to influence broadcasting, that is, conductivity and dielectric constant. It had been observed that the relation between the dielectric constant and the moisture content tended to be linear in the lower ranges of moisture content of the soil.

Equipment used by Mr. Fletcher consisted of a crystal-controlled oscillator, oscillating at a frequency of 3.9 megacycles per second. A precision-type condenser was used which had a capacity of 500 micro-micro-farads with a straight-line-frequency plate shape. A vacuum-tube voltmeter indicates when resonance is reached. Special condensers are used. The receiving circuit inductance,

(*Continued on page* 53)

Fig. 1. Schematic diagram of the dielectric measuring equipment.





Primary instruction in "blinker" light communications. Simulated battle-front scene adds realism to subject.

ESCS CODE TRAINING

An entirely new technique has been adopted by the Eastern Signal Corps School to speed code instruction.

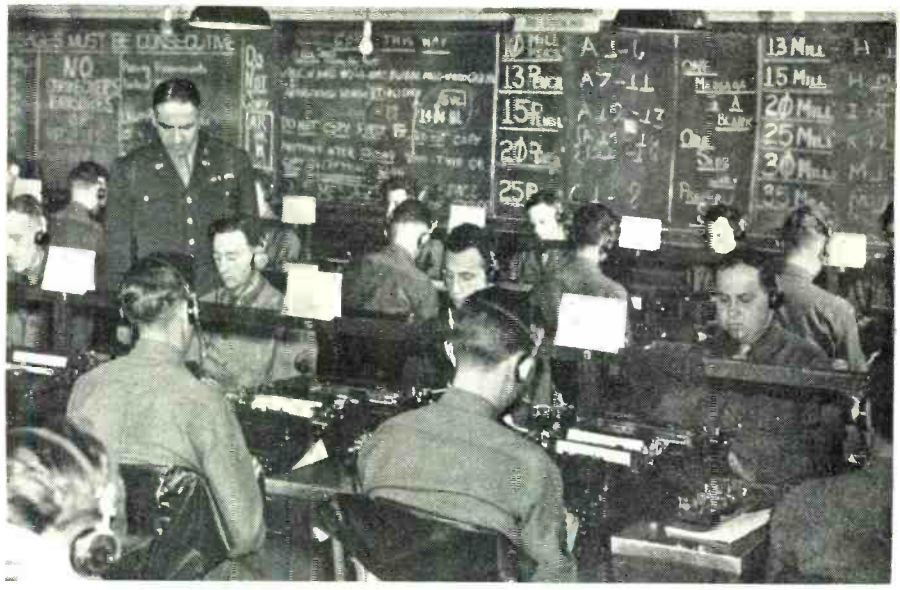
"DON'T leave it all to the student's imagination!" said Colonel W. O. Reeder, Commandant, the *Eastern Signal Corps Schools,* "Dramatize it! Give it life!"

Signal Corps work is necessarily complex, but instructional methods now employed to punch across salient points of technical procedure are vivid, forceful, simple and above all, visual. Seeing, in the opinion of military educators, is more than just believing—it materially simplifies the task of learning. A recent illustration may be found in the experience of Captain Reuben Abramowitz, Assistant Officer in charge, Radio Division, Enlisted School. Throughout more than thirteen years of direct personal responsibility for the administration of code and traffic classes at Fort Monmouth, Captain Abramowitz has become one of the nation's foremost authorities on radio operator training. Until Colonel Reeder's directive, however, the Captain has been, by his own admission, "simply following the traditional method." He referred to the fact that primary instruction in "blinker" light communication has always been tacked on behind, and subordinated to, fundamental practice at the telegraph sounder.

"We made the mistake," admits Captain Abramowitz, of demanding that our students accomplish two jobs at the same time. It worked well enough . . . but not quickly enough! Originally, each classroom position comprised a triple unit of headset, buzzer and partially enclosed light bulb. All were actuated by a Boehme keying head. The students read the light in terms of flashes coordinated with those sounds produced by his buzzer. Actually, he found the light bulb a source of eyestrain, his interest in blinker operation suffered considerably and his possible confusion by the endeavor to coordinate sight and sound became a constant danger.

Later modifications and improvements in this basic technique reduced student difficulties, but the entire concept was even then in mounting disrepute. Motivated by the encouragement of interested superiors, including the late Colonel Wallington, and Lt. Col. Lee L. Shaffer, now Commandant Enlisted School, Captain Abramowitz cut to the heart of the problem by divorcing sight from sound. Blinker operation is wholly visual, keying is entirely phonetic. They have nothing in common beyond the similarity of symbols which they convey. Therefore, the Captain set up his lights independ-

Captain Reuben Abramowitz



Typical view of classroom operation in code training at one of the Signal Corps schools.

ently and was upon the verge of a discovery. Separate lights for each student were costly, burned out quickly, and required continual attention, one or two should be enough for the entire class, but how to display them so as to attract the most attention and command unflagging interest?

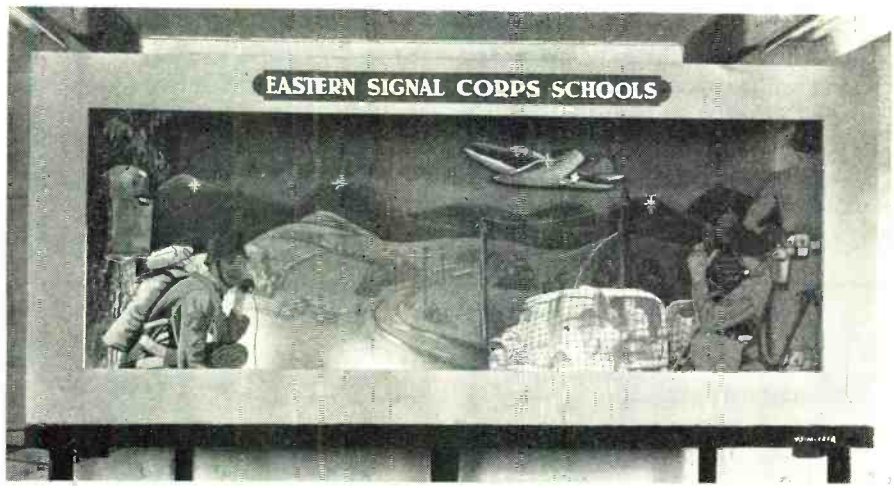
A student with artistic ability was called upon to block out a rough landscape, a reproduction of normal terrain. Captain Abramowitz punched a pinhole in the paper just at the horizon line, another at the crest of a hill, a third amongst the branches of a tree. He had found his solution. The artist, with several assistants, was then commissioned to reproduce his landscape in full color and on a large scale. When mounted upon the classroom wall, this painting bore at the horizon a small hole behind which was a keyed neon bulb. Results were highly gratifying. The painting provided authentic background for the blinker, making it easy upon the students' eyes. Only one bulb was required for the entire class. The use of neon, instead of filament, lamps comprised a technical improvement, since gas-filled bulbs will follow keying vibrations with much more immediate response. This made it possible for students to qualify at higher speeds, and in fewer hours than ever before.

Fortified by these excellent results, the good news about the new method of blinker instruction was rapidly broadcast to other signal corps schools and Army Training Branches.

Camp Crowder installed a landscape similar to that of Captain Abramowitz, a picture of which appeared in the recent Life magazine article, dealing with the Signal Corps. Other schools have followed suit, including the Western Signal Corps School at Camp Davis.

Not content to rest upon these not inconsiderable laurels, the indefatigable Captain Abramowitz has produced a refinement of his original idea.

(*Continued on page* 91)



Close-up of visual training aid developed by Captain Abramowitz for classroom study.

Accuracy, speed and thoroughness are the basic requirements for students in the course.

THE SAGA OF THE VACUUM TUBE

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

Part 6. Covering the period during which Dr. Lee de Forest was at the height of his inventive career. Many of his tube patents are discussed.

IN THE evolution of the vacuum tube the scene shifts back to America, and to Lee de Forest. De Forest had become very much interested in wireless telegraphy while in his senior year at Yale. Some time after leaving Yale he went to work for the Western Electric Company in Chicago, and later for the magazine "Western Electrician." While there he entered into active partnership with E. H. Smythe of the Western Electric Company. Mr. Smythe was a telephone engineer and had several inventions to his credit at that time. The purpose of the partners was to develop a new system of wireless telegraphy. They first devised a new type of detector, which they called a "Responder." In September, 1900, while conducting tests of the new detector, de Forest noted that when the induction coil used in the experiments was in operation, the gas light in the room, which was of the Welsbach burner type, dimmed. When the coil operation ceased, the light returned. Further experiments made it obvious that the variations in the air pressure caused by the sound waves from the spark gap of the induction coil were what caused the dimming of the light. But in the meantime de Forest and Smythe were imbued with an idea that influenced their thoughts ever after.

Smythe made a note of one of their discussions of this phenomenon on September 20, 1900 as follows:

In developing a hypothesis to fit the observed effect of the inductance coil discharge on the Welsbach light it was suggested that the action was due to an electrification and consequent expansion of the gases of the flame.

De Forest suggested an analogy between sun-spots and their accompanying magnetic disturbances and the miniature magnetic storm in the induc-

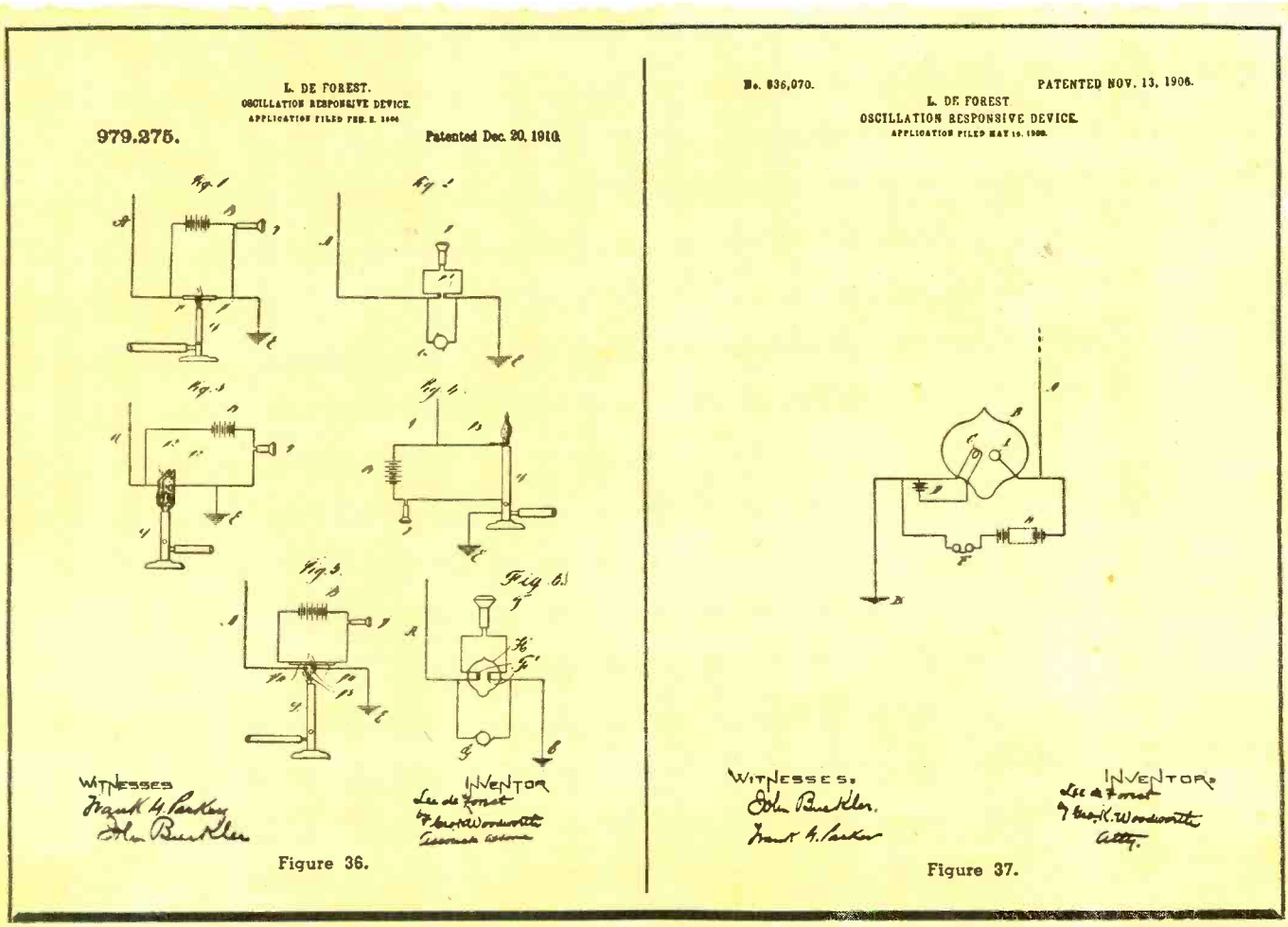


Figure 36.

Figure 37.

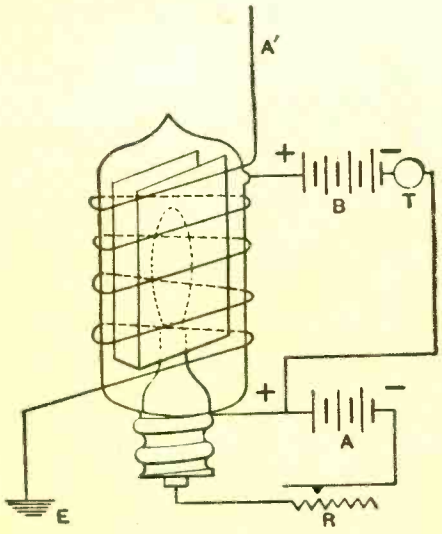


Figure 38.

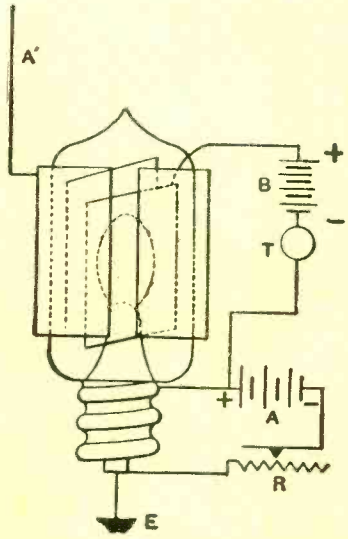


Figure 39.

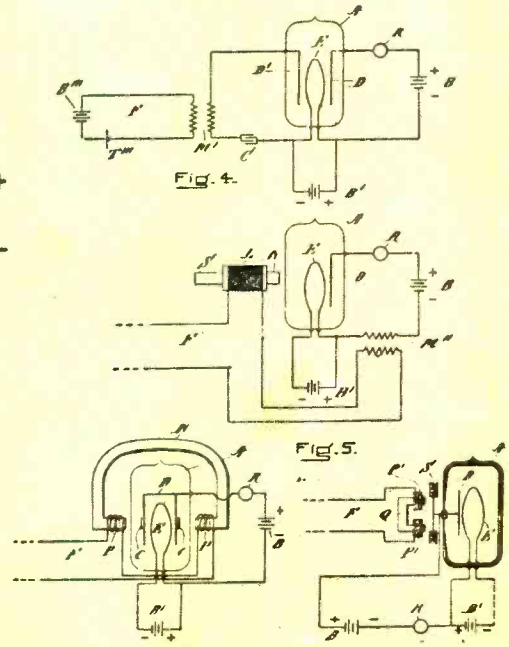


Figure 40.

tance coil and its effect upon the flame. If it should be found true that an electrification of a volume of gas causes expansion, a detector for transmitted impulses might consist of a volume of gas confined and provided with a sensitive instrument adapted to indicating slight changes in pressure. The impulses might be made to affect the gas directly (by confining it in a high upright tube) or indirectly by means of an aerial upright conductor terminating in the receptacle. Possibly the gas could be made more sensitive to the impulses by being rarefied or heated.

While the suggested method of utilization was never realized, the records are of academic interest, and the idea so expressed may well have been the foundation of the later work, by de Forest alone, on the Bunsen burner and rarefied gas tube, both of which were steps in the evolution of the Audion.

A student of the history of the development of wireless during the first decade of this century will find the study of pertinent patent specifications of that period most absorbing. For our purposes at this time we shall examine only those patents forming a definite sequence of steps from the germ of the idea of the heated gas detector to the accomplished fact of the three-electrode grid-type Audion. Some of these devices were found impracticable. The three which are significant are: Patent 979,275 (application date February 2, 1905), which is the parent Bunsen burner patent and is important because it is the first embodiment of the heated gas detector; 836,070 which covers the two-element Audion; and 879,532 (application date January 29, 1907) which covers the three-element grid-type Audion.

We describe briefly twelve patents granted to de Forest, as showing the continuity of development of the Audion. For the convenience of the reader we have starred the significant patents noted above.

About 1903 de Forest, having broken with Smythe, began to search for genuine response to electrical vibrations in the gas flame. He found that the conductivity of the Welsbach burner flame was very small for the range of voltages at which a wireless telegraph detector would be required to operate. Experiments with the flame of the Bunsen burner followed, with the conductivity of the flame increased by the introduction of salts of the alkaline metals. This was actually the first form of Audion. It was not a very practical device, and de Forest thought of it only in connection with wireless telegraphy.

De Forest applied, on February 2, 1905, for a patent ★(U. S. Patent No. 979,275)[125] on such a device and for associated devices shown in Figure 36, among which was one consisting of a bulb filled with a gas (which might be air), in which were two electrodes intended to be heated by a dynamo, although from the diagram given in the patent it would seem difficult of accomplishment. The specification contained numerous claims, and in some cases used such vague phrases as "a self-restoring constantly receptive oscillation responsive device comprising in its construction a sensitive gaseous medium." The various items in this specification were subsequently divided into separate applications which issued as patents as follows: 867,876, issued October 8, 1907; 867,877, issued October 8, 1907; and 867,878, issued February 11, 1908. This last specification claims asymmetric conductivity in the Bunsen burner type detector.

His next patent specification (U. S. Patent No. 823,402),[126] which is for a static valve, discloses another Bunsen burner device, the flame of which is rendered more conductive by the use of salts, and this flame is also described as having asymmetrical conductivity. In this patent he states that positive electricity passes more readily in one direction through the flame than in the other. That is, the Bunsen burner flame acts as a rectifier, and is described as a valve in this specification. This specification also refers to an incandescent lamp type valve which could be used for a similar purpose (as a static valve, and refers to Fleming's paper in the Proceedings of the Royal Society of London[127] for a full description of the physical embodiment of the device.

De Forest's next patent specification (U. S. Patent No. 824,637)[128] was for an oscillation detector "of great simplicity and sensitiveness." This specification covered an invention comprising a receptacle which incloses a gaseous medium put into a condition of molecular activity, so that it is highly sensitive to electrical oscillations when two highly resistant electrodes are heated by an electric current. In the specification, however, it was stated that heating the electrodes was not even necessary, and that the gas might be made responsive to electrical oscillations by heating or by any other suitable means, such as covering the elec-

trodes with a radioactive substance. This specification shows two batteries, one to heat one electrode, the other connected between the electrodes and in series with a telephone receiver.

The original application was subdivided into two others, which issued as patents nos. *836,070[129] and 836,071[130]. The first of these covers a partially exhausted receptacle into which are sealed two electrodes, one of which may be an ordinary incandescent lamp carbon filament, the other a disc of platinum or other material. Two batteries were shown, as in the original application. The gaseous medium was to be rendered sensitive to electrical oscillations by radiation of heat from the incandescent electrode. (See Figure 37.) *This was the two-element Audion.*

The next specification (U. S. Patent No. 824,638)[131] discloses another type of Bunsen burner detector, in which electrodes of platinum or carbon are placed in the flame. It was claimed that the passage of electrical oscillations through the gaseous medium altered its conductivity.

The next patent specification (U. S. Patent No. 837,901)[132] shows an incandescent lamp detector having a mercury-filled projection on the bulb, which acts as a cold electrode.

This was followed by another specification (U. S. Patent No. 841,386)[133] in which an oscillation detector is described. This consisted of an evacuated vessel having two separated electrodes between which intervened a gaseous medium which formed the sensitive element upon being heated or otherwise rendered highly conducting.

The hybrid name "Audion" was given to this device by C. D. Babcock, one of de Forest's technical aids. The name was derived from the Latin verb *audire* meaning *to hear,* and the Greek derivative *ion. Ion* comes from the Greek verb *ienai* meaning *to go,* and the word "ion" had been previously used in connection with electrolytic phenomena to designate an atom carrying a charge and in motion. Hence, "Audion," a device to enable us to hear electricity in motion.

The first public announcement of the invention of the Audion was given by de Forest at the October 26, 1906 meeting of the American Institute of Electrical Engineers in New York, in his paper entitled "The Audion, A New Receiver for Wireless Telegraphy"[134]. This paper was discussed both at this meeting, and at a meeting in Philadelphia which took place two weeks later.

De Forest's paper began by giving an account of the Bunsen burner and electric arc experiments as the foundation of all his work. He described his new invention as a detector for use in wireless telegraphy. It consisted of a partially evacuated glass bulb containing an incandescent lamp filament, the filament being flanked by two platinum "wings" parallel to the plane thereof and about 2 mm. away from it on either side. In the paper de Forest referred to three types of filaments; platinum, tantalum, and carbon.

At the Philadelphia discussion, in response to a question from H. C. Snook, one of the members present, de Forest stated that he was using tantalum filaments entirely, that he had never been able to use the tungsten filament, but that he thought that it (tungsten) might give better results than tantalum. He also said that some work had been done with filaments of the Wehnelt type, coated with alkali salts of potassium and sodium, and that although their life had been short they might yet be produced so as to be better than the tantalum filament.

In his paper de Forest made reference to the work of Elster and Geitel as follows:

"Elster and Geitel, beginning in 1882 a systematic investigation of the ionization produced by incandescent metals, frequently employed an exhausted glass vessel containing an insulated platinum plate, stretched close to which passed a fine metallic filament brought to incandescence by an electric current."

One of Elser and Geitel's earlier papers "Ueber die Electricitat der Flamme" is cited as the foundation of their work, and de Forest then gives a diagram of their later apparatus as described above, taken from a subsequent paper published in 1887.

De Forest also made reference to the work of Fleming with an "Elster and Geitel" tube but stated that the action of the Audion was quite different from that of such a device, and that the Audion acted as a relay rather than as a rectifier. That this was his sincere belief may be adduced from the statements and diagrams of variations in methods of operation, such as the use of an external electrode connected to the antenna (See Figure 38), and the use of what we now know as magnetic control, by passing the high-frequency current through a helix of wire around the Audion bulb (See Figure 39), or through a flat coil brought close to the tube with its axis perpendicular to the tube. These arrangements involved no metallic connections between the oscillatory circuit and the "wings" and hence could not be considered as rectifiers. De Forest attributed the action to the influence of the electrostatic field in the case of the external electrode, and to the electromagnetic field in the case of the coils, on the motion of the ions within the bulb. He also attempted to explain the action of an external permanent magnet on the "flux" (space current) within the bulb.

The discussions which followed the paper showed that the exact principle of operation of the device was not clear, even to de Forest. In response to a question from Percy Thomas at the New York discussion, as to whether the action depended on the ionization of the residual gases or the particles coming from the electrodes themselves, de Forest replied:

"I think that it is due to the ionization of the residual gases; the gases still exist in the lamp, because the vacuum is only that which obtains in all incandescent lamps."

In response to another question from H. C. Snook at the Philadelphia discussion de Forest stated:

"If the exhausting process is carried too far, the Audion loses its sensitive ness. The gas particles rather than the particles of the metal dust are the carriers. I do not believe the dust particles are controlling at all."

Only the day before presenting this

(*Continued on page* 91)

Figure 41.

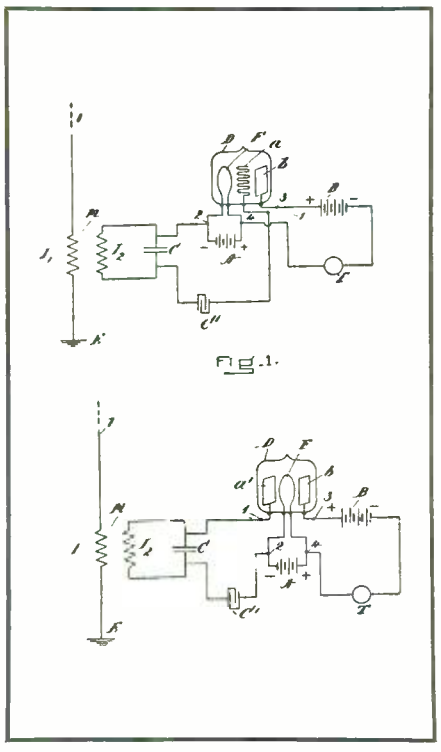
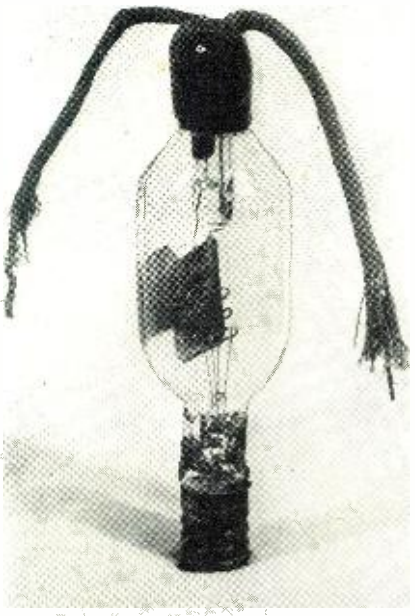
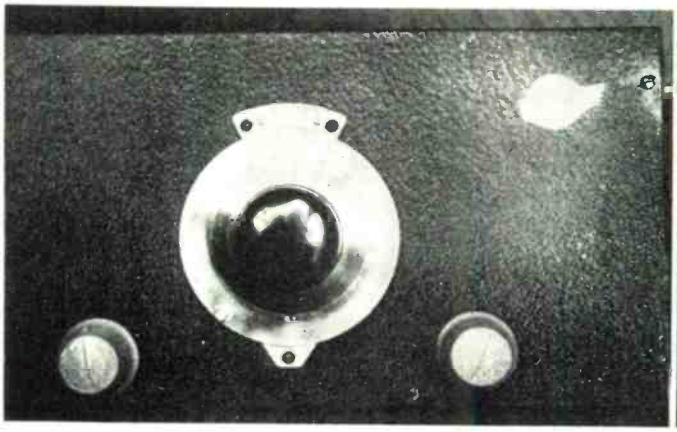
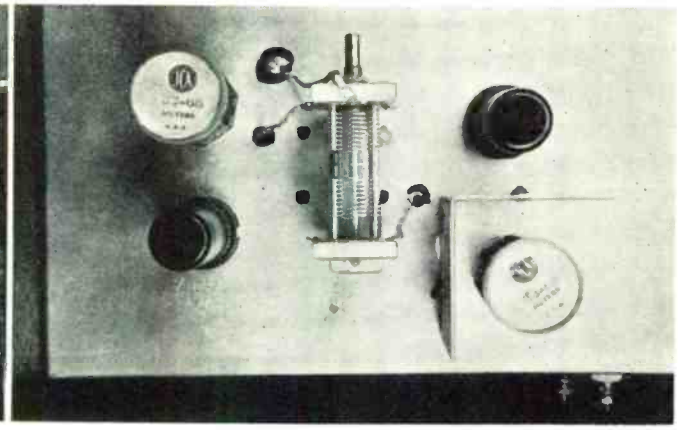


Figure 42.





Precision tuning and logging is aided by using quality vernier dial.



A small metal baffle prevents coupling between r.f. circuits.

R-F CONVERTER

by WILLIAM F. FRANKART

Constructional data for building an efficient unit for the reception of short wave broadcasts.

MANY amateurs and experimenters have sold their communications receivers to the *Signal Corps* and other government services where they were sorely needed for use in our training centers and in other spots where it was essential that military personnel be supplied with sets on short notice. As a result, there has been an increasing demand for an inexpensive converter that can be used with existing sets still in the hands of the layman in order that he may tune in on the various short wave bands. Such a unit is herein described.

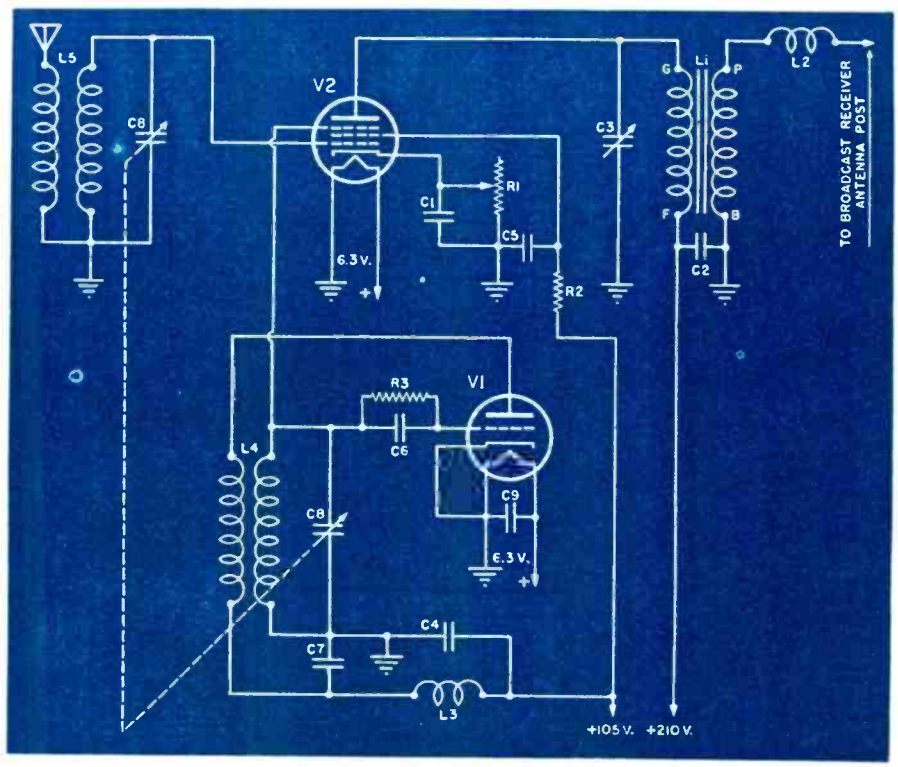
The converter is built on a chassis measuring 11x7x2" and the cabinet may be out of wood or metal, whichever suits the particular taste of the builder. Simplicity is the keynote. Of special interest is the fact that no normal provisions need be made for alignment. This is accomplished by tuning C3 to the frequency difference between the oscillator VI and the 1st detector V2. The unit operates in conjunction with any good broadcast set. One having a tuned R-F stage ahead of the mixer is preferred. The broadcast receiver is tuned to the same frequency as the special IF transformer used in the converter. With the coils and layout used, this works out to be approximately 750 kc. This method of alignment, though rather crude, does have some advantages and certainly is simple to adjust. The advantages include variable selectivity and front panel control.

It should be further stated that the IF frequency will vary as the difference found in one set of coils, but the constructor will find that the setting of the condenser C3 and the broadcast receiver will generally hold over one coil range.

The intermediate frequency transformer used in the converter is a very compact R-F coil with the shield can removed.

The small isolation choke coil L2 is used to keep the shielded (low capacity shielded) cable which goes between the converter and the broadcast receiver from interfering with the operations of the converter.

(*Continued on page* 93)



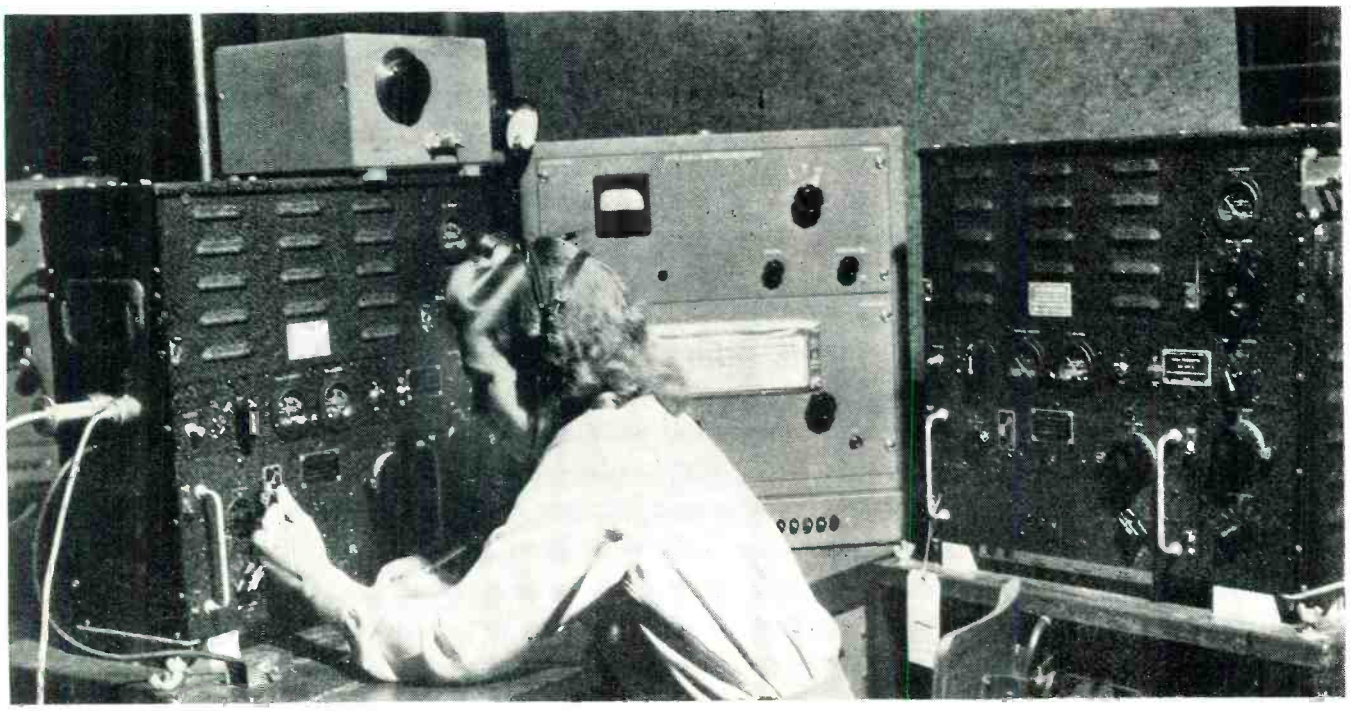
Schematic diagram of the R-F Converter.

C_1, C_2, C_4, C_5, C_7—.006μfd. oil fil. Tubular condenser.
C_3—250 μμfd. midget variable condenser.
C_6—100 μμfd. mica condenser.
C_8—Bud LC 1662 Dual 50 μμfd. midget condenser.
C_9—.01 μfd. oil fil. tubular condenser.
L_1—Miller R-F Coil B. C. 624 RF.
L_2—.6 mh RFC (or Ohmite 5 meter choke).
L_3—2.5 mh RFC.
L_4, L_5—4 prong 2 winding plug—in coil kit (ICA No. 1471-S, 4 Prong).
R_1—1000 ohm Pot. wire.
R_2—5000 ohms 1 w. insulated resistor.
R_3—50.000 ohms 1 w. insulated resistor.
V_1—6J5 or 6C5 or 6P5G.
V_2—6SK7 or 6SJ7 or 6AB7.

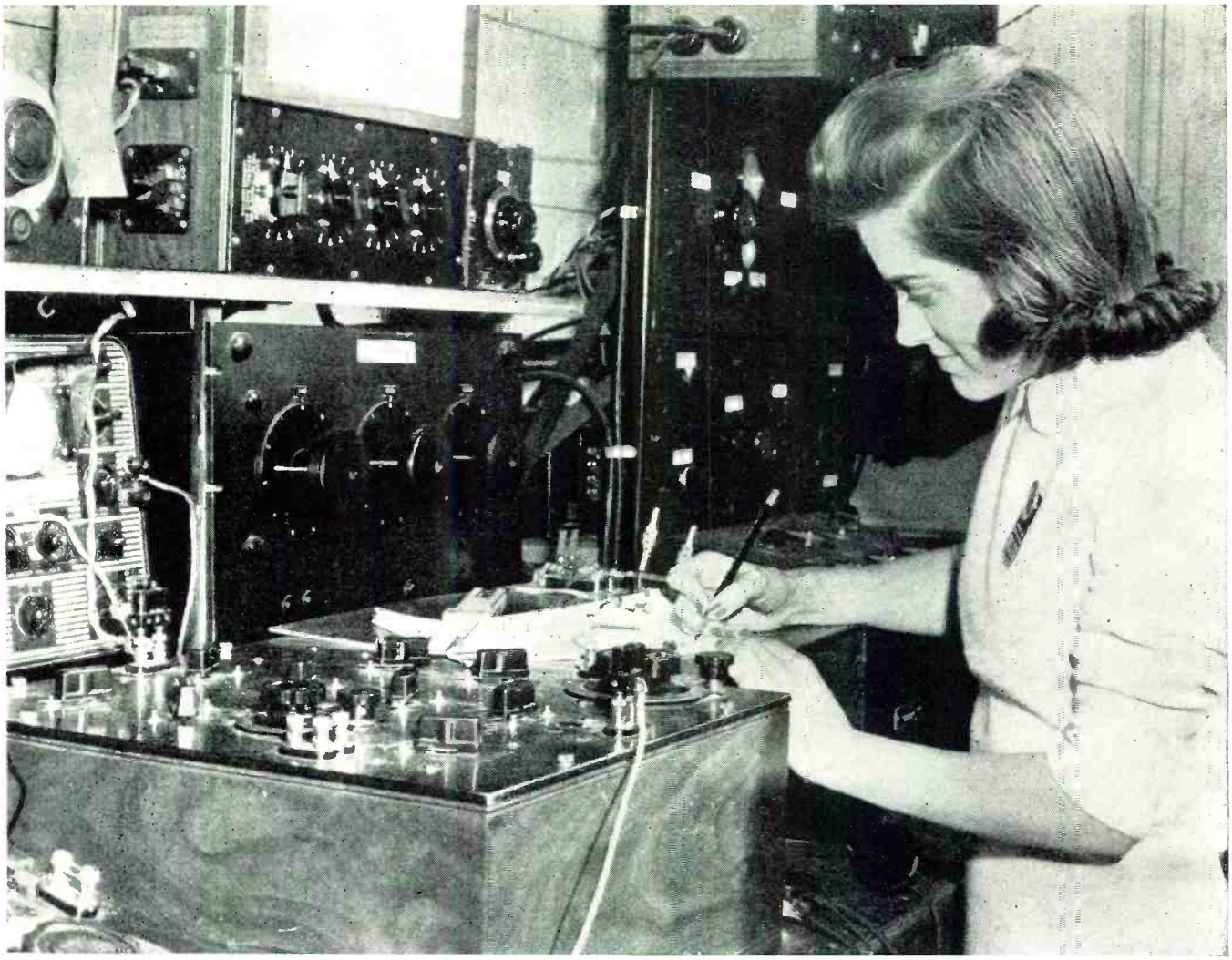
Mrs. D. Ausmus, laboratory technician of the early 20's, re-enters ranks of women war workers. See photo, lower left, page 31.

WOMEN IN INDUSTRY

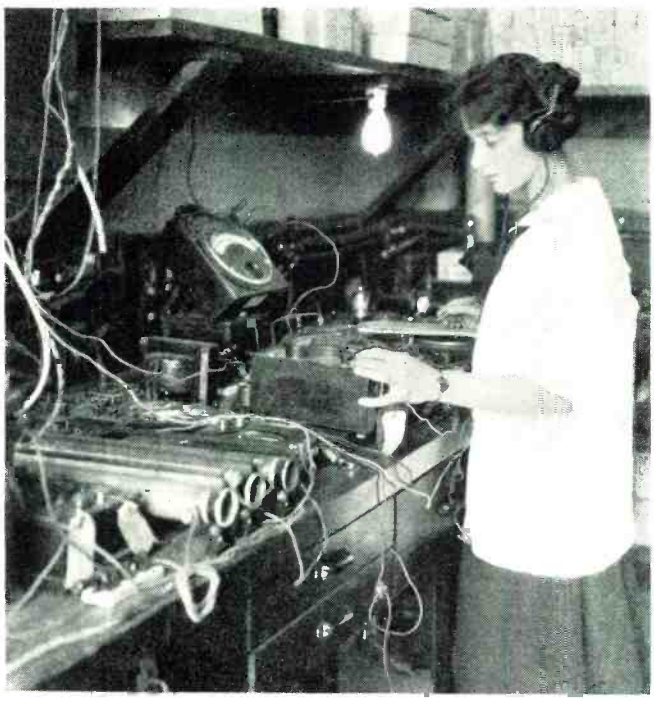
WITH the call of additional men to our armed forces creating a shortage of manpower in our industries, women have been called upon to sacrifice many of their household duties and concentrate on aiding home-production. They have answered the call magnificently, replacing men in all types of industries, from riveters to highly trained radio technicians. Women with college education or with some radio experience were put through an intensive course in radio and electronic engineering and are now assuming responsible positions in the manufacturing of radio equipment. They have proven themselves highly capable of performing intricate tasks in the designing, construction and testing of radio equipment used by our armed forces throughout the world.



Replacing manpower, Billie Brooker, Iowa State physicist with B.S. degree, masters calibration of radio transmitters in laboratory of war plant. Her work involves theory and application of engineering fundamentals.



College graduate Margaret Allen applies her technical knowledge in engineering section of plant manufacturing radio receivers.



Mrs. D. Ausmus, nation's earliest feminine radio research technician, as she appeared with testing device 20 years ago.

Operation of complicated light control panel in television studio won high praise for electronics-trained Joan Beckett.

LABORATORY TYPE V.T.V.M.

by McMURDO SILVER

Fada Radio and Electric Co., Inc.

A vacuum-tube voltmeter of unusual stability and low-circuit loading, useful up to 200 mcs.

Fig. 1. V.T.V.M. with removable a.c. probe at right, ready to be connected directly to any R.F. circuit to be measured.

THE use of vacuum-tubes for measuring voltages present in high-impedance circuits as a means of minimizing the loading caused by application of any conventional measuring device to the circuit under investigation is old to the art—probably about as old as the high-vacuum, gas-free, triode itself. The basic concept is predicated upon the phenomenon of change in plate current of a vacuum tube resulting from change in grid voltage, and partakes of the amplification possibilities inherent in commercial triodes, pentodes, etc.

It is possible in a well-designed vacuum-tube voltmeter to reduce to practically insignificant proportions the apparent loading of a high impedance circuit, the voltage across, which is to be measured. This is a distinct and particular advantage of almost essential merit in investigation of radio frequency circuits. In radio receivers particularly, a series of cascaded parallel-resonant circuits are usually employed to derive amplified signal voltage from preceding vacuum tube amplifiers and to serve as a means of transferring such amplified voltage on to succeeding amplifier stages. In the design, and in the servicing, of such equipments the process is tremendously simplified if a means be available which permits the measurement of actual amplification per stage by the simple process of shifting meter terminals from the input of one amplifying stage to the output of such stage, and so on throughout the entire series of cascaded amplifying stages.

The need for such a measuring instrument has become increasingly acute over the past decade, during which the complexity and variety of radio frequency and electronic equipment circuits and functions has multiplied prodigiously. Today, while it is not impossible to service a complex radio receiver in the field without a vacuum-tube voltmeter, the process is so simplified if one be available that it seems safe to say that vacuum-tube voltmeters will be standard equipment for even the most unambitious serviceman in the postwar period. In a wartime period when competent design-engineering hours are of vital importance, the "vacuum-volts," as it seems convenient to call the V.T.V.M., is of priceless value in the speeding up the analysis of all sorts and kinds of high-impedance circuit developments.

Manufacturers have not been backward in offering "vacuum-volts" to the industry, some types having been on the market for substantially a decade, but these earlier models have left much to be desired. More recent instruments, offered under the name of "electronic voltmeters," are, in many cases, not true vacuum-tube voltmeters in that the minimization of circuit loading of the true vacuum-tube voltmeter has been frequently sacrificed to provide a multiplicity of voltage ranges of quite high, but nevertheless finite, impedance. For example, the electronic voltmeter might be thought of as a vacuum-tube voltmeter having a resistive range-multiplier shunted across the terminals of the circuit under measurement, with the actual "vacuum-volts" arranged so as to include more or less of such shunt resistance in its input circuit as a means of altering effective ranges of measurement. Such an instrument is, fundamentally, only an extension of the limiting ohmic resistance possibilities of the d.c. milliammeter, or d.c. microammeter, which constitutes the actual indicating device of the instrument. It

is a means of increasing the meter resistance "seen" by the circuit under measurement well beyond that economically and mechanically possible to the meter itself. As such, it is a step in the right direction, but only a step. This is because the resistive input range-multiplier must be of some finite resistance which, in the case of radio-receiver, radio-frequency measurements, may still be sufficiently low to so load the circuit under measurement as to mask its true, unloaded performance. Such an arrangement will result in additional serious losses due to the lengths of connecting leads.

In the light of the foregoing, it may seem appropriate to regard as a true "vacuum volts" only an instrument presenting negligible resistive, capacitative and inductive loading to the circuit to be measured—an instrument presenting to the circuit to be measured substantially only the two terminals of the vacuum tube employed to translate the voltage appearing across a high impedance circuit into direct current which then actuates the actual visual indicating meter. The instrument illustrated and diagrammed herewith is such.

In order to accomplish a design satisfying the above requirement, a number of seemingly incompatible conditions must be reconciled, and numerous other factors taken into account. As a starter, the vacuum tube which must be employed as the a.c.-d.c. rectifier essential to translate a.c. volts into direct current to actuate the indicating meter, must have high inter-electrode resistance to keep circuit loading at a minimum. It must have low inter-electrode capacity to prevent both detuning and loading of the circuits to be measured. Automatically it must be a small receiving-type tube, since in addition to the above it must be so portable that its input terminals may be capable of application directly to the circuit under measurement to avoid the loading and losses of long connecting leads. Two inches of connection between circuit under measurement and the "vacuum volts" can be so serious as to destroy the validity of measurements made at radio frequencies previously considered high, but in conventional, widespread use today.

A vacuum tube of electrical and physical properties suitable for such application will be small in size, and hence limited in terms of voltages which may safely be applied to its electrodes. This means that it will be suitable, without an input range multiplier such as would deleteriously load the circuit to be measured, only for measurement of voltages within the maximum inter-electrode voltage rating stated to be limiting by its maker. Fortunately, in the present state of the art, this is not a serious limitation, since few, if any, circuit measurements which the freedom from loading which the vacuum tube voltmeter provides will require a range in excess of 100 volts. But a single range of 100 volts would render the "vacuum-volts" quite inflexible in terms of service applications, since its greatest usefulness will lie in accurate determination of voltages of much smaller magnitude.

Hence some sort of range-multiplier arrangement is essential to provide the variety of voltage ranges which will be needed in service if the instrument is to be truly useful. The range-multiplier will almost certainly be resistive in character, and it must be located, not across the input, but somewhere in the circuit of the instrument where it will be divorced from, and may not affect, the input characteristics thereof. The means of accomplishing this essential end—the end that differentiates the "vacuum-volts" from the simple "electronic voltmeter" falls nicely into place in the design problem when certain other requirements are satisfied.

The simplest "vacuum-volts" would be a triode between the grid and cathode of which would be applied the voltage to be measured, and which voltage would be indicated by the change in plate-current flow through a suitable meter and source of plate voltage. Such a system would be, and is, suitable for relatively coarse, qualitative measurements of potential, but is quite unsuitable for precise quantitative measurements. The reasons lie in the inherent instability of the vacuum tube itself due to the inescapable variations in applied plate and filament voltages when these be derived from commercial a.c. (mains) sources, which they must be if the final instrument is to be both versatile and portable.

If the actual measuring vacuum tube be a diode, the only variations which will seriously affect its stability will be filament voltage and its own internally generated contact-potential. Since plate voltage is not required, variations from this source may be neglected, while if the tube be of the popular, and almost universal, indirectly-heated cathode type, then thermal inertia coupled with judicious selection of heater voltage will swamp out quite effectively all significant variations due to heater voltage variation. Using a diode as the actual measuring vacuum tube, it becomes possible to follow it with a vacuum tube voltmeter of conformation such that the range-multiplier resistance network has no effect on input impedance for practical, and academic purposes.

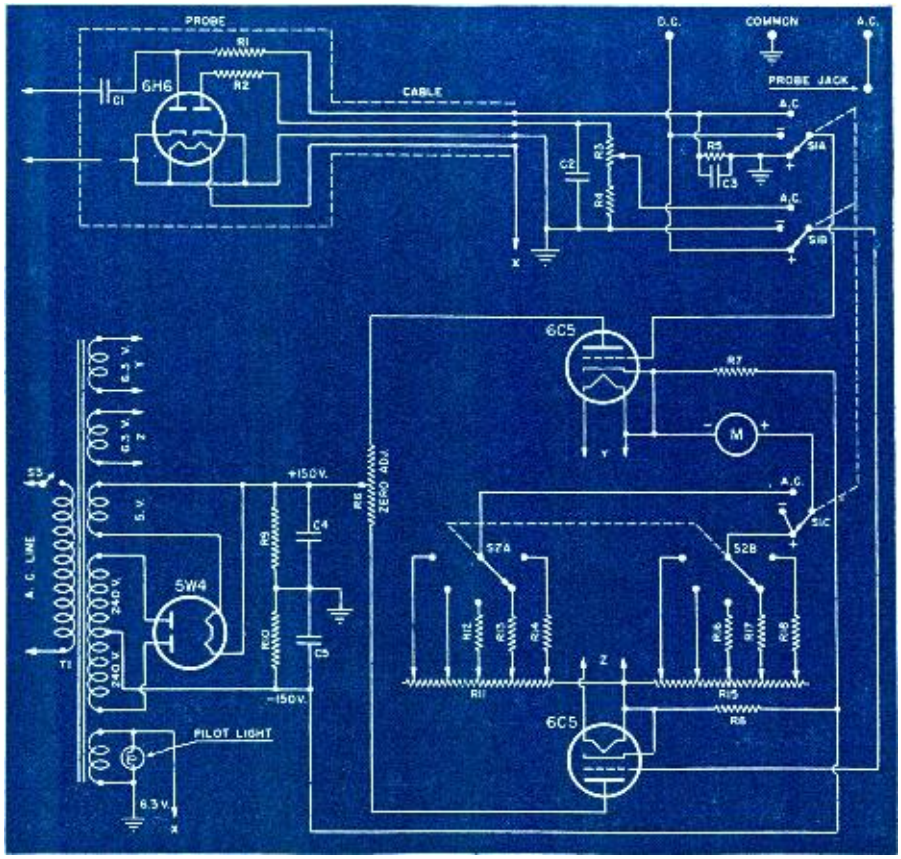


Fig. 2. Schematic diagram of the sensitive V.T.V.M.

C_1—.01 μfd. mica condenser
C_2, C_3—.1 μfd. 600 V. paper condenser
C_4, C_5—8 μfd. 450 V. elec. condenser
R_1—9 megohm ½w resistor
R_2—8 megohm ½w resistor
R_3—3 megohm volume control
R_4—3.5 megohm ½w resistor
R_5—5.4 megohm ½w resistor
R_6—3,000 ohm w.w. potentiometer
R_7, R_8—50,000 ohm ½w resistor
R_9, R_{10}—50,000 ohm 1w resistor
R_{11}, R_{15}—25,000 ohm adjustable w.w. resistor
R_{12}—15,000 ohm ½w resistor
R_{13}—70,000 ohm ½w resistor
R_{14}—220,000 ohm ½w resistor
R_{16}—40,000 ohm ½w resistor
R_{17}—135,000 ohm ½w resistor
R_{18}—440,000 ohm ½w resistor
T_1—Power transformer, 115 volts, 50/60 cycle, 3—6.3 volt secondaries, 1—5 volt secondary and 1—480 volt 40 ma. center tap secondary.
S_1—3P3P gang switch
S_2—2P5P gang switch
S_3—SPST toggle switch

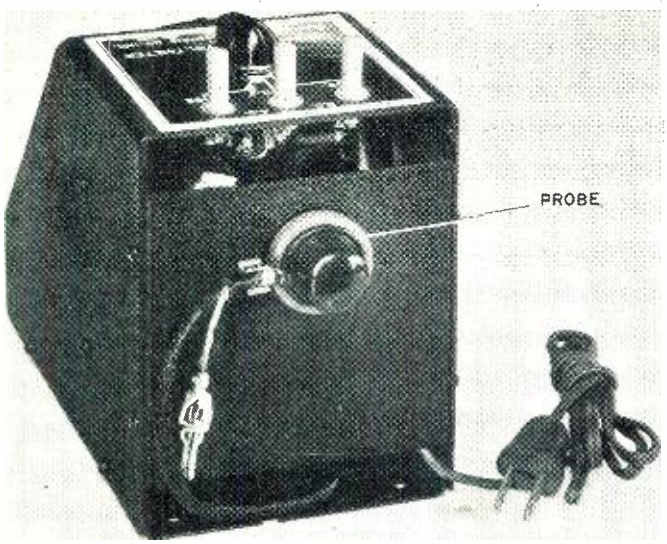


Fig. 3. Rear view showing a.c. probe inserted in its jack.

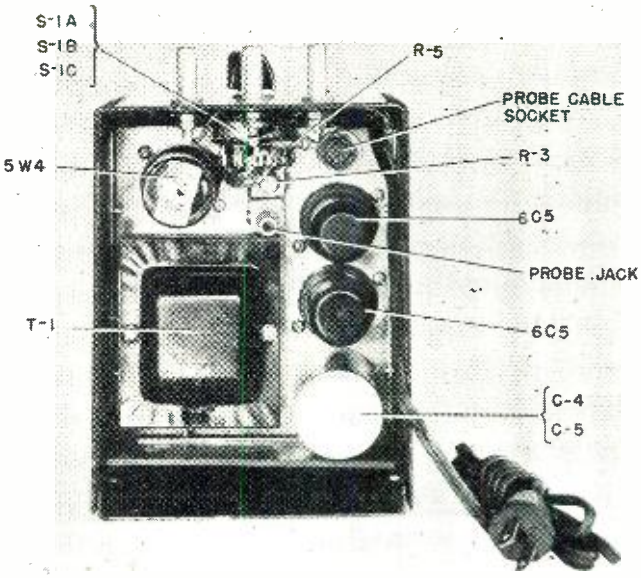


Fig. 4. Internal construction and parts layout of the V.T.V.M.

However, the problem of contact potential generated within the diode will still be present, and will operate disadvantageously upon the final effectiveness of the instrument. This contact-potential may be balanced out by the employment of two diodes, one for measurement of the voltage to be indicated, the second arranged to buck out the contact-potential generated within the measurement diode—somewhat in push-pull fashion, diagramatically. By means of a suitable, adjustable resistive load for the bucking diode, completely disassociated from the measuring diode, the contact-potentials of the two diodes may be made equal and opposite in sign.

The problem of insuring the minimally requisite order of stability for the following vacuum-tube voltmeter still remains. Fortunately the use of high orders of degenerative feedback in vacuum-tube amplifier circuits afford orders of stability obtainable simply and economically in no other way.

If two triodes be used, so arranged that their plate currents under resting conditions may be made identical, and if each be provided with a considerable percentage of inverse feed-back, then one triode may be used to cause a change in plate current proportional to applied grid voltage, while the second triode balances both the first triode, and the diode contact-potential through "seeing" the out-of-phase contact-potential developed in the second, or bucking, diode. The use of a high percentage of inverse feed-back operates to render the two triodes adequately independent of unavoidable fluctuations in heater and plate voltage.

The simplest means of obtaining the desired inverse feed-back is by means of a resistive load for each triode common to its plate and grid circuits in the common-cathode return circuit. If such load is common to both plate and grid circuits, then it will operate to subtract some significant proportion of total plate voltage from the plate circuit, and apply it as negative grid voltage. This presents an impossible condition, since in such case the triode grids would be biased so far negative that small changes in input voltage from the measuring diode would be unable to affect triode plate-current changes to actuate the meter. Since, in a practical instrument, the effective plate load of each triode is in its cathode return, common to plate and grid circuits, there seems at first little that can be done about it. Since the triodes are functioning as direct current amplifiers, the capacitive degenerative feed-back schemes possible to audio-frequency amplifiers are of no avail. The solution is to first provide the desired inverse feed-back needed to insure circuit stability against power supply voltage fluctuations by means of cathode resistors so large as to "cut-off" plate current in each triode, then offset the excessive negative grid bias resulting from this action by providing a direct current bucking voltage almost sufficient to do so, applied to the triode grid circuit only.

It now becomes possible to include the indicating meter in series with a range-determining resistive network connected between the two cathodes of the two triodes—completely divorced from the input circuits. By so doing an additional advantage is augmented, in that the current rise through the indicating instrument is limited in such manner that application of excessive voltage to the "vacuum-volts" as a whole will not ordinarily damage the meter—nor will a possible plate-to-grid or grid-to-cathode short circuit, resulting in a sharp rise in plate current in the event of tube failure, destroy the meter itself as it would were the meter connected directly in the plate circuit of one or both triodes.

Provision of the two diodes, with an insulating condenser to eliminate the d.c. component of any a.c. voltage to be measured in series with the input of the measuring diode, summarizes as an accessory unit to the "vacuum-volts" proper. It consists of the two triodes and associated circuit components. Degeneration makes them extraordinarily stable, and the arrangement described above of connecting the indicating meter and range-multiplier network between their cathodes now results in a d.c. "vacuum-volts" of minisculic circuit loading when the a.c. diode arrangement, most easily built as a detachable "probe," is removed from circuit and the d.c. voltage to be measured is applied to one triode grid only.

The d.c. "vacuum-volts" so provided will not only show higher input resistance, and hence less loading of circuits under measurement, than conventional magnetic or electronic voltmeters. but, like all d.c. meters, will possess polarity sense. To avoid the inconvenience of reversing connecting leads from the "vacuum-volts" to a circuit under measurement when the d.c. polarity therein may reverse, it is possible to arrange a selector switch to apply the potential to be measured to first one, then the other, of the two triode grids. This feature makes it possible to shift the meter to read d.c. potentials of opposite, or changing, polarity without reversal of external connections. The mere shift of a switch knob effects polarity selection and indication.

Faced with the need for sizable quantities of "vacuum-volts" immediately required in war work, and finding it impossible, despite high priority and precedence ratings, to procure satisfactory instruments upon the market, engineers were forced to take the earlier results of other units, modify them to suit the immediate needs and availabilities, and produce the instruments needed for their own rush work, rather

(*Continued on page* 48)

OSCILLATOR AND DETECTOR DEMONSTRATOR

by H. C. LAWRENCE

Demonstrator, formulas and methods of calculating circuit and component characteristics for war radio training classes.

THE War requirements of the Army and Navy have necessitated the training of a large number of radio technicians. Many of these men —and women—have never seen the inside of a radio before; it is necessary, therefore, to give them a complete new concept. This concept is made doubly difficult to grasp by the fact that electricity itself cannot be seen. One cannot see the charge on a capacitor or the current in a resistor. One must know about these things by what else happens, such as a spark's jumping as the capacitor is discharged or heat being dissipated as the current flows through the resistor. Many demonstration units have been worked up in an attempt to drive home some of the teaching that is easily forgotten if it never passes beyond the blackboard and text book stage.

The equipment described was designed in an attempt to obtain something extremely easy and economical to construct and yet contain the maximum amount of demonstratable material. It consists of a Hartley oscillator of the self-rectifying type, and an absorption circuit that is used both as a wave meter and a simple receiver. The oscillator circuit is provided with pilot lights to show currents in the various parts of the circuit. With a few simplifying assumptions it is possible to calculate the performance of various parts of this circuit to a degree sufficiently accurate to fix in the minds of the students why they should learn to calculate this information and what they have when calculations are completed.

The oscillator unit may be used to demonstrate:

(1) Appearance of wire-wound and carbon resistors, tubes, sockets, tubular paper capacitors, variable capacitors, molded mica capacitors, pilot lights, high Q inductors, and relation between physical size and inductance.

(2) Relation between schematic diagrams and actual parts.

(3) Appearance of a coil relative to its Q and inductance.

(4) Oscillator circuit and how it works.

(5) Relation of d-c resistance to a-c.

(6) Use of bypass capacitors and calculation of reactance at high frequency as compared to resistor being bypassed.

(7) Relation of currents in a resonant circuit to those in connecting branches of the circuit.

(8) Calculation of coil inductance from tuning frequency with a given capacity and from dimensions of coil.

(9) Calculation of reactance of inductance and capacitor.

(10) Calculation of currents in resonant circuit, and power losses in circuit both from the resonant impedance of the circuit and the circulating currents and resistance as obtained from the Q of the coil and capacitor.

(11) Calculation of power requirements of a resistor from any two constants (current, voltage, resistance).

(12) Calculation of resistance value to give a certain voltage drop and current through a circuit if a voltage drop is given.

(13) Dissipation of power in a resistor by heat.

(14) Power input to tube and circuit efficiency.

The addition of the absorption circuit allows demonstration of:

(a) Resonance and effects of off-resonance tuning as it affects voltage.

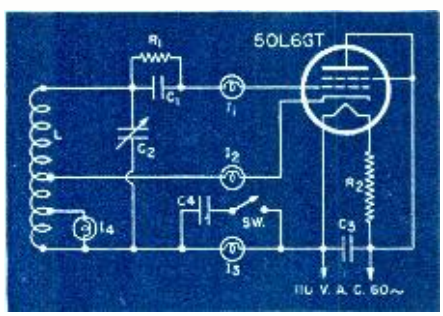
(b) Effect of orientation of coils on mutual inductance.

(c) Use of a wave meter for measuring frequency.

(d) Appearance of a coil of a medium Q.

(e) Absorption of power from one circuit by another and reduction of circulating currents in first circuit as power is absorbed.

Fig. 1. Oscillator schematic diagram.



(f) Increase in plate current of oscillator tube as load is placed on circuit.

(g) Appearance and operation of neon glow tube.

The addition of a crystal detector and earphones allows demonstration of:

(a) Detection.

(b) Effect of Q on selectivity and voltage developed across a coil.

A suitable choice of oscillator frequency is one that will not cause interference in nearby broadcast receivers and one that will allow an easily constructed coil of relatively high Q. A high Q coil gives good frequency stability and high resonant currents that are easily demonstrated.

The tube chosen should be easily obtained, and have a heater voltage such that a dropping resistor is needed. This dropping resistor should be of low enough wattage rating compared with the actual dissipation that it will get very hot in use.

The schematic diagram of the oscillator is shown in Figure 1. The circuit is that of a Hartley oscillator in which the plate is at r-f ground. A-C voltage is applied to the plate circuit. This makes for simplicity of construction and at the same time gives a modulated r-f output that can be detected and heard on a receiver. The fact that the plate and other currents are modulated by the a-c line voltage does not disturb any calculations made, since all values of current and voltage are effective or r.m.s. Small pilot lights are soldered in all leads to the resonant circuit and another lamp is soldered across a turn of the inductance to show relative currents in these circuits. Pilot lights of the same voltage and current ratings are used in all cases so that relative currents are evident. If the capacity of C_2 is kept large compared with the tube and distributed capacities, the resonant current will be almost entirely in the tank circuit and the resonant frequency will be determined by the tuning capacity C_2.

Capacitor C_4 is included so that lamp I_5 can be bypassed for r-f to show how the r-f currents will flow through a capacitor.

The data on this oscillator (Fig. 1)

will be near enough to that of similar oscillators that in the absence of suitable measuring equipment, it may be used for class calculations and demonstrations. This data is as follows:

L—12 turns of No. 10 tinned copper wire, 1.5 inches mean (center of wire) diameter, 2.25 inches long. Measured Q without pilot light current indicator is 360. Tunes to 8.5 megacycles with 110 μμfd capacity.

C_1—.007 μfd 200 volt paper capacitor.

C_2—15 to 430 μμfd receiver tuning capacity, 0.015 inch spacing between plates, 21 plates. Area of each plate = 1.6 sq. in. (The effective area of each plate is approximately semi-circular with a radius of 1 inch. The shaft is set off center.)

C_3—.1 μfd 400 volt paper capacitor.

C_4—.004 μfd 200 volt mica capacitor.

R_1—3300 ohms ½ watt carbon resistor.

R_2—450 ohms 10 watt, w.w., resistor.

I_1, I_2, I_3, I_4—Mazda 0.25 amperes, 6-8 volt pilot light.

Tube—50L6GT—Heater current 0.150 A, heater voltage 50.

D-C cathode current with no load—13 ma.

R-F voltage across L = 130 volts r.m.s.

D-C voltage across R_1 = 7 volts.

Coil Inductance from Dimensions:

The formula for computing the inductance of air core radio coils is:

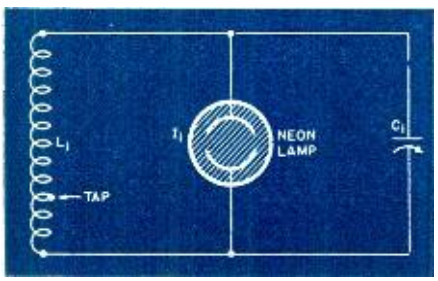


Fig. 2. Wave meter.

$$L = \frac{0.2\ A^2N^2}{3A + 9B + 10C} \quad \ldots\ldots\ldots (1)$$

where:

L is in microhenries (μh).

A is the mean diameter of the coil in inches.

B is the length of winding in inches.

C is the radial depth of winding in inches.

N is the number of turns.

The quantity C may be neglected if the coil is a single-layer solenoid as is nearly always the case for high frequency coils.

Substituting the proper values for the coil of the transmitter in formula (1), we obtain:

$$L = \frac{(0.2)\ (1.5)^2\ (12)^2}{(3)\ (1.5) + (9)\ (2.25)} = 2.6\ \mu h$$

Coil Inductance from Resonant Frequency:

The value of inductance obtained from the coil dimensions may then be checked against that obtained by finding the resonant frequency of the coil with a known capacity:

$$f = \frac{1}{2\pi\sqrt{LC}} \quad \ldots\ldots\ldots (2)$$

or

$$L = \frac{1}{4\pi^2 f^2 C} \quad \ldots\ldots\ldots (3)$$

Substituting the proper values in equation (3):

$$L = \frac{1}{(4\pi^2)\,(8.5 \times 10^6)^2\,(110 \times 10^{-12})}$$

$$\therefore L = 3.17\ \mu h$$

The difference in L as obtained from the two methods of measurement is due partly to inaccuracy in measurement of coil dimensions, partly to lead inductance and distributed capacities not included in the values substituted in equation (1), and partly to approximations made in obtaining equation (1).

Reactance of C_1

C_1 is provided to make a low impedance path across R_1 for r-f currents, while maintaining the resistance to d-c necessary to obtain bias for the tube. The reactance of this capacitor is:

$$X_c = \frac{1}{\omega C} \quad \ldots\ldots\ldots (5)$$

$$X_c = \frac{1}{(2\pi)\ (8.5 \times 10^6)\ (0.007 \times 10^{-6})}$$

$$\therefore X_c = 2.67\ \text{ohms}$$

It is seen that the impedance of this path is less than one thousandth of what it would be without C_1.

No Load, Plate and Screen power is:

$$P = EI = (110)\ (13 \times 10^{-3}) = 1.4\ \text{watts}$$

Calculation of Circulating Current and Losses in Resonant Circuit:

The circulating current in L can be calculated from the inductance of L or the capacity of C_2 and the voltage across L.

$$E_o = I_o \omega L = \frac{I_o}{\omega C_2} \quad \ldots\ldots\ldots (6)$$

where:

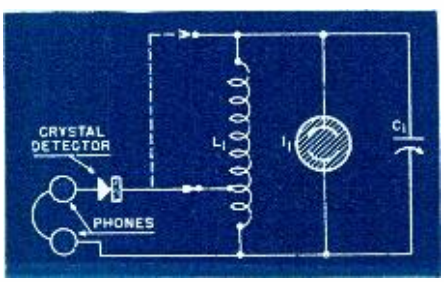
E_o = r-f voltage across L

I_o = circulating current in resonant circuit

$$I_o = \frac{E_o}{\omega L}$$

$$I_o = \frac{130}{(2\pi)\ (8.5 \times 10^6)\ (3.17 \times 10^{-6})}$$

Fig. 4. Receiver circuit.



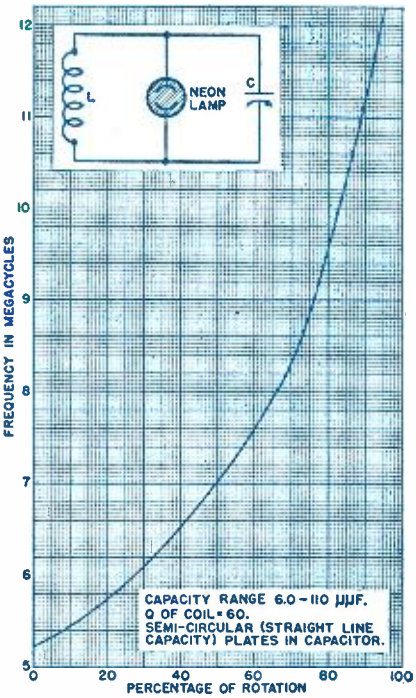


Fig. 3. Absorption wavemeter calibration.

$$\therefore I_o = 0.766\ \text{amperes} \quad \ldots\ldots (6A)$$

or:

$$I_o = E_o \omega C_2$$

$$I_o = (130)\,(2\pi)\,(8.5 \times 10^6)\,(110 \times 10^{-12})$$

$$\therefore I_o = .765\ \text{amperes}$$

From the measured Q of the coil, the r-f resistance of the coil may be calculated. Since an air dielectric tuning capacitor with good insulation was used, it is reasonable to assume that all the losses are in the coil, so that the measured coil Q is that of the resonant circuit.

$$Q = \frac{\omega L}{R} \quad \ldots\ldots\ldots (7)$$

$$R = \frac{\omega L}{Q} \quad \ldots\ldots\ldots (8)$$

$$R = \frac{(2\pi)\,(8.5 \times 10^6)\,(3.17 \times 10^{-6})}{360}$$

$$\therefore R = 0.47\ \text{ohms}$$

The d-c resistance of the wire in the coil can be obtained from wire tables.

$$\text{Length of wire} = \pi dN \quad \ldots\ldots (9)$$

where:

d = diameter of coil

N = No. of turns

$$\text{Length} = (\pi)\,(1.5)\,(12) = 56.7\ \text{in.}$$

The resistance of No. 10 copper wire is approximately 1 ohm per 1,000 ft. The resistance of 56 inches is approximately 4.71×10^{-3}.

This is a little more than one hun-

(*Continued on page 76*)

WHAT'S NEW IN RADIO

New products for military and civilian use.

NEW DUST-TIGHT RELAY

A new dust-tight relay especially designed for aircraft applications requiring high current-carrying capacity without sacrifice of compactness and light weight has been announced by the *General Electric Company.*

The new relay is a solenoid-operated

device with the normally-open contacts rated at 10 amperes direct current. These contacts will make or break 30 amperes at altitudes up to 40,000 feet.

When the relay is in the energized or de-energized state, the contacts will remain in the open or closed position without chattering, even when subjected to mechanical frequencies of from 5 to 55 cycles per second at 1/32-inch amplitude (1/16-inch total travel) applied in any direction. The relay is designed for use in an ambient temperature range of from 95° C to minus 40° C, and will withstand 95 per cent humidity at 75° C on 48-hour tests and operate immediately thereafter. Manufactured by the *General Electric Co.,* Schenectady, N. Y.

NEW AMPERITE REGULATOR TUBES

The *Amperite* regulator tube decreases the 40% voltage variations experienced on railway signal systems to 5%. Having no moving parts the

Amperite regulator gives many years of uninterrupted service with no maintenance cost. It is not affected by temperature or humidity conditions.

For the above particular type a standard screw base is used. Similar regulators however can be furnished with standard radio octal base.

Four page illustrated Folder may be had on request, by addressing the *Amperite Co.,* 561 Broadway, N. Y.

NEW "TUBE TYPE" CRYSTALS

Newly added to the wide range of Piezo electronic quartz crystals produced by *John Meck Industries,* is this special purpose type, housed in a conventional metal tube case.

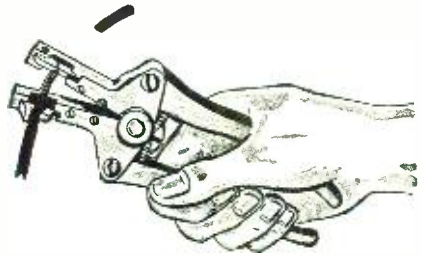
By means of this unusual mounting, complete freedom from moisture and atmospheric pressure changes are secured.

The new *John Meck Industries* plant at Plymouth, Indiana, is fully equipped to fabricate all crystal oscillators and resonators, from the raw quartz.

Other divisions serve the Armed services by constructing many types of electronic equipment closely allied to the *John Meck Industries* peacetime activities.

"SPEEDEX" WIRE STRIPPER

The "Speedex" Wire Stripper is a very unique and effective tool for speedily stripping the insulation from any type of electric wire. It promises to find favor in many fields because of

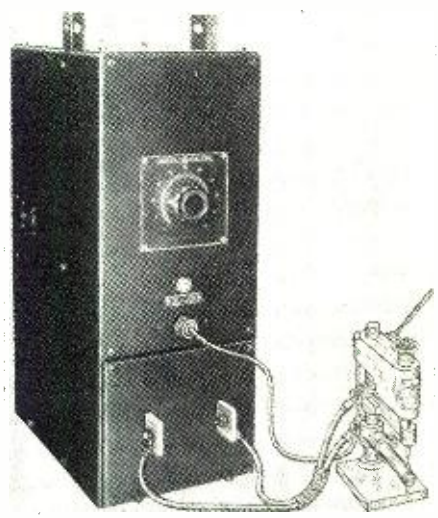


the time it saves in doing the job. Manufactured by the *Wood Specialty Mfg. Co.,* Rockford, Ill.

NEW HALF-CYCLE ELECTRONIC SPOT WELDING CONTROL

A new electronic half-cycle, synchronous control for the precise operation of resistance-welding machines has been announced by the *General Electric Company.* Mounted in a protecting cabinet, the control is furnished in two types: the CR7503-A136, which also includes a welding transformer and is designed for bench mounting, and the CR7503-A133, which is without a transformer and is designed for wall mounting.

The control features a new tube, the easily replaced GL-415; a new circuit which makes higher-speed welding possible; and a simplified initiating circuit which improves performance and reduces maintenance. The new design also incorporates heat control by the phase-shift method. The heat



adjustment is made by a dial mounted on the front of the cabinet.

The control facilitates the welding of tinned copper, steel, or alloy wires; of studs from 0.01 to 0.05 inch diameter to flat surfaces, with little or no indentation on the opposite surface of the metal; and the spot welding of unusually thin (less than 0.01 inch) pieces of stainless or mild steel, nickel, or silver to brass or bronze, with negligible oxidation or discoloration.

The control also makes possible the welding of low resistance joints which are unaffected by temperatures considerably in excess of 125 C, the point at which certain types of soldered joints weaken and often collapse. This results in the complete elimination of solder, with a corresponding saving of tin, and a saving of approximately 50 per cent in time.

A product of the *General Electric Co.,* Schenectady, N. Y.

NEW FREQUENCY METER

The *Fred E. Garner Company* has just announced production of four new models of their TELRAD line of frequency meters. All models are crystal-controlled and, by means of a class "C" harmonic amplifier circuit embodied in the units, accurate frequency carrier signals are provided every 10 kc. and every 100 kc. from one hundred cycles to forty-five megacycles. A carrier signal is also produced every 1,000 kc. from one megacycle to one hundred twenty m.c. A convenient panel-mounted "on-off" switch permits use of a 1,000 cycle modulated note.

TELRAD Crystal Controlled Fre-

(*Continued on page* 62)

TECHNICAL BOOK & BULLETIN REVIEW

"THE SPEAKER'S NOTEBOOK," by William G. Hoffman. Published by *McGraw Hill Publishing Co.*, New York City. 314 pp. plus index. Price $2.50.

Of particular value to instructors at our radio training centers and to engineers who are called upon to speak before large gatherings is this new book. It discusses methods of effective speaking and gives actual examples of outstanding speeches, stories, epigrams and aphorisms which can be directly employed in planning any kind of speech. There are 232 stories alone classified under headings and indexed for easy reference which will supply information for almost any point a speaker wishes to make.

Many advanced students are now finding themselves in great demand to serve as teachers. Many of them lack the necessary confidence and basic knowledge in order to explain completely and forcefully various subjects which they are called upon to present to the student body. The book serves its purpose admirably to instill a confidence within the minds of those new instructors and makes the tasks of presentation far simpler.

"PRE-SERVICE COURSE IN AUTOMOTIVE MECHANICS," by James V. Frost. Published by *John Wiley & Sons*, 404 Fourth Ave., New York City. 536 pp. plus index. Price $1.96.

This book was prepared at the request of the *War Department* and the *U. S. Office of Education* in conformance with the official pre-induction training course outline, No. PIT-202.

The subject matter has been arranged in accordance with the *Federal Course of Study*, edited by the *War Department*, Washington, D. C. The text has been divided into nine chapters for one full year of study; the first five chapters are for the first term and the last four are for the second term. In the choice of words and in the treatment of the subject, the aim has been to make the book understandable to all grades of high school students. Each unit has been supplemented by appropriate illustrations and diagrams.

"WHAT YOU SHOULD KNOW ABOUT THE SIGNAL CORPS," by Harry M. Davis & F. G. Fassett, Jr. Published by *W. W. Norton & Company, Inc.*, 70 Fifth Avenue, New York City. 204 pp. Price $2.50.

This book covers all the phases and activities of the United States Army Signal Corps. It gives full information on experiments in meteorology, aviation, and the making of training films and the taking of action pictures in battle, and gives the history of com-

(*Continued on page* 94)

By CARL COLEMAN

THIS newly inaugurated column is being conducted of, by and for all commercial radiomen in the various branches of communications. It is your column—a place where all of you may exchange ideas and information with others and where you can know where and what your ex-watchmates in that old gang are doing now during the present conflict. Correspondence may be addressed to "GK" at RADIO NEWS, 270 Madison Avenue, New York, N. Y.

Charlie Birch, ex-RMCA and more recently with F.C.C. as radio inspector in New York is expected to be back at RMCA in the big city by the time this gets to press. Bob Small ex-unifruitco has for some time been in the Pacific area with the Navy as radio material and maintenance man. Another ex from the same outfit, Joe Graham, is with F.C.C. monitor service. Earl Dannals ex-Army and S.B. is with the Navy in charge of a station outside the U.S. Bill Reuman ex-Merida has been at WWRL for some time as many of you probably know. Lawrence Tuna W2DZ who had quite a bit of experience in the Mexican Campaign and with the A.E.F. in World War Number One now operates his own radio and electrical business in New York City. (Free adv.!) Dave Carruthers ex-KUFC is still holding down as radio inspector for the U. S. Maritime Commission in the New York area, together with a real old-time radioman, Charlie Guthrie, who was a Navy operator—way back when.

At this writing the turnover in radio operators seems to have slowed up with things becoming a bit more stabilized in these lines and there appears to be more men that are available for maintenance and repair work than were previously on hand. Many who have licenses but have been out of the game for years seemingly want to return to their first love. Incidentally, many of these present jobs turning up seem to be more than just "Duration" affairs and many of the old gang have obtained excellent billets which will still be with us after the present difficulties are overcome.

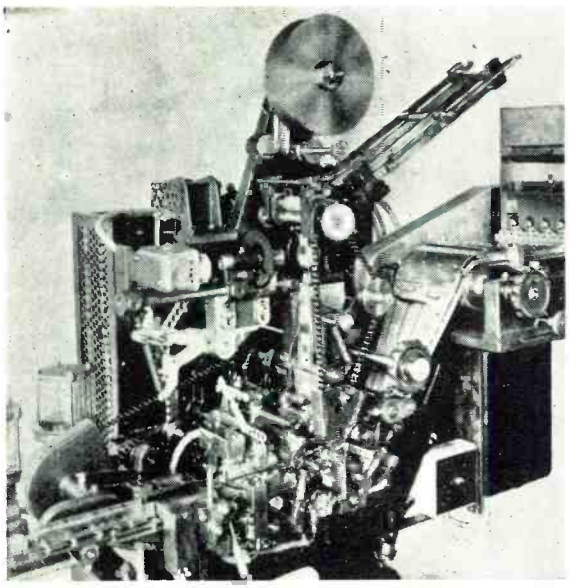
There are still openings in the maintenance and repair line of marine radio work and those not engaged in defense work are invited to contact "GK" at the above address as we know of several outfits doing marine work who are looking for radiomen. We have often wondered why the average radio operator, especially aboard ship in the past, was considered by many to be of somewhat erratic nature and having a rather inferior position aboard ship. Although many of the operators in past years were often younger men than the other officers aboard their work was always competently performed and this view toward operators was often hard to understand.

However, now during the present world conflict it has hit home to the general public as well as

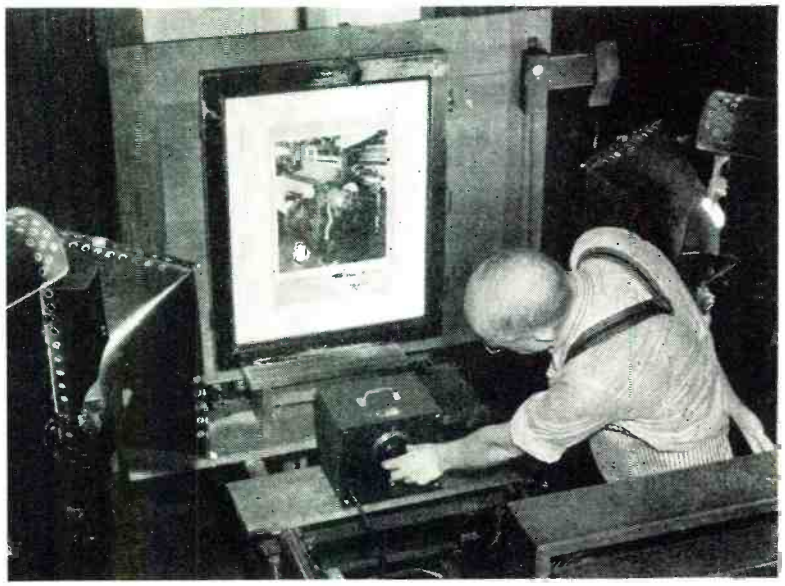
(*Continued on page* 46)

"I'd feel heap better if I had blanket to send up smoke signals."

INDUSTRIAL ELECTRONICS

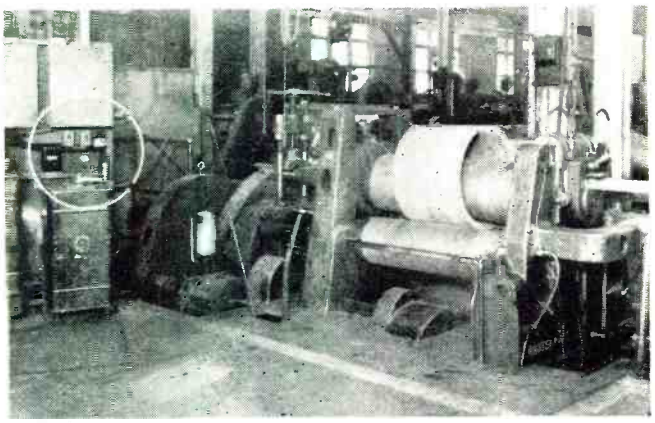


Cellophane wrapping machine using photoelectric relay to synchronize cutting and printing.

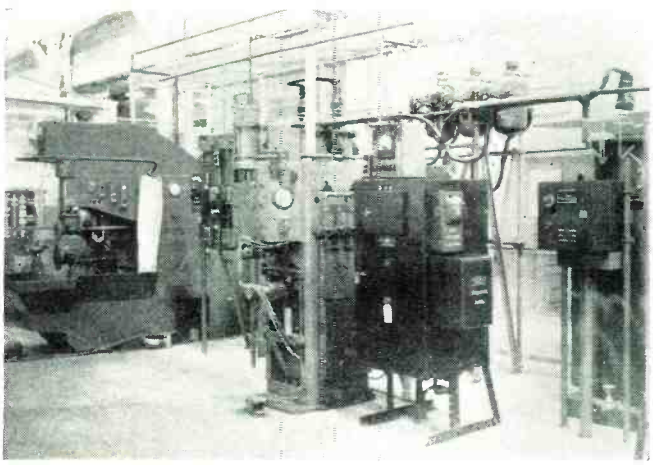


Photographic engineer using a Totalux to integrate light intensity with time, in reference to exposure in photography.

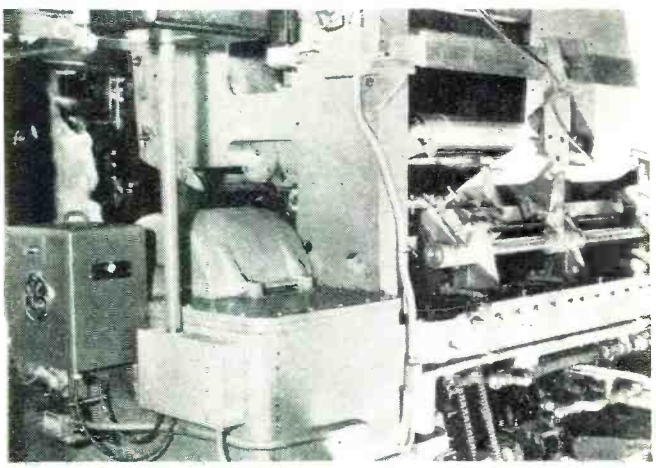
STUDENTS as well as engineers have indicated a desire for more information on the part that radionics and electronics are playing in the industrial picture. There are two main purposes behind the greatly expanded use of industrial control equipment of this type; namely, to conserve manpower and to increase production. The accompanying illustrations show in a small way some applications to industrial use of this equipment. Naturally at this time many of these installations are being used on restricted projects related to the war effort and cannot be released. Considering that research has proceeded at about five times its usual rate of development during the last year it is not hard to imagine the host of new applications which will be available when the war is over. In the meantime many applications of a non-restricted nature are available for study. Careful investigation should be made of these in order to accurately determine the industrial trends in the postwar period.



Bending roll equipped with electromagnetic strain-gage equipment. Alarm is given when machine is overloaded.



Resistance-welding area. General front view shows 200-kva. seam-welding machine and 75-kva. welding press.



Photoelectric color register control for multicolor gravure press. View of drive side, showing complete color-unit equipment.

ADAPTOR UNIT— FOR BASIC OSCILLOSCOPE

by GUY DEXTER

Constructional data for a simple, self-contained unit for modernizing basic oscilloscopes.

A LARGE number of *basic* oscilloscopes were built or bought by amateur station operators during the last ten years. These simple instruments contained only the barest essentials, having no input amplifiers or linear-sweep oscillators, and were not very useful beyond checking transmitter modulation, the purpose for which they were originally designed.

With the curtailment of amateur transmitting activities, civilian interest has shifted to radionic experimentation and set servicing, and the usefulness of a complete oscilloscope in those fields is well known. The problem of modernizing the old modulation-checking oscilloscopes has come up frequently during recent months because of the present radio instrument shortage. Occasionally, complete designs for home-built oscilloscopes, using special hard-to-obtain parts, have been described in constructional articles. But no direct solution has been offered thus far to the problem of adding the missing circuits to an existent basic 'scope.

The adaptor unit described in this article accomplishes complete modernization of the basic oscilloscope in a simple manner. Compact, self-contained, and easy to build from spare parts, it need only be connected by means of three leads to any simple 'scope of the modulation-checking variety. The basic 'scope may be of either the one-, two-, or three-inch style. A complete, stabilized oscilloscope is thus obtained for producing wave patterns, alignment figures, voltage deflections, and the numerous other indications which are so valuable to radionic and radio service testing.

By employing the adaptor, no changes are necessary in the wiring of the actual oscilloscope unit. The latter is accordingly left unaltered and may subsequently be employed without the adaptor whenever usage demands the basic unit alone. The adaptor is likewise not permanently tied in with the simple oscilloscope and is thus free to be used in other radio and television applications demanding a separate sweep-amplifier unit. Signal voltages are fed directly into the adaptor and reach the deflection plates of the cathode-ray tube either directly or through amplifiers, depending upon switch settings.

General Description

The adaptor unit comprises separate horizontal and vertical deflection amplifiers, a linear-time-base sweep oscillator, and power supply. The amplifiers employ type 6SJ7 tubes connected as high-gain pentodes and are provided with individual gain controls. The sweep circuit employs a single 884 tube in the conventional circuit developed by RCA.

The two amplifiers are so arranged with switching systems that a signal may be amplified before application to the deflection plates of the cathode-ray tube or may be switched around the amplifiers to be applied directly to the plates. Flexibility of operation is thus afforded for a number of different measurements. The amplifier circuits are of the conventional resistance-coupled type with unbypassed cathode resistors.

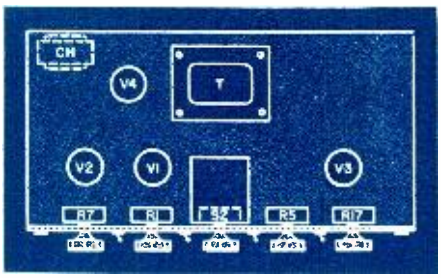


Fig. 1. Chassis layout.

The sweep-oscillator circuit delivers an oscillating voltage of saw-tooth waveform between 20 and 11,000 cycles in seven ranges selected by means of a rotary switch. In each range, the frequency is continuously variable, being adjusted by means of a variable resistor. The selector switch, S2, cuts in capacitors in the bank extending from C2 to C8 to select the various frequency ranges. Variation of frequency within the ranges is accomplished by adjustment of the rheostat R5. The limits of the frequency ranges, corresponding to maximum and minimum settings of the rheostat, for the various capacitors are: C2, 20 to 59; C3, 43 to 132; C4, 109 to 340; C5, 280 to 880; C6, 670 to 2180; C7, 1500 to 4900; and C8, 3600 to 11,400 cycles. An appropriate synchronizing voltage may be injected into the grid circuit of the sweep oscillator, the magnitude of this voltage being controlled by the potentiometer, R1. An external source of synchronizing voltage may be connected to the terminals T3 and T4 and the toggle switch, S1, set to EXT. Or a 60-cycle synchronizing voltage may be taken from one end of the transformer secondary supplying the tube heaters by throwing S1 to the 60 cycle position. The sweep oscillator circuit employed in the adaptor is extremely stable when synchronized with either external or internal voltages. Once synchronized, a single cycle of waveform may be "locked" on the 'scope screen for long observation periods.

Adequate switching is provided to enable flexibility of operation. S5 is the vertical plate switch. When S5, a double-pole, double-throw toggle switch, is thrown to DIRECT, an input signal voltage is fed directly from the vertical input terminal, T1, to the vertical plates of the cathode-ray tube. When S5 is thrown to AMP., however, the signal is impressed upon the vertical amplifier grid to undergo amplification before reaching the vertical plates. Note that S5 disconnects the output connection of the vertical amplifier when in the DIRECT position.

S4 controls horizontal plate input. In most measurements, the horizontal plates of the cathode-ray tube will receive the sweep oscillator output voltage to establish the linear time base. S4 will accordingly be thrown to AMP., and S3, which is the sweep selector, will be thrown to LINEAR. The saw-tooth wave is thus amplified and applied to the horizontal plates. When some external source of sweep voltage is to be employed, however, S3 is thrown to EXT., and the source of voltage, such as an oscillator, is connected between terminal T2 and a ground. Any signal whatever which is to be amplified and applied to the horizontal plates is fed into the system in this manner. When a signal is to be fed to the horizontal plates directly without amplification, the signal source is again connected between terminals T2, but switch S4 is thrown to DIRECT.

The amplitude of the vertical signal voltage, and accordingly the height of the pattern on the 'scope screen, is controlled by the potentiometer R17. Likewise, horizontal signal voltage amplitude is controlled by the potentiometer R7, to regulate width of the pattern.

Switches S1, S3, S4, and S5 are of the toggle type. S6 is installed on the synchronization control, R1. Intensity and Focus controls for the cathode-ray tube are an integral part of the basic 'scope and accordingly are not included in the adaptor unit. Switch S2, the frequency-range selector, is a

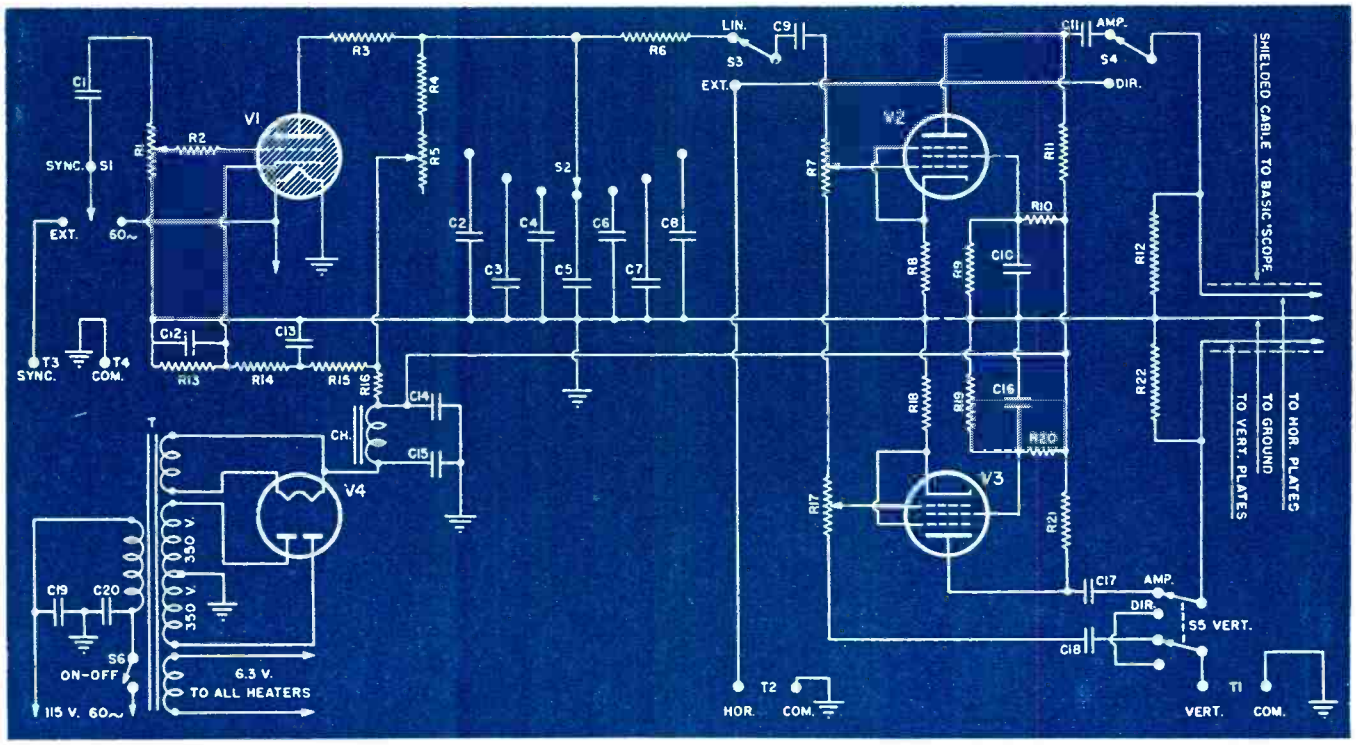


Fig. 2. Schematic diagram and parts list of adaptor unit for basic oscilloscopes.

C_1—.1-μfd. 600-v. tub.—Aerovox
C_2—.25-μfd. 400-v. tub.—Aerovox
C_3, C_{19}, C_{20}—.1-μfd. 400-v. tub.—Aerovox
C_4—.04-μfd. 400-v. tub.—Aerovox
C_5—.015-μfd. mica—Aerovox
C_6—.005-μfd. mica—Aerovox
C_7—.002-μfd. mica—Aerovox
C_8—.0008-μfd. mica—Aerovox
C_9, C_{11}, C_{17}, C_{18}—.5-μfd. 600-v. tub.—Aerovox
C_{10}, C_{13}, C_{14}, C_{15}, C_{16}—8-μfd. 450 d.c.w.v. midget tub. electrolytic—Aerovox
C_{12}—25-μfd. 25-v. midget tub. electroyltic—Aerovox

R_1—250,000-ohm pot.—I.R.C. Type CS
R_2—25,000 ohms ½ watt—Aerovox
R_3—500 ohms ½ watt—Aerovox
R_4—300,000 ohms ½ watt—Aerovox
R_5—1-megohm pot.—I.R.C. Type CS
R_6—1 megohm ½ watt—Aerovox
R_7, R_{17}—500,000-ohm pot.—I.R.C. Type CS
R_8, R_{18}—850 ohms ½ watt—Aerovox
R_9, R_{19}—27,000 ohms 1 watt—Aerovox
R_{10}, R_{20}—120,000 ohms 1 watt—Aerovox
R_{11}, R_{21}—100,000 ohms 1 watt—Aerovox
R_{12}, R_{22}—2 megohms 1 watt—Aerovox

R_{13}—2000 ohms ½ watt—Aerovox
R_{14}—25,000 ohms 1 watt—Aerovox
R_{15}, R_{16}—60,000 ohms 1 watt—Aerovox
S_1, S_2, S_4—s.p.d.t. toggle switches—Arrow
S_3—Single-pole, 7-position rotary switch—Centralab
S_5—d.p.d.t. toggle switch—Arrow
S_6—s.p.s.t. vol.-control switch built into potentiometer R_1
T—Power transformer: 350-0-350 v., 70 ma.; 5 v., 3a.; 6.3 v., 2.5 a.—U.T.C. Type R-2
CH—15-henry 100 ma. midget filter choke—U.T.C. R-19

single-pole, 7-position rotary type SW.

Connections to the basic 'scope are made by means of the three-conductor shielded cable shown in the circuit diagram. For ease of connection, this cable may be terminated by appropriate three-pin plugs for insertion into sockets at the adaptor and the 'scope.

The power supply for the adaptor unit is self-contained, consisting of the transformer, T; rectifier tube, V4; filter choke, CH; and filter capacitors, C14 and C15. This supply employs small-sized components of standard design and is compact in nature. For still greater compactness, the reader might employ one of the smaller metal rectifier tubes, such as type 5W4, if one of these is available in his spare parts assortment.

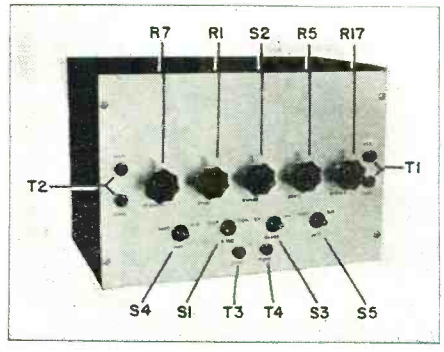
Mechanical Construction

The adaptor unit is built on a 7"x10" x3" chassis and 7"x10" panel, as shown in Figures 1 and 3, and is housed in a snug-fitting cabinet. These dimensions and the layout shown in the drawings permit the most compact arrangement of parts consistent with stable operation.

To meet the shortage of steel cabinets and chassis, the builder may form his metal components from galvanized iron sheet. This material is still fairly easy to obtain in most towns and is entirely satisfactory for the purpose. If the builder is unable to do the work himself, he may have his local sheet metal shop cut the metal panel and form the chassis and cabinet at a reasonable cost. After completion of the work, the pieces may be given a coat of black or grey lacquer of either smooth or wrinkle finish as individual taste might dictate.

Components are arranged on the chassis as shown in Figure 1. The four controls and the rotary frequency-selector switch S2 are mounted on the front panel above the chassis. Leads from the controls pass through holes drilled along its front edge and lined with rubber grommets. The selector switch is mounted, as shown in Figure 1, in a shield can which also holds the frequency-range capacitors, C2 to C8,

Fig. 3. Panel assembly.



and it is then mounted on the front panel in the center position, as shown in Figures 1 and 3. This arrangement of the frequency-range components makes a neat, shielded assembly, grouping the capacitors in an enclosure.

The toggle switches are mounted through the panel and front lip of the chassis along the lower line, as shown in the photograph, Fig. 3. The on-off line switch, S6, is mounted on the synchronization control, R1.

By mounting the power transformer along the extreme rear center portion of the chassis, as shown in Figure 1, and the small filter choke under chassis in the rear left-hand corner, hum interference with the input amplifiers and sweep oscillator will be prevented. In individual duplications of the instrument, however, it may become necessary to rotate the filter choke for best isolation. This will be particularly likely when a choke other than the one specified is employed.

The three-lead shielded cable for connection to the basic 'scope is brought out through a clearance hole on the right-hand side of the cabinet. This hole is cut near the bottom of the cabinet and is aligned with a similar hole cut in the corresponding lip of the chassis. For maximum ease of disconnection, a three-pin socket may

(*Continued on page* 64)

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.

ALLIED'S RADIO CIRCUIT HANDBOOK

Published by *Allied Radio Corporation*, 833 West Jackson Boulevard, Chicago, Illinois. Price. 10c.

A new publication containing radio and electronic circuits with analyses, comparisons, and discussions. The method of presentation was especially planned to make this book a useful text for the classroom and for home study as well as a reliable guide for experimenters and builders. Fundamental principles of radio are illustrated and explained in sixteen basic circuits. The application of these principles to various components of receivers, transmitters. and other electronic units is shown in twenty-five additional circuits of conventional radio and electronic units. A schematic and pictorial diagram is shown for each unit, ranging from simple one-tube sets to superheterodynes.

This well-prepared booklet should prove to be very useful as a supplementary text for radio classes. Forty pages, 8½"x11". Address all information to the *Allied Radio Corp.*, 883 W. Jackson Blvd., Chicago, Ill.

NEW BOOKLET DESCRIBES "ELECTRONICS AT WORK"

Electronic applications in industry, in the war, in medicine and the home are illustrated and described in a new 44 page booklet announced by *Westinghouse Electric and Manufacturing Company.*

A few typical applications shown in this booklet "ELECTRONICS AT WORK" are: resistance welding control for sewing plane parts together at 1,800 stitches per minute; cathode-ray oscillograph for electrical circuit and lightning phenomena analysis at speeds of 1/100 of a millionth of a second; high-frequency induction heating units for plastic molding; tin reflowing and surface hardening; ignitron rectifiers for converting alternating to direct current in aluminum and magnesium production; industrial X-ray units for "inside" inspection of vital metal parts; Precipitron for removing air-borne dust particles as small as 1/250,000 of an inch.

Various types of electronic tubes, key units of every electronic device, for such applications as industrial control, diathermy, power conversion, X-ray and radio are illustrated and the primary use of each identified.

(*Continued on page* 94)

ELECTRONIC POSTWAR ERA

"A RECORDING spectrophotometer, utilizing photoelectric cells, provides the most reliable method of analyzing color ever devised, defining accurately some 2,000,000 different shades, working for textile, paper, chemical and paint industries. Electronic devices automatically square the lengthwise and crosswise threads in weaving. Electric eyes guard sheets of metal on a conveyor, discarding those with defects. Vacuum tubes turn on the lights as the sky darkens, turn them off when it is light. Electronic devices, through carrier current, send messages and control distant apparatus linked only by power wires. Electronic rectifiers supply power to produce vital metals like aluminum. Electronic devices control the high-speed wrapping of packages, fill ginger-ale bottles to the proper level, remove slate from coal at the mines, sort the pure crystals of rock salt, level elevators, open doors, control punch presses, detect smoke and fumes, measure vibration and thickness. X-ray, priceless electronic tool of the doctor, now examines heavy steel castings for imperfections, detects porosities in welded seams, sees hidden defects in automobile tires, searches candy bars for foreign materials, picks good oranges from bad, analyzes metals and alloys in terms of diffraction patterns.

On Guard

"The tiny electron is a many-muscled guardian. Electronic devices detect planes at a great distance, aim and fire guns, explode mines, guide planes and ships through fog, detect fires and certain poisonous fumes.

"The genetic effect of electronic X-rays has already produced new kinds of flowers, many well improved strains of fruits, vegetables, and grains as seeds are bombarded with millions of volts. The electronic microscope has revealed to biologists the character of the tobacco mosaic virus, a deadly crop disease that has cost growers millions of dollars a year. The electron will not long remain an abstraction for the farmer.

"Well—well, Gentlemen! and what do you suppose our Chinese allies would say if they saw this?"

X-Ray

"In 1895 Roentgen observed—then named—the X-ray. Dr. W. D. Coolidge developed the Coolidge X-ray tube at Schenectady—and medicine had one of its most precious tools. Radiography today discloses when broken bones are mending, when teeth are decaying, how to treat a sinus condition; it shows the presence of tuberculosis and silicosis. Often on the heels of diagnosis comes therapy, as X-rays treat skin disorders and infections and wage war against cancer, gangrene and gas bacilli. By inductothermy, another electronic application, heat is safely generated in living tissues. The electrocardiograph amplifies the faint voltages of the heart muscle and records the action on photographic paper for the observation and guidance of the physician.

Radio Today

"Even radio is no longer just Bing Crosby, and baseball games and music while you shave. It is mobile police protection at all hours, weather observer, automatic pilot, instant communication for fireboat and fire truck, operator of remote power stations, fire fighter, cradle watcher. It has learned to serve as well as to amuse and educate. Tomorrow, when the thunder and pain and preoccupation of war have passed, radio—released from the manacles of static by frequency modulation, or FM, and stripped of its blinders by television—will transport you to Carnegie Hall, to the White House, and to Ebbets Field, bringing you the clear high note of the violin, the timbre of the voice, and even the color of the umpire's tie. Electronics has in store for millions of homes of the future a radio performance that as yet has not been a part of their experience.

Electronic Research

"Only a short time ago the engineers of *General Electric* constructed a 20-million-volt induction electron accelerator. This is a research tool that whirls electrons at the highest speed ever produced, only a fraction of a per cent less than the

(*Continued on page* 54)

PRACTICAL RADIO COURSE

by ALFRED A. GHIRARDI

Part. 17. Study of harmonic distortion produced by triode power amplifier tubes and conditions for maximum undistorted power output.

IN audio amplifier circuits, the achievement of *maximum* power output from a power tube cannot be the sole consideration, because when it is operated into the value of load impedance that results in maximum power output (see last month's lesson) the amount of objectionable harmonic distortion it produces in the waveform of the signal is usually greater than can be allowed for good fidelity. Since the harmonic distortion produced is usually of equal or greater importance than the achievement of maximum power output, it is important to understand its causes and be familiar with the practical methods for reducing it.

How 2nd Harmonic Distortion Is Caused by Triode Power Tubes

Even though a triode is operated with the correct values of cathode, grid and plate voltages applied to it (as specified by the manufacturer) for Class A amplification, some distortion of the signal waveform will result due to the fact that the dynamic operating grid-voltage plate-current characteristic is not a straight line as is ordinarily assumed, but is somewhat curved (especially near the lower bend) as illustrated at (*A*) of Fig. 2. For any given triode, the amount of this curvature depends upon the value of the plate load; the higher the load resistance the less is the curvature. (This is not true in the case of pentodes; for these the curvatures of the dynamic characteristic increases if the resistance of the load is made too high.) As we shall now see, this curvature results in non-linear amplification of the signal voltage applied to the grid.

At portion (A) of Fig. 2 is plotted the dynamic operating characteristic C-P-D of a typical power triode. Notice that this is slightly curved upward, and the bend is greater at the lower portion than at the upper end. A grid bias voltage of proper value is applied so as to make the no-signal operating point occur at *P* for Class A operation. Now if a sine-wave signal voltage is applied to the grid (as indicated), the plate current will swing between the maximum value *D* and the minimum value *F*. The plate current rise (from its no-signal value *E*) for each positive half-cycle of the signal voltage is *E-D*. The fall for each negative half-cycle is E-F. Because of the upward curvature of the dynamic characteristic (especially at the lower end), the plate current rise E-D is greater than the fall E-F. Consequently, the positive half cycles of the resulting plate current variations will be *greater* in amplitude than they should be; and the negative half cycles will be *smaller* than they should be. This results in the lopsided, distorted plate current waveform shown at the right. Both the signal voltage wave applied to the grid, and the resulting distorted plate current wave, have been shaded in this illustration to clearly show up this distortion in the plate current wave.

As is well known, any recurring wave can be analyzed into a fundamental wave and waves of harmonic frequencies. The lopsided wave of the particular shape produced here (for a triode tube) may be regarded as the *resultant* wave produced by an undistorted fundamental sine wave (such as would be produced if the dynamic characteristic were a straight line as shown by dotted line APB) plus an added sine wave of double the frequency, a *second harmonic,* having the proper amplitude and phase relationship. Practically no 3rd or higher harmonic is necessary here to accurately complete the distorted waveform. This is the reason why a triode power amplifier tube is said to cause chiefly second harmonic distortion. (A wave can actually be broken down and its harmonic waves studied by means of a device known as a harmonic analyzer.)

The lopsided, distorted waveform is drawn again separately as the solid curve at (B) in order not to complicate the diagram unduly for the analysis we are about to make. The ideal undistorted *fundamental* plate current wave which would result if the dynamic characteristic were the straight line *APB* has been superimposed over it and drawn in dotted form to distinguish it. The 2nd harmonic sine wave which, when combined with this fundamental, will produce the actual resultant distorted plate current wave very closely has also been drawn in dotted form in its correct phase relationship. Notice that the axis *x-x* of the second harmonic does not coincide with that of the fundamental.

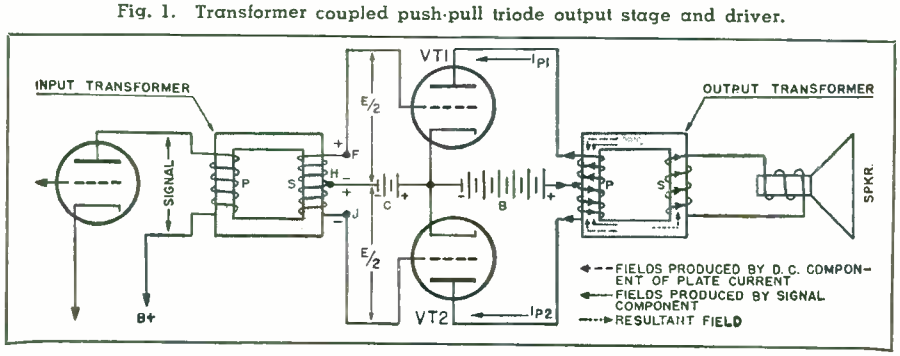
It should be understood clearly at this point that even though a distorted wave, voltage, or current is spoken of as containing harmonics, it does not necessarily mean that these harmonics exist as separate waves, voltages or currents distinct from the distorted one. What is really meant is that the effect or action of the distorted one is exactly the same as if it were replaced by one of the *fundamental* frequency and those of the associated harmonic frequencies, all of simple sine-wave form. If the resultant distorted waveform can be reproduced closely by combining a pure sine wave of the same frequency (fundamental) with simply a *2nd harmonic* sine wave of proper amplitude and phase relationship, it is usually said that the distortion is due to the 2nd harmonic present, for if the 2nd harmonic were eliminated, a pure undistorted waveform would result.

In the output of a power amplifier triode, then, some distortion is present. This distortion is predominantly second-harmonic in single-tube amplifiers. The percentage of second-harmonic distortion present in any case may be calculated by the following formula:

$$\% \text{ 2nd harmonic distortion} = \frac{\left(\frac{I_p \text{ max.} + I_p \text{ min.}}{2}\right) - I_o}{I_p \text{ max.} - I_p \text{ min.}} \times 100$$

where I_p max. and I_p min. are the maximum and minimum values of the plate current respectively and I_o is the zero-signal plate current (all expressed in amperes); see (A) of Fig. 2.

Fig. 1. Transformer coupled push-pull triode output stage and driver.



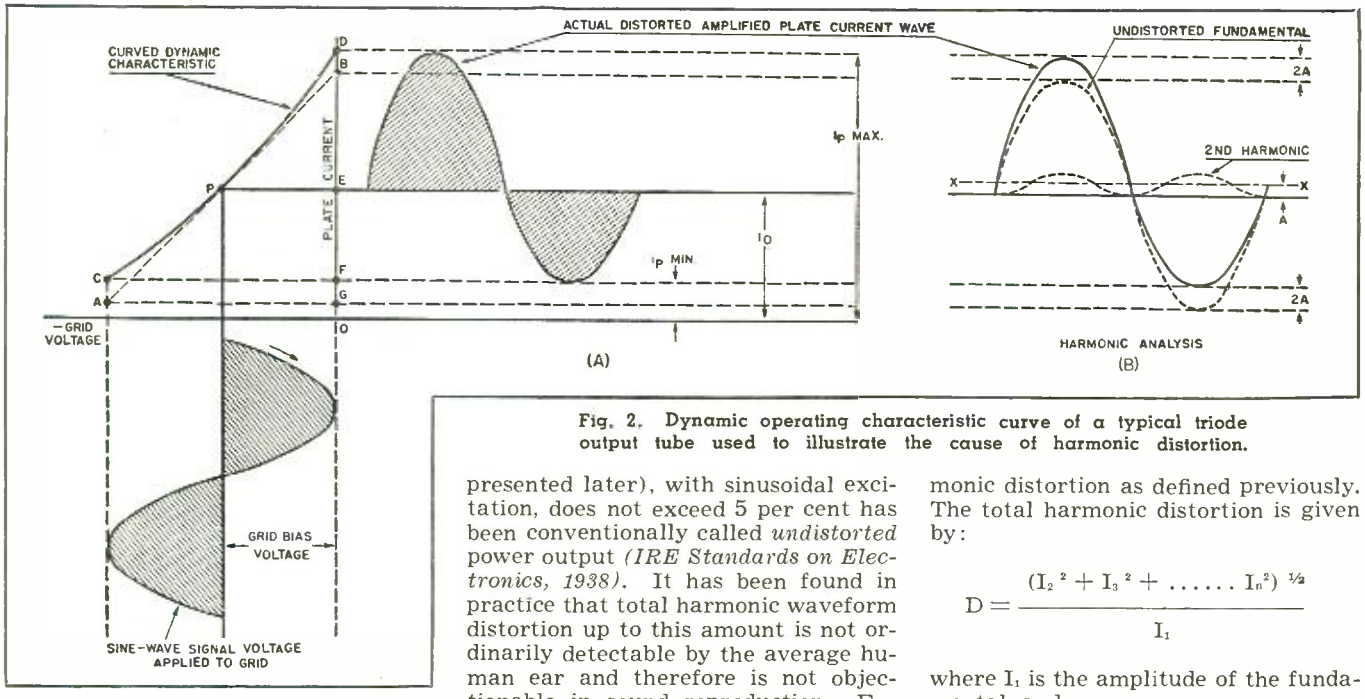


Fig. 2. Dynamic operating characteristic curve of a typical triode output tube used to illustrate the cause of harmonic distortion.

Harmonic Distortion Limits the Available Undistorted Power Output of Tube

It was shown in a previous lesson of this series that for any given input signal voltage and given operating voltages applied to the various electrodes, the signal power output deliverable from an amplifier tube is a *maximum* when the a.c. plate resistance R_P and the load resistance R_L are *equal*. (This condition of maximum output operation disregards, of course, any signal distortion that may be produced by the tube operating under this condition.)

Now if a triode power tube is worked into a load impedance as low as its a.c. plate resistance, its E_g-I_p dynamic characteristic will be found to be curved rather excessively, and because of this, appreciable 2nd harmonic (and possibly even some third harmonic) distortion will result—usually more than is allowable for good fidelity if the tube is used in an audio amplifier. Consequently, if the harmonic distortion is to be kept within the allowable limits for good fidelity, a higher value of plate load must be used. Unfortunately, for triodes, a higher value of load resistance reduces the harmonic distortion but at the same time also reduces the signal power output deliverable from the tube. Therefore, a compromise must be effected in practice, dictated by the value of the actual maximum harmonic distortion allowable.

Allowable Limits of Harmonic Distortion

The amount of harmonic distortion that may be tolerated varies greatly in different applications, consequently there really is no single criterion of permissible distortion acceptable in all cases. In the radio field, power output for which the *total* generated harmonics (see definition of *total* harmonics presented later), with sinusoidal excitation, does not exceed 5 per cent has been conventionally called *undistorted* power output *(IRE Standards on Electronics, 1938)*. It has been found in practice that total harmonic waveform distortion up to this amount is not ordinarily detectable by the average human ear and therefore is not objectionable in sound reproduction. For this reason, when the *total* harmonic distortion is less than this 5 per cent value the signal is usually said to be *undistorted*. Whenever this statement is encountered it should be remembered that this does not mean that there is absolutely no distortion present, but rather that the amount present is within the limits of ordinary acceptable fidelity. The strict standardization of such a value is not recommended, since it involves a direct contradiction between its definition and the technical significance attached to it.

The choice of 5 per cent total harmonic distortion as a criterion of distortion is wholly arbitrary. In some cases, distortion of this magnitude is entirely permissible; in other cases it is far too large to be tolerated. For example, as we shall see later, in some power amplifiers the power tubes are purposely operated with a value of load impedance that enables almost their maximum power output capabilities to be utilized, even though such operation is accompanied by excessive harmonic distortion in the plate current wave. In such cases, the distortion is cancelled out by some special method of harmonic cancellation (such as push-pull, inverse feedback, etc.). Consequently, the excessive distortion caused by the tubes in such amplifiers is entirely permissible, for it is removed from the signal later in the amplifier.

The distortion may be expressed in either of the following two ways. The individual harmonic components of output current may be expressed separately as percentages of the current of fundamental frequency. Usually the 2nd and 3rd harmonics will suffice, but higher-order harmonics should also be given if they are of the same degree of importance as the 2nd and 3rd harmonics. The more usual way, however, is to express the percentage of distortion in terms of the *total* harmonic distortion as defined previously. The total harmonic distortion is given by:

$$D = \frac{(I_2^2 + I_3^2 + \ldots\ldots I_n^2)^{1/2}}{I_1}$$

where I_1 is the amplitude of the fundamental, and

I_2, I_3, ... I_n are the amplitudes of the 2nd, 3rd, ... nth harmonics

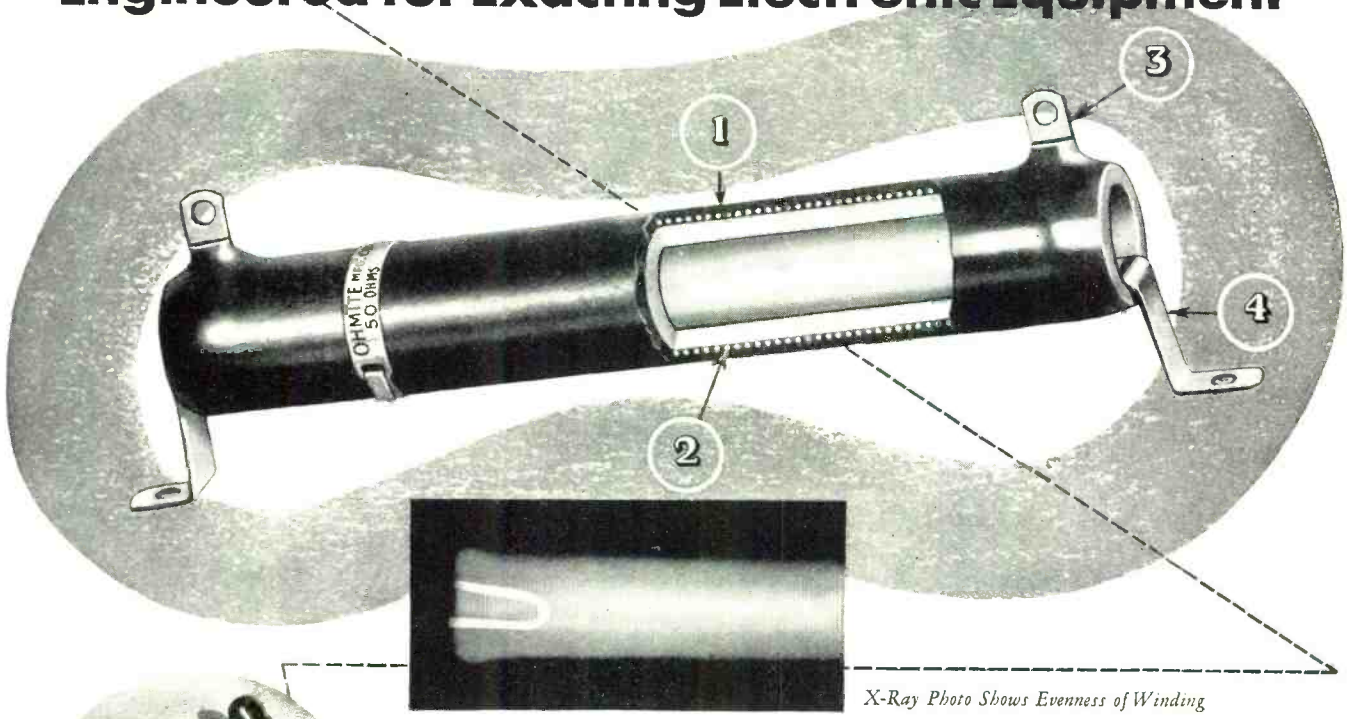
The distortion may actually be measured by a harmonic analyzer, of which several types are generally available. Some types measure the *total* harmonics (D, above); some measure the separate harmonics.

Another reason for the practical undesirability of assigning any arbitrary value to the allowable percentage of total harmonics lies in the fact that odd-order harmonic distortion (3rd, 5th, etc. harmonic) is relatively more objectionable than even-order harmonic distortion (2nd, 4th, etc. harmonic). Now the distortion caused by triode power amplifier tubes is mainly of 2nd harmonic variety, as we have seen. As we shall see later, that caused by pentode power amplifier tubes is mainly 2nd and 3rd harmonic distortion with some 4th often present —their relative values depending upon the load resistance the tube is working into (as we shall see). Furthermore, for some loads the 2nd harmonic distortion is predominant, for others the 3rd harmonic is predominant, etc. Now a total harmonic distortion of 5 per cent is much more objectionable if it consists mainly of 3rd harmonic distortion than it would be if it consisted mainly of 2nd harmonic distortion, since 3rd and other odd-order harmonics are more objectionable to the human ear. Hence a power pentode tube having a total distortion of 5 per cent (most of it 3rd harmonic) would actually be delivering a signal of poorer audible quality than a triode power tube which also had a total distortion of 5 per cent, most of which was 2nd harmonic. This illustrates why the designation of any one value of *total harmonics* as the permissible percentage of harmonics for good fidelity for all cases is not wise, strictly speaking, for there is really no single criterion

(*Continued on page* 70)

OHMITE RESISTORS

Engineered for Exacting Electronic Equipment

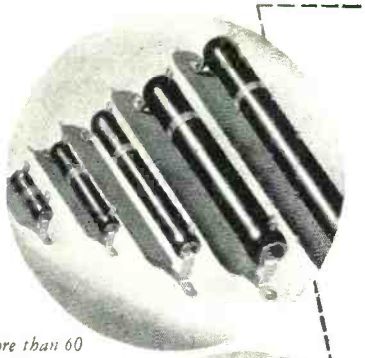


X-Ray Photo Shows Evenness of Winding

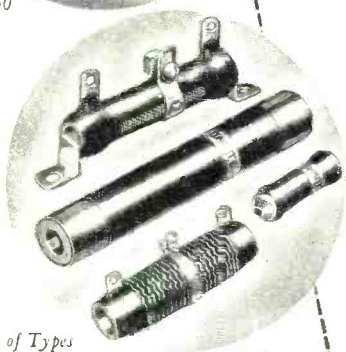
THE cut-away view shows several of the outstanding features of one of the most widely used Ohmite Resistors.

1. The resistance wire is wound on a ceramic core. Ohmite Vitreous Enamel holds the wire rigidly in place—insulates and protects the winding—dissipates heat rapidly—withstands humidity.
2. The evenness of the winding, shown in the x-ray photo, prevents "hot spots" and failures—and makes for long, reliable service on the job.
3. The resistance wire is both mechanically locked and brazed to copper terminal lugs, assuring perfect electrical connection between lugs and wire. The lugs are tin-dipped for ease in soldering the connecting wires.
4. The mounting brackets hold the resistor firmly yet resiliently in place. They are easy to mount—easy to remove.

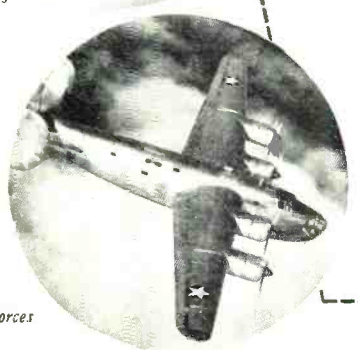
More than sixty different core sizes make possible an almost endless variety of regular or special resistors to meet every need. Core sizes range from 2½" diameter by 20" long to 5/16" diameter by 1" long. Wattages range from 1 to 1500 watts—Resistances, from a fraction of an ohm to 250,000 ohms. Available in fixed, adjustable, wire or flexible lead, tapped, ferrule, Edison base, bracket, cartridge, strip, precision, non-inductive and other types. Ohmite Engineers are glad to help you on any resistor problems.



More than 60 Core Sizes



Wide Range of Types for Every Need



Used in the Armed Forces and in Industry

SEND FOR OHM'S LAW CALCULATOR

Helps you figure ohms, watts, volts, amperes — quickly, easily. Solves any Ohm's Law problem with one setting of the slide. Send for yours—enclose only 10c in coin for handling and mailing.

Quick-Reference Catalog No. 18—Free

Gives helpful information on Ohmite stock resistors, rheostats, chokes, and tap switches for all types of applications. It's Free!

OHMITE MFG. CO. • **4885 Flournoy St., Chicago, U.S.A.**

Be Right with OHMITE

RHEOSTATS • RESISTORS • TAP SWITCHES

QTC

(*Continued from page* 38)

other ship officers that this is quite a reliable group of men with above the average education and that they are a very vital necessity in the defense of our country and in the offensive actions being taken by this country and our allies throughout the various war fronts. They have come to realize the value of reliable and efficient radio communication by the armed forces and merchant marine as the present radio personnel aboard ship, in the air and on land have consistently demonstrated the ingenuity and ability of American radio operators. We have become firmly confident that the old convictions by the public toward radiomen in general will be replaced by a still more understanding thoughtfulness and a highly respectful attitude when the part played by radio and radar in the present war is fully understood.

Of course, all of you have heard of the gentleman (Scotch) now living in Canada who sometime ago mailed his 1943 Xmas cards just ahead of a penny boost in the Canadian postal rates. Well, Labor Day is not far away and for most vacations (if any) are now over or will be shortly, we hope you have had, or will have a nice one as the case may be. Vacations for many of us are "out" for the duration and a seven-day week, the general rule, not the exception, together with long hours —but think how easy an eight-hour day and a five- or six-day week will seem after it's all over!

A word of caution regarding some recent experiments may not be amiss. During several recent tests and experiments with daylight signal lamps at a nearby city a certain well-known radioman was called upon to explain the whys and wherefores to the local gendarmes who in all probability had not the slightest idea what was being experimented with having never seen such equipment before (or since—we hope). So, even if you are carrying out tests and experiments which you believe might aid in the war effort, be certain that the proper authorities have been notified beforehand and secure any necessary approval if such may be required, otherwise results may become very serious as well as embarrassing to those concerned.

The War Shipping Administration of the U. S. Maritime Commission has certainly done a good turn in supplying approved broadcast receivers and short-wave receivers to the Merchant Marine, to replace the re-radiating disapproved types—after all, the most up-to-the-minute news can be obtained with a good receiver immediately and the men in the Merchant Marine are certainly entitled to the best that can be provided for them in these days.

Earl Prescott, another marine operator from way back, has been working at a very vital war job ashore for some time in Lynn, Mass., we hear. There are a good many other oldtimers we have not heard from for some time, the whereabouts of some of these seem to travel slowly in troubled times such as we are having at present but by next issue we will have considerable information for you concerning operators and maintenance men in the various branches of our "game."

Have you ever stopped to think what others think of you, or look at yourself as others look at you? Can you think what the average person thinks of the very peculiar people called Americans when he sees them take a glass, put sugar in it to make it sweet, then lemon to make it sour, alcohol to give it warmth and then a bit of ice to cool it off, after all that he says: "Here's to you" and promptly proceeds to drink the mixture himself?

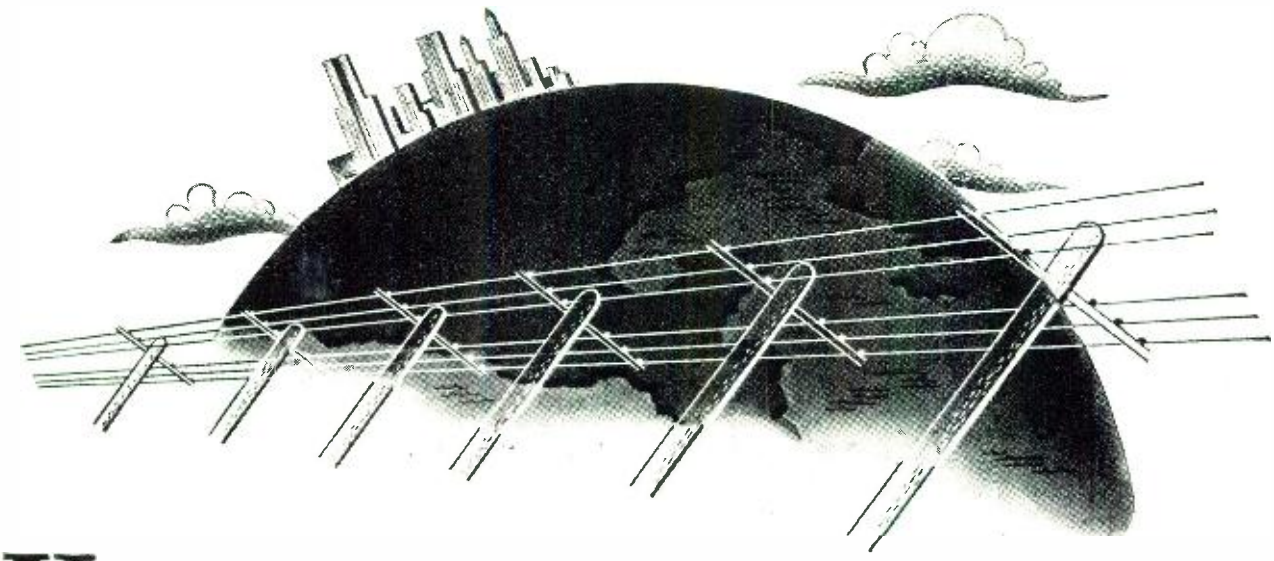
Test equipment for those in maintenance and repair surely is at a high premium, one such outfit we know of doing marine work have been for the past ten months trying to get some of the multi-meter variety type units for urgently needed repair work aboard ship and up to this writing have met with no success at all. Meters for such work have had to be constructed by several firms with a resultant loss of time for their men. If you have such instruments sell them to some of the firms who advertise in the various publications for same, as they are impossible, for some who must have them, to obtain under present conditions. If you do have and use instruments of this nature, show them utmost care as they are not replaceable in most cases and will not be until some time after the war.

A world conflict like the present war, while naturally something all of us wish to be over with as soon as possible nevertheless brings with it progress more rapid than in peace time. A few months will develop equipment that in more peaceful times would require years, as witness safety measures now provided aboard ships of our Merchant Marine such as better equipped and designed lifeboats, rafts, emergency lighting systems and modern radio communication and P. A. systems. These added safety features will in most all cases be required in the future as standard equipment on all sea-going vessels for the greater safety of men and ships as well as aboard passenger vessels and those with valuable cargo. After the war when equipment becomes available which must be kept secret at present many improvements will be found aboard ship in the various types of radio equipment such as receivers, transmitters, direction finders, UHF equipment, etc.

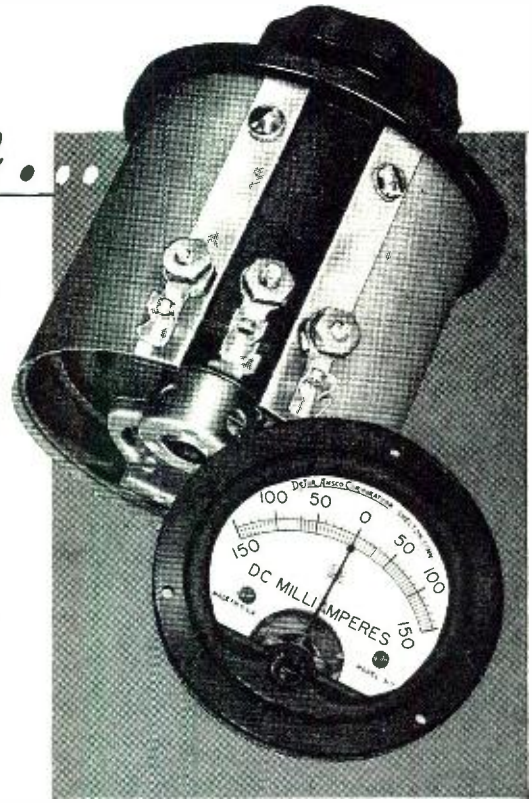
We have hardly had time to get organized in order to make this issue, however we request that you contact us regarding your activities and any you may know of and in the forthcoming issue we will have considerable information on various activities.

—30—

ONE OF A SERIES OF ADVERTISEMENTS SHOWING DeJUR PRECISION PRODUCTS IN ACTION ON THE HOME FRONT



Keeping them open . . .



Imagine what would happen if the electric power lines in your community broke down as you're reading this. Thanks, however, to the Public Utilities and their vigilant band of crack trouble-shooters, the possibilities are indeed slim.

Aiding in tracking down trouble in power stations, factories, fields, homes and shops are instruments incorporating dependable DeJur Components. Standing faithfully, they have proved their worth in innumerable cases . . . have helped head off disaster, pointed unerringly to the causes of breakdowns, kept lines open and current moving. On the home front as well as the battle front, DeJur Products deliver satisfactory service.

KEEP BUYING
WAR BONDS AND STAMPS

Awarded for Excellence in Production and Quality of Material

DeJUR-AMSCO CORPORATION

SHELTON, CONNECTICUT

MANUFACTURERS OF DEJUR METERS, RHEOSTATS AND POTENTIOMETERS

NEW YORK PLANT: 99 Hudson Street, New York City • CANADIAN SALES OFFICE: 560 King Street West, Toronto

V.T.V.M.

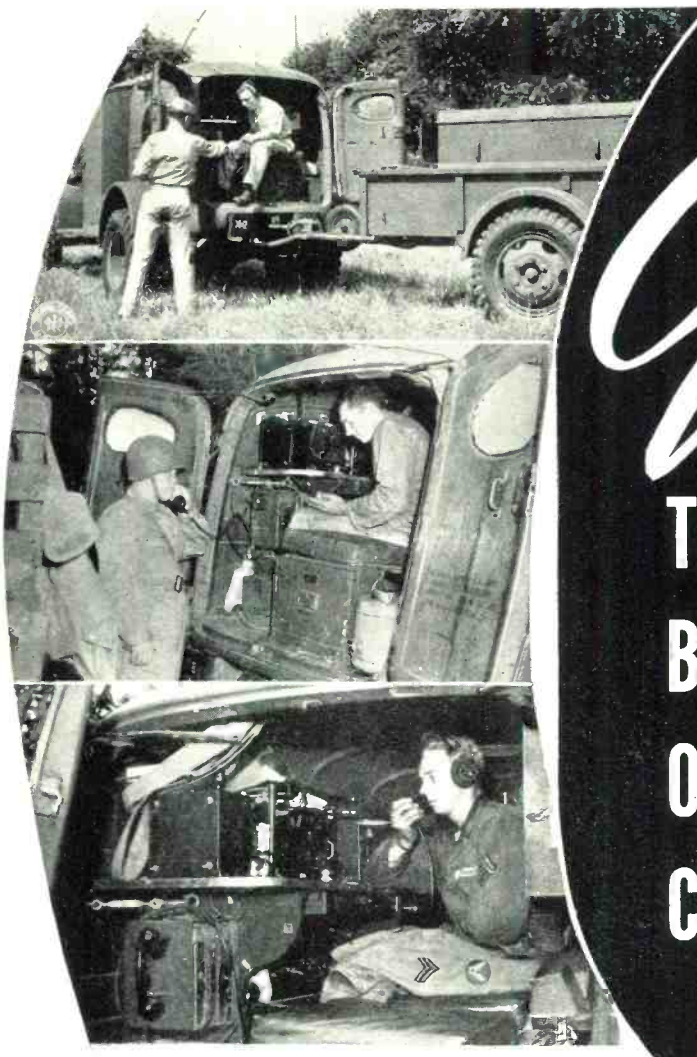
(*Continued from page* 34)

than go out and buy them. This gave rise to significant mechanical and electrical simplifications in the instrument illustrated herewith, as well as the elimination of a multiplicity of inherently unstable resistors from the original design. Since the resultant instrument not only satisfies all of the premises propounded above, but constitutes that today hard-to-find entity, a true "vacuum-volts," and since it can be constructed and calibrated quite easily in other needful laboratories, some further description seems appropriate.

Approximately 5" wide, 10" deep and 6" high, the "vacuum-volts" illustrated in Figs. 1, 3 and 4 is a most versatile instrument for the measurement of a.c. and d.c. voltages in the range of .1 to 100 volts. Since, as previously stated, a single range of 100 volts would not permit accurate determination of small fractions of such maximum such as are vitally needed in stage-gain measurements in r-f and a-f circuits, this maximum is broken up into five differing ranges such as to provide full-scale readability down to small fractions of 1 volt. This is accomplished by providing a switch to select resistor networks suitable for full-scale ranges of 1, 3, 10, 30 and 100 volts. The fact that these ranges are available for either a.c. or d.c. gives the instrument a total of ten ranges. The five d.c. ranges are all of equal and identical (linear) slope across the meter scale, the incremental progression for increasing applied a.c. voltage differing slightly therefrom. Two d.c. scales are provided, serving for the two essentially different ranges having factors of "1" and "3". Two similar meter scales are provided for a.c. ranges, with indication on the basis of r.m.s. values of a sine wave, or 71% of the peak value of a complex a.c. wave.

A total of four adjustments, plus on-off switch and pilot lamp, control all operations. One internal screw-driver adjustment on the chassis, seen in Fig. 4, permits balancing of the diode contact potentials in a.c. measurement. So stable is the instrument that once this adjustment is set, it may be forgotten until the characteristics of the diode change as a result of long usage. The knob to the left of the pilot lamp bezel is the triode "vacuum-volts" balance, connected between the triode plates and B+. It permits "zeroing" the meter before measurements are made. Again, so stable is the design that one setting of this zero-adjustment is usually sufficient for all ranges. Below the meter face is the range selector knob. On the top panel are three binding-post/jacks for a.c. or d.c. input connections, with, in front of them a 3-position switch knob to select between a.c. and either positive or negative d.c. input.

Of the three binding-posts, one is



Winning THE BATTLE OF COMMUNICATIONS

Mobile communications units assembled by Hallicrafters are helping to win the battle of communications on every fighting front. They are built to endure the rigors of modern warfare . . . The consistent performance of SCR-299 has been highly praised by leading members of our armed forces for its adaptability in meeting all the requirements of combat duty . . . A phrase best describing the SCR-299 was given when a leading military authority said, "It is to communications what the jeep is to transportation."

hallicrafters

CHICAGO, U. S. A.

THE WORLD'S LARGEST EXCLUSIVE MANUFACTURER OF SHORT WAVE RADIO COMMUNICATIONS EQUIPMENT

BUY MORE BONDS!

ARMY E NAVY

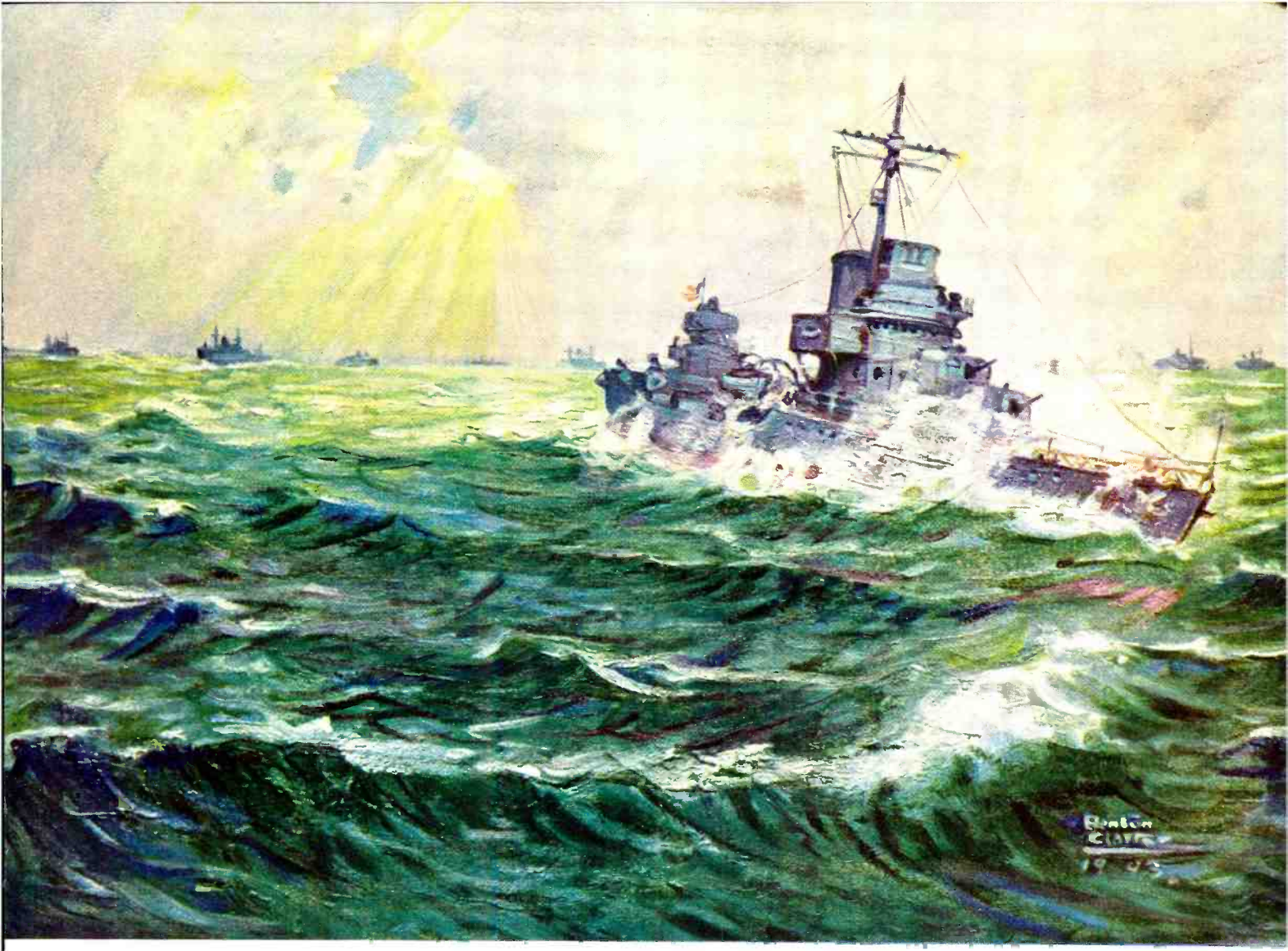
literally a dummy, the second is for "ground" input on a.c. or d.c., and the third is for "hot" d.c. input. The "dummy" connects internally to the jack visible in Fig. 4 just above the power transformer along the vertical centerline. The probe containing the debased 6H6 dual-diode, a.c. input insulating condenser and the two diode load resistors may either be plugged into this chassis jack through an aperture in the rear of the instrument, as in Fig. 3, when low-frequency a.c. input connection may be made to the two instrument binding-posts, or it may be removed for r-f work and the probe plug and alligator clip connected directly to the circuit under measurement. This latter method eliminates connecting lead lengths which would destroy accuracy in r-f measurements by putting the measurement diode right at the points of circuit potential to be measured. The probe resonant frequency is above 300 megacycles, which allows accurate measurements to be made to 150 or 200 megacycles. The a.c. input resistance naturally decreases with frequency, ranging from above 1 megohn just below the broadcast band on down to a little less than 20,000 ohms at 100 megacycles. Well above 100,000 ohms input resistance for all frequencies below 10 megacycles, and of very low input, or shunt, capacitance, the instrument is universally useful.

Examination of the circuit diagram of Fig. 2 together with what has been previously set forth, will indicate operational functions of the various component parts. The power supply develops a total of approximately 300 volts of d.c., filtered by C4 and C5, and split into two 150-volt sections by R9 and R10. The upper section supplies plate voltage to the two 6C5 triodes, the 150-volt section below ground operating to almost offset the negative grid bias developed across the two feed-back resistors, R7 and R8.

Gang switch S1A, S1B and S1C select between a.c. and selected-polarity d.c. inputs. S2A and S2B select the range-multiplying resistors for a.c. and d.c. Since these resistors must be adjustable to initially set the calibration, by setting full-scale meter readings on the different ranges to agree with known input voltages, each multiplier is made up of a selected portion of one common 25,000-ohm adjustable, wire-wound resistor in series with ½ watt fixed resistors of appropriate values. While one 25,000 adjustable resistor would serve for setting both the five a.c. and five d.c. meter ranges, two are used, one for a.c. and one for d.c. This prevents the physical jamming and overlapping.

The parts list appended should enable any experienced serviceman to build such an instrument. A 0-1 milliammeter could be substituted for the 0-200 microammeter shown, with suitable changes in multiplier resistor values only, but would make 2 volts about the minimum possible range for full-scale meter deflection.

—30—



SH-H-H-H! THE ENEMY IS LISTENING!

● Sailors at sea couldn't listen to their favorite radio programs until one of our foremost radio manufacturers was commissioned to build a special sea-going receiver. It was found that ordinary radios "rebroadcast" and tipped off the ship's location. And without any radio, morale suffered.

Now, it's different! Sailors around the world are listening to radio programs from home through this low-radiation receiving set. The speed with which it was produced and put in service is a tribute, in part, to the *E·L* engineers asked to provide a suitable power supply. They did it—fast, and well.

This is just one of the many contributions to America's war effort which *E·L* research and specialized knowledge of vibrator power supplies and electronic circuits has made possible. You'll find *E·L* Vibrator Power Supplies on the job in all types of service, and on every front where the United Nations are fighting.

Wherever electric current must be changed, in voltage, frequency or type, *E·L* Vibrator Power Supplies and Converters offer a wide range of advantages, for peace, as well as for war.

For Operating Radio Transmitters in Lifeboats—E·L Model S-1229-B Power Supply. Input Voltage, 12 Volts DC; Output Voltage, 500 Volts DC; Output Current, 175 MA; Dimensions, 7½" x 5½" x 6¼".

For Operating AC Radio Receivers from DC Current—E·L Model 262 Marine Power Supply. Input Voltage, 110 Volts DC; Output Voltage, 110 Volts AC; Output Power, 250 Volt-Amperes; Output Frequency, 60 Cycles; Dimensions, 10½" x 7⅝" x 8¼".

Electronic
LABORATORIES, INC.
INDIANAPOLIS

***E·L* ELECTRICAL PRODUCTS**—Vibrator Power Supplies for Communications . . . Lighting . . . Electric Motor Operation . . . Electric, Electronic and other Equipment . . . on Land, Sea or in the Air.

GUNNER BY REMOTE CONTROL

HIS battleground is located far from the fighting fronts. His skill and long experience have been lent to the making of vital parts—parts that are vital to a boy in a bomber over Germany or his neighbor's son in a fighter in the Pacific. Their equipment is dependent on split-hair accuracy of Utah Parts—and he's giving it to them. He's a gunner by remote control.

There are hundreds like him at Utah—soldiers in coveralls. By the skill of their hands and the sweat of their brow, they're making sure that Utah Parts don't fail at the critical moment—as a switch releases a stream of machine gun bullets . . . as a headset receives a command to take a strategic height. These and many other vital electrical and electronic devices are being turned out in quantity and *on time* . . . by this precision task force at Utah. Important to the success of this task force is the work of the Utah laboratories. Here, new solutions to electrical and electronic problems are being worked out. Here, a great store of knowledge and experience is being accumulated.

Tomorrow that knowledge and experience will be at the service of peacetime America. There will be better Utah products built—more convenience, enjoyment and efficiency for many Americans—because of today's great advancements, necessitated by war.

UTAH RADIO PRODUCTS COMPANY, 824 Orleans Street, Chicago, Illinois. Canadian Office: 560 King Street, West, Toronto. In Argentine: UCOA Radio Products Co., SRL, Buenos Aires. Cable Address: UTARADIO, Chicago.

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

Utah

Moisture Content of Soil

(*Continued from page 23*)

vacuum-tube voltmeter, and condensers form a tuned receiving circuit which shows a maximum of current induced from the oscillator at resonance by the reading of the voltmeter depressed to a minimum. In this way the sum of the condensers is equal to a constant. By taking a reading on the first condenser the capacity of the second is known. A change in the capacity of either necessitates a corresponding change in the other condenser in order for resonance to be maintained.

The condenser, CS (Fig. 1) consists of four parts, two copper plates, a porous plate dielectric, leads, and a shield to protect the plates from undue violence in use. This shield also acts as a handle. The function of the copper plates and leads is obvious, while the porous dielectric serves to increase the uniformity of distribution of moisture between the plates and in coarse textured soils, adds to the accuracy of the readings, at the same time minimizing breaks in the calibration curve due to swelling of the soil at the higher moisture contents.

When a measurement is to be taken, the special soil condenser described above is inserted into the soil and equilibrium is allowed to take place. The leads are then plugged into the capacitor, which is then tuned to resonance and a reading is taken on the precision condenser.

While experiments in this field are not complete, results have shown the procedure to be highly satisfactory. Soils used, varied from a sandy loam to a fine loam. Two kinds of special soil condensers have been experimented with—plate type and cylindrical. Soil used with the second type was a sandy loam but due to the size of the condenser the curve in the readings had a flatter slope and the points showed greater variability than in the case of the first type condenser. The points on the curves were found by burying a condenser in soil contained in a large porous earthen pot, wetting the soil and taking capacity readings and moisture samples as the soil dried.

In tests with the plate condensers, soil was packed between the plates for the dielectric rather than the porous plate. The first bend in the curves, or readings, obtained was at about the optimum moisture, at which point they flattened out at about water-holding capacity. Optimum moisture content is two-thirds of the water holding capacity which is the amount of water in a soil layer one inch thick after gravitational water has drained from the larger pores.

Calculation of the theoretical dielectric constant of each soil from the corresponding moisture content and degree of compaction showed that the

rise in a curve could not be completely attributed to moisture content. In order to find whether the colloid present was responsible for the increase in the dielectric constants, different amounts of colloid were added to water and readings taken. By plotting sodium sulfate (Na_2SO_4), points obtained for both salts (chloride and sulfate) fell on the same curve. Thus, apparently, the amount of colloid did not increase the dielectric constant of soil.

It has been shown that when a condenser was placed about one foot from an irrigated row of flowers, and following an irrigation from one side of the condenser, that readings were likely to show a variation as high as 4 or 5 percent in a distance of six inches.

If preliminary work and further research progress according to plan, it is expected that radio will soon have another scalp to hang on its antenna.

—30—

Postwar Era

(*Continued from page* 42)

speed of light. *General Electric* has already begun work on a 100-million-volt accelerator.

"To the men in laboratories, and to the men in the factories and the offices of the electrical industry, it seems natural to speak of electronics as a science of the future because it gives such promise of great things to come. Yet that promise is based solidly on the present, as the electronic tasks and achievements sketched so hastily here will indicate. Of electronics' part in the war little has been said, but much will one day be written. While war with one hand withholds and obstructs our peaceful progress, commanding the energies of science for its own purposes, with the other it actually pushes forward research and application. Under the lash of necessity, developments which might have taken years are compressed into months. The world will reap these fruits of war, and they will not be bitter. A single example, in the field of ultra-short-wave radio, helps to make the point. Air transport pilots will have constantly before them, on the screen of a cathode-ray tube, clear warning of any obstacles ahead, so that mountains will lose their terror in darkness and thick weather, and blind landings will be facilitated. At sea the ship's pilot will detect nearby shipping or icebergs through fog and darkness as plainly as in clear weather by day.

"The inspiration which electronics gives to the engineer springs from its fundamental nature. Before the invention of electronic tubes, electrical engineering was largely a science of wires and circuits. We were concerned with the jars and bottles and pipes in which electricity was stored, through which it was distributed.

—30—

Some were REPAIRMEN . . . STENOGRAPHERS

. . . and some have been with us for a good many years. Now they form a solid battlefront behind the fighting front. Thanks to these men and women, the Kenyon Transformer Co. is building not only more transformers but even better transformers . . . something which, in view of the excellence of our product, we thought was impossible.

Valiant People . . . their hands are tough, their eyes are sharp, and their minds are determined. And, when day is done, you will find them at a Red Cross blood bank, or tending a Victory Garden, or collecting scrap-metal—doing just what America expects us all to do in this monumental struggle for human rights and dignity.

Your war bonds help the war effort—
buy more

THE MARK OF EXCELLENCE

KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK, U. S. A.

Spot News
(*Continued from page* 14)

what is now known as the Wheatstone bridge. In his paper, Wheatstone paid tribute to Samuel Hunter Christie, whose experimental work on magnetic induction, prompted the development of the bridge.

Wheatstone was a professor of experimental physics at Kings College, London for many years. Through his efforts, many improvements in the dial telephone with characters, type printing telegraph and submarine telegraphy appeared.

Wheatstone, who was knighted in 1868, died in 1875, in Paris.

WITH THE INAUGURATION OF MAJOR GENERAL INGLES as Chief Signal Officer, has come many changes in the administrative structure of the Signal Corps. Three new services have been created. These are . . . Engineering and Technical Service, Procurement and Distribution Service and Personnel and Training Service. In addition, the old Signal Operating Service has been designated as the Army Communications Service. In the new structure, the Signal Corps is composed of five operating services, instead of two.

Heading the Engineering and Technical Service, is Major General Roger B. Colton who was formerly Chief of the Signal Supply Service. Major General William Henry Harrison now directs the Procurement and Distribution Service, while Brigadier General J. V. Matejka now guides the Personnel and Training Service Division. On the Army Communications Board is former Chief of the Signal Operating Service, Brigadier General F. E. Stoner.

In direct control of all personnel in the Signal Corps for both military and civilian, is the newly created Personnel and Training Service.

Major General James A. Code, Jr., remains in his post as Assistant Chief Signal Officer. Other Signal Corps assignments which are the same as under the old setup are Executive Office, Colonel William D. Hamlin and Office of Planning, Colonel F. H. Lanahan, Jr.

Major General Harry C. Ingles, new Army Chief Signal Officer, taking his oath of office.

THE BROADCASTING BUSINESS has been catapulted to first-page prominence during the past few weeks, as a result of the Cox investigation of the FCC. In Capitol Hill and in government buildings around town, a riot of activity prevails.

During a public hearing, Eugene L. Gary, general counsel to the Select Committee of the House of Representatives investigating the FCC, told of the nature of the investigation. Several days later, Charles R. Denney, Jr., general counsel of the FCC, James Lawrence Fly, FCC chairman and chairman of the Board of War Communications, and Harold D. Smith, Director of the Budget, appeared before Representatives Cox, Hart, Wigglesworth and Miller, to testify. Testimony was keen and caustic. Many more weeks will be consumed by the investigating committee in studying the FCC situation.

In the meanwhile, many bills and amendments calling for changes in the Communications Act have been proposed. The last bill, to be proposed, just before Congress adjourned, was H.R. 3109 which was introduced by Representative Holmes of Massachusetts. The proposed bill calls for the organization of the Commission into two divisions of three members each, to be known as Division of Public Communications and Division of Private Communications. Public service would be the interests of the Division of Public Communications, according to the bill. The Division of Private Communications would have jurisdiction over wire and radio communications transmitted by a common carrier for reception by a designated addressee.

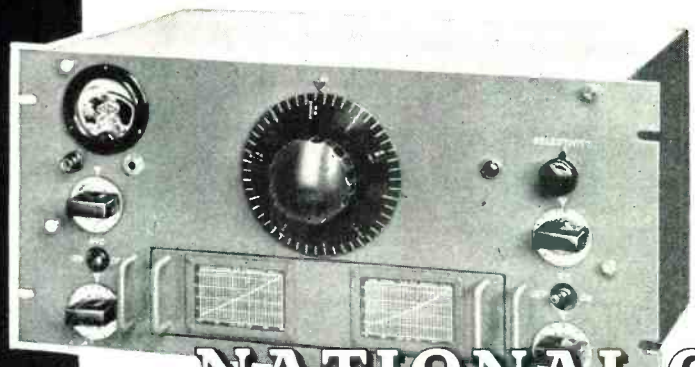
The proposed act emphasizes the fact that the Commission would have no power over the regulation of the business of the licensee of any broadcast station. The power of censorship or the right to interfere with free speech is also forbidden under this act. The bill also provides for appeals to the District Court in the District of Columbia and to the Supreme Court if necessary. The appeals permitted by this act, include any radio operator whose license has been revoked or suspended by the Commission.

The bill was referred to the Committee on Interstate and Foreign Commerce, who also have under advisement several other proposals for

REPUBLIC P-47

OFFICIAL PHOTOGRAPH,
U.S. ARMY AIR FORCE

In receivers as in airplanes, it is the margin of superiority that wins victory. Almost good enough is no good at all.



NATIONAL COMPANY

MALDEN, MASS., U. S. A.

amendments to the Communications Act of 1934.

It appears as if several more bills will be proposed when Congress reconvenes in September. Then radio activity will really be swinging along.

AN INTRIGUING REPORT ON A 28,000-MILE TOUR of inspection of the African, Middle Eastern and China-Burma-Indian theaters of operations, was filed by Major General Dawson Olmstead, just before his retirement as Chief Signal Officer of the Army. General Olmstead stated that he was intensely impressed by the tremendous task in providing communications on the scale called for by our world-wide operations. He pointed out that modern wire and radio communication is required in places where there never had been any before . . . in deserts, jungles, the Himalayan mountains. General Olmstead said that as he went half way around the world, he watched with pride the United States Army communication groups instructing, operating and maintaining our global network of communications. However, he pointed out, although our boys are doing a wonderful job, there is still a bigger job to be done.

The commanders of the American forces in North Africa were particularly pleased with the operation of the five-pound Walkie-Talkie units and the f-m armored force and artillery units, said General Olmstead.

General Olmstead also reported that British Signal Officers paid tribute to the American designers and manufacturers who have produced communications equipment that has stood up so well under the stringent conditions of warfare in all climates.

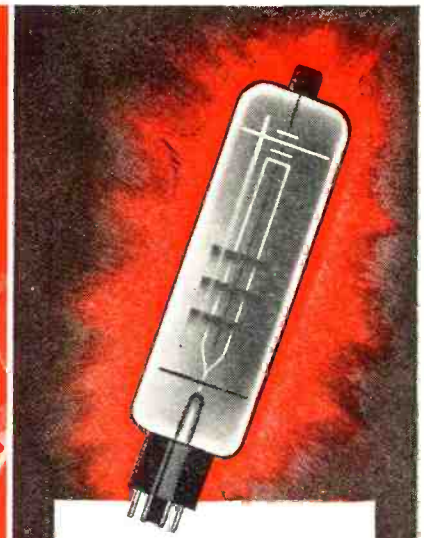
THE MYSTERY OF THE LAST MINUTE WITHDRAWAL of the renomination of FCC Commissioner Payne, deepens. The post is not expected to be filled until after Labor Day, when chairman Wheeler whose Senate Interstate Commerce Committee considers FCC appointments, returns. Thus the FCC will, during the interim, have only six members.

Commissioner Payne, who had been a veteran FCC member, refused to comment on the incident. During White House press conferences, no official word on the Payne situation was available either. Labor Day or thereabouts seems to be the day when we'll have the facts.

THE STEEL WIRE RECORDER that was demonstrated at the recent NAB War Conference in Chicago and then described in these columns, is now seeing service in many military and industrial activities. The Navy is using many of the machines on sea as well as in the executive offices in Washington. They are very useful in rolling, tossing ships, since there are no parts that will shift. And, in addition, recording is possible in any position of the machine, even when it is upside-down.

FROM HUNDREDS OF MILES AT SEA CAME

THE ALARM THAT SAVED MIDWAY!



Midway was ready when the Jap attempt to capture this strategic U. S. outpost came June 4 to 7, last year. Long before the Jap fleet of battleships, carriers, cruisers, destroyers and transports could bring their big guns into range—vigilant patrol planes with modern radio communications equipment had sounded the alarm. Many miles from Midway's shores American planes blasted their fleet... drove their survivors into a frantic homeward retreat.

REPEATEDLY it has been said—"this war is different". Yes, different because, on land, at sea and in the air, battles are being planned and fought with weapons never before available to our fighting men. Among these is the electronic tube. It is reassuring to know that no nation is making wider or better use of this great weapon of modern warfare than the U. S. A. To help serve the vast requirements of our Army and Navy National Union, for example, is producing electronic tubes on a scale far exceeding its peace-time peak. Yet, dramatic as are the achievements of electronics in war, there will be even more miraculous peace-time tasks for tubes to perform. Expansion in the use of electronic devices will bring many new calls for service work. With quality tubes, fine test equipment and new merchandising plans, National Union will be prepared, as never before, to help steer this profitable business your way.

NATIONAL UNION RADIO CORPORATION • NEWARK, NEW JERSEY • LANSDALE, PENNSYLVANIA

NATIONAL UNION RADIO AND ELECTRONIC TUBES

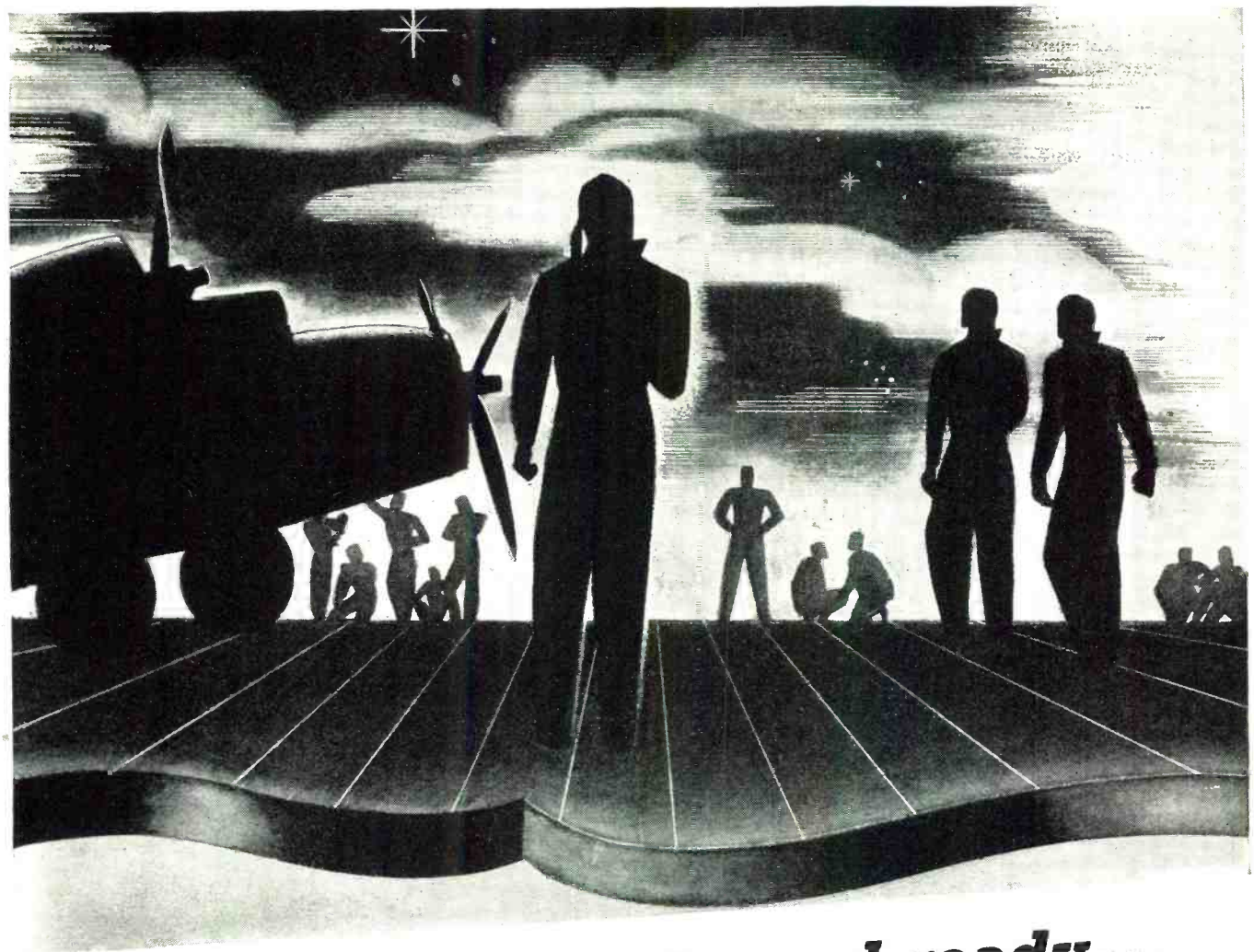
Transmitting Tubes • Cathode Ray Tubes • Receiving Tubes • Special Purpose Tubes • Condensers • Volume Controls • Photo Electric Cells • Exciter Lamps • Panel Lamps • Flashlight Bulbs

Even the Marines and Canadian naval headquarters have shown an interest in the recorder. American broadcasters in London are experimenting with the unit, too, for recording of on-the-scene activities, and rebroadcasting either from over there, or here, by using a wire record that has been flown here. Since the spool containing the record occupies little room, and weighs little, too, there is practically no objection to its being shipped via plane. The only real problem, at the present, is the scarcity of recorders. It is believed, however, that increased production facilities available soon will fill at least the minimum demands of military and commercial quarters.

IN COMMEMORATION of the sixth anniversary of the death of Guglielmo Marconi, the Veteran Wireless Operator's Association presented three Marconi Memorial Radio Institute scholarships to high school students at ceremonies over WOR. the Mutual Network, July 20. Ted R. McElroy, world's champion code operator, opened the program by transmitting the signal S. Major General Joseph O. Mauborgne, former chief signal officer, also appeared at the broadcast.

Personals . . .

Harry B. Gilmore, secretary of Western Electric, retired recently after 41 years of service. He was succeeded by **Norman R. Frame,** who has been with the company for the past twenty years. . . . **Palmer M. Craig,** has been named chief engineer of the radio division of Philco. He joined Philco in 1933. . . . The World Broadcasting System has been purchased by Decca Records. **Paul Deutsch** will continue as president. . . . **Lloyd A. Briggs,** general superintendent of RCA Communications has been elected vice-president and general superintendent of that company. . . . **Roy C. Coderman** has resigned his post as assistant chief of the OWI Bureau of Communications Facilities and rejoins the radio division of Western Electric. He has been on leave of absence from A. T. & T. since December 1, 1941. . . . **Noran E. Kersta,** manager of NBC's television department, has been commissioned a first lieutenant in the Marines. . . . Many changes in the technical personnel of CBS have occurred in the past few weeks. **H. A. Porter** has joined the CBS maintenance department. **Barney Zweig** is now at the short-wave studio as a technician. **Dramin Jones,** former staff technician for WABC's Columbia Island transmitter is now assistant supervisor of the maintenance department. . . . **S. I. Cole,** president of Aerovox Corporation, was elected a member of the executive committee of the RMA, at the recent convention in Chicago. . . . A new engineering committee of f-m broadcasters has been formed with **John V. L. Hogan** (W2XQR-WQXR) as chairman, and **Franklin M. Doo-**



Wide awake and ready . . .

Engineers, like fighter pilots, are cool and calculating individuals . . . fellows who believe in nothing unless proven. Along with them, we know that the future holds out promises of many new and revolutionary developments . . . and every angle and possibility is being carefully analyzed. However, like your true engineer, we make no predictions . . . we're simply wide awake and ready.

Meanwhile, there's work to be done . . . important war work . . . and this occupies our immediate attention. It isn't new to us because our experience goes back to the beginning of radio. We've manufactured sound systems, test equipment and numerous electronic devices. We maintain a model organization where management-labor relations are the most cordial . . . making for the highest standards of quality and efficiency. Yes, ECA is busy . . . but, occasionally, our production schedules enable us to take on additional contracts.

Now . . . more than ever . . . invest every dollar you can spare in United States War Bonds and Stamps.

ELECTRONIC CORP. OF AMERICA

ELECTRONIC CORP. eca OF AMERICA

45 WEST 18th STREET
NEW YORK 11, N. Y.
WAtkins 9-1870

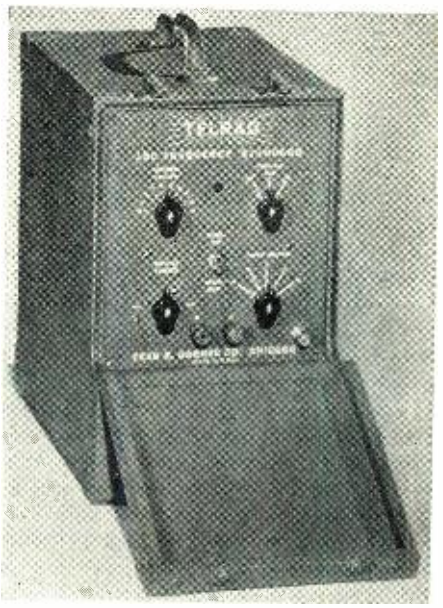
little (W65H-WDRC), **J. R. Poppele** (W71NY-WOR), **Walter Evans** (W57PH, W67B, W75P and W49FW), **Vin Ulrich,** engineer in charge of War activities, at Hytron, was married recently. . . . **Dr. Joseph Slepian,** associate director of Westinghouse Research, was honored recently for his work on the ignitron. He received the Benjamin Garver Lamme medal awarded annually by the American Institute of Electrical Engineers.

—30—

What's New

(*Continued from page* 37)

quency Meters have proven themselves in field and factory, on all types of radio equipment, to be ideal for (1) setting transmitters that are not crystal-controlled on any desired frequency; (2) continuously monitoring transmitted signals; (3) locating any desired frequency on a receiver dial; (4) checking frequency characteristics of crystal-controlled transmitters or receivers; (5) aligning and calibrating receivers, in both IF and RF stages; (6) checking accuracy of field or production oscillators, signal generators, and frequency meters that are not crystal-controlled; and (7) checking crystals in the field or in production.



Special models designed for use under adverse conditions are available equipped with two precision crystals that have been ground to produce exact frequencies of 100 and 1,000 kc. and tested for efficient operation at temperatures from—35° to 55° Centigrade and have temperature co-efficients of maximum drift of only 2 and 3 cycles per megacycle per degree Centigrade respectively.

Models are available for either a.c. or portable battery operation. Additional information may be obtained from the manufacturer: *Fred E. Garner Co.,* 43 East Ohio Street, Chicago, Illinois.

—30—

Adaptor Unit

(*Continued from page 41*)

be mounted in the chassis hole. A similar plug and socket connection may be employed at the other end of the cable for connection to the 'scope.

In the writer's layout, baffle shield partitions were not found necessary for hum-free operation. However, should interaction between circuits result from attempts to achieve a more compact arrangement of parts, it will be advisable to mount shield partitions, both above and below the chassis, between the front line of tubes and the power supply components. The top shield must extend all the way to the top of the cabinet; the bottom shield to the lower edge of the chassis.

For best results, the mechanical assembly of the adaptor unit must follow the usual rules of good practice. All mountings to chassis or panel must be made securely. Lock washers should be used liberally throughout, and single-bolt fastenings are to be avoided. All components must be thoroughly fastened in place before the electrical wiring is undertaken.

The signal-input terminals are banana-type jacks which are fed through the panel or chassis in the following positions: horizontal input pair through panel on left-hand side (See Figure 3), vertical input pair through panel on right-hand side, and synchronization voltage pair through panel and chassis along lower center portion of front panel. The high-potential jack in each pair is insulated from the panel or chassis by means of fiber or bakelite shoulder-type washers. The low-potential ("common" or "ground") jack in each pair is mounted directly in contact with the metal.

The panel must be securely fastened to the chassis by means of several screws. In order to obtain a good electrical bond between the two, all paint should be removed from the surfaces of contact.

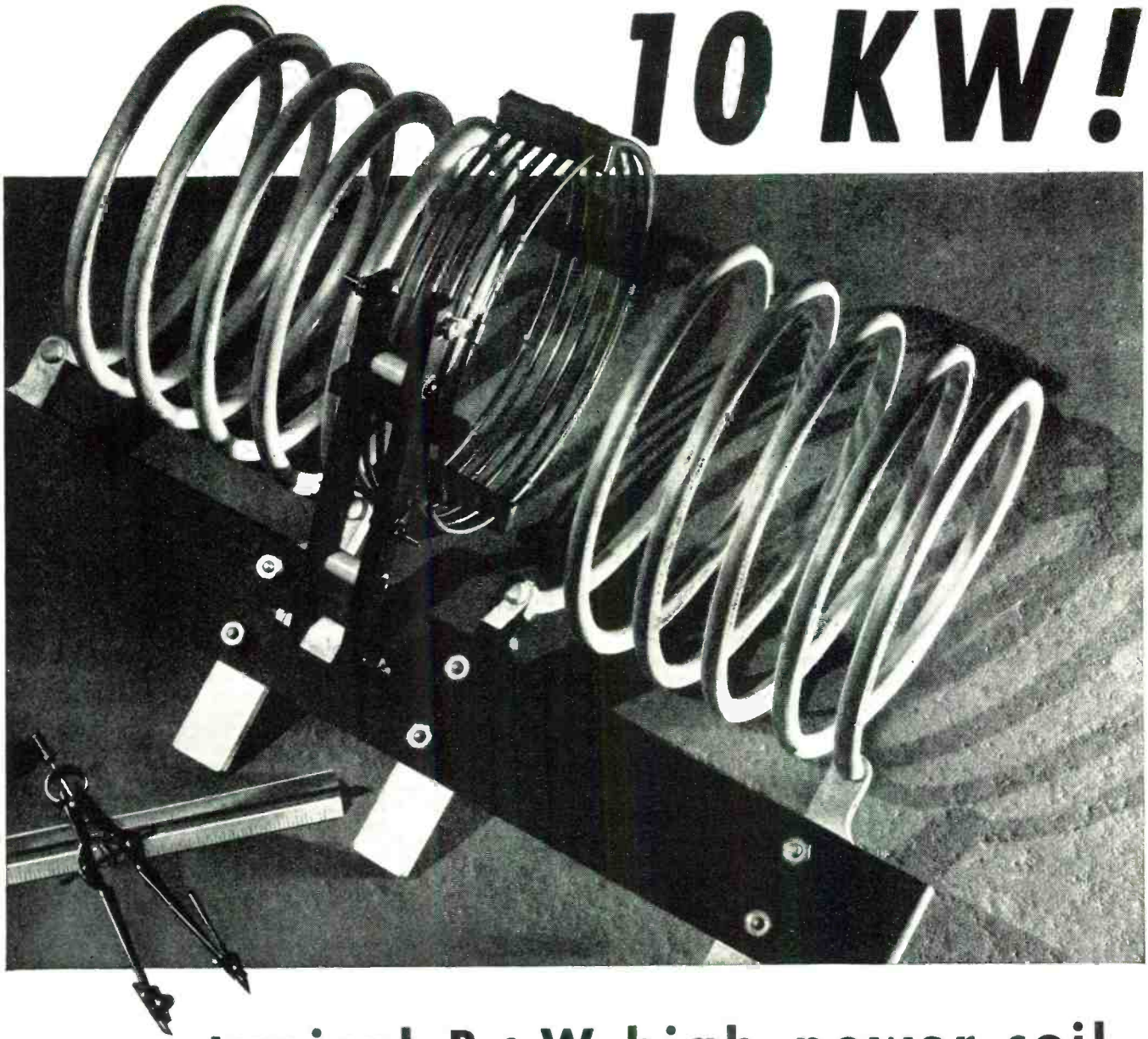
The switches and controls have been arranged on the front panel for ease of manipulation and minimum disturbance. This accounts for the placement of toggle switches beneath the control knobs. Settings of the latter will, as a result, not be disturbed by free fingers when the switches are thrown.

Control knobs are of the small, fluted, finger-grip type. The name plates are made by lettering in black India ink on plain white strips of Bristol board. These strips are given a coat of clear lacquer, after lettering, for waterproofing and protection against soiling. They are then cemented to the front panel. An alternative method of mounting the name plates would employ transparent cellophane tape to hold the lettered strips to the panel.

Electrical Construction

In the mechanical layout, shown in

10 KW!



...a typical B & W high-power coil

Over 10" in diameter by 20" long, and designed for 10 KW. service, this variable-link final amplifier, plate coil, is a good example of B & W engineering at work on the job of matching modern inductor requirements. B & W Inductors of this general type are available in all standard frequency ranges. Coils are bolted in place, and may be switched for band-changing with a minimum of time and effort. Connections are silver-soldered, and all metal parts, including coils, are heavily silver-plated. Coils in the unit illustrated are of ⅝ copper tubing. Other B & W Air Inductors of this type utilize tubing as large as 1".

FAST DELIVERIES on all B & W Air Inductor types are assured by our greatly expanded facilities, and straight-line production on most smaller types. Engineering data on any type upon request.

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)*

B&W

TURRETS — BAND HOPPERS — SWINGING LINK ASSEMBLIES, ETC.

SPECIAL RADIO AND ELECTRONIC EQUIPMENT ASSEMBLIES

Variable Air Condensers

(Integral neutralizing types)

MANUFACTURERS OF QUALITY ELECTRONIC COMPONENTS FOR OVER A DECADE

Figure 1, all parts have been placed for best electrical efficiency. This arrangement permits short leads to be run between circuit components and reduces interaction to a negligible level.

Wiring of the unit is straightforward. A heavy, single-strand hookup wire should be employed, keeping all wiring close to the chassis. Soldering lugs may be employed as miniature cable clamps to hold the wiring snugly against the chassis. Whenever possible, the normal leads of the parts themselves should be used for connections. An example is the pig-tail leads of the capacitors.

For best results, as much of the wiring as may be run together should be cable. Permissible conductors for the cable include the "B"-plus lines, ground returns, and screen leads. A.C. leads must be run in separate cables apart from all other leads. Amplifier and oscillator grids must be connected directly to the associated controls by as short and direct leads as possible. These connectors should be short lengths of stiff conductor, such as "skinned" hookup wire.

The low-potential jacks in each of the input terminal pairs must be connected together and to a common ground lug fastened at some point on the chassis. A heavy bus bar, of at least No. 14 gage, must be employed for the purpose. Amplifier cathode resistors, all bypass and filter capacitors, and amplifier controls should be returned to this same common bus.

All a.c. wiring must be made with twisted-pair leads run close to the chassis and well away from all other wiring in the unit. Extreme care must be taken to segregate the a.c. conductors from the rest of the wiring.

The signal input leads and those leading to the three-wire 'scope cable must be segregated from *all other* wiring in the unit. It is advisable to cover each such lead with high-grade shield braid and to ground the latter to the chassis at several points.

The frequency-range capacitors, C2 to C8, are wired to the rotary selector switch and pressed compactly together. The switch-capacitor assembly is then inserted into its shield can from which only two leads emerge.

Rosin-core solder must be used throughout in the wiring of the adaptor, since acid-core solder and some of the other fluxes and pastes give rise to later corrosion and noisy joints.

Testing Completed Unit

After the assembly and wiring have been completed and all wiring has been checked, the adaptor unit will be ready for preliminary checking.

(1) With the adaptor disconnected, place the basic oscilloscope into operation, adjusting its brilliance and focus controls for a sharp dot pattern in the center of the screen. High brilliance must *not* be used, because of the danger of "burning" the screen with this stationary dot,

(2) Without switching on the adaptor unit, connect the adaptor cable to

Where was RCA on the night of January 2, 1940?

● January 2, 1940 — 23 months and 5 days before Pearl Harbor — where was RCA on that night?

● It was at the point of launching a peace-time program that was to be recognized eventually as an important military measure. For that program was one of *simplification*.

● It was called the *RCA Preferred Type Tube Program* and was inaugurated because the several hundred different tube types then in existence resulted in short, uneconomical manufacturing runs, complex problems of warehousing and replacements, and other inefficiencies which made it impossible to give the ultimate customer the maximum of dependable service and the greatest value for his money.

● With the advent of war, the government recognized the advantages of such a program and issued an "Army-Navy Preferred List of Tube Types." The latest revision of this list is dated March 1, 1943. We will be glad to send you a copy on request.

● The urgent requirements of war are proving the worth of this program in releasing for other purposes the large quantities of materials ordinarily tied up in many types and styles of tubes. Also, the principle of Preferred Type Tubes is proving a blessing on the fighting fronts— where vital replacements can be expedited for equipment designed to use standard types of tubes.

★ *Buy United States War Bonds and Stamps* ★

RCA

RCA ELECTRON TUBES

RCA VICTOR DIVISION · RADIO CORPORATION OF AMERICA
CAMDEN, N. J.

TUBE RECOMMENDATIONS FOR POST-WAR DEVELOPMENTS

The advantages of the Preferred Type Tube Program are so far-reaching that it is only logical to assume that we will continue the program after the war. Our applications engineers will be glad to consult with equipment manufacturers concerning the tube types most likely to be on our list of post-war preferred types.

the 'scope's vertical, horizontal, and ground terminals. No displacement or distortion of the dot should now occur on the cathode ray screen. Any variation from the original sharp, clear, centered point will indicate that stray voltages are being picked up by the cable or the adaptor wiring,

(3) With the line switch *off* in the adaptor unit, set R7 and R17 at midscale, set S1 to EXT., S2 to C8, S3 to LINEAR, S4 to AMP., and S5 to AMP. Next, switch on the power to the adaptor by means of the R1 control knob, leaving R1 set at minimum after the switch has been cut in,

(4) Increase the setting of R7 slowly, observing that the amplified high-frequency voltage from the sweep oscillator is now swinging the original dot across the cathode-ray screen so rapidly that a single horizontal line appears. Note also that the length of this line may be increased by increasing the setting of R7, and vice versa. This completes the test of the horizontal amplifier and sweep oscillator,

(5) To test the vertical amplifier, set R7 at minimum and S3 to EXT. With the other controls in the same positions as specified under (3), connect a source of low-voltage a.c. (the 6.3-volt winding of a spare filament transformer will suffice) to the vertical input terminals T1 and COM. Increase the setting of R17 slowly, observing that the original dot is now deflected vertically on the cathode-ray screen, describing a vertical line, the length of which is controllable by means of the R17 setting.

(6) By means of the gain controls in the horizontal and vertical amplifiers, it should now be possible to vary the pattern on the screen from a fine, clear point to a vertical line when an a.c. voltage is applied to the vertical input terminals, or to a horizontal line when no vertical signal is applied but when the sweep oscillator is operating,

(7) With the a.c. voltage source connected to the vertical-input terminals, as described under (5) and with the vertical line maintained on the cathode ray screen, throw S3 to LINEAR and observe that now a wave pattern appears on the screen. By switching S2 to the C3 position and adjusting R5, the sweep oscillator may be placed in step with the 60-cycle line frequency. When the correct adjustment of oscillator frequency is reached, a single complete a.c. cycle will appear on the screen. This cycle pattern will slide from side to side on the screen, but it may be brought to rest and locked in place by synchronizing: throw S1 to 60 CYCLES and increase the setting of R1 until the pattern becomes motionless. If the pattern is too high, extending beyond the top and bottom of the screen, it may be shortened from both ends vertically by reducing the setting of R17; if it is too wide, extending beyond the two sides of the screen, its width may be reduced simultaneously by backing off the setting of R7,

(8) A synchronizing voltage may also be introduced via terminals T3 and T4 provided switch S1 is thrown to

DOING OUR JOB WELL...
Welcoming more jobs to do

Majestic
Mighty Monarch of the air

To meet the demands of our armed forces, American Industry was forced to step up its production and manufacturing standards.

Majestic was among the first to adopt the new tempo. Walkie-Talkies, Marker Beacons and Electronic Equipment of several kinds leave the assembly lines in a never ending stream. Crystals, with their requirements of infinite precision, are being produced by the thousands.

Majestic has done its job well — and in doing it has become a stronger organization; stronger in personnel—stronger in resources and facilities. Guided by veterans of the radio industry, it has not yet reached its peak in production capacity — its new strength has not yet been fully taxed.

Majestic welcomes more jobs to do.

MAJESTIC RADIO AND TELEVISION CORPORATION

2600 West 50th Street • Chicago, Illinois

Builders of the WALKIE-TALKIE, "Radio of the Firing Line"

$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*

EXT. Some frequency other than 60 cycles may thus be employed. Likewise, a sweep voltage other than that generated by the internal saw-tooth oscillator may be introduced via terminals T2 and COM., provided the sweep switch, S3, is thrown to EXT. In the absence of a variable-frequency oscillator as a source of sync.voltage, a signal may be made to synchronize itself by running a jumper between the VERTICAL and SYNC. high-potential input terminals,

(9) Signal voltages may, if they are sufficiently high level, be presented directly to the deflection plates of the cathode-ray tube, without amplification. The signal voltages are applied in the usual manner to terminal posts T1 and COM. and/or terminals T2 and COM. For direct vertical input, switch S5 is thrown to DIR.; for direct horizontal input, switch S4 is thrown to DIR.

—30—

Buy War Bonds

Practical Radio Course

(*Continued from page* 44)

of permissible distortion acceptable for all cases.

Maximum Undistorted Power Output of Single Triode Power Amplifier

Since the harmonic distortion produced by a single-triode power-amplifier tube operated with its proper voltages is mainly of 2nd harmonic variety, and 2nd harmonic distortion within 5 per cent is acceptable, we are justified in saying it produces "*undistorted* output if its total harmonics do not exceed 5 per cent." It has been experimentally determined that for a triode the *maximum undistorted* (harmonics within 5 per cent) power output for any given signal input voltage is obtained when the load resistance is equal to about *twice* the a.c. plate resistance of the tube at the time the plate current is at its peak value. Under this condition, when $R_L = 2R_p$, the power output becomes:

Max. undistorted power output =

$$\frac{(\mu E_g)^2}{9\,R_p}$$

This is very little less (actually about 11 per cent less) than the maximum power output (neglecting distortion) of which the triode tube is capable.

In the foregoing equation the power is in *watts* if E_g is the *peak* value of the signal voltage (in volts) applied to the grid. In a single-tube Class A amplifier, this voltage is limited to a value approximately equal to the grid bias voltage recommended for the tube, if tube grid overloading is to be avoided. Even with the load resistance equal to twice the tube plate resistance, there is a considerable curvature at the bottom portion of the dynamic operating characteristic. Therefore, in order to avoid distortion, signal input voltages high enough to reduce the plate current below a certain critical value on negative peaks must not be applied, for the lower bend may be reached at signal voltages which are not even nearly large enough to drive the grid positive on the positive peaks.

It should be remembered that what has been said here applies strictly to triode power amplifier tubes only. Pentode and beam power tubes present somewhat different conditions, as we shall see later.

The plate load resistance values ordinarily specified for the various amplifier tube types on the Tube Characteristics charts of tube manufacturers are those that will result in maximum *undistorted* power output being transferred to the load. The actual amount of harmonic distortion that exists when the tube is operated under the conditions specified is also stated in some

The SPRAGUE TRADING POST

EXCHANGE — BUY — SELL

Your own ad run FREE!

The "Trading Post" is Sprague's way of helping radio servicemen obtain the parts and equipment they need, or dispose of the things they do not need during this period of wartime shortages. Send in your own ad today—to appear free of charge in this or one of the several other leading radio magazines on our list. Keep it short — WRITE CLEARLY — and confine it to radio items. "Emergency" ads will receive first attention. Address it to:

SPRAGUE PRODUCTS CO., Dept. RN39
North Adams, Mass.

WANTED—1½ V. 90 V. A-B pack batteries. Also 1A7, 1A5, 1H5 and 1N5 tubes. Ellison's Radio Service, Centertown, Ky.

SIGNAL GENERATOR WANTED—RCA or Philco. Will trade late table model radio or pay cash. Service Radio Co., 3320 White Oak Drive, Houston, Texas.

RIDER MANUALS WANTED—Will pay cash for complete set. Give details and price. L. W. Bakewell, 434 W. Locust St., Springfield, Mo.

FOR SALE—100-watt R.F. unit, HK-24 final. Completely portable with self-contained 1000 volt power supply, Xtal oscillator, meter, relays. In 13x20x12-inch steel cabinet. Will give full output up to 30 megacycles. Ideal for schools engaged in radio instruction. E. F. Harris, 60 E. Norwich, Columbus *(1)*, Ohio.

WANTED—Howard 435-A or 436-A receiver; also Howard 610 power pack. Morris Hagemeister, Manfred, N. Dak.

WANTED—Electric tube tester in good condition and not too old. Also 0-1 or 0-5 ma. meter. Will pay cash. Reginald H. Cox, Hoyt Station, Sunbury County, N.B., Canada.

WANTED — Chanalyst, 3" oscilloscope, Aerovox LC checker, Hickok or Jackson Signal Generator, tube tester, multimeter. First class equivalent quality acceptable. Dick's Radio Service, 4705 Delmar, St. Louis, Mo.

XMITTER PARTS TO SELL OR TRADE—Am offering wide variety of parts in normal used condition. These include resistors, modulation transformer, sockets, neutralizing condenser, RF tuning condensers; fixed condensers; oil-filled condensers, etc.—all from a Western Electric 9-A low-level modulation 400-watt transmitter used in aircraft ground station service in 3000-6000 kc.band. Would like to trade for 24-A tubes, 27's, 45's, 80's, 117L7GT, or power pack Xfrms, or 0-1 ma. meter. Write for complete list. Gerald L. Cook, 12453 Maple St., Blue Island, Ill.

NEEDED AT ONCE—Late model oscilloscope *(3")*; also university LH horns with or without units. Cash waiting. Fred Allen, Brockton Sound Service, 449 Howard St., Brockton, Mass.

"EMERGENCY"—We need 75 each of the following tubes: 12SA7; 12SK7; 12SQ7; 50L6; 35Z5; 35Z3; 6SA7; 6SK7; 6SQ7; 1A7; 1N5; 1H5; 1A5; and 3Q5, as we have over 100 radios for service that cannot be returned to customers due to grave shortage of tubes in this district. Please write airmail how many you can ship —prices—condition, etc. Roy Davis Company, Orange Park, Florida.

EQUIPMENT TO SWAP OR SELL—Signal generator, tube tester, volt-ohm-milliammeter, condenser checker, 10 pairs of earphones, "B" eliminator, dynamic speakers, tubes, condensers, and much misc. equipment. Write for details. Robert Wood, 10950 Longview Ave., Detroit *(5)*, Mich.

WANTED—Will buy tube checker for latest type tubes. Also want the following tubes, glass or metal, 12SK7; 12SA7; 35Z5; 35Z3; 1A7; 12SQ7. Send details. Fields Radio Shop, Tuscaloosa, Ala.

SIGNAL GENERATOR WANTED—to use with R.F.O., also Hickok Oscillograph. Must be in good condition. Write giving full details. Radio Electric Appliance Co., 111 East Main St., Lancaster, Ohio.

WANTED—Meissner 5-tube A.C. TRF kit; phono oscillator, earphones, milliammeter *(0-5 ma.)*; 0-50 D.C. voltmeter. I have 50L6, 35Z5, 35L6, 25L6 and 0Z4 tubes, power transformers, speakers, auto vibrators, oscillator coil and Jackson tube tester to trade. W. J. Pettit, 1715 Austin St., Houston *(3)*, Texas.

RECEIVER WANTED—Will buy new or used Hallicrafter receiver. W. B. Ford, Box 1239, Morenci, Ariz.

WILL BUY—Volt-ohmmeter or a tube tester. Describe and name price. J. P. Hyde, Fairfax, Va.

INSTRUCTION SHEET WANTED—or book for model 660 Electronic multitester made by Radio City Products Co. Will pay postage on same. Quote price. Bonded Key Shop, 1731 Wayne St., Toledo *(9)*, Ohio.

METERS FOR SALE—Weston 3" round types. One 0/4/8/150 A-C voltmeter model 476. One 0/15/150 ma. DC model 301. Practically new condition. Cash only. John R. Kelly, 261 Linden Ave., Towson *(4)*, Md.

SELL OR TRADE—Inter-communicator, 1 master, 1 sub. Will take to 10 sub-stations. Want test equipment, short wave receiver, Rider's manuals, or what have you? Fred E. Vaughn, Box 546, Eugene, Oregon.

WANTED FOR CASH—Good vacuum tube voltohmmeter or what have you? Also want service manuals and new radio tubes of needed types. Gunderson Radio Service, New London, Minn.

FOR SALE—60-watt Amp. Airline with two G-12 Rola speakers, with outside and inside cases, 200 ft. cord, Amperite high imp. mike and small stand. Price $175. Perfect condition. Stewart Rivers, 7038 Woodland Ave., West Philadelphia, Pa.

COMMUNICATION RECEIVER WANTED — for armed forces. Preferably Hallicrafter with "S" meter. Also tube tester, late model for loctals; and voltohmmeter. Cash. C. M. Edwards QM 1/C, 45 Construction Battalion, Headquarters Co., Communications Section, c/o Fleet Post Office, San Francisco, Cal.

WANTED—Wilcox-Gay Recordio Jr; Kadette Tunemaster; National model CRM oscilloscope or Thordarson T-11K99 oscilloscope. A. M. Stump, 15 Niagara Ave., Dayton, Ohio.

SHOP EQUIPMENT WANTED—for new service business. Need new or used RF signal generator, multimeter or tube checker and multimeter combined. Cash for any I can use. Avery Lenty, 401 E. Church St., Salem, Illinois.

BUG FOR SALE—One electronic bug for either American or International code. A-1 condition. $15. Donald H. Hazell, Signal Corps Message Center, Camp Hood, Texas.

MANUAL FOR SALE—Rider's XIII *(new)* $10. Peter Grzywna, 106 N. Ferry St., Schenectady *(5)*, N. Y.

NEEDED IMMEDIATELY—Test equipment in good condition; 12SA7, 12SK7, and 12SQ7 tubes, also Rider's manuals, any or all vols. Cash. Bob's Radio Shop, Box 179, Christiansburg, Ohio.

CASH WAITING—for Micro and 0 to 1 MA meters; testing instruments and oscilloscopes; overhead screw recording unit; 12, 35, and 50 volt tubes, etc. What have you? Rush price and complete information. Scott Radio Service, 163 Hanover St., Bridgeport *(4)*, Conn.

OVER 500 REPLIES FROM ONE LITTLE AD!

When an Illinois serviceman went out of business "for the duration" he sent us a Trading Post advertisement featuring his shop equipment. This was run at no cost to him and here, in a letter typical of dozens of others being received, is what he says of the results:

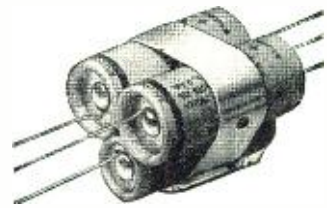
"I received over 500 letters and cards, and sold all of my equipment to the third man who wrote. When I open my shop after the war, I'll be using Sprague Condensers again and wouldn't think of using any others. Sprague have always given me 100% service!"

Here are a few of the many other comments:

"Just a line to thank you for running my ad for a UTC Varitone and to let you know it was successful." C.T.H., New York.

"This free service is deeply appreciated by myself and other local servicemen who have either purchased or disposed of equipment through the Sprague Trading Post." N.J.C., Chicago.

"Some time ago, I sent in a Trading Post ad for an oscilloscope and had almost forgotten it until I received four letters from people wanting to sell scopes. I was able to purchase one at a very reasonable price." S.R.M., Ohio.



Ask for Sprague Atoms (midget drys) by name! Use them universally on EVERY electrolytic condenser replacement job!

SPRAGUE PRODUCTS CO.
North Adams, Mass.

SPRAGUE CONDENSERS AND KOOLOHM RESISTORS

Obviously, Sprague cannot assume any responsibility, or guarantee goods, services, etc. which might be exchanged through the above advertisements.

instances, but when it is not, it is understood that it is within the limits allowable for good fidelity. The values given for single Class A *triode* power tubes are usually for operation with second harmonic waveform distortion of about 5 per cent at maximum output, (since the 3rd and higher order harmonics are small under these conditions).

It is interesting to note that for given circuit constants the second harmonic distortion for single Class A power triodes and beam power tetrodes increases more or less linearly from zero to full power output. Hence while the second harmonic distortion may be as high as 5 per cent at full power, it would be less at lower power outputs. Advantage is sometimes taken of this characteristic by selecting a larger power tube than the power output desired would ordinarily warrant, and then operating it at considerably less than rated power output so the harmonic distortion will be low. Use of a push-pull arrangement, or inverse feedback, would accomplish the same result.

Push-pull Connection for Eliminating Second-Harmonic Distortion

One effective and often-used method of eliminating practically all the second (and higher *even* order) harmonic distortion produced by power amplifier tubes is to operate two identical tubes (or one "twin" tube) in what is known as a *push-pull* circuit arrangement. Since the push-pull connection eliminates only second, and higher *even*-order harmonic distortion produced by the tubes, it is used mostly for triodes, and sometimes for beam power tubes, since these produce the largest proportion of 2nd harmonic distortion. That produced by pentodes is mainly 3rd harmonic (which cannot be eliminated by the push-pull circuit). Since the push-pull connection eliminates practically all the second harmonic distortion caused by the tubes, the maximum power output that can be obtained from the two tubes in push-pull (assuming a prescribed amount of second harmonic content is allowable in the combined output) is greater than *twice* as much as that deliverable by a tube of the same type operating singly and under the same voltage conditions and with the same prescribed amount of second harmonic content in its output.

How the Push-pull Connected Amplifier Operates

The push-pull circuit functions on the basic idea of so connecting the two identical amplifier tubes and their auxiliary components that the signal always causes the plate current in one tube to *increase* while that in the other tube *decreases*. Then the plate currents of the two tubes are made to flow in such relative directions in a center-tapped-winding output transformer that all the even-order harmonics (2nd, 4th, etc.) generated by one tube cancel out those generated by the other.

The basic circuit arrangement commonly used to accomplish this is illustrated in Fig. 1.

In this circuit the signal voltage is introduced through the push-pull input transformer (also called a *coupling* or *inter-stage* transformer) which has a secondary winding, *S*, tapped at its electrical center H. If E is the total signal voltage developed across the winding at any instant, one half of this (or E/2) will appear between the center tap and either end of the secondary winding. Therefore, since each end of the secondary winding connects to the grid of one of the power tubes, and the center tap connects through the grid bias voltage source to both cathodes, one half of the total signal voltage is applied to the grid circuit of each tube. (This means that in order to fully drive the grids of two tubes connected in a push-pull circuit, twice as much voltage is required across the input transformer secondary as would be necessary to drive a single similar tube over its full permissible grid swing.

Let us now investigate what happens to the signal applied to the push-pull stage. The alternating signal voltage is developed across the entire input transformer secondary winding, S, so that at any given instant the potential of the center tap of the winding is midway between that of the two outer terminals (see Fig. 1). Consider, the instant that an alternating signal voltage E is induced in the full winding. This makes the potential of the upper

terminal (F), E volts *positive* with respect to the lower terminal J. Since terminal H is at the electrical center of the winding, the terminal F will have swung E/2 volts *positive* with respect to this center tap at this instant, and the terminal J will have swung E/2 volts negative with respect to this center tap H. Thus, the signal voltage is applied to the grids of the two tubes 180° out of phase. Any other circuit arrangement that provides two equal signal voltages that differ in phase by 180° may be used in place of the transformer. Circuits involving vacuum tubes to provide this phase reversal or inversion have been developed and are used in some amplifiers. They are known as *phase inversion* circuits.

Of course the grid of tube VT1 is not actually allowed to go *positive* with respect to its cathode due to this signal, for the value of negative grid bias applied by the "C" bias voltage source is sufficient to maintain the grids negative with respect to the cathodes at all times (Class A operation). What actually happens is that, depending upon its instantaneous polarity, the signal voltage developed in each half of the secondary winding either aids or opposes the steady negative C-bias voltage applied to its circuit, thereby causing the negative potential of the tube grid to which the particular half of the winding is connected, to raise or lower in accordance with the impressed signal voltage. When the signal voltage developed in one-half of the winding causes the grid associated with it to become *less* negative (thereby causing its plate current to *increase),* the signal voltage developed in the other half of the winding at the same instant is of such polarity as to cause the grid associated with it to become equally *more* negative (thereby causing its plate current to *decrease).* Thus we have a sort of see-saw *(push-pull)* action between the grid potentials (and plate currents) of the two tubes.

This brings us to a consideration of the important action that takes place in the output transformer. The primary winding, P, of this transformer is tapped at its electrical center, the midpoint connecting to B + and the two outer ends connecting to the plates of the tubes so that the plate current of each tube flows through its own half of the primary winding in the direction shown by the arrows (Fig. 1). Each half of this winding forms the plate load for the tube connected to it. Suppose again that at some particular instant the signal is causing the grid potential of tube VT1 to become *less* negative, and that of VT2 to become correspondingly *more* negative. Plate current I_{P1} then *increases* while plate current I_{P2} *decreases.* Since these two currents flow in *opposite directions* through an equal number of turns in this primary winding (as shown by the arrows), the effect of any changes of *opposite* nature in them is *additive* both as regards resulting change of "magnetism" in the core and voltage induced in the secondary. For example, in the case being considered, since plate current I_{P1} flowing through the upper half of the winding *increases,* the magnetic field produced by it *increases* correspondingly. At the same instant the plate current I_{P2} flowing through the lower half of the winding *decreases,* and the opposing magnetic field produced by it *decreases* correspondingly. Under this condition, the two magnetic fields produced by the currents flowing through each half of the primary winding no longer equal and neutralize each other, but produce a resultant field which induces a signal voltage in the secondary winding, S, in the direction determined by the direction of flow of the larger primary current.

On the next half cycle of the incoming signal voltage, the plate current of VT1 *decreases* and that of VT2 *increases* correspondingly, so that the direction of the resultant field reverses, and a signal voltage is induced in the secondary winding in the opposite direction. This action is repeated during each half cycle.

Now that we understand how the push-pull amplifier circuit arrangement amplifies the signal, we are ready to learn how it eliminates from the output signal the 2nd, and all other *even-order,* harmonic distortion components generated by the two tubes.

(To be continued)

Every Page is a Spark Plug for Your Ingenuity

The Chapter Headings Tell the Story

1 Loud Speakers and Their Use
2 Superheterodyne First Detectors and Oscillators
3 Half-Wave and Voltage Doubler Power Supplies
4 Vibrators and Vibrator Power Supplies
5 Phono-Radio Service Data
6 Automatic Tuning
7 Frequency Modulation
8 Television
9 Capacitors
10 Practical Radio Noise Suppression
11 Vacuum Tube Volt Meters
12 Useful Servicing Information
13 Receiving Tube Characteristics

MYE TECHNICAL MANUAL

"Keep 'em listening," is the ambition of every radio serviceman, engineer, amateur and experimenter. Here is the book you need as ambition's assistant. The latest technical data is the biggest help you can get to overcome parts shortages through making the most of available materials; to solve the problems posed by faltering receiving sets.

MYE TECHNICAL MANUAL

The new MYE Technical Manual is the practical answer to every-day questions. Every page is a spark plug for your ingenuity. Theory is blended with practice in simple terms—easily applicable—up-to-the-minute—much of the data never before published.

MYE TECHNICAL MANUAL

Servicemen tell us it is exceptionally complete. "The buy of the year," says one . . . "Must be within reach on the bench," says another . . . "Can't get by one day without referring to it" . . . so it goes; summarized into one word, it is "indispensable."

MYE TECHNICAL MANUAL

408 pages, hard cloth covers, profusely and accurately illustrated. A real wartime helper. Your nearest Mallory distributor can supply you. Price $2.00, while the supply lasts.

P. R. MALLORY & CO., Inc., INDIANAPOLIS, INDIANA

P.R.MALLORY & CO.Inc.
MALLORY

Approved Precision Products

Demonstrator
(*Continued from page 36*)

dredth the r-f resistance. The r-f resistance, of course, includes some radiation resistance. This resistance is also slightly greater when the indicating lamp is included in the circuit.

The power lost in the resonant circuit is:

$$P = I_c^2 R \quad \ldots\ldots\ldots\ldots (10)$$

Substituting from equation (8) and equation (6A):

$$P = (.766)^2(.47) = 0.276 \text{ watts}$$

This power may also be computed from the resonant impedance of the circuit and voltage across it.

$$Z = \frac{\omega^2 L^2}{R} = Q\omega L = \frac{Q}{\omega C} \quad \ldots\ldots (11)$$

Substituting measured values in the second of these relations, we obtain:

$$Z = (360)(2\pi)(8.5 \times 10^6)(3.17 \times 10^{-6})$$

$$\therefore Z = 61{,}000 \text{ ohms}$$

The loss is:

$$\frac{E^2}{Z} = \frac{(130)^2}{61{,}000} = 2.78 \text{ watts}$$

To supply this loss, the wires leading to the resonant circuit must carry a current:

$$I = \frac{P}{E} \quad \ldots\ldots\ldots\ldots (12)$$

$$I = \frac{2.78}{130} = 21.4 \text{ ma.}$$

In a practical circuit these leads will also carry d-c grid current, d-c cathode current, and some of the resonant current because some of the tuning capacity is in the tube. This latter will be small for large values of tuning capacity.

Calculation of R_2 Value and Power Rating:

Tube requires 0.150 amperes at 50 volts.

Line voltage = 115. Drop across resistor is:

$$E_{R2} = 115 - 50 = 65 \text{ volts}$$

The value of R_2 should then be:

$$R = \frac{E}{I} = \frac{65}{0.15} = 433 \text{ ohms}$$

The power rating required is:

$$W = \frac{E^2}{R} = \frac{(65)^2}{433} = 9.8 \text{ watts}$$

A commercially available value of 450 ohms, 10 watts will be satisfactory.

D-C Grid Current from Voltage Drop Across R_1:

$$I = \frac{E}{R}$$

$$I = \frac{7}{3300} = 2.1 \text{ ma.}$$

Wattage rating of resistor:

$$P = \frac{E^2}{R} = \frac{(7)^2}{3300} = .0147 \text{ watts}$$

Wave Meter:

The schematic circuit of the wave meter is shown in Figure 2. The circuit constants are as follows:

C_1—6 μμfd min., 110 μμfd max. cap. trimmer.

L_1—20 turn coil, No. 12 d.c.c. wire coil 2 inches dia., wires wound in a bundle and securely tied with string to prevent change in shape. Tap-2 turns from one end. Q = 60.

I_1—¼-watt neon lamp to show resonance.

A calibration curve expressed in frequency vs. percent rotation of the capacitor is shown in Figure 3, the capacitor has semi-circular plates and 100% rotation is 180° from maximum capacity. Accurate duplication of this wave meter should make it possible to use it for demonstration work without individual calibration.

It can be pointed out that while the

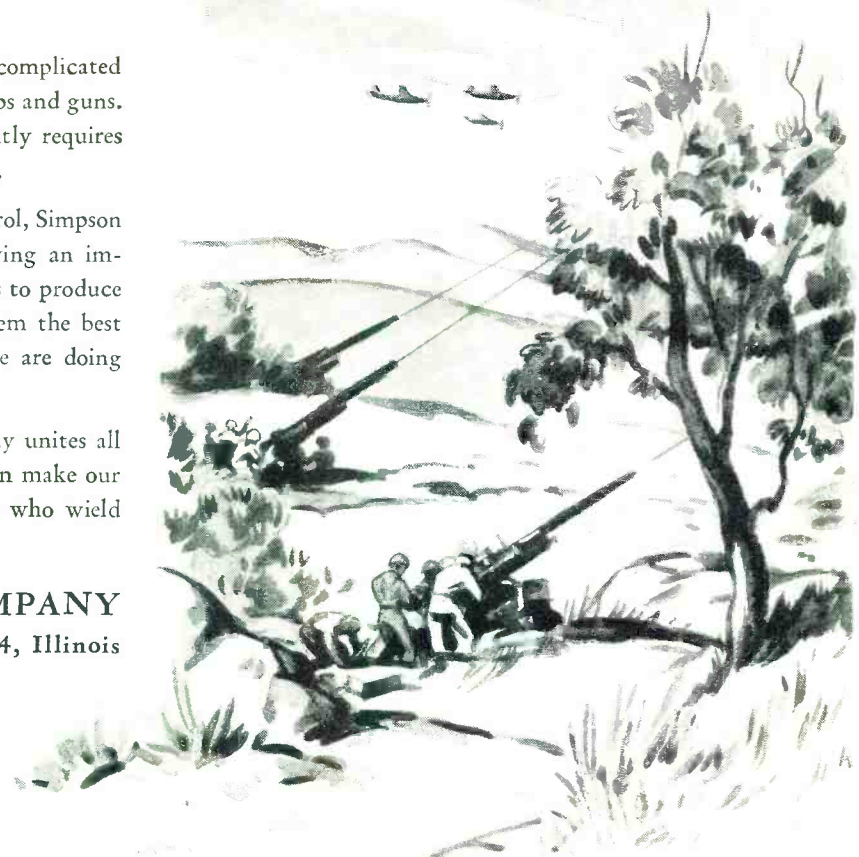
KEEPING THINGS UNDER CONTROL

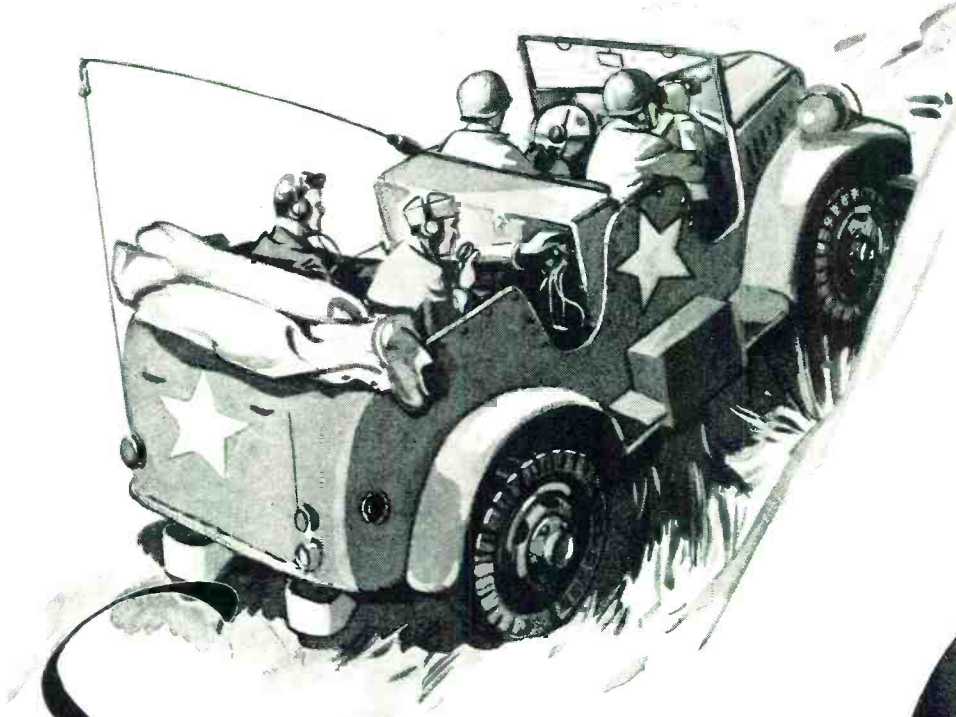
A WAR MACHINE is an intricate and complicated mechanism, with all its planes, tanks, ships and guns. To keep it functioning smoothly and efficiently requires split-second timing, and precise coordination.

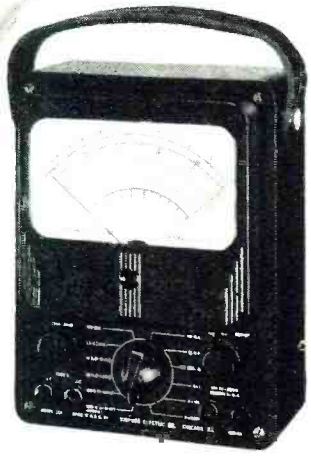
In this vital task of keeping things under control, Simpson Instruments and testing equipment are playing an important part. So our part, here at Simpson, is to produce all the instruments we can, and to make them the best that skill and ingenuity can devise. This we are doing wholeheartedly.

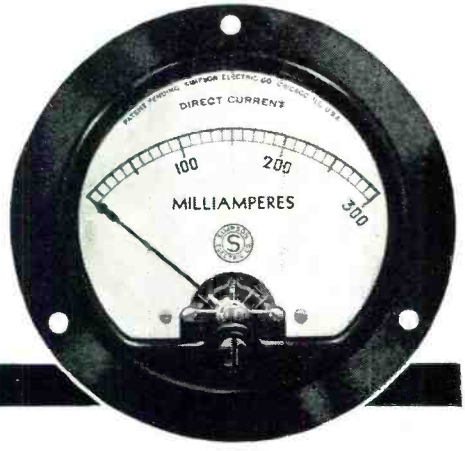
Our only aim is the common cause that today unites all industry and all American workers. If we can make our weapons as good, and as tough, as the men who wield them, victory will be well in hand.

SIMPSON ELECTRIC COMPANY
5200-5218 Kinzie Street, Chicago 44, Illinois









Simpson

INSTRUMENTS THAT STAY ACCURATE

Buy War Bonds and Stamps for Victory

capacity range is 110:6 or 18.3 and should give a frequency range ratio of $\sqrt{18.3} = 4.3$, the actual range is only about 13: 5.5 or 2.4. This reduction in range is caused by the distributed capacity of the coil.

The frequency of the transmitting oscillator can be measured by holding the coil of the frequency meter near the coil of the transmitter and tuning the wave meter until the neon tube lights. The wave meter should then be moved a greater distance from the transmitter so that a sharp indication is obtained. The dial scale is then read and referred to the calibration curve.

The effect of the relative positions of two coils on the coupling between them is demonstrated by holding the wave meter in one location and rotating it. Variation in the coupling is indicated by the brilliance of the neon lamp.

A resistance of about 20,000 ohms connected across the wave-meter coil will lower the Q and more coupling will be required to light the neon lamp. Also, the tuning will be less critical, indicating a less sharp resonance curve.

Absorption of power from the resonant circuit is shown by the dimming of the lamp I_4 as the resonant wave meter is coupled closer to the transmitter.

Receiver:

Connection of a crystal detector and earphones to the wave meter as shown in Figure 4 makes a simple receiver. If desired, an antenna and ground may be connected to the receiver. No ground should be connected to the transmitter as no isolating transformer is used in the system. If desired, a short antenna of 5 or 6 feet may be connected to the cathode of the 50L6GT through a .002 μfd capacitor. This will give greater transmitting range but may also cause interference with nearby radio receivers.

Tuning will be broad when the detector is connected across the complete coil and sharp when connected to the tap. This is because of the impedance transformation of the coil. It will be noted that the coil is an auto-transformer.

These are just some of the possible demonstrations with this unit. Many more can be devised by the individual instructor to suit the work being carried on.

—30—

Crime Detection

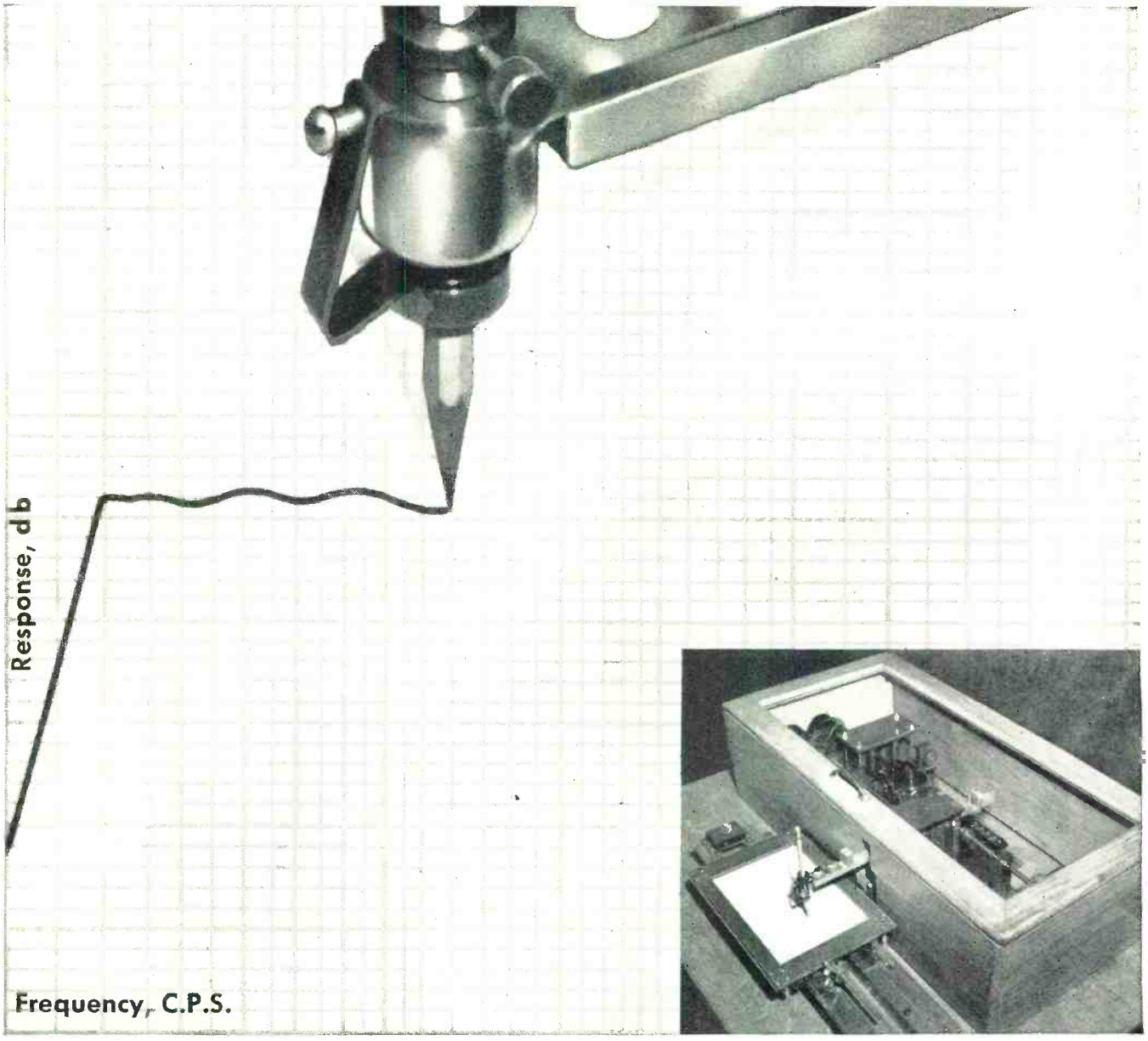
(*Continued from page* 22)

were developed some years ago by Thomas P. McCaleb of Harvard University.

In the radio alarm, a centimeter-wave signal is directed from a "watch-house" to a simple receiver in such a manner that an intruder is forced to cross this invisible beam on entering the protected area. The presence of the intruder's body causes a shadow effect; that is, the intensity of the radio beam is reduced and the signal delivered to the receiver is made fainter. By means of appropriate electronic circuits, this signal reduction may be utilized to actuate an alarm relay.

In another version, a low-power centimeter-wave signal beam is directed toward the only spot where the intruder might be found entering. A simple microwave receiver is then set up at the transmitting point in such a manner that should the signal beam be reflected by an object at the "protected" point it would be received by the receiver antenna. The intruder's body would provide such a reflecting medium. Success of this system depends upon isolation of the receiver from all signals except the one which is reflected. This calls for extreme directivity of both transmitting and receiving antennas and perfect isolation of transmitter from receiver. The receiver would then normally be unresponsive, although it and the transmitter would be operated continuously. The intruder's body would, immediately upon appearance at the protected spot, reflect the signal to the receiver which would then set off an electronic signal-relay to actuate the alarm.

By employing microwaves, directive antennas might be kept to a small size and transmitter and receiver might be



It writes by ear...

For years, Shure Engineers have relied upon accurate and scientific measurement in determining microphone performance. They do not rely, alone, upon listening or point by point measurement.

Shure Engineers designed this Automatic Curve Recorder to plot the operating characteristics of our microphones. It writes by ear.

This and other advanced testing techniques have enabled Shure to meet and often exceed the rigid requirements of microphone design demanded by the Army and Navy. You will have every right to expect new standards in microphone performance after the war is won.

ARMY E NAVY

SHURE MICROPHONES

SHURE BROTHERS, 225 West Huron Street, Chicago

Designers and Manufacturers of Microphones and Acoustic Devices

made compact. However; the necessity for complete isolation of the two units from each other, and the fact that not all microwaves are readily reflected from the human body combine with the present illegality of such private transmitters to render the u. h. f. alarm presently impractical. A particular advantage of the system, however, is the fact that a large area (such as a farm) might be continuously scanned by the invisible alarm beam to give immediate indication of intrusion upon the grounds.

CAPACITY-CONTROLLED OSCILLATORS. These oscillators operate in the radio-frequency range, actual frequency being unimportant, and are provided with a "hair-trigger" grid adjustment such that the circuit will trip an alarm relay if the capacitance of the grid circuit is altered, as by the presence of an intruder. In order to effect this capacitance change, an "antenna," consisting of a square metal plate of metal screen or gauze, or just a length of wire, is concealed under a carpet or within the partitions at an expected point of intrusion.

Circuits and data for practical capacity - operated electronic - relay alarms have been described in RADIO NEWS (May 1943; June 1942).

Electronic Picture Spoilers

The rules of certain factories and public buildings are perfectly clear with regard to the taking of unauthorized photographs within the buildings. In spite of this clarity, however, a certain amount of illegal snapshooting goes on. Experienced criminals are known to carry super-miniature cameras, resembling pocket watches, lapel emblems, fountain pens, and the like, by means of which they obtain photographs of special machinery, factory layouts, patents, plans, and secret devices while under the guise of an employee or visitor.

Vigilant taking of cameras from all persons at the main entrance does not completely put an end to the taking out of information in the form of photographs, since a considerable amount of criminal ingenuity has been exerted in the direction of "spy camera" design.

The electronic picture spoiler aims, as its name implies, to make certain ruin of any unlawful negatives which are being transported from a building. Its nature is simple, the spoiler consisting only of an X-ray machine situated at each exit ordinarily used by persons leaving the building. The machine literally sprays the passageway with X-rays which ruin any and all photographic negatives being carried on the person. And an added feature of the arrangement is the fact that the picture carrier is entirely unaware of the process, since the X-ray machine may be located on the other side of the wall, out of sight, to send its rays silently and undetected through the partition, carrier's pocket, and all. Only when he attempts to develop the negatives, does he discover that he is without pictures entirely!

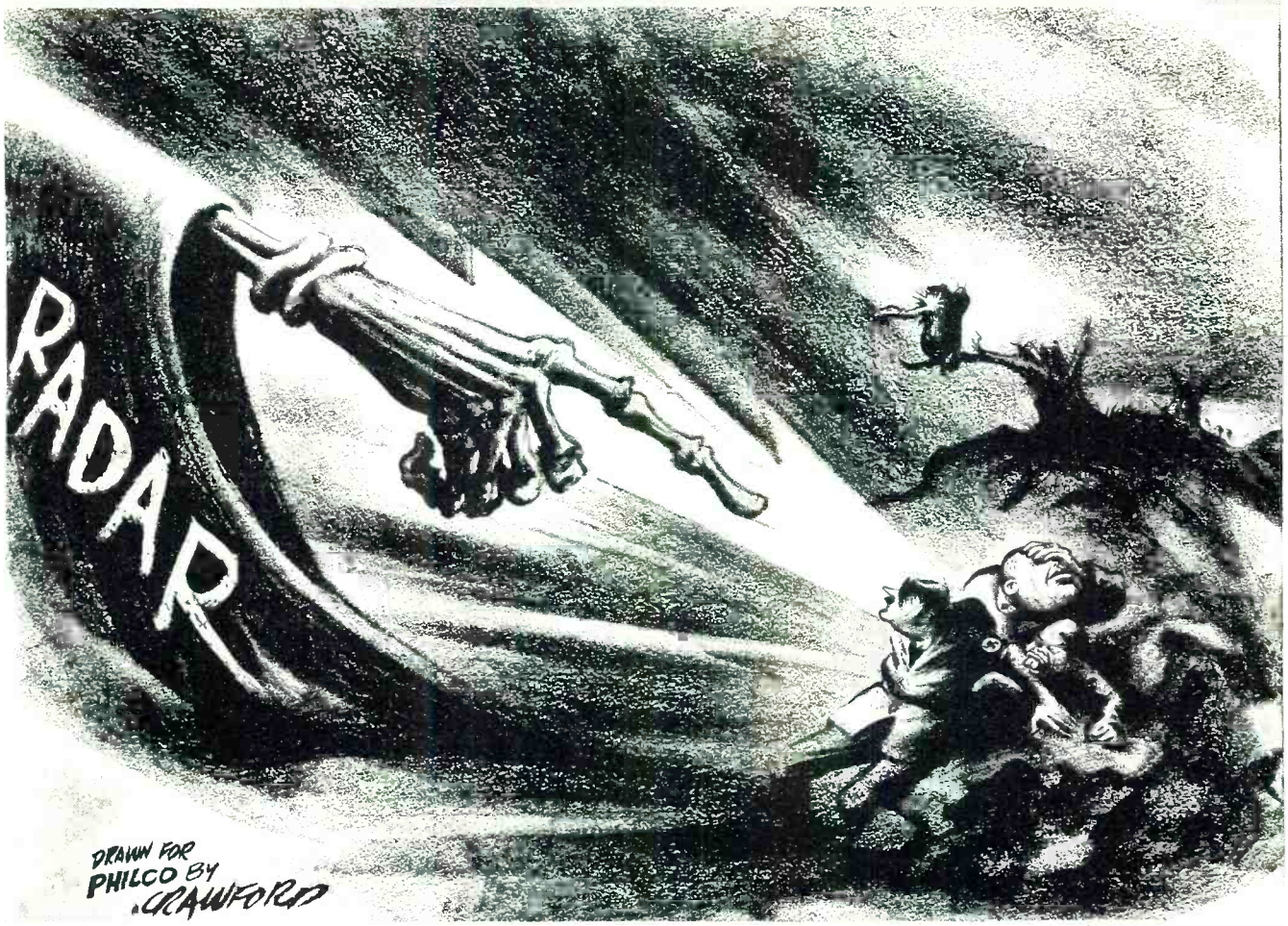
The Lie Detector

A highly important contribution of electronic science to crime detection is the *psychointegroammeter,* known also as the "lie detector." So striking has been the performance of this instrument in spotting deception on the part of a suspect and in establishing the details of various crimes and enabling investigators to secure confessions, that this instrument has been termed the "outstanding contribution of electronics to criminology."

Undoubtedly, no other electronic instrument in the hands of the criminal investigator has so stirred his imagination in recent years as has the lie detector. Its introduction into widely publicized cases has repeatedly been the basis of special news articles. And its coming has brought peace of mind and new hope to the innocent man, as well as terror to the guilty character.

Spotting deception by various observations on bodily phenomena has been attempted by serious researchers along several different schemes. Prior to the introduction of the electronic instrument, the psychointegroammeter, blood pressure or heart action were minutely observed while the suspect answered carefully propounded questions. Various variations in these bodily functions seemed to occur during times when the subject lied. How-

There's No Escape!



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.

RADAR, the fabulous radio device that *"sees through"* fog, clouds and darkness, that searches out enemy targets and warns against the approach of hostile forces, has given us a thrilling story of American ingenuity. Long before Hitler screamed his ominous threats of secret weapons, the scientific branches of our Army, Navy and government were quietly developing this miracle of radio.

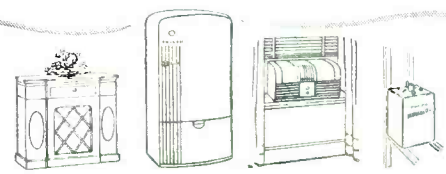
The time came when the radio industry of America was called upon to produce Radar quickly and in decisive quantities to turn the tide of Axis conquest. That's when Philco, with the facilities of the world's largest radio manufacturer and with vast research experience in the field of ultra-high frequency radio waves, was able to render its vital service to the might of our fighting forces.

Today, Radar is one of Philco's most important war production activities. Tomorrow, the advance of science in the Philco laboratories will appear as peacetime miracles of radio, television, refrigeration, air conditioning and electronics for the homes and industries of America—under the famous Philco name.

PHILCO CORPORATION

BUY WAR BONDS AND STAMPS

Hasten Victory . . Build for tomorrow . . Invest a part of your income in War Bonds.



PHILCO—the Quality Name in Millions of American Homes.

LISTEN TO
"OUR SECRET WEAPON"

Hear Rex Stout expose Axis lies and propaganda. Every Friday evening, CBS stations.

ever, certain other functional variables entered to make the results reliable only a part of the time.

An instrument, which has been found to be correct in spotting lies over ninety percent of the time, is a development of Dr. Reginald D. MacNitt, Head of the Department of Social Science at Wilmington College in Wilmington, Ohio. This instrument makes use of this psychological and physiological principle—that during certain emotions the electrical resistance of the human skin alters, becoming lower when the subject is lying and increasing during moments of emotional relief. This reaction is not under the influence of the mind, and apparently is not due to increased perspiration on the skin surface.

The simplest possible circuit for utilizing this electrodermal reaction in spotting deception might be a simple ohmmeter circuit, such as illustrated in Figure 4, for indicating changes in skin resistance. In order to be workable, this simple circuit would have to be provided with moistened electrodes of a non-polarizing type (non-polarizing to prevent galvanic action) which might be applied to the subject's wrists. If a sensitive galvanometer were employed, the normal skin resistance would be read, this value increasing or decreasing as the subject answered questions.

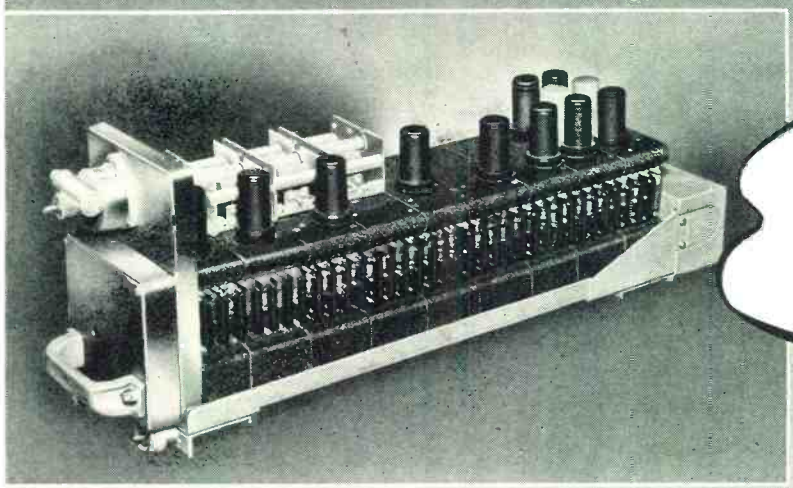
Ability to detect the changes will depend upon the response of the instrument. however, some of these changes being too minute to be observed with the simple circuit of Figure 4.

Dr. MacNitt's instrument has been refined to give indications of small changes in the dermal resistance. A bucking voltage (in the form of a bias to one of the tubes in the circuit) is applied to "balance" out the normal skin resistance reading, so that the meter may start from zero. The instrument thus becomes a very sensitive electronic ohmmeter. A portion of the instrument is a d.c. amplifier which amplifies the small current increments arising from skin resistance variations sufficiently to make them actuate a recording milliammeter, such as shown in Figure 1. A block diagram is shown in Figure 5.

The modern lie detector records cardiac (heart) amplitude together with electrodermal response in order that these indications may be coordinated. Records are made on an Esterline-Angus recorder, as shown in Figure 1. Sample records are shown in Figure 6 and Figure 7. Carefully prepared questions are arranged prior to the lie test. A preliminary run is made with the lie detector connected to the patient to get an indication of his normal reactions under question. The interrogation is then begun, the carefully-worded and ordered questions, relating to numerous subjects including the crime, being asked. The patient's heart amplitude is picked up by an electrical stethoscope placed at his chest, these indications being recorded along the right hand side of the

HARVEY "Unitized" COMMUNICATION RECEIVERS

feature

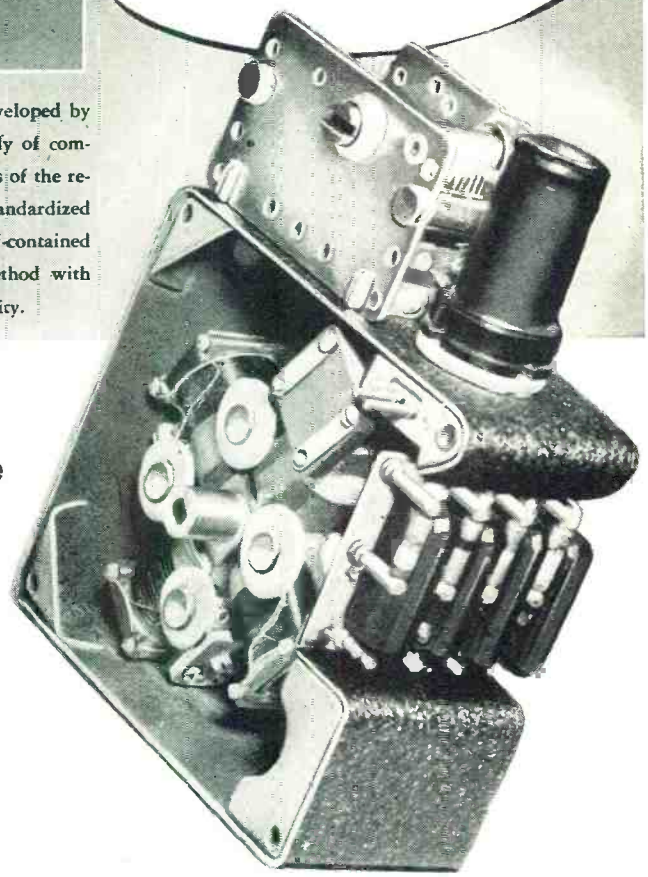


CUSTOM-BUILT PERFORMANCE

combined

with mass-production, simplicity of assembly and field servicing

Unique and revolutionary methods have been developed by Harvey engineers for the production and assembly of communication receivers . . . which separate the circuits of the receivers into basic circuit-elements by the use of standardized R. F., I. F. and Audio cells that are complete self-contained circuits. Mass production is achieved by this method with important improvements in sensitivity and selectivity.



Cell-unit construction creates *new standards* in radio performance

The R. F. Amplifier cell, shown at the right, is typical of Harvey "Unitized" construction. The standardized case supports the variable tuning condenser and a remote cut-off high-mu pentode tube. The rotary turret coil assembly is mounted on a hollow trunnion, and the R. F. transformers are rotated by a band change control, which connects the desired coil to the fixed components of the circuit.

L/C ratios of the R. F. circuit are greatly improved by the Harvey turret coil which provides up to 40% less minimum circuit capacitance than is found with conventional band switch methods. The exceptionally high Q of Harvey R. F. circuits is due to coil design and use of low-loss coil forms, minimum contact resistance between a coil and the circuit through use of solid silver contactors provided with wiping action, and efficient shielding. Such features assure performance from Harvey multi-band receivers equal to the finest single-band receivers with comparable tuning ranges.

Inherently short leads, a characteristic of Harvey "Unitized" construction, minimizes mutual inductance and stray capacitance between critical portions of the circuit. When assembled with adjoining cells, inductors are enclosed within metal cases, providing exceptionally effective shielding.

Write for descriptive data on Harvey Communication Receivers. Cells to meet specific requirements are available to other manufacturers for use with their products.

For over a quarter century geared to flying production

Electronics Division

HARVEY MACHINE CO., INC.

6200 Avalon Blvd. • Los Angeles, Calif.

Other Harvey Divisions aiding the United Nations

AIRCRAFT DIVISION
ORDNANCE DIVISION
SPECIAL MACHINERY DIVISION

record sheet, and his electrodermal reactions are picked up by non-polarizing electrodes on his wrists, these indications being recorded on the record sheet proper.

Emotional reactions experienced by the subject when he lies result in large changes in dermal resistance and large changes in cardiac amplitude, both of which show up readily on the record sheet delivered by the indicating meter. By expertly arranging the questions, many facts regarding almost unsolvable crime may be ascertained.

Figure 7 shows a record actually taken from the recorder. The test was to establish if a shooting was accidental or intentional. The subject maintained that it was accidental. However, the lie detector record shows him distinctly to have been lying when he answered "no" to the investigator's question.

Acknowledgment

The writer takes this opportunity to acknowledge with appreciation the assistance given by the following in the gathering of material and preparation of this article; The Esterline-Angus Company; Dr. Reginald D. MacNitt *and the* Bureau of Psychointegroammeter Research, *both of Wilmington College, Wilmington, Ohio; and* Prof. R. C. Davis *of Indiana University.*

-30-

Arctic Networks

(*Continued from page* 19)

fect in all respects, and many improvements have been made between the original models used and those now in service. All in all they have provided an economic, reliable source of power for low and medium power radio stations in areas of sufficient wind. Likewise, they proved not to need any technical upkeep, even though they were exposed to all weathers. Some of these generators are now in their fifth year of service and have had no attention, other than the renewing of the generator brushes every second year. One of the many amusing incidents that occurred in connection with the installation of these wind-driven generators was at a Post near the rim of the Arctic. For two days, while the work of erection had been going on, a band of the local Indians watched intently. Then, on the morning when the test run was made for charging the batteries of the station, they peered intently at the tower on which the generator was turning in a good stiff breeze. They continued to watch 'til evening when the Company Post Manager asked the chief what the trouble was. The chief replied that they were waiting to see the tower take off. Yes, they had only seen one propeller turn before in their lives and that had been a single engined 'plane and, of course, the 'plane took off when the propeller turned at a high speed.

The circuit and the design of the transmitter and power pack for this type of radio communication system, while not a technical problem of any great degree, did require many refinements and considerations that would not have been necessary if the equipment had been for use in or near civilization, or if it had been for use by technically trained radio operators. One of the major considerations was to keep it as simple as possible and ensure that all the main parts were replacable by plug-in type spares, that is, such main parts as are generally considered most likely to cease functioning, such as vibrators, electrolytic condensers, etc. In this respect, this communication system of the Hudson's Bay Company was one of the first in Canada and possibly in the United States to use the plug-in vibrators and condensers in large numbers for speedy non-technical replacement purposes. Standardization of parts, and keeping to a bare minimum, the variety of spare parts needed, was another important consideration, in the design problem, and it is interesting to note that the signal branches of the United States and Canada, have also kept these considerations behind the various types of radio equipment they have in use throughout the battlefronts of the world. However, the major consideration was the keeping as simple as possible the transmitting unit, for the men who were to operate them,

The devil rode that night . . .

"Driven by an angry wind, rain beat down with the fury of bullets, and waves swept across the deck like a frenzied mob. As orders went out clearly over the microphone, I remembered a night back in 1932 when a similar storm swallowed words even as I spoke them, and lack of proper communications resulted in tragedy for some of my men."

Purely hypothetical is the case above . . . but you may be sure that after the war, when entirely new Electro-Voice Communication Microphones are released for general use, they will fill a definite need aboard ships. Fitting easily into the hand or attached snugly to the face, weighing barely more than a whisper, Electro-Voice Microphones are incomparable from the standpoint of stability, articulation and reduction of background noise.

Builders of war equipment may secure information concerning new Electro-Voice developments from us. However, if limited quantity needs can be filled by any of our Standard Model Microphones, with or without minor modifications, contact your local radio parts distributor.

In order to maintain existing civilian equipment at maximum efficiency, we suggest that you submit your Electro-Voice Microphone to your supplier for TEST and REPAIR at our factory.

Electro-Voice MICROPHONES

ELECTRO-VOICE MANUFACTURING CO., INC. • 1239 SOUTH BEND AVENUE • SOUTH BEND, INDIANA

Export Division: 13 East 40th Street, New York 16, N. Y. — U. S. A. *Cables:* ARLAB

were as we have already shown, only capable of switching them on and off in the great majority of cases. In addition to the above considerations, the fact that the circuit had to be very stable, led to the choice of the Pierce oscillator followed by an RF tube, for the basic circuit of the transmitter. This choice enabled spare parts to be kept to a minimum, and was also found to give all the kick needed for 30 watts of CW.

The decision as to what type of receiver was necessary, involved a complete knowledge of the proposed network throughout the entire area, and a knowledge of how this network was to be controlled by area, each area having its own control station or center. With this knowledge, it was a simple matter to pick out a reliable commercially made commuications receiver, and have the manufacturer modify it for the Company's radio requirements. This arrangement has proved more than satisfactory over a period of four years.

The question has probably arisen in most readers' minds as to what type of transmission was decided on for this communication network. There will be many who would favor 'phone transmission and others would favor CW transmission for this type of work. However, this question could not be settled on the technical merits of either type alone, and many considerations had a bearing on the final decision to use CW solely throughout the entire network. Not the the least of these was the fact that a far greater degree of privacy would be obtained by using CW, and as the greater part of the traffic to be handled over the stations was purely Company business, this was quite important. Again, the fact that these stations were installed, not only for economic reasons, but to enable the men at these isolated outposts of civilization to communicate with their similarly situated neighbors, anywhere in a 500-mile radius, meant that they would be on the air for quite a percentage of time, and thus to avoid undue QRM, it was deemed essential to use CW.

The subject of frequency or frequencies used in this arctic network has not been discussed although naturally it is one that holds much interest for all radio communication men. However, the fact that these are assigned by the Dominion Government in Canada, and that under present wartime conditions, it is not advisable to discuss them, has purposely caused this subject to be omitted.

Antenna systems for use throughout the system has been a subject of much experiment, but once again technical desires had to be tempered with such points as ease of matching to the transmitter and standardization of design. These points were more important than would appear at first sight, for although the original installation of the stations were done by technical men, the arctic winds, as previously mentioned, reach velocities that have sometimes devastating effects on aerial arrays. Hence, if the man in charge of the Post and station where this can and does happen, had to put up a new aerial array, it must of necessity be of similar design and not require any alterations or tuning at the transmitter end. So, while many arrays for rhombics, Vee's, and other types of directional aerials were experimented with, it was in the end decided that the standard half-wave doublet, fed by a 72-ohm line, was most suited, for in addition to the considerations already mentioned, it was found to give consistently good results over all types of northern terrain when used for point-to-point communication.

While not pertaining to the actual equipment of the stations, a problem that was very important as it had to be solved before the system could go in operation, was the means by which the northern staff was to be trained in the technique of sending and receiving the morse code. Solution of this problem again entailed a complete knowledge of how the northern staff of the Hudson's Bay Company is initially employed for these isolated trading posts. Generally, it may be said, northern staff is recruited from the age class of 18 to 25, and generally in groups of ten to fifteen men two or three times a year. These groups are given a three-month preliminary training at the Head Office of the Company in Winnipeg, Manitoba, in the neces-

FIX ANY RADIO
Amazing New Invention

Simplified Radio Servicing by Comparison Method

Find radio faults with a new simplified method. Repair radios in minutes instead of hours. Revolutionary, different **Comparison** technique permits you to do expert work almost immediately. Most repairs can be made without test equipment. Simple point-to-point, cross-reference, circuit suggestions locate faults quickly and easily.

COMPLETE ONLY $1.50
SPECIAL OFFER
READ THE DETAILS

REPAIR ANY RADIO IN MINUTES

Learn how to locate the source of trouble in any radio without equipment. Make needed tests, measure voltage, trace the signal, by using only a resistor, small condenser, and a crystal detector. Inject signals without any signal generator. Test parts by the new **Comparison** method. Test tubes without equipment. Repair any radio expertly following illustrated, simplified plans. Improve your radio servicing ability. Examine the plan without obligations, without risk. Send coupon.

FOR BEGINNERS OR EXPERTS

Developed by M. N. Beitman, radio engineer, teacher, author, & serviceman

Learn important short-cuts in trouble-shooting; find any radio fault with ease. Follow the comparison tests given on 16 large trouble-shooting blueprints. Over 1,000 practical repair hints. Hundreds of simplified tests using a 5c resistor and a filter condenser. Covers every radio set—new and old. Introductory material for beginners and to serve as a review for experienced radio men. Also several chapters on test equipment. Presented in manual form. 112 illustrated pages, 8½x11 inches. Entire plan is stark new and will help you get ahead in radio quickly.

PRACTICAL USEFUL FACTS AND HINTS

Hundreds of service hints, trouble-shooting ideas, simplified tests, repair suggestions, and alignment methods are included. Benefit by the experience of others. Use the most practical method for finding the fault and making the repair. Save time on every job.

FIX MOST SETS WITHOUT TESTERS

Follow the COMPARISON technique and repair 4 out of 5 sets without equipment. Speed up your work; locate faults quickly; make repairs efficiently. Be fair with yourself and try this new plan without obligation. Take advantage of our "no-risk" trial. Send coupon today. Use this time-saving, money-making radio servicing technique for 10 days without any obligations. See how quickly you will learn these helpful methods. Save time on every radio job every day. Learn new short-cuts in radio servicing. Get ahead in Radio. Amaze others with your ability to find radio faults and make repairs. Prepare for higher rank and better pay in the Army. Act today.

MONEY-BACK GUARANTEE

You must be entirely satisfied or your money will be refunded without a question. The training will more than pay for itself on the first radio job or with higher rank in the Army. Examine and use this unique plan for 10 days at our risk. Send coupon right now—use the plan this week.

Other Supreme Publications

PRACTICAL RADIO FOR WAR TRAINING

This new, 1943 manual will clarify the important radio facts, explain the principles which may have puzzled you, and point the way to faster radio repairing. You will find hundreds of practical hints for mounting parts, testing components, trouble-shooting, using instruments. Needed useful theory in each chapter is followed with practical applications. This is the book that will help you repair radios faster, or obtain a good radio War-job, or get ahead in the Armed Forces. Use this book as your ready reference for finding the right answer to every radio problem. Written by M. N. Beitman. 336 large pages, 6x9 inches. Printed on thick, enamel paper. Almost 300 illustrations and diagrams to help you. Seal leatherette cover. Attractive manual-binding. Sold with a money-back guarantee. Price only..... **$2.95**

How to MODERNIZE Radios for Profit

Cash-in by improving audio circuits, modernizing cabinets, adding features usually found on late model sets. Practical job-sheets with schematics and photographs make the work easy. You are told how to obtain modernization work, what to charge, and how to complete the job quickly and efficiently. The complete, large size, 8½x11 in. manual is priced at only..... **$1.00**

MOST-OFTEN-NEEDED RADIO DIAGRAMS

The most-popular radio diagrams available in low priced manuals. Large size: 8½ x 11 inches.

1942 Manual, Volume 5, 204 pages.....
1941 Manual, Volume 4, 192 pages.....
1940 Manual, Volume 3, 208 pages.....
1939 Manual, Volume 2, 192 pages..... **$2.00** each NET

1926-38 Manual, Volume 1, 244 pages, alignment, hints, parts lists..... **$2.50**

PRACTICAL RADIO MATHEMATICS

Introduces and explains the use of arithmetic and elementary algebra in connection with units, color code, meter scales, Ohm's Law, alternating currents, ohmmeter testing, wattage rating, series and parallel connections, capacity, inductance, mixed circuits, vacuum tubes, curves, the decibel, etc., etc., and has numerous examples. Net..... **25c**

SEE YOUR JOBBER OR SEND COUPON

SUPREME PUBLICATIONS
328 S. Jefferson St., Chicago 6, Illinois

Ship my copy of the complete **Simplified Radio Servicing by COMPARISON Method** manual. I must be entirely satisfied or you will refund my total remittance.

☐ I am enclosing $1.50, full price. Send postpaid.
☐ Send C. O. D. I will pay the mailman $1.50 and a few cents postage.
☐ Also send other **Supreme Publications** books as listed in letter.

NAME: .....

ADDRESS: .....

(Use Coupon or Send Order in a Letter)

sary rudiments of northern life. It was, therefore, a comparatively easy matter to include a radio operating course combined with meteorology in this preliminary training. This ensured that all new men would be able to operate at the stations of this northern system. It was also found necessary to arrange training for the men, or at least a percentage of them, who were already in the north at the Posts where these stations were being installed. This was not quite so easy to arrange as for the new employees. However, as men at these northern posts come out on holiday every two to three years, and while out on furlough, are generally given a refresher course in merchandising and fur grading, it was found that a percentage of them could be kept at Head Office long enough to receive training in radio operating. It was found that by adopting the above outline as the basic system of training, that enough men were ready to operate in the network as it grew in size throughout its four-year development period.

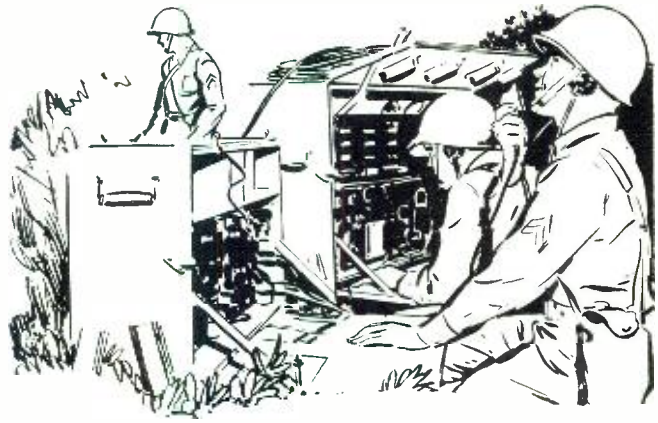
It might be asked and rightly so, would not a saturation point be reached where all the northern staff could operate, and the training problem would no longer exist? This happy state of affairs was anticipated by the Company, but due to the outbreak of war in 1939, the Company has lost a large percentage of their younger northern staff—all of whom were excellent radio operators—to the armed services, with the result that new staffs have to be continually trained as radio operators, although not necessarily new in the employment of the Company, for many of the older men in the northern staff, who originally were not considered as potential men for training in this work, have responded to the emergencies of war.

In normal times, this article could contain much more detail about this northern radio communication system, such as how it began to perform important government meteorological work, and thus was able to claim the unique distinction of operating the most northerly meteorological station on this continent, roughly 500 miles within the Arctic Circle. How this radio-meteorological work spread throughout the north and finally had to be partly taken over by the agencies of the United Nations, as its importance grew in the air war against the Axis. How the northern water transport system of the Company, stretching hundreds of miles north of the Arctic Circle, found the benefits of short wave radio communication and ended up by having their own network, during the summer season, of 13 vessels. And, how to write about these points in detail would necessitate the reproduction of a map of these northern areas showing the stations, control systems, etc., of the whole network, and as this would be of great interest and service to the Axis, the article has to end by saying "Censored."

—30—

GET ON THE TECHNICAL FRONT

Whether you go into military service or remain in Civilian ranks, Radio offers you the big opportunity for bigger pay, rapid promotion and substantial positions during and after the war. Radio Technicians are needed everywhere. You don't have to give up your present job to start Radio Training. National Schools of Los Angeles has developed a home plan of practical Radio Training to fit your needs, regardless of your age, education or draft status.



Get into RADIO now!

RADIONICS 3 Big Fields in 1 { RADIO / ELECTRONICS / TELEVISION

Sales and services in this miracle industry have boomed in a few short years to billions of dollars. That requires more and more experts, trained men, to fill the ever-increasing number of technical positions constantly opening up. Everywhere you go you hear about Radar as a war weapon and how in peacetime it will have many applications in seeing thru fog, clouds and darkness. Ambitious men enrolled with National Schools today are preparing themselves for perhaps the most far-reaching technical-industrial expansion the world has ever known. They are looking ahead to *personal prosperity*. You can too. Mail the coupon today.

MASTER ALL BRANCHES OF RADIO

Now, as never before, the urgent need for Trained Radio Men has created a tremendous shortage. Manpower is being mobilized for duty on the TECHNICAL FRONT: Radio Engineers, Service men and operators. Experts in shops, in laboratories and countless undreamed-of other applications are on the "MUST HAVE" list. The war has stimulated demand in both Civilian and military fields. Regardless of whether you remain a civilian or enter Military Service, National Radio Training will qualify you for a real future, a good pay job, responsibility and marvelous opportunity for advancement.

LEARN AT HOME

NOW, you can learn at HOME in your spare time. National's VICTORY training plan speeds up your progress right from the start, yet omits absolutely nothing vital to your preparation.

QUALIFY FOR THESE JOBS

Radio Expert — Broadcasting
Aircraft — Marine
Industrial Electronics
Studio Technician
Government Service — Remanufacture

NEW OPPORTUNITY BOOK

All about Radio!
Just off the press! It's free!
Including Lesson Book—
2 valuable books for the asking
Mail Coupon!

Take your place as Radio Technician in America's Victory Program NOW! Also be ready for continued advancement in industrial rebuilding when the War is over.

SHOP METHOD HOME TRAINING

offered by a real established

TECHNICAL TRADE SCHOOL

For 38 years National Schools has trained ambitious men for Top Pay trades. Squarely behind your Home Training are the modern, completely-equipped Training shops of National Schools where we develop and prove every Shop Method Assignment sent to you. Every phase of your training is personally supervised by an established Faculty of practical, experienced instructors and engineers.

They have developed progressive methods of training you in your own home, based on actual shop practice. Unique training facilities give you Home Training based on Resident School Shop principles—methods not available from any other source, to our knowledge. You'll be amazed when you receive our Complimentary Lesson and full details.

KEEP PRESENT JOB WHILE LEARNING

Regardless of previous education or age, you can Train for Radio. Continue your present job. Earn while you learn.

MILITARY SERVICE

Prepare for Radio opportunities in U. S. Gov't Service, in Army, Navy, Marine, Air Corps, Coast Guard and other branches. Pre-induction preparation gives many National graduates promotion and increased pay from the start. In addition, the time you spend in military service further develops your Radio technical ability so after the war you will be well qualified to handle the most expert, high-paying jobs in the booming Radio Industry. Many men now in military service are today taking National's shop-field training.

NATIONAL SCHOOLS

Los Angeles California

ESTABLISHED 1905

REQUEST FULL DETAILS

MAIL OPPORTUNITY COUPON FOR QUICK ACTION

National Schools, Dept. RN-9. (Mail in envelope or paste on penny postal)
4000 So. Figueroa, Los Angeles 37, Calif.

Mail me FREE, without obligation, one Lesson and Opportunity Book, with full details about how I CAN become a RADIO Technician.

NAME _____ AGE _____

ADDRESS _____

CITY _____ STATE _____

For the Record

(Continued from page 4)

will be widely used after the war by the private fliers. This will add greatly to the problem of traffic control inasmuch as the average flier will take off and land from his own property and not from an official airport. Here again radio will be the guiding agency for the direction of such traffic.

Governmental agencies charged with the responsibility of inspection of radio for aircraft must insist that certain high standards be set up for the manufacturer of all radio equipment. *Now is the time to establish such a format.* If this is not done there is the risk that many small manufacturers will enter into the aviation radio field and will compete with one another in turning out cheap transmitters and receivers for the thousands of new private fliers. Such a practice cannot be tolerated as the safety of the public would be jeopardized by failures of radio communications equipment that would surely result.

We predict that the established manufacturers of such equipment will maintain a high level in the design of their units. They will cooperate in every way possible with the authorities and with those who must maintain and install the equipment to see that their units are used properly. Many of them will operate their own maintenance departments. In this way they will be certain that their units will perform to their fullest capabilities.

A RECENT survey in several large cities indicates that there are still plenty of console type radio receivers available for sale to the public.

Investigators have found that a black market has existed and certain dealers have been able to obtain equipment of late design for sale to the public. Governmental agencies were quick to spot this condition and steps have been taken to correct the sale of illegitimate receivers throughout the country.

Many concerns are installing phonograph units and radio chassis in old style cabinets which have been laying around in warehouses for years and selling them to the trade at good prices.

Our *Washington reporter* advises that the OPA in its ruling which became effective July 26 covered this situation with a new set of regulations. (See Spot Radio News, Page 8.)

THE term "Radionics" continues to receive more and more attention from the press. We have seen its appearance in many publications of late. Many manufacturers of electronic equipment are now changing over to that new term. Our readers, judging from the many hundreds of letters received, also like the term "Radionics." We will therefore continue to use it wherever it will be most descriptive of the art.

73 . . . OR

ESCS Training

(*Continued from page 25*)

The first installation was bi-dimensional. Its flat surface was unable to provide an impression of depth and perspective. With assistance from the Officers Candidate School drafting and visual aids department, an improvement upon the basic idea has been designed, and is nearing completion. This structure, measuring twelve feet in length, five in height and three in depth was planned and executed by S/Sgt. Ralph A. Vernacchia and T/5 Stanley Elkman upon an original suggestion from Captain Abramowitz.

Its tri-dimensional reproduction of geographical contours, foliage, vehicles, human figures and an airplane offer emphatic visual impact. Simulated blinker lights are set on a hilltop, in the plane itself and in the immediate foreground. It is expected that installation of this display at the new and greatly expanded code and traffic section will mark another significant achievement in the rapid training of Signal Corps Radio Operators by means of dramatic visual facilities.

—30—

Saga of Vacuum Tube

(*Continued from page 28*)

paper de Forest filed another patent application (U.S. Patent No. 841,387)[135] on an arrangement entitled "Device for Amplifying Feeble Electrical Currents." This application disclosed an incandescent lamp having, in addition to the carbon or metal filament, two metal plates sealed into the bulb. (See Figure 40.) This was not new but the external connections and method of use disclosed were new. The arrangement was said to depend on the electrostatic attraction between the plate connected to the antenna and the filament for its operation. This application contains the first mention of what Fleming later termed a "split cold electrode" and was the first form of the three-electrode Audion.

The next patent application by de Forest was for an "Improvement in Oscillation Detectors" of the type described in U. S. Patents Nos. 824,637 and 836,070. This application, which issued as U. S. Patent No. ★879,532,[136] disclosed a second cold electrode in the form of a grid placed *between* the incandescent electrode (filament) and the other cold electrode (plate). (See Figure 41.) This third electrode had actually been added to the assembly in a laboratory test on December 31, 1906.[137] This was the three-electrode grid type Audion, although de Forest originally applied the term to the two-electrode arrangement.

The first public disclosure of the grid type Audion by de Forest was made at the Brooklyn Institute of Arts and Sciences on March 14, 1907 in connection with a paper on "The Wireless Transmission of Intelligence."

It is perhaps well that no scientist has developed a mechanism whereby we can see into the future. All parents know that the first seven years of a child's life are serious years; years demanding study of this new being, noting its characteristics, guiding it through hazardous days, observing and developing its potentialities. Yet could de Forest have foreseen the turbulent days ahead in the seven years following the first disclosure of his brain-child, the grid type Audion, he might not have taken the trip to Brooklyn on March 14, 1907. De Forest never lacked courage, but the time consumed in tireless efforts to make his contemporaries understand his brain-child, his corporate troubles and desperate attempts to obtain financial backing, the endless litigation into which he was plunged, all were a tragic waste to the man interested primarily in the furtherance of wireless communication. While other men might have cracked under the strain of those years and been lost in the depths of despair, to de Forest had been given the strength and buoyance to lose himself in his work in moments of distress. Trouble produced in him mental stimulation. His brain was most productive when his back was against the wall.

About the time of this first public disclosure of the grid type Audion de Forest was organizing the "De Forest Radio Telephone Company" to develop and market the de Forest wireless telephone system. Funds for this purpose were insufficient and hence a subsidiary company, the "Radio Telephone Company" was formed late in the same year to manufacture and market wireless apparatus on which de Forest owned or controlled patents.

De Forest used the Audion as a detector for both wireless telegraphy and wireless telephony. Only two of the two-element Audions were ever sold, and these to the U. S. Navy for use at the Brooklyn Navy Yard.[138]

Grid type Audions for use as detectors were incorporated in a number of sets of radio-telephone apparatus sold to the U. S. Navy in 1907. When the U. S. Fleet of "Fighting Bob Evans" made its memorable cruise around the world in 1907-1908 over

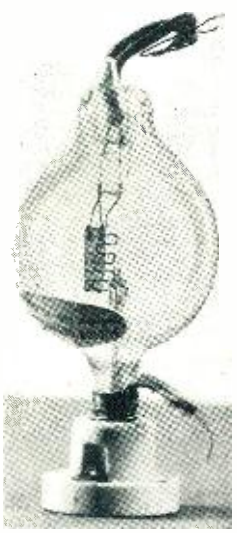
twenty vessels were equipped with such de Forest apparatus. However, radio telephony was so very experimental at the time that a few years thereafter a Naval representative reported, as if with relief, that "all wireless telephone sets thus far supplied, having proved unreliable in action, have been withdrawn from service." [139]

Since from this time on only the grid type Audion was in commercial use, future use of the word Audion, unless otherwise stated, will apply to this type bulb.

The first commercial Audions, a photograph of one of which is shown in Figure 42, were made with a narrow flat plate of platinum or other metal placed near a carbon or metal filament in a more or less cylindrical bulb. Between the plate and filament was fixed a grid or simple zig-zag of wire. The plate and grid were supported on wires sealed through the glass. These were made for de Forest by H. W. McCandless & Company, 67-69 Park Place, New York City, who were manufacturers of Christmas-tree type incandescent lamps.

About 1908 the filament structure was changed to the two-filament type, as shown in Figure 42, the filaments to be used consecutively, in order to increase the useful life of the device. About the same time the bulb shape was changed from cylindrical to spherical.[140] This was done at the suggestion of McCandless, who felt that the spherical bulb would permit of easier assembly. A photograph of one of the earlier spherical types is shown in Figure 43. This tube was made with a candelabra type base which was not changed till some time later.

Figure 43.



References

125. *de Forest, Lee: "Oscillation Responsive Device." U. S. Patent No. 979,275, application date February 2, 1905, issued December 20, 1910.*

126. *de Forest, Lee: "Static Valve for Wireless Telegraph Systems." U. S. Patent No. 823,402, application date December 9, 1905, issued June 12, 1906.*

127. *Fleming, J. A.: See Reference 107.*

128. *de Forest, Lee: "Oscillation Responsive Device." U. S. Patent No. 824,637, application date January 18, 1906, issued June 26, 1906.*

129. *de Forest, Lee: "Oscillation Reponsive Device." U. S. Patent No. 836,070, original application date January 18, 1906, divided application filed May 19, 1906, issued November 13, 1906.*

130. *de Forest Lee: "Oscillation Responsive Device." U. S. Patent No. 836,071, original application date January 18, 1906, divided application filed May 19, 1906, issued November 13, 1906.*

131. *de Forest, Lee: "Oscillation Responsive Device." U. S. Patent No. 824,638, application date January 20, 1906, issued June 26, 1906.*

132. *de Forest, Lee: "Wireless Telegraphy." U. S. Patent No. 837,901, application date February 14, 1906, issued December 4, 1906.*

133. *de Forest, Lee: "Wireless Telegraphy." U. S. Patent No. 841,386, application date August 27, 1906, issued January 15, 1907.*

134. *de Forest, Lee: "The Audion—A New Receiver for Wireless Telegraphy." Proceedings A.I.E.E., Vol. 25, 1906, pp. 735-763. Discussion on pp. 764-779.*

135. *de Forest, Lee: "Device for Amplifying Feeble Electrical Currents." U. S. Patent No. 841,387, application date October 25, 1906, issued January 15, 1907.*

136. *de Forest, Lee: "Improvement in Oscillation Detectors." U. S. Patent No. 879,532, application date January 29, 1907, issued February 18, 1908.*

137. *Archer, G. L.: "History of Radio." American Historical Society, 1938, p. 92.*

See Also Carneal, Georgette. *"The Conqueror of Space." Horace Liveright, 1930, pp. 195-196.*

138. *Arvin, W. B.: "The Life and Work of Lee de Forest—Part VIII."* Radio News, *Vol. 6, No. 11, May 1925, p. 2066.*

139. *Robison, (Commander) S. S.: "Manual of Wireless Telegraphy for Use of Naval Electricians." 2nd edition, 1911, p. 169.*

140. *de Forest, Lee: "The History of the Radio Tube, 1900-1916."* Radio News, *Vol. 24, No. 6, December 1940, p. 8.*

Figure Captions

Figure 36. The Bunsen burner patent. This was the fundamental de Forest heated gas patent.

Figure 37. The two-electrode Audion patent. Note the use of two batteries, one for heating the filament, the other for applying positive potential to the plate.

Figure 38. The Audion with external electrostatic control. An antenna and ground connection is made externally to a wire wrapped around the glass envelope of the tube. Reproduced from *Proceedings A.I.E.E., 1906.*

Figure 39. The Audion with electromagnetic control. Reproduced from *Proceedings A.I.E.E., 1906.*

Figure 40. The first three-electrode Audion patent. Note the external connections.

Figure 41. The grid-type Audion patent. Note the use of the condenser in series with the grid.

Figure 42. Early cylindrical candelabra-base Audion. This specimen was probably made in 1908, since it has a double filament. Photograph courtesy *Radio Corporation of America.*

Figure 43. Early spherical bulb single-grid, single-plate Audion. Both filaments of this Audion are still good, hence the projecting wire has not been connected to the base shell which is of the candelabra type.

(To be continued)

R-F Converter

(Continued from page 29)

The builder who possesses a broadcast receiver of good quality, will have with the addition of this converter, a short wave combination capable of giving remarkable performance. Most radio parts jobbers are still able to supply most of the items needed. Furthermore, inasmuch as standard parts are used many of them will be found in the average service shop or experimenters, laboratory. The use of an efficient all-wave antenna is highly recommended. No converter can work at its best unless it terminates at a proper receiving system.

Inasmuch as standard tubes are used it is possible to use substitutes simply by changing supply voltages.

—30—

Coming October Issue

"Wave Guides"

Book Review

(*Continued from page* 38)

munications in the Signal Corps. Here, in nontechnical language, is a bird's-eye view of the Signal Corps, what it is, how it works, what its duties are, and its place in the Army as a whole. One of the authors, Mr. Davis, is an electrical engineer and science writer, formerly on the staff of The New York Times and more recently employed in the Office of the Chief Signal Officer in Washington. The other author, Professor Fassett is on the faculty of the Massachusetts Institute of Technology and is the Editor of the Technology Review.

"RADIO TROUBLESHOOTER'S HANDBOOK," by Alfred A. Ghirardi. 3rd Revised & Enlarged Edition. Published by *Radio & Technical Publishing Company,* 45 Astor Place, New York City. 744 pp. Price $5.00.

A practical working handbook designed to supply a wealth of factual radio servicing data for shop use by radio repairmen. It facilitates their task of troubleshooting, adjusting and repairing home, portable, and auto-radio receivers and automatic record changers of all types so that they may do this more easily, more quickly and more profitably. The Third Edition retains all the features that made the previous two so popular and successful among practical repairmen. All existing text, illustrations and data have been gone over and revised fully to bring them up to date.

Radiomen interested in keeping up to date in these days when technical information on new developments is hard to get will find this book an invaluable aid.

—30—

Mfrs.' Lit.

(*Continued from page* 42)

A copy of booklet B-3264 may be secured from Department 7-N-20, *Westinghouse Electric and Manufacturing Company,* East Pittsburgh, Pa.

FOLDER DESCRIBES NEW GHIRARDI RADIO TROUBLESHOOTER'S HANDBOOK

Ghirardi's newly revised and expanded 3rd Edition "Radio Troubleshooter's Handbook" containing 744 manual-size pages of valuable time-saving data covering all phases of radio service work is described and a detailed listing of its 75 topic section titles given in an attractive new 4-page folder in color just issued by the Radio & Technical Publishing Co., 45 Astor Place, New York City. This colorful folder, which is creating such interest, also points out the specific advantages this new 744-page Handbook offers the busy technician working under present "wartime" servicing conditions—

Copies of this new folder are avail-

Buy More
U. S. WAR BONDS AND STAMPS

RADIO NEWS

Correspondent Reaches the War Zone

★ In line with the policy of Ziff-Davis Publishing Company, publishers of RADIO NEWS, of bringing you the top news of the radio and communications industry, Kenneth R. Porter has been given a roving commission to report technical, on-the-spot news and information covering these subjects.

Mr. Porter, accredited by the War and Navy Departments, by British and other censor officials, has just arrived in London on the first leg of a global trip to report, at first hand, important details of developments, devices and uses, direct from the scene of action—of radio's most dramatic role—winning the war for the United Nations!

Mr. Porter was selected for this important assignment because of his wide experience in radio and aviation, as a newspaper correspondent and factory periodical editor, and with his further background on special assignments for the U. S. Army Signal Corps.

Watch for Mr. Porter's vivid, accurate, highly informative accounts of radio and communications in action in the war zones — appearing in forthcoming issues of RADIO NEWS — the top news of the industry and its accomplishments.

ZIFF-DAVIS PUBLISHING COMPANY

CHICAGO • NEW YORK • WASHINGTON, D. C. • LOS ANGELES • LONDON • TORONTO

ENGINEERS

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

This section is designed to help the radio, radionics, and communications industries obtain trained, experienced, technical men to facilitate vital war production.

Help!

We need Engineers and Laboratory Assts.

We're going places in electronics— NOW and after the war.

Want to come along?

If you are not now using your full talents for the war effort, you may participate in the development of new and revolutionary communications methods. Outline your education, experience, marital status and salary requirements. Address

•

BOX 318, c/o RADIO NEWS
540 N. Michigan Ave., Chicago 11, Ill.

WANTED

1. RADIO, ELECTRONIC ENGINEERS preferably with experience in radio, ultra high frequencies, general electronics.
2. RECENT GRADUATES — in electronics or physics.
3. TECHNICIANS—experienced in radio and electronics.
4. MECHANICAL ENGINEERS—experienced in the design of high production items and familiar with manufacturing practices and requirements.
5. DRAFTSMEN — experienced in product layout and/or detailing.

This increase in staff is required to take care of war work of high military urgency and for post-war requirements.

If you are employed in essential war work to the full extent of your skill, do not apply.

Write to: PERSONNEL OFFICE
Delco Radio Division
GENERAL MOTORS CORPORATION
KOKOMO, INDIANA

ELECTRICAL ENGINEERS
ELECTRONIC ENGINEERS
CIRCUIT ENGINEERS
CHEMIST
MICRO-CHEMIST
ELECTRONIC DRAFTSMAN
PHYSICIST

For war and post-war development work with major manufacturer in the field of electronics.

Write, stating education, experience, and salary requirements.

TUNG-SOL
LAMP WORKS, INC.
370 Orange St., Newark

Persons in war or essential activity not considered without availability statement.

WANTED
Several Radio and Electronic Engineers

First, we are seeking the services of one or two trained engineers who have had ample experience in electronic engineering. The men selected will not only be concerned with present war production, but should eventually develop key positions in postwar operation.

Second, we are also looking for a few young engineers who have had good schooling and background to be trained for specialized work with us.

This is an excellent opportunity for men who qualify to connect with a progressive, highly regarded manufacturer of transmitting tubes. Many special benefits will be enjoyed in your association with this company.

Write at once giving complete details of past experience. Interviews will be promptly arranged.

Persons in war work or essential activity not considered without statement of availability.

Chief Engineer
UNITED ELECTRONICS COMPANY
42 Spring Street
Newark, New Jersey

★ INDUSTRIAL ★ MAN-POWER BUREAU

This section is designed to help the radio, radionics, and communications industries obtain trained, experienced, technical men to facilitate vital war production.

ENGINEERS

Junior, Semi-Senior, and Senior
Male or Female

Wanted for developmental work with an outstanding manufacturer of electronic components. Interesting work. Good living conditions. Salary in keeping with experience and background. Write stating qualifications in full. Interview arranged promptly.

Write to: Personnel Dept.

SPRAGUE SPECIALTIES COMPANY
North Adams, Mass.

Those now employed in essential industries will be engaged only in compliance with the War Manpower Commission rulings.

LARGE, well-established Baltimore electronic organization, now occupied with War Work, finds it necessary to add to its staff a few "top" Technicians and Supervisors in each of the following categories:

PRODUCTION ENGINEERS

Men with well-rounded manufacturing background to develop into Supervisors. Capable organizers who have ability to effectively manage departmental manufacturing units.

PLANNING ENGINEERS

To determine piece part planning schedules and assist in planning, routing and scheduling problems.

MATERIAL CONTROL SUPERVISORS

Men capable of supervising maintenance of material control records. Responsible for allocating material and requisitioning material and parts as needed.

These positions are permanent. We are looking for men of above average ability who are interested not only in present earnings, but also future security with a progressive organization.

Top salaries will be paid for exceptional people.

Reply by letter stating citizenship, draft status, number and ages of dependents, education, experience, age, height, weight, religion, etc.

All replies will be acknowledged immediately and will be held in strictest confidence.

(Those already employed in an essential activity will not be considered without a statement of availability.)

Box No. 316, % RADIO NEWS,
540 N. Michigan, Chicago 11, Ill.

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

R. C. A.
Communications, Inc.
66 Broad St., N. Y. C.

Electronics & Electrical Engineers Wanted

Steady work assured. Ideal location in Northern Indiana away from the congestion of a large city. State experience, salary requirement and draft status.

PENN ELECTRIC SWITCH CO.
Goshen, Indiana

RADIO ENGINEER

WITH AMATEUR EXPERIENCE IN CONSTRUCTION OF TRANSMITTING EQUIPMENT FOR EXPERIMENTAL WORK ON HIGH FREQUENCY INDUSTRIAL APPARATUS. MUST BE DRAFT EXEMPT. 100% WAR INDUSTRY. WRITE STATING EXPERIENCE, TRAINING, AND SALARY EXPECTED TO REMLER COMPANY, LTD., 2101 BRYANT STREET, SAN FRANCISCO, CALIFORNIA.

ELECTRICAL ENGINEER

Graduate engineer wanted by Northern Ohio Manufacturer in business 50 years. Not just a war job. Permanent position for man with some experience in experimental and design work on electric motors ½ to 5 HP. Company now 100% on war orders. Prefer man with deferred draft status. Box 317, % Radio News, 540 North Michigan, Chicago, 11, Ill.

WESTERN ELECTRIC CO.

"The Arsenal of Communications Equipment"

WANTS

INSPECTION ENGINEERS

For quality control work.

MEN OR WOMEN

Background required: Knowledge of D.C., A.C. and electronic theory. High school with some college background in Physics and Mathematics or radio school essential. Experience in amateur radio with license desirable but not required

To do inspection and testing of radio and other high frequency equipment.

Those now on war work should not apply.

WRITE OR APPLY IN PERSON TO A.C.C., EMPLOYMENT DEPT.

WESTERN ELECTRIC CO.

100 Central Ave. Kearny, N. J.

MONDAY THROUGH SATURDAY 8:30 A.M. TO 3 P.M.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

RADIO CALLING

100% WAR WORK
AND

POST-WAR OPPORTUNITIES

Men with experience in high frequency circuits on transmitters and receivers, for the following work:

Factory Technicians — Development Engineers
R.F. Coil Engineers — Process Engineers
Production Engineers

Married men with children or otherwise draft deferred given preference.

THE HALLICRAFTERS CO.
2611 S. Indiana Avenue, Chicago, Illinois

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

TECHNICAL WRITERS WANTED!

Engineers and physicists who have had experience in (spare time) writing technical manuscripts on electronic design or applications including radio, television, facsimile, etc. Highest rates.

Reply Box 310, c/o RADIO NEWS
540 N. Michigan Ave., Chicago

TECHNICIAN

Fastest growing radio publication has permanent position for well-educated engineer with knowledge of electronics and physics.

Send full qualifications to

Box 310, c/o RADIO NEWS
540 N. Michigan Ave., Chicago, Ill.

able from local radio supply houses, radio dealers and bookshops, or direct from the publishers. Dealers not already supplied can obtain desired quantities, with space for their imprint, free upon request to the publisher.

"THE ABC OF ELECTRONICS AT WORK" DESCRIBED IN NEW BOOKLET

The fundamental principles of the six basic ways in which electronic tubes function are explained in a new 36 page booklet announced by *Westinghouse Electric and Manufacturing Company.*

Schematic drawings of the tube construction and diagrams showing the typical circuits for the various functions are used to explain how electronic tubes rectify, amplify, generate, control, transform light into current and current into light. Industrial and military applications for each of the six basic functions are described and illustrated in this booklet, "THE ABC OF ELECTRONICS AT WORK." High-frequency heating, dynamic balancing, resistance welding control, radio and radio-telephony, television, Precipitron, industrial and medical x-ray are a few of the electronic devices that are included.

A copy of booklet B-3260 may be secured from Department 7 N 20, *Westinghouse Electric and Manufacturing Company,* East Pittsburgh, Pa.

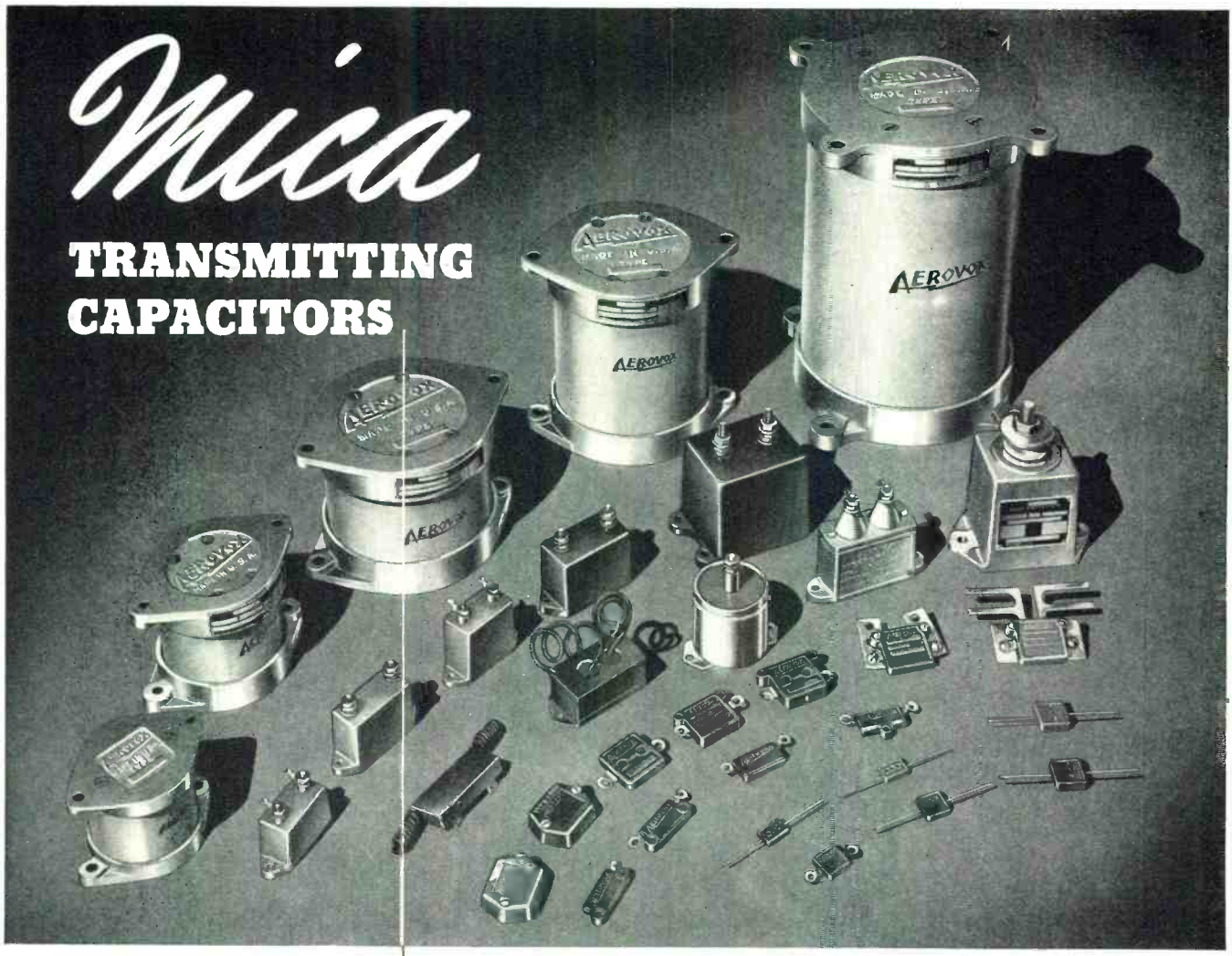
-30-

Index to Advertisers
September, 1943

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

PHOTO CREDITS

Page Numbers	Credits
20, 22 (top)	Esterline-Angus Co.
22 (bottom)	Dr. R. D. MacNitt and the Bureau of Psychointeroammeter Research; Wilmington College, Wilmington, Ohio
24, 25, 56	U. S. Army Signal Corps
30, 31, 39	General Electric



OUR WAR EFFORT

From January 1941 to December 1942, Aerovox . . .

- Stepped up production output 500% for our Armed Forces.

. . .

- Increased production floor space 300%.

. . .

- Sought, hired, trained, and put to work additional workers—à 300% increase in productive personnel.

. . .

- Opened second plant in Taunton, bringing work to available workers there.

. . .

- And—doing more and more; growing week by week!

• Be it tiny "postage-stamp" mica capacitor or large stack-mounting unit—regardless, it's a *precision* product when it bears the Aerovox name.

Only the finest ruby mica is used. Each piece is *individually gauged and inspected.* Uniform thickness means meeting still closer capacitance tolerances. Also, sections are of exceptionally uniform capacitance, vitally essential for those high-voltage series-stack capacitors. Meanwhile, the selection of perfect mica sheets accounts for that extra-generous safety factor so characteristic of ALL Aerovox capacitors.

• Consult your local Aerovox jobber, about your wartime capacitor requirements. Ask him about the new Aerovox catalog listing many new types and values to meet the growing requirements of radio and electronics. Ask about the Aerovox Research Worker. Or write us direct.

AEROVOX Capacitors

INDIVIDUALLY TESTED

AEROVOX CORPORATION, NEW BEDFORD, MASS., U. S. A. • SALES OFFICES IN ALL PRINCIPAL CITIES
Export: 100 VARICK ST., N. Y. C. • Cable: 'ARLAB' • In Canada: AEROVOX CANADA LTD., HAMILTON, ONT.

Long, uninterrupted service is called for in a capacitor and to fulfill that requirement three things are necessary:—intensive experience . . . advanced engineering . . . rigid production standards. This combination has given Tobe Capacitors a proud record, with almost complete absence of "returns."

The Tobe Oil-Mite Capacitor, shown here, has consistently lived up to an established reputation for long life. This capacitor, impregnated and filled with mineral oil, is most carefully made and most conservatively rated. It is performing day-in, day-out duty as a filter condenser in war equipment. Inquiries in connection with your condenser problems will receive our prompt attention.

LONG LIFE ASSURED

CHARACTERISTICS OF TOBE OIL-MITE CAPACITORS

STANDARD CAPACITY TOLERANCE.	= 10%
TEST VOLTAGE.....	Twice D.C. rating
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
RATINGS.....	.05 mfd. to 2.0 mfd. 600 V.D.C. .05 mfd. to 1.0 mfd. 1,000 V.D.C.
GROUND TEST	2,500 Volts D.C.
POWER FACTOR.....	At 1,000 cycles—.002 to .005

TOBE DEUTSCHMANN CORP. TOBE CANTON · MASSACHUSETTS

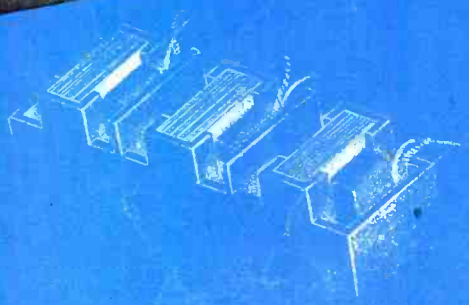
A SMALL PART IN VICTORY TODAY
A BIG PART IN INDUSTRY TOMORROW

Printed in U. S. A.

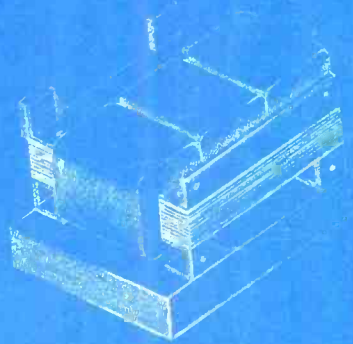
Combinations for Victory

Savings in materials and machine time are vital to victory. Substantial savings can frequently be effected by combining elements. Typical UTC design refinements of this type are illustrated.

The design of this unit combines switch plate, name plate, and cover.



This unit employs a special die cast housing which combines the mounting of six units, eliminating twelve sets of brackets, twenty-four screws, and a special outer case.



UTC three phase to single phase transformers combine the mounting facilities of the transformer and condenser. This and electrical design reduced the volume and weight of the UTC design forty per cent compared to contemporary design.

Two reactors, four condensers, and two shielded transformers are combined in this hermetically sealed container. Separately cased, the volume and weight would be doubled.

May we design a Victory Unit to your application?

UNITED TRANSFORMER CO.

150 VARICK STREET ★ NEW YORK, N. Y.

EXPORT DIVISION: 100 VARICK STREET NEW YORK, N. Y. CABLES: "ARLAB"

HE SHOUTS COMMANDS IN A WHISPER!

With a rumbling rush that shakes the earth and blazing guns that fill the air with chattering fury, iron men in tanks of steel go crashing through the enemy lines.

And directing the onslaught of this armored force is a voice made sure and strong by war . . . the battle voice of radio. Though commands may be spoken in but little more than a whisper, this voice cuts clearly through the surrounding din and uproar of action . . . calls the plays for tank teamwork that wins.

On land, on sea, and in the air, radio and Radar equipment is helping to write the history of this war. When that history has been completed by victory, Belmont will have an interesting story to tell . . . a story of wartime developments applied to better products and better living in a peacetime world. Belmont Radio Corporation, 5921 W. Dickens Ave. Chicago 39, Ill.

Belmont Radio

TELEVISION ★ FM ★ ELECTRONICS

KEEP BUYING WAR BONDS!