

IN THIS
ISSUE:

RADIOTHERAPY ON SHORT WAVES BY DR. LEE DE FOREST

RADIO'S GREATEST MAGAZINE

RADIO-CRAFT

with
**POPULAR
ELECTRONICS** ★



AUGUST

25¢

CANADA 30¢

1943

SEE PAGE
654

OVER 100 ILLUSTRATIONS

Their guns were loaded and aimed...yet

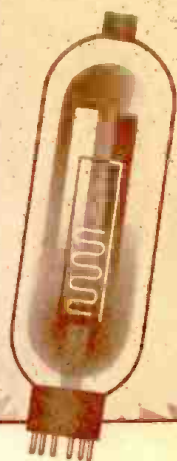
ELECTRONICS FIRED THE FIRST SHOT!



At many points where our boys landed along the North African coast there was little, if any, resistance because electronics had already won the day. By short wave radio America's motives had been made clear. Days of fighting were avoided. Thousands of lives were saved.

This historic military achievement and many others on today's world battle fronts have won the electronic tube a place among the great weapons of modern warfare. Yes, electronic tubes can *fight*! And to supply these fighting tubes for our fighting forces the men and women of National Union have doubled and *redoubled* production. We know the day is coming when these tubes and the knowledge and

skill which build them will be reconverted to the needs of peace. In National Union's plans for this new age of electronics that lies ahead, your job, as a service engineer, will be more important than ever before. All that you'll need to gear up your business to this bigger job—tubes, test equipment, guidance in servicing and selling—National Union will have ready for you at the word "go".



On Sunday, November 8, in North Africa, the sound which broke the peaceful stillness of that eventful night was not the booming of allied guns, nor yet the throbbing engines of countless landing barges. It was a VOICE—the friendly voice of the President of the United States saying "We come among you to repulse the cruel invaders—Have faith in our words—Help us where you are able."

NATIONAL UNION RADIO CORPORATION • NEWARK, NEW JERSEY • LANSDALE, PA.

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

A FREE LESSON SHOWED BILL HOW HE COULD MAKE GOOD PAY IN RADIO

BILL, YOU'RE ALWAYS
FOOLING WITH RADIO—
OUR SET WON'T
WORK—WILL
YOU FIX IT?

I'LL TRY, MARY,
I'LL TAKE IT
HOME TONIGHT

I CAN'T FIND OUT
WHAT'S WRONG—
GUESS I'LL MAKE A
FOOL OF
MYSELF
WITH MARY

HELLO, BILL—GOT A
TOUGH ONE
TO FIX?
LET ME
HELP YOU

HELLO JOE—WHERE'VE
YOU BEEN LATELY—
AND WHERE DID YOU
LEARN
ANYTHING
ABOUT
RADIO?

I'VE BEEN STUDYING RADIO AT HOME, BILL,
WITH THE NATIONAL RADIO INSTITUTE. YOU
OUGHT TO TAKE THEIR COURSE. I'VE GOT
A GOOD RADIO JOB NOW. LET'S MAKE A
CIRCUIT DISTURBANCE TEST—STARTING WITH
THE AUDIO OUTPUT STAGE
AND TESTING EVERY STAGE
RIGHT BACK TO THE
ANTENNA. LISTEN FOR
THE CLICKS WHEN I
TAP THE GRID LEADS

SAY—WHERE
DID YOU LEARN
THAT TEST? IT'S
A GOOD ONE

HERE'S THE TROUBLE, BILL, IN THE
FIRST I.F. AMPLIFICATION STAGE. I
LEARNED THAT TEST EVEN BEFORE
I STARTED TAKING THE COURSE,
BILL. IT'S DESCRIBED IN A
FREE LESSON WHICH THE
NATIONAL RADIO INSTITUTE
SENDS YOU WHEN
YOU MAIL A
COUPON FROM
ONE OF THEIR ADS

I'VE SEEN THEIR ADS
BUT I NEVER THOUGHT I
COULD LEARN RADIO AT
HOME—I'LL
MAIL THEIR
COUPON RIGHT
AWAY

I'M CONVINCED NOW THAT THIS
COURSE IS PRACTICAL AND
COMPLETE. I'LL ENROLL NOW

AND THEN I CAN MAKE
REAL MONEY FIXING
RADIO SETS

OR INSTALL AND SERVICE
LOUD SPEAKER SYSTEMS

OR GET A JOB
IN A BROADCASTING
STATION OR AVIATION
RADIO OR
POLICE RADIO

THE GOVERNMENT NEEDS
CIVILIAN RADIO OPERATORS
AND TECHNICIANS. IF I'M
DRAFTED, KNOWING RADIO
CAN WIN ME EXTRA RANK
AND PAY. HUNDREDS OF
N.R.I. TRAINED MEN
HAVE GOOD RADIO JOBS

I will send you a Lesson on Radio Servicing Tips **FREE**

TO SHOW HOW PRACTICAL IT IS
TO TRAIN AT HOME FOR

GOOD JOBS IN RADIO

Every man who works on a
Radio Receiver, either profession-
ally or as a hobby, should have a
copy of my Free Sample Lesson,
"Radio Receiver Troubles—Their
Cause and Remedy." To get your
copy without obligation mail the
Coupon below. It will show you
how practical my lessons are—
give you a real idea of the vast
amount of information my Course
gives you!

**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 serv-
icing jobs.

EXTRA PAY IN ARMY, NAVY, TOO

Men likely to go into
military service, soldiers,
sailors, marines, should mail the Cou-
pon now! Learning Radio helps Serv-
ice men get extra rank, extra prestige,
more interesting duties. MUCH HIGH-
ER PAY. Also prepares for good Radio
jobs after service ends. Over 1,700
Service men now enrolled.

Broadcasting Stations. Aviation and
Police Radio. Ship Radio and other com-
munications 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 Gov-
ernment, too, needs hundreds of compe-
tent civilian and enlisted Radio men and
women. Radio factories, with huge war
orders to fill, have been advertising for
trained personnel. And think of the NEW
jobs Television, Frequency Modulation, and
Electronics will open after the war! This
is the sort of opportunity you should not
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 pre-
pared 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 teach-
ing Radio.

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

MAIL COUPON NOW for FREE Sam-
ple Lesson and 64-page Illustrated book.
See the many fascinating jobs Radio of-
fers and how YOU can train at home. If
you want to jump your pay—mail Coupon in
an envelope or paste on a penny postcard!
—J. E. SMITH, President, Dept. 3HX,
National Radio Institute, Washington, 9, D. C.

YOU CERTAINLY KNOW
RADIO SOUNDS AS
GOOD AS THE DAY
I BOUGHT IT.

THANKS! IT CERTAINLY IS
EASY TO LEARN RADIO THE
N.R.I. WAY. I STARTED ONLY
A FEW MONTHS AGO, AND I'M
ALREADY MAKING GOOD MONEY.

THIS SPARE TIME
WORK IS GREAT
FUN AND
PRETTY SOON
I'LL BE READY
FOR A FULL
TIME JOB

OH BILL—I'M SO
GLAD I ASKED YOU
TO FIX OUR RADIO.
IT GOT YOU STARTED
THINKING ABOUT
RADIO AS A CAREER,
AND NOW YOU'RE
GOING AHEAD
SO FAST

OUR WORRIES ARE OVER.
I HAVE A GOOD JOB
NOW, AND THERE'S A
BIG FUTURE AHEAD
FOR US IN
RADIO

GOOD FOR BOTH 64 PAGE BOOK **FREE**

Mr. J. E. SMITH, President, Dept. 3HX
NATIONAL RADIO INSTITUTE, Washington, 9, D. C.

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

Name.....

Address.....

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

Zip.....

RADIO-CRAFT

with
Popular Electronics

★
HUGO GERNSBACH
Editor-in-Chief

FRED SHUNAMAN
Associate Editor

G. ALIQUO
Circulation Manager

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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."

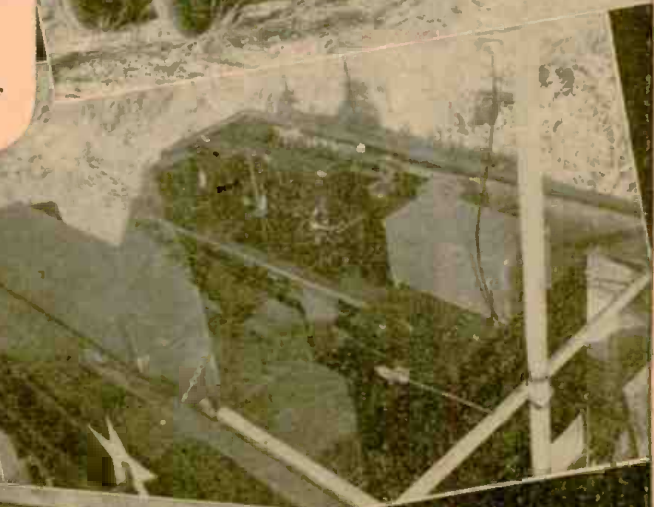
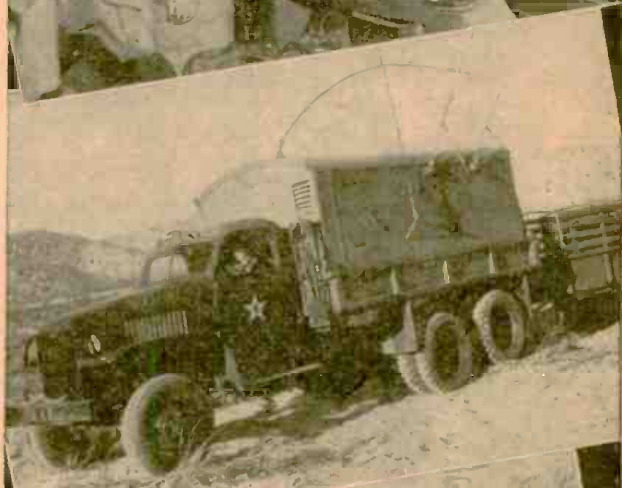
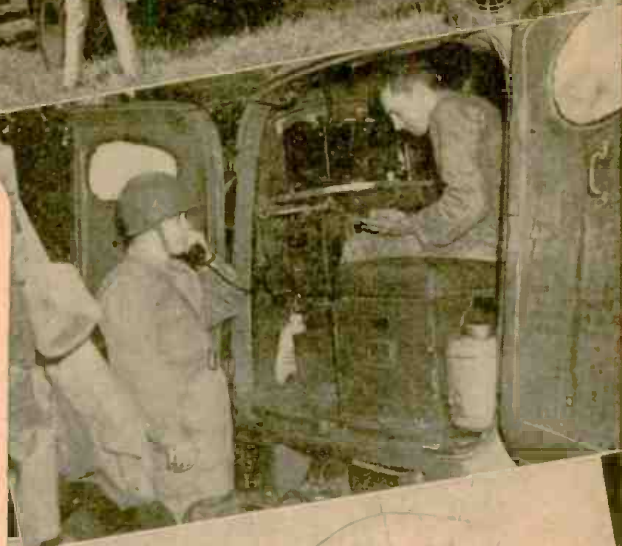
BUY MORE BONDS!

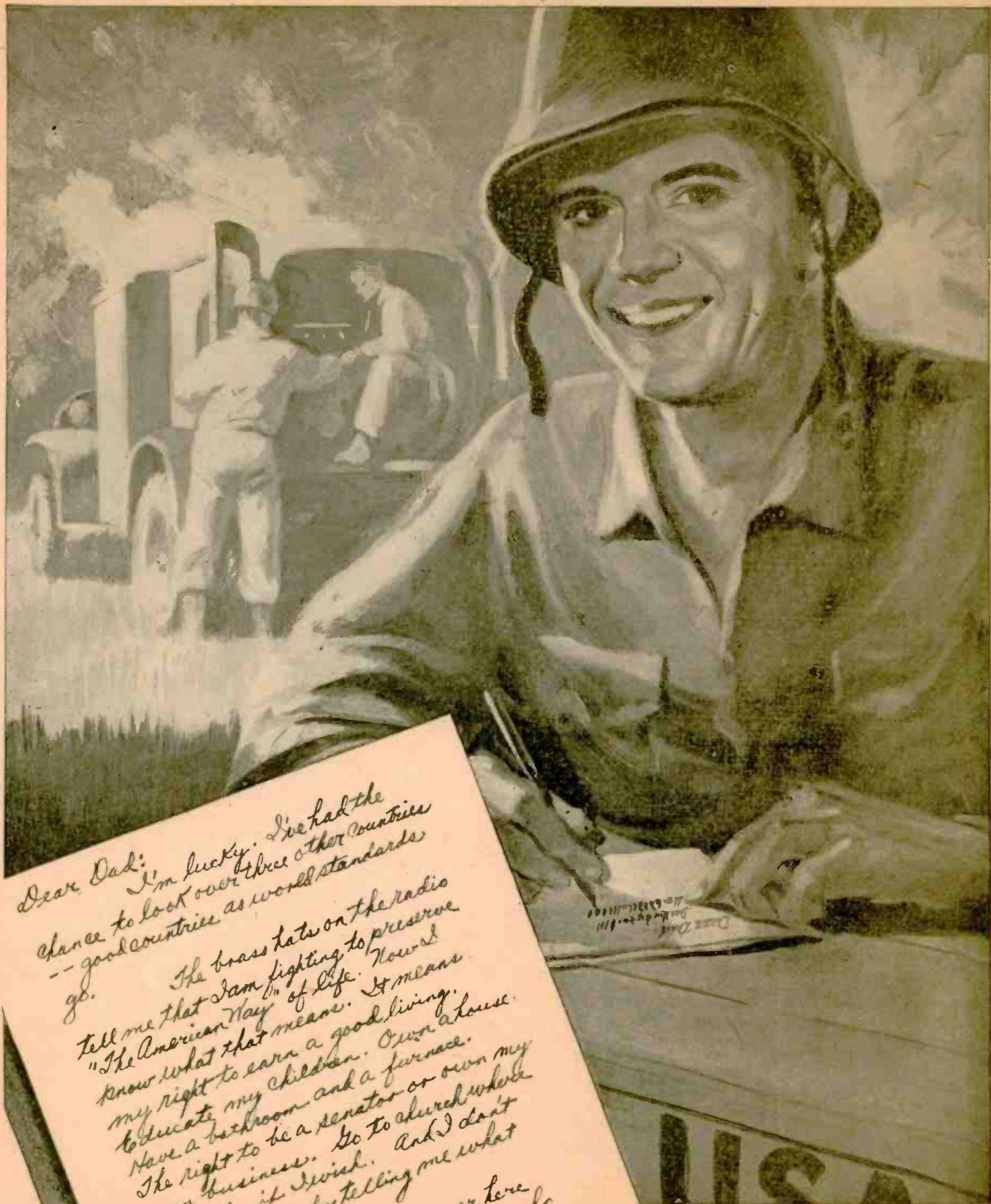


hallicrafters

CHICAGO, U. S. A.

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





Dear Dad:
I'm lucky. I've had the
chance to look over three other countries
-- good countries as world standards
go.

The brass hats on the radio
tell me that I am fighting to preserve
"The American Way" of life. Now I
know what that means. It means
my right to earn a good living.
To educate my children. Own a house.
Have a bathroom and a furnace.
The right to be a senator or own my
own business. Go to school where
I wish, if I wish. And I don't
want anybody telling me what
I have to do.

While we're over here
taking care of our enemies who
think they know what's best for us...
don't you men at home forget what
we're fighting for.

Your Son

BUY
MORE
BONDS!



hallicrafters

CHICAGO, U. S. A.



RADIO-CRAFT

with

POPULAR ELECTRONICS

.... A unique method
how to relieve civilian
radio tube shortage ...

"RADIO'S GREATEST MAGAZINE"

THERE IS NO TUBE SHORTAGE!

By the Editor — HUGO GERNSBACH

THE present severe radio tube shortage, for U. S. civilians has already reached alarming proportions, and is bound to grow worse as time goes on. Many authorities are convinced that there will be few, if any, tubes for civilian markets for the duration. The thin trickle of radio tubes which appear on the market are wholly inadequate to take care of the present radio tube famine.

As reported in the July issue of RADIO-CRAFT, estimates of as high as 100,000 radio sets silent in Detroit and approximately the same number in Philadelphia, were made recently by the WALL STREET JOURNAL.

I have worked out a rather simple plan, whereby it will not be necessary for our tube manufacturers to supply radio tubes for the civilian market at all. Let the civilian be patriotic as far as radio tubes are concerned and let him say to the tube manufacturer, "Make all the radio tubes you possibly can, strictly for military purposes, because it is known that our armed forces now must have every available radio tube manufactured—we civilians can get along without any new tubes!"

The new plan can be described in a few sentences as follows:

There are in this country at the present time over one hundred and thirty million radio tubes—in radio sets. This is a very conservative estimate, because with over forty million radio sets in the U. S. and figuring only four tubes per set (a low estimate) this would give us one hundred and sixty million tubes. Let us therefore assume that there are only one hundred and thirty million tubes. This figure is based upon the fact that there are hundreds of thousands of radio sets which have obsolete types of tubes which have been discontinued years ago, and are no longer made.

Now, as we all know, many people have more than one radio set such as portables, automobile sets, midget sets and others. Often such sets are not used at all, or only rarely. Let us also assume that these receivers contain only a total of twenty million tubes. This will give us a sizable working pool upon which to draw, in the plan outlined here.

As a radio set becomes silent on account of tube burn-outs, not all the tubes are affected in such a receiver. If the set has, let us say, six tubes, only one tube out of six may have stopped functioning. The other five tubes are still good and may perform for months, if not years. *But that one defective tube cannot be replaced at the present time.* Consequently one more set becomes silent. But if you should have a spare radio set you may look at the tubes in that receiver and you may find a tube that you can use in your receiver that went silent. If, on the other hand, you don't find the right tube, then your favorite radio receiver will probably remain silent for the duration.

But suppose, now that we know that there are over twenty million tubes available in the United States, we say, "Why not use these tubes to make the country's silent radio sets play again?" But how are we to do this? Strangely enough this is the simplest part of the plan. In every hamlet, town or city we have radio servicing establishments, radio stores—and if none of these should be available in a small community, there is always an electrician

or even the general store who can help out in the present emergency.

Patriotic citizens who have spare radio tubes in radio sets which are not often used will be asked in a national drive to take these tubes to the nearest *Radio Tube Exchange Depot*. The radio store or radio serviceman will welcome this idea not only for purely patriotic reasons, but because he will also make his expenses in the ensuing exchange, or swap, of thousands of tubes. The transactions will run somewhat as follows.

John Q. Citizen has six tubes for which he has no use, but he wants to get, let us say, a 7B7 tube, which he needs in his set gone silent. The radio servicing store will first test his tubes and obviously refuse those that are either obsolete or burned out. In this case, John Q. Citizen's six tubes thus shrink to five good tubes. Now, then, there are two things that the Radio Tube Exchange Depot can do. It can either buy the tubes outright, or John Q. Citizen can take a receipt for the five good tubes. The receipt is made in duplicate and it further states that John is in need of a number 7B7 tube. Hundreds of other citizens have in the meantime come to the same Depot, where all the different tubes are put in large boxes or baskets, assorted as to types. As the customers in need of tubes come to the Tube Depot they will therefore find the tube or tubes that they require.

At the end of a week, John Q. Citizen returns to the Depot and finds that there are plenty of 7B7 tubes which now become available to him. Further, as all the exchange tubes are loose and not in cartons, they cannot be sold as new. The Depot can either sell the tubes or exchange them at a small service charge anywhere from 10c to 25c per tube. John therefore can get the 7B7 tube which he needs, either by buying it outright, or by swapping it for another equivalent tube, by paying the small service charge. Remember, John has a credit for five good tubes. If the Depot in the meantime has disposed of John's tubes, he can get five other tubes that he needs in exchange. Or the Depot can pay him cash for the tubes, if this is agreeable to John.

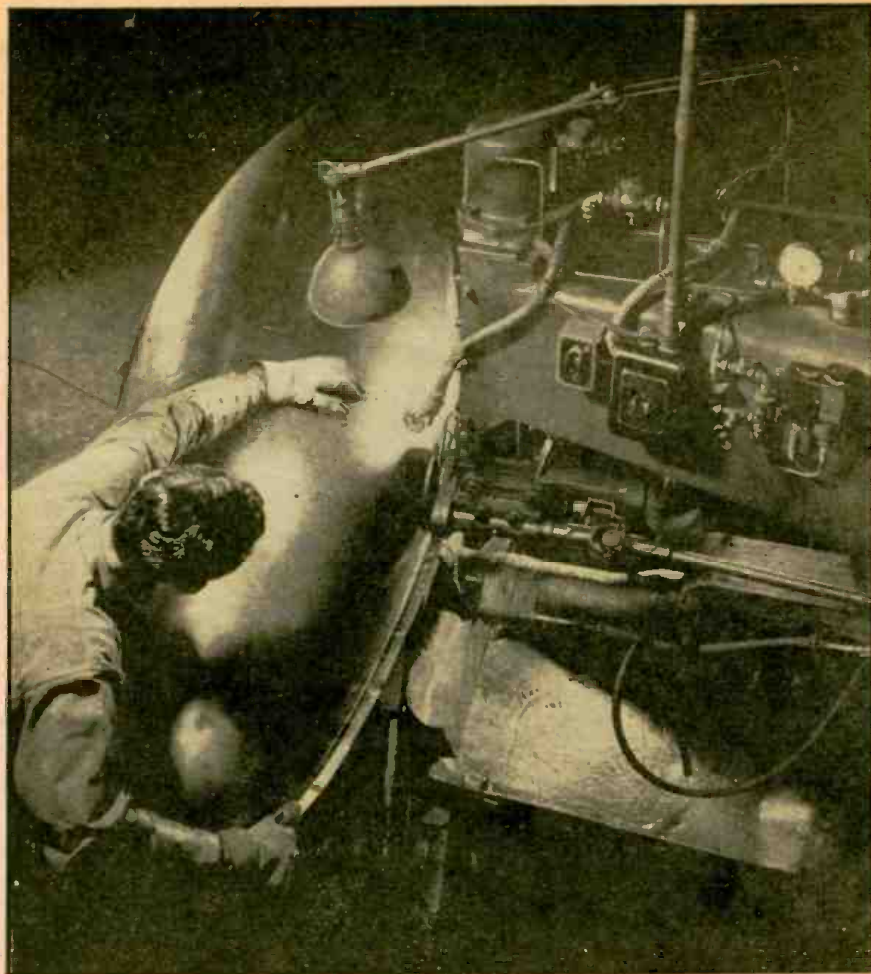
This is the plan in the rough. Obviously there are a number of points which will have to be worked out and safeguards must be devised so that the usual racketeers will not take advantage of the plans by buying up certain scarce tubes and bootlegging them at fancy prices. It is felt that if the idea is put into work, the War Price Administration can easily devise means to safeguard the Radio Tube Exchange plan.

The fundamental idea is, that there seems to be a sufficient amount of radio tubes in the country to take care of all present civilian shortages. The details in working out the plan in a satisfactory manner should not be too difficult in solving.

The preliminaries of the Radio Tube Exchange Depot have already been worked out by RADIO-CRAFT. Next month and during succeeding months RADIO-CRAFT will chronicle the progress of the plan and report on its functioning.

It is felt that the plan will work—indeed it is essential that it *MUST* work, because it seems to be the only sane method during wartime and for the duration, to secure radio tubes for civilians without hampering our war effort.

A Digest of News Events of Interest to the Radio Craftsman



"EXPENDABLE" GAS TANKS ELECTRICALLY STITCHED

Gasoline tanks which are simply dropped when their contents are finished are now being seam welded by electron-controlled machines, according to advices received last month from the Lockheed plant near Los Angeles. The new technique permits substitution of steel for war-scarce aluminum formerly used for such tanks.

Equipped with precise General Electric electronic control, which insures tough vibration-proof and gas-tight seams, the

machine shown above "stitches" two halves of the tank together at the rate of 60 inches per minute, taking only four minutes for the complete tank.

Since no additional metal is deposited in this process, welding rod formerly used in torch welding is also saved.

In use, two of the streamlined tanks are attached, like pontoons, to the Lightning P-38 and, when empty, may be dropped off to give the plane additional speed.

MORE FARM BATTERIES ALLOTTED

A directive issued last month by the Consumers Durable Goods Division instructs manufacturers of radio batteries to fill all orders from farm distribution outlets up to 98 per cent of their total radio battery production, during the period beginning June 14 through August 30. To do this they are authorized to disregard preference ratings other than AAA and those assigned on Form PD-3A (Army, Navy, Maritime Commission, and War Shipping Administration) applications.

Another directive to battery manufacturers performs the same function with respect to flashlight batteries, except that the

percentage of total production to be set aside for farm supply during the same period is 20 per cent. In the same way, 50 per cent of No. 6 batteries, a type suitable for fence control, telephone and ignition uses, are directed to farm use.

Little or no change in the prevailing disposition of radio batteries can be expected through the directive since distribution of these products to farms has followed the specified percentages closely. However, the directed distribution of the other types of batteries will bring a marked increase in their supply to farms.

WERS ACTIVITIES EXTENDED BY NEW FCC REGULATIONS

The scope of War Emergency Radio Service has been extended by a special action of the Federal Communications Commission, to provide for rapid mobilization of the nation's protective facilities in any "emergencies endangering public safety, or important property," it was announced last month by the FCC and the OWI.

Up to the time of the FCC amendment to the regulations governing them, WERS stations were limited to operation only during or immediately following air raids, impending air raids or other enemy military operations or acts of sabotage.

The amended rules permit Civilian Defense licensees in the WERS to use their stations to provide essential communications over limited distances in the event of such emergencies as floods, explosions, hurricanes, fires, or other emergency situations affecting the nation's security.

The amended rules also provide for the designation of one or more of the licensed WERS stations as "control units". So that fire-fighting and other facilities may always be in readiness, Civilian Defense licensees in this service may use their station units, under the supervision of such "control units", during the first 15 minutes of each hour, for the exclusive purpose of handling essential communications preparatory to any anticipated emergency.

The FCC has also enlarged the periods which WERS stations may use for training, practice and testing. These were previously limited to one two-hour period on Sundays and a similar period on Wednesdays, the latter only during the first 90 days of the station's operation. Three two-hour periods are now provided each week: Sunday, 5 to 7 p.m., Monday and Wednesday, 10 p.m. to midnight, Eastern War Time.

WERS is now established in 200 communities (according to latest reports), with more than 3,700 separate two-way stations and 6,000 licensed operators. At the present time, there are in the War Emergency Radio Service 192 Civilian Defense, eight State Guard, and two Civil Air Patrol station licensees. Each station licensee may use from 2 to 100 or more radio station units, whose operation is coordinated to form a comprehensive local communications system.

It is anticipated that this change in the Rules will provide increased opportunities for amateur radio operators as well as other qualified radio operators, technical men, and engineers to contribute their time, energy and talent to the war effort.

FURTHER RELAXATION OF FM BROADCAST RULES

Further relaxation of FM broadcast rules was announced by the Federal Communications Commission last month. Owing to manpower shortages, these stations have been hard put to keep up to the minimum F.C.C. requirements as to service.

Order 111-A continues the requirement that each FM broadcaster must give at least six hours daily program service (with the exception of Sundays) between the hours of 6 A.M. and midnight, but suspends the requirement that two hours of this service must be devoted to programs not duplicated in the same area by any FM or AM broadcast station. Each FM licensee is still required, insofar as possible, to develop "a distinct separate broadcast service from that otherwise available in the service area."

HOME RADIO MAINTENANCE BACKED BY F.C.C. HEAD

Assurance to broadcasters that the Federal Communications Commission is firmly behind efforts to keep home-front radio facilities in action during the war was given last month by Chairman James L. Fly, in an address at Chicago.

"Every effort should be made," said Fly, "to keep existing broadcast transmitters on the air, present receivers going and public radio communications circuits in operation. For, after all, the job of mass communications carried on by the broadcasting industry is one of the most significant of all essential services rendered on the home front.

"The needs of both military and civilian fields have had to be met. It has required real ingenuity to serve these related needs . . . There appears to be no reason why any appreciable number of radio receivers should go out of service."

The F.C.C. chairman also added his share to the symposium on "post-war radios," his support going to the conservative party. "Let's not foster the idea," he said, "that from now on people are going to live in a Buck Rogers world, composed of living rooms resembling the radio control room of a battleship. The public must be served with the best and widest possible service, but this does not mean a series of contrivances such as Gene McDonald's 'Crystal Gazer's Post-war Dream.'" —(*Radio-Craft*, July, Page 582.)

TRANSMITTING TUBE FAMINE NEW THREAT TO RADIO FANS

Radio listeners have had their troubles in keeping on the air, due to tube shortages. According to a statement issued last month by Mr. F. H. McIntosh, chief of the domestic and foreign broadcast branch of the WPB Radio and Radar Division, this shortage is likely to hit from a new and more dangerous quarter. An acute lack of transmitting tubes for broadcast stations has begun to make itself felt.

Here is a new angle for the listener. He is faced with the prospect that even after breaking his neck to obtain replacement tubes for his favorite receiver, he may be unable to hear programs he desires because the broadcaster may be shut down for lack of tubes.

According to Mr. McIntosh, the production of all types of broadcast equipment is still strictly limited, and the conservation of existing tubes and parts is an urgent necessity. Military demands for equipment are heavy, and requirements of the armed services have the manufacturers loaded to capacity.

The most severe shortages, it was pointed out, exist in water-cooled or radiator type tubes; multi-element tubes generally; recording equipment and better-grade microphones. Quality wire-wound resistors and mica condensers are tight, and their delivery must be individually scheduled by the Radio and Radar Division. It might confidently be expected that sufficient receiving-type tubes and replacement parts would be available to maintain all sets now in operation.

The broadcasters themselves are doing much to conserve equipment now in use. Plate voltages have been cut and every effort made to operate apparatus under conditions that will prolong its life. Pools of surplus parts have been created, so that components required by one station may be obtained from the idle stock of another.

ELECTRON "MACHINE GUN" AIDS STUDY OF METALS

A new and valuable application of electronics in the field of metallurgy was revealed last month by Dr. Earl A. Gulbransen of Westinghouse Research laboratories. Inspection of metal and oxide surfaces with an electronic diffraction camera opens the road to new advances in improved metal surfaces, bringing with it longer-wearing bearings and cylinders for airplane and automobile engines, better tin-plate in which the tin will cling more tightly to the surface underneath, and cheaper methods of making stainless steel.

Electrons are shot through a three-foot vacuum tube and bounced off a highly polished button of aluminum or steel on which an oxide coating is being built. The electrons ricochet off the faces of the block-like molecules that form the coating and continue downward at an angle to strike a strip of photographic film. There they trace a pattern of black and white semi-circles that appear when the strip is removed from the camera and developed. This design is formed by the electrons bouncing off the different faces of the molecules in the coating.

The electronic bullets are forced out of a small aluminum rod at the top of the vacuum tube by 50,000 volts. When this voltage is applied, a pin-point area on the end of the rod gives off free electrons that speed through the tube at the rate of four and a half million miles an hour. The polished metal buttons that Dr. Gulbransen uses as targets are inserted six at a time in a magazine that fits into the side of the vacuum tube. By revolving the magazine he can bring any one of them into the field of electronic fire. Electric resistance wires in the magazine heat the buttons to accelerate the formation of coatings. Growth of the oxide coating can be also speeded by admitting measured amounts of oxygen and hydrogen into the tube.

Small amounts of alloy metal can alter the nature of the coating formed on a piston ring, cylinder wall or motor bearing. Iron, for example, acquires a coating of rough iron oxide when exposed to air but when one per cent of chrome is added to the iron the coating formed is chromium oxide, a thin, protective layer that hinders the oxidation of the metal.

Dr. Gulbransen inspects the target of his "machine-gun." This three feet of steel pipe is a genuine electron tube, in spite of the fact that it resembles a section of water main more closely than it does one of the tubes in your radio. The associated apparatus is used to maintain the vacuum and control the admixture of traces of desired gases, when required.



F.C.C. MANPOWER SURVEY BRINGS QUICK RESULTS

As part of its program to ease the present shortage of skilled technicians in the communications industry, the Federal Communications Commission last month mailed to the War Manpower Commission and interested groups in the industry the first series of names of first- and second-class radiotelephone licensees who have reported themselves available for immediate employment in essential communications jobs. The list was prepared from responses to the Commission's postcard survey of a sample

of 1,000 of the nation's 20,000 licensed radiotelephone operators in these classifications.

To date over 550 holders of first- and second-class radiotelephone licenses have answered the F.C.C.'s query. Information obtained from the questionnaire related to the licensee's present employment, his draft status, whether or not he was using his license in his present job, and his availability for either full- or part-time employment in the communications field.

POPULAR ELECTRONICS*

By RAYMOND F. YATES

PART VII—PHOTOELECTRICS

A FEW years ago, photoelectrics was a highly specialized subject interesting only to the classical physicist. Today, even the man in the street has a nodding acquaintance with it. Photoelectrics now forms a highly important and very special part of the science of electronics.

No connection had been established between light and electricity up to the year 1873 when Willoughby Smith publicly announced a discovery by J. E. Mayhew. This man, a heretofore unknown person,

compared to other types of photo-sensitive devices, they are slow and require a relatively large amount of time before they recover their pre-exposed condition. Thus they are unsuited for uses where an extremely rapid series of light impulses are to be accommodated. Cells of this type are "photo-conduction" cells, meaning that the resistance of a conductor is changed upon exposure to light.

Bequerel, the Frenchman, discovered in the late part of the last century, what has since become known as the photo-voltaic cell. He found that two silver plates coated with chloride of silver developed an electric current when one of the plates was illuminated after they were immersed in water. Today we also have dry photo-voltaic cells later.

It was left to Hertz to discover still another (and the last) photoelectric effect. This unfolding of new knowledge came in the year 1887. Hertz used two highly polished zinc electrodes on a spark coil. He discovered that the electric discharge started moving readily when the freshly cleaned electrode surfaces were illuminated with light from burning magnesium, which happens to be very rich in ultra-violet rays. We now know that these rays can ionize gases.

AN EXPERIMENT IN PHOTO-ELECTRICITY

The Hertz experiment (Fig. 1) can be duplicated by any home scientist and a small arc lamp may be used for the illumination in place of the magnesium ribbon. A piece of glass placed between the light source and the spark gap will destroy the effect because ordinary glass will not transmit ultra-violet rays.

Quartz, on the other hand, will. This we can easily prove if a small plate of quartz may be had.

Shortly after Hertz, Hallwachs came along to demonstrate that negatively charged and freshly cleaned zinc plates very rapidly lost their charges when exposed to ultra-violet light. Curiously enough, ultra-violet light appeared to have strong photoelectric effects whereas light of the longest wavelength (red) had no effect.

We now know, of course, that photo-emissive phenomena, such as we have just been considering, is much more intense where light of the highest frequency (short wavelength) is used as an exciting agent. What was happening both in Hertz's and Hallwachs' experiments, though they did not know it at the time, was that free electrons were being hammered out of the zinc by the action of the light and that these free electrons were ionizing the surrounding gas (air).

We learn then that the degree of photo-emissive effects (release of electrons from a surface by the action of light) will depend on (1) the frequency (or wavelength) of the light and (2) the intensity of the light; for a given metal, that is. Naturally, the metals vary a great deal in photoelectric response. Apparently the more chemically active a metal is the greater its response

under the impact of light. This would lead us to believe that metals like sodium, lithium, potassium and caesium would make ideal photoelectric material. This is substantially correct in the case of photo-emissive cells.

The mechanical and electrical arrangement of a cell of the emissive type is shown in Fig. 2. The anode is simply a piece of metal; sometimes a rod, sometimes a loop and sometimes a screen through which light passes on its way to the photo-sensitive cathode. This photo-sensitivity will depend upon the wavelength of the light and its intensity in lumens. As the wavelength goes down (longer waves) a point will finally be reached where a cell with any given metal will not respond at all. This is called the threshold frequency and it never extends beyond the red rays, which, it will be recalled, have little ability to stimulate chemical action of any kind. This is proven by the fact that such rays are safe to use with most photographic films.

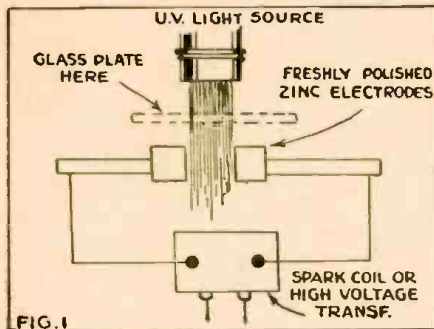
Photo-emissive cells are of two principal types; the gaseous and the vacuum. In the first case, they are filled with some gas like inert argon.

GAS VS. HIGH-VACUUM PHOTOTUBES

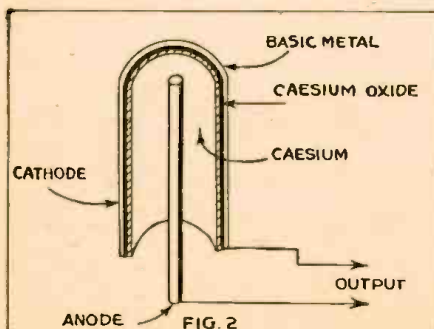
Gas-filled cells are used because the extremely low voltage output of the vacuum cell calls for excessive amplification. However, the vacuum cell is highly dynamic; that is, its response is instantaneous because of the immeasurably small time lag of the electrons released from the photo-active surface. In the case of the gas-filled cell, matters are somewhat different. Here the released electrons must first ionize the gas present and it is not a mere matter of electron transit time between cathode and anode. When a gas-filled cell receives a light impulse, the electrons ionize the gas by impact and the gas must also de-ionize at the end of the light shock. Time is required for this. Hence, there is a distinct limit to the frequency that can be handled with a gas-filled cell whereas the frequency response curve of a vacuum type cell is flat.

Although gas-filled cells require less amplification (vacuum tube) than vacuum cells, current in either case is so low as to make (in the case of the gas-filled cell) at least one stage of amplification necessary where a relay for the release of heavy local energy is required.

During our discussion of thermionic vacuum tubes in the last two chapters, we discovered that these devices were extremely sensitive to changes of charge (voltage) on their grids. Unfortunately, photo-emissive cells of either kind do not supply

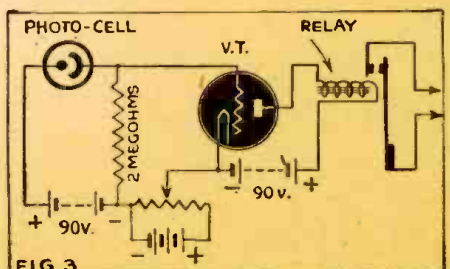


was the real discoverer of the first photoelectric effect. He demonstrated that the electrical resistance of the element selenium changed between light and dark. Ordinarily this substance has a resistance estimated to be four-thousand million times greater than copper, which places it in the category of insulators. However, by carefully annealing selenium under conditions of controlled temperature, it can be brought to a crystalline state where its electrical resistance is considerably lowered and where a relatively great change in resistance takes place between the dark and the light.



It was in 1879 that Alexander G. Bell and Sumner Tainter took up the work started by Mayhew and developed selenium cells wherein two metallic surfaces were separated by the especially prepared selenium. As an index of the change in electrical condition, it may be said that, in the dark, some of the cells had an electrical resistance of 300 ohms and that this suddenly dropped to 150 ohms upon exposure to bright sunlight.

Such cells are still in use today although,



*Application for Trade Mark Title, pending in U. S. Patent Office.

a great deal of voltage and hence unaided are not well suited to V.T. amplification. However, with the circuit shown in Fig. 3, the cells can be adapted to such amplification. Here a high resistance is placed in the input of the amplifier or between the amplifier and the cell so that a voltage drop large enough for adequate amplification may be had.

A review of the various metals and their photo-sensitivity produces the following list in order of their response, the best coming first:

Caesium
Rubidium
Potassium
Barium
Sodium
Strontium
Lithium
Calcium

It was discovered some time ago that best results with photo-emissive metals were had if they were placed on a metal cathode. Thus today one of the most popular cells is the so-called Caesium-oxide-silver photo-electric tube, shown in Fig. 2.

COLOR-FREQUENCY RESPONSE RANGES

Widespread industrial uses of photoelectric cells calls for considerable color sensitivity or, in short, peculiar sensitivity to certain wavelengths of light. This varies with the metals used. Caesium is very active in the middle range of the spectrum. In the case of every metal, the trouble comes at the end of the spectrum when red is approached. Staining the active surface with dyes increases the response of cells but this is really a makeshift and still leaves considerable latitude for improvement.

The color-sensitivity graphs (Fig. 4) will help the student to fix these matters in mind and to get some notion as to the limitations of these cells.

In the examination of the graph, it will be noted that the wavelength of the color is measured in Angstrom Units. This amounts to standard practice inasmuch as the centimeter is so large as to become cumbersome when used as a unit. The Angstrom unit amounts to 10^{-8} cm. Thus on this basis, violet light has a wavelength of 4000A. Red, on the other hand, has a wave length of 8000A. As we probably know, one color does not abruptly change to another in the spectrum. Even the ultra-violet has what we might call a little spectrum of its own and its photo-electric activity increases as the wavelength becomes shorter.

During the past few years, a new type of gas cell has come into wide use. This is known as the photo-glow cell. Here a light responsive surface starts a gas discharge. A relatively high voltage is placed across the cell but no current will pass so long as no electrons are emitted or, in other words, so long as no light strikes the cathode. Electrons ejected from the photo-sensitive surface by the action of light ionize the gas and permit electric discharge

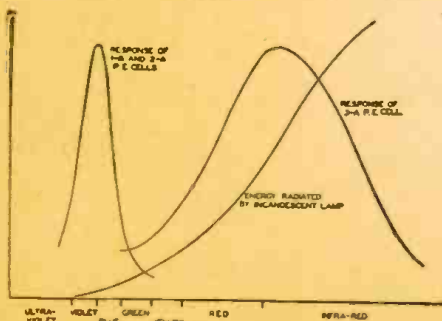
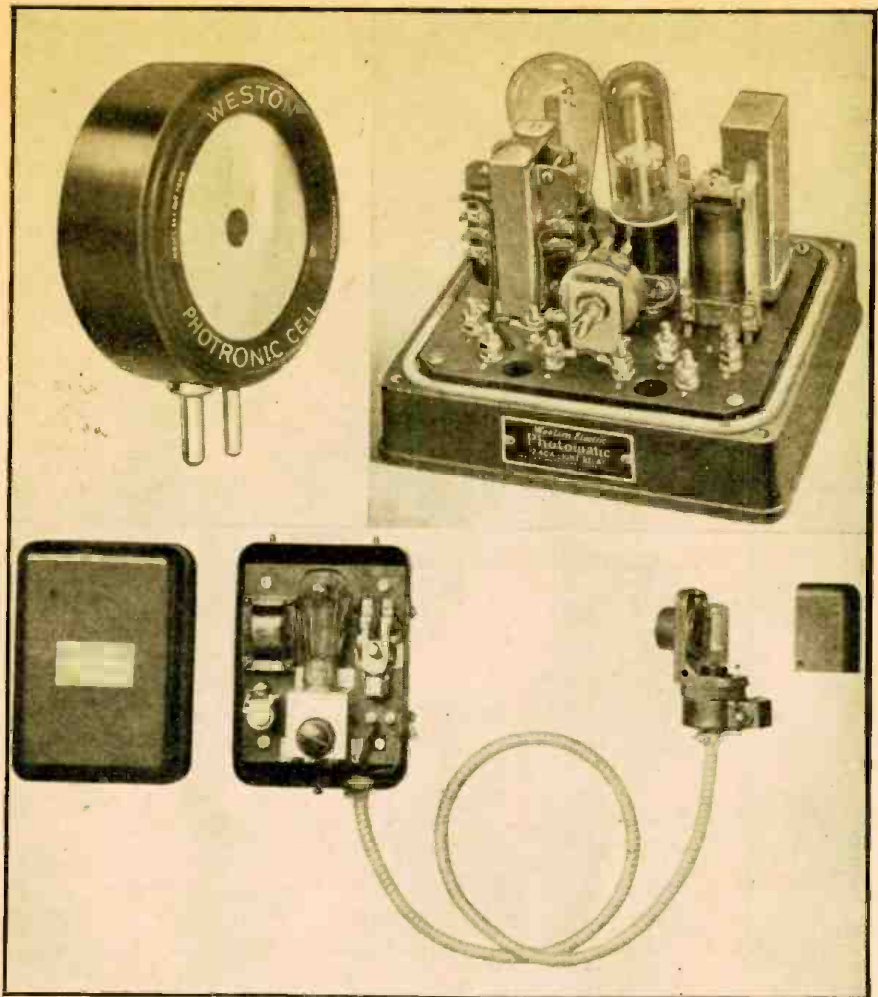


FIG. 4



The sensitive photo-electric cell at the top left is similar in principle, though different in appearance, to those already studied. Besides it is a complete photoelectric relay unit, with photocell, amplifier and mechanical relay all visible. The unit in the bottom picture is a relay built for industrial use and may be wall-mounted.

to take place. When this happens, relatively large amounts of current pass and such cells may be employed to operate a relay direct, without any V.T. amplification. However, once the discharge is initiated, it will continue until the voltage drops.

It is now possible to purchase what is known as a "multiplier" tube or cell. The multiplier effect is brought about by a clever arrangement of sensitized cathodes and anodes and it is based on the fact that one high-speed electron (not light, this time) striking an electron supplier surface such as those used in photo-electrics, will usually knock off several more electrons. This is called "secondary emission." These electrons respond in the manner of reflected light (the angle of reflection equals the angle of incidence) and they therefore behave in the manner shown in Fig. 5. It will be seen from this diagram that the effect is accumulative and that a kind of amplification (electron) takes place within the tube.

AN EXPERIMENTAL PHOTO-CELL

Every student of electronics will wish to experiment with these fascinating photo-electric devices. Photo-cells may be purchased for as little as \$1.50 each at the present time but, of course, the amplifiers cost a bit more. However, this is not the case with photo-voltaic or photo-conductive cells and either one of these may be made at home with very simple equipment. In this chapter we have described the construction of a photo-voltaic cell and the next

chapter will carry outlines of experiments which may be made with this and also with selenium cells that may be homemade.

Before we describe the construction of the photo-voltaic cell, it can be said that, once the electrode is formed, the cell may be set up in any kind of container and with any sort of mechanical arrangement. The plan shown in the drawing (Fig. 6) does not have to be followed by any means.

The results obtained by these photocells are surprising. Friends may be amazed with all sorts of tricks such as doors that are opened by means of light or motors operated by merely waving the hand. Truly, the photocell is the magic wand of science today.

Bill of Materials

- 1 test tube
- ¼ pound lead nitrate
- 1 piece of sheet copper 1 inch by 4 inches
- 2 binding posts
- 1 lead electrode ½ inch by 4 inches
- 1 cork

To this modest list of needed materials we might add a little tar or asphaltum and a few bits of metal too unimportant to mention in a bill of materials.

PREPARING THE ACTIVE SURFACE

It will first be necessary to so treat the copper that a layer of cuprous oxide will be formed on the surface. If the sheet copper (after having been carefully cleaned with emery cloth) is placed in a hot flame such as that provided by a bunsen burner, or

(Continued on page 683)

THE versatility of Dr. De Forest's genius has been such that public knowledge has not been able to keep up with it. He is known to all as the inventor of the three-element electron tube on which all progress in radio subsequent to its invention has been based. He is not so well known as one of the earliest and most persistent workers in the development of broadcasting. His station maintained regular broadcast schedules for a period of weeks, years before "America's pioneer broadcast station" was built. In the '20's he devoted much time to the talking movie, and did much to bring that medium to perfection. Now he has turned his attention to radiotherapy, and with some effect, as will be seen from this article.

RADIOTHERAPY ON

So-called "diathermy" effects are not the beneficial results of high-frequency applications where intensity of radiation, effects, are kept low. Some new concepts, in the field of radiotherapy, are

By LEE DEFORST, Ph.D.; Sc.D.

ANY association of radio with sickness and medicine in the mind of the public today is probably limited to the thought that radio broadcast reception has proven beneficial to the bed-ridden in homes and hospitals, has whiled away in countless cases the tedium of the lives of shut-ins, thereby promoting recovery. This in spite of the fact that the quality of much of today's radio programs might well prompt grave question whether such agency is more curative than devastating in its general effects upon the nervous system of the sick and suffering. Certainly it demands strong fibre and general well-being to healthily endure our average daily program of sales-talk and crooning!

The foregoing considerations were partly instrumental in inducing me, who had originally conceived and planned so vastly different a course for broadcast evolution, to investigate the potentialities of transmitted radio waves as an actual curative agency for many human ailments; to myself share in a new application of radio, one far more definitely destined to human welfare than was broadcasting.

Regarded from the viewpoint of radio engineering, the history of progress in short-wave therapy parallels in a measure that of the development of better refined means for production of high-frequency electric currents and radiations therefrom. Thus the early work in diathermy, like that also of D'Arsonval, was handicapped by the necessity for employing spark-gap condenser discharge and damped oscillations. Even when the Poulsen arc-in-hydrogen gave us a source of continuous undamped waves the generator equipment was necessarily so heavy, the D.C. voltage available in hospital or office so low, that little of the actual advantage resulting from undamped waves could be realized. Moreover, the highest frequencies obtainable with the arc-generator were far too low to reveal the then-hidden advantages of short-wave therapy.

The oscillating circuits today employed, originally conceived by this writer in 1912 and subsequently for communication purposes, made possible the obtaining of radio-frequency emissions from vacuum tubes, and thus makes possible the present non-contact vacuum tube radio-therapy short-wave emitters of today.

RADIOTHERAPY

The instrumentality commonly known as short wave and ultra-short wave therapy is the direct outgrowth of modern radio engineering development. It seems, therefore, ap-

propriate and convenient to style this new modality by the above title, as embracing the entire Hertzian spectrum available for this purpose, where the electrical frequencies employed lie well above those useful in the older diathermy (one half million to two million per second) and below those of the so-called micro-wave lengths, of less than one meter (frequencies above 300,000,000 per second).

OPTIMUM RANGES FOR RADIOTHERAPY

In diathermy the frequencies employed are too low to make possible radiation of any useful amounts of energy from the applicator electrodes. As a consequence we have there only true conduction currents, whose frequencies, while high enough to insure against any harmful electrolyzing effects in the body, are yet far too low to be classed as condenser currents, capable of inducing within the member placed between the electrodes (assuming these to be insulated from the body) "electric displacement" currents possessing the slightest therapeutical values.

The range of frequencies usefully available for inducing within the living body—placed between two condenser electrodes—corresponding high-frequency currents of useful volume, lies approximately between 6 and 300 megacycles. In other words, these oscillations have a wave-length range lying between 1 and 50 meters. For convenience this range has been empirically divided into two classes, the so-called "short waves", for all those lying between 50 and 10 meters; and the "ultra-short" waves, lying between 10 and 1 meter.

DESIGN OF RADIOTHERAPY OSCILLATOR

The alternating current from the light socket is stepped up by a power transformer, to the proper plate voltage, then rectified. Absolute stability must obtain at all times, so that the tubes may dissipate a maximum of the input power as radio-frequency output power, with a minimum in the form of heat through the tube glass, thus insuring long tube life. The supply of direct current

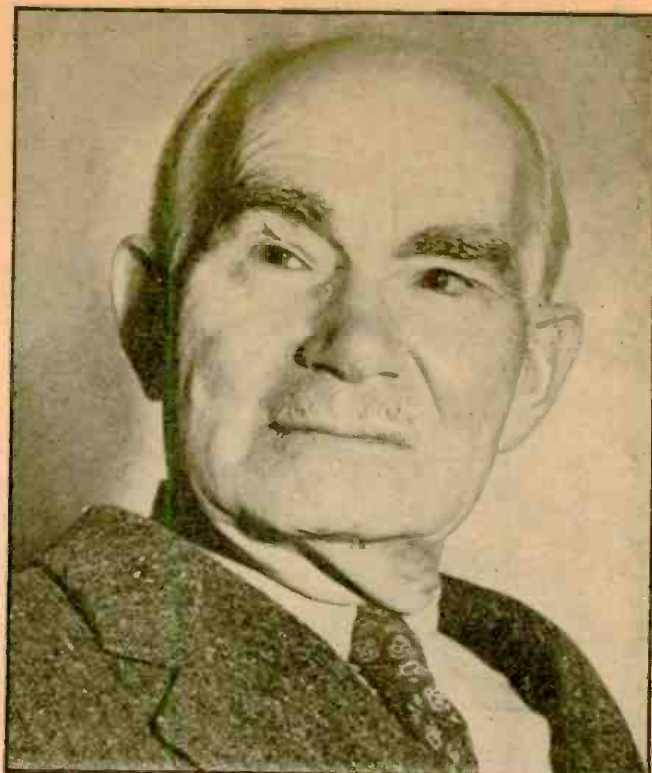


DeForest engaged in experimental work in his Los Angeles laboratory.

SHORT WAVES

only ones responsible for the tronic treatments, as shown by and consequent heating ef- based on latest researches opened up in this article.

(FATHER OF RADIO)



to the oscillator plates, together with proper over-all design, will ordinarily prevent any interference with radio broadcast reception.

To obtain portability, efficient design of the oscillatory circuit is of prime importance. Ease of operation calls for a single output power intensity control. This should be of the variable condenser resonance-control type, for it is not wise to reduce electron emission by filament rheostat control, which inevitably shortens tube life. For maximum irradiation the output circuit

is adjusted resonant with the oscillatory circuit. The plate voltage of the oscillator tubes having thoriated tungsten filaments must not be reduced for the purpose of controlling power output, as this will greatly reduce the effectiveness of the irradiation treatment. Here again we see the need of circuit stability, and the emitter should be so designed that it is impossible to upset the oscillatory circuit or cause the oscillator tubes to draw excessive current by any movement or placement of the applicator

pads, or by any adjustment of the controls.

APPLICATION

The radiotherapy emitter is in fact nothing more than a short-wave radio transmitter. The output (applicator) circuit is the equivalent of the antenna radiating circuit of a radio station.

We merely bring the "antenna" (represented by one applicator pad and its cable) over into close proximity with the "earth" (here represented by the other applicator pad).

Then one lies down upon the "earth" with the "antenna" pad resting above the body; and the identical lines of electric force which constitutes the "Hertzian

waves" in radio telegraphy instead of flying out through space to the ends of the earth, are concentrated into a bundle of lines which thread back and forth through the body many million times per second and, by setting up both resistance currents, and especially the so-called displacement currents within the tissues of the body, produce instantaneous heating and other physiologically important effects throughout the depth of the body thus irradiated.

To obtain equal irradiation from both applicators, an exceedingly valuable advantage in practice, exact electrical measurements must be made of the inductance and capacity used, both in the closed circuit and in the output coupling circuit. Again stability is paramount. Unipolar treatment, using only one applicator on the body, the other connected but lying idle on a table, is perfectly feasible, and is recommended where a minimum of irradiation is required. One large and one small applicator may be used if desired.

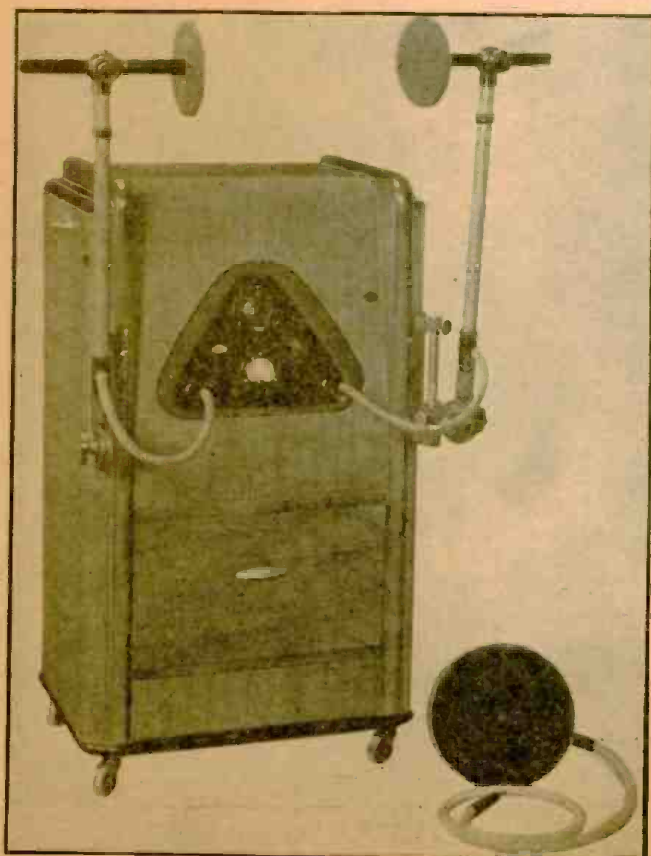
The wave-length selected for this single frequency, general utility radio-therapy emitter (18 meters) proved to be one requiring the least amount of power to most quickly develop a temperature equilibrium in the tissues being irradiated. It proved high enough to make possible the close confinement of the radiation area by proper placement of the applicator pads.

A GENERAL-UTILITY DEVICE

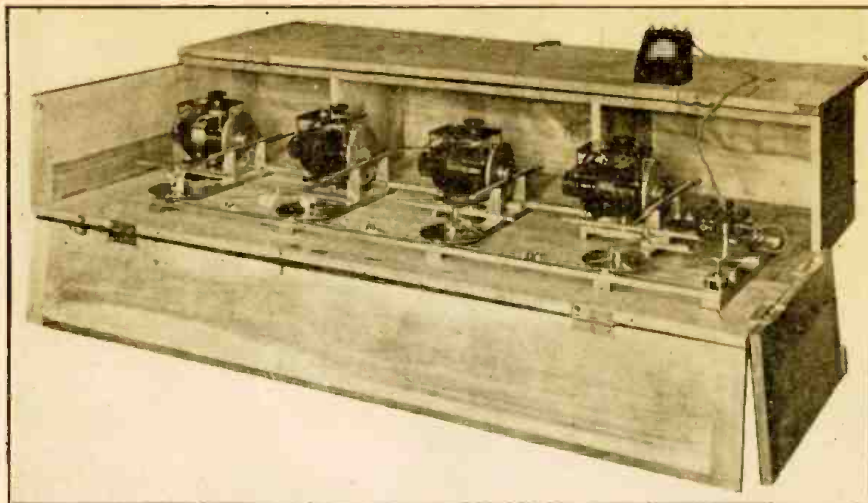
Further consideration in the design of this emitter decreed that the output power in radio-frequency watts must be sufficient to quickly and efficiently irradiate any portion of the body desired—or the entire body, for hyperpyrexia¹—at the frequency selected; yet should not be so great as to cause excessive expense in operation, or excessive bulkiness and weight in the emitter itself. Operating at the frequency or wave-length selected I have found a maximum radio-frequency power of 3,000 to 4,000 milliamperes to be sufficient for all purposes except hyperpyrexia treatments. Actually at

¹ Artificial Fever

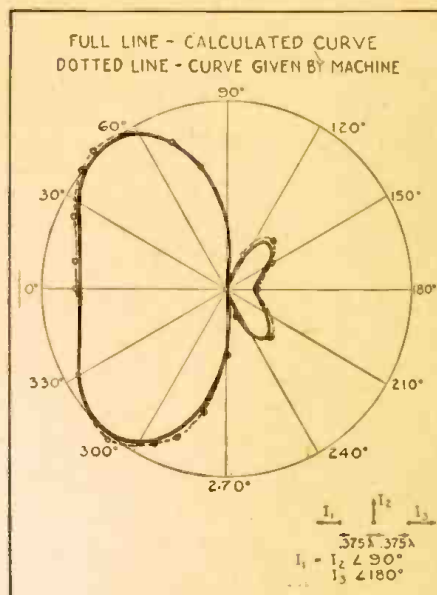
(Continued on page 685)



One of the latest Do Forest radiotherapy instruments.



Above is the complete Polar Diagram Calculator. The small hand crank which rotates it may be seen just above the right corner, forward. Fig. 2, right, is a standard polar diagram of one type of antenna system.



New Thinking Machine

Makes Polar Diagrams

MODERN radio engineers are not satisfied with erecting an antenna and "broadcasting" signals in all directions, as was the case when the art was new. A station situated on the sea-coast has no reason for sending half its power to sea, to be heard only by the occasional ship, when centers of dense population lie just inland.

Directional antennae concentrate the power of the transmitter in one direction from the aerial system, and energy which would otherwise have been largely wasted is used to increase the station range in more profitable directions. WOR is a notable example of a station which has benefited by the use of a directional antenna. Its program area has been extended in the populous New York and New England areas at the expense of signal strength over the Atlantic.

Point-to-point services require antennae even more directional. The whole output of the transmitter must be concentrated in a single beam aimed at the receiving station, if the requirements of efficiency are to be met. Short-wave broadcast stations in the foreign service, transmitting programs to be received in comparatively small areas a great distance from the transmitter, also use the beam technique.

These directional antenna systems occasionally use half-a-dozen aeriels, so coupled that the current in each varies in phase to an extent previously determined by calculation. When more than two aeriels are involved, such calculations become tedious indeed, and one engineer, H. Paul Williams, of Standard Telephones and Cables, Ltd. (London, England), was led thereby to design a machine which would do the calculating. By using this comparatively simple device, computations which would formerly have taken a day may be done in 15 minutes. Furthermore, the human factor is taken out of the problem. Set up correctly, the machine cannot make a mistake. Much checking—a process even more tedious than the original calculation—is thus avoided.

The machine will remind readers of the

recently-described Memnoscope. The resemblance is superficial only, and is because both machines are made from small motors coupled together mechanically and made to do a job far different from the one for which they were designed. There is another similarity—the functions of both these machines are those which have been attributed to the human mind. Memory and the ability to calculate—to sum up the total effect of a number of factors—are exhibited by a few rewound electric motors.

The motors used in this machine have three-phase stators and single-phase rotors. In use as a calculator, the rotor remains stationary, being held fixed and moving only as the operator wishes to change its position. The motor becomes in effect a transformer and the voltage developed in the rotor secondary is led out to an external A.C. voltmeter. In the type of motor used, phase of the voltage in the rotor is exactly proportional to its angular position with respect to the stator. It is this effect which is used by the calculator.

When any two aeriels, whose radiation pattern would otherwise be non-directional, are placed a given distance apart, and fed by current from the same transmitter, the field from one aerial will reinforce that from the other in certain directions, and weaken it in others. By varying the phase relations of the current in the aeriels, and by properly spacing them, the radiation pattern can be varied, so that the full power of the station may be concentrated in certain desired directions. Modifications of the pattern—or irregular-shaped patterns—may be obtained by using more than two aeriels.

The phase difference and distance between aeriels in a directional antenna system is simulated on the radiation pattern calculator by a set of rods and cams, used to set each rotor in proper relation to the others, so that the current in each has the same phase relation to that in the others, as has the current in the aerial it is supposed to represent, to the other aeriels in the system.

The amplitude of the current in each aerial is imitated by means of a potentiometer

across the output of each rotor, by means of which the output voltage can be set to any desired value. A fifth potentiometer permits taking a voltage directly from the line. Since in any antenna system, it is possible to use one of the aeriels as a reference, its phase angle being considered zero, this voltage at zero phase angle may be considered as another aerial, making it possible to calculate systems using 5 aeriels on the 4-motor machine.

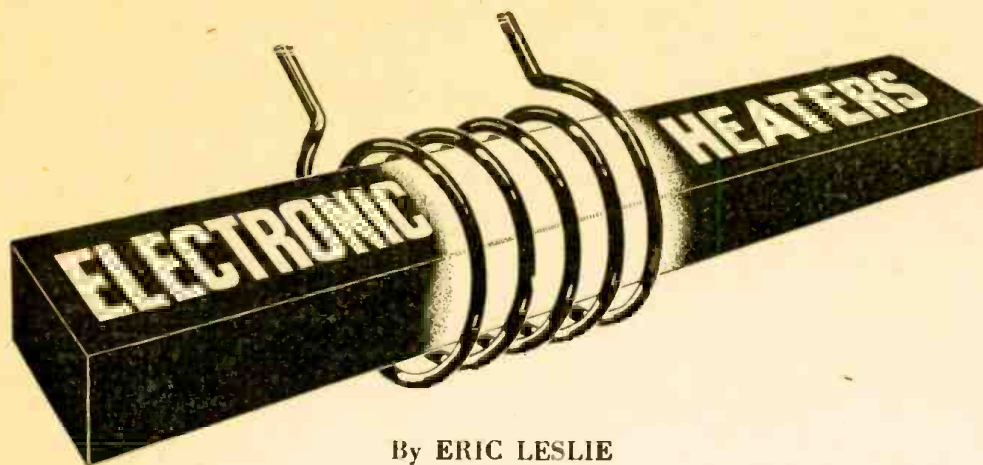
In actual broadcasting, the output from one aerial reinforces that of another in certain directions and neutralizes it in others. By connecting all the rotors up in series, it is possible to sum up the total effect of all these re-inforcements and cancellations with a simple A.C. voltmeter.

To calculate the comparative range from the reference point of an antenna system composed of, say, two aeriels, the calculation is made first for a point in any given direction. Then a calculation is made for a point 10, 15 or other number of degrees to one side or the other of the line already taken. This is repeated till the calculator has worked clear around the circle. The points are connected, giving an area which indicates the comparative range in all directions. Such a polar diagram is shown in Fig. 1.

The calculating machine works in the opposite direction. With the cams and rods, which are easily seen in the photograph, holding the rotors in the correct relative position, they are all rotated simultaneously by means of the hand crank on the main shaft. Readings from the voltmeter can be taken any desired number of degrees apart—a valuable feature in dealing with antenna patterns with long, narrow lobes.

All that is now necessary is to transfer the points to paper and draw the line, which in connecting them, traces out the radiation pattern. The inventors point out that, by adding a turntable and a recording voltmeter, the machine could trace out its own polar curve—with an infinite number of points—automatically and entirely without human help or interference!

Illustrations by courtesy of Electrical Communication.



By ERIC LESLIE

ELECTRONICS Explodes Rivets and Glues Plywood—Electronic Sewing Machines “Weld” Fabrics—Forgings Hardened by Electronics—Electric Heat Solders Crystals—Electronics Speeds Tinplating—Plastic Molding Improved By Electronics.

These and similar headlines in recent technical literature have brought home to the reader the growing importance of Electronic Heating in our new-dawning Age of the Electron.

While much has been written about the use of electronic heating in modern industry, little has been said about the electronic heater, the heart of the whole process. One would gather that “electronic furnaces” were a deeply guarded trade secret, or the apparatus too complex and involved for popular description.

Such is far from the truth. Electronic heaters are simple. They are hardly distinguishable from any other generator of radio-frequency energy. (So much so, that no group of amateurs can look long at one of the new high-frequency units without a discussion of how best to put an antenna on it.)

PRE-ELECTRONIC INDUCTION HEATER

Like many other electronic devices now attracting popular attention, the heater is not new. Induction heating indeed goes back to pre-electronic days. “Frying an egg on a cake of ice” is an old experiment and “popular science” demonstration. It can be carried out on ordinary 60-cycle current with a very large inductor of the iron-core type. This is concealed in a cabinet, on top of which is placed the (rather flat) cake of ice. An ordinary iron frying pan can now be placed on the ice and the egg broken into it. The iron pan acts as the short-circuited secondary of a transformer, the primary of which is the concealed inductor. Eddy currents set up in it create heat enough—due to the resistance of the iron—to bring the pan to a temperature at which the egg can be fried.

The power-line frequency of 60 cycles can be used for a demonstration, but could not be used economically for any type of industrial heating. The lowest frequencies which have wide commercial use are in the order of 10 kilocycles, and those between 50 and 500 Kc. are more common. No matter what the frequency, the principle is still the same. Like the frying-pan of the 60-cycle experiment, the metal is heated by eddy-currents set up in it by the rapidly changing magnetic field of the heater coil.

We should expect that high-resistance materials would be more readily heated than those which are better conductors of electricity. Where the induced currents meet with more resistance, more heat is

generated. Excellent conductors, such as silver and copper, are difficult to heat. The depth to which the eddy-currents penetrate depends also on the resistance of the material being heated, varying for any given frequency, with the resistance of the metal.

One of the earliest applications of high-frequency heating was in the tube industry itself. At a certain stage in the evacuation process it is necessary to heat the metal elements of the tube to drive off any gases which otherwise might be released later, while the tube was in actual operation. A radio-frequency coil is lowered over the tube for a few seconds. When it is raised, plate, filament and grid are a glowing orange, though the glass envelope is comparatively cool.

HEATING THE SURFACE ONLY

Because it is a practical way of heating metal behind a glass wall, induction heating has been used for years in the vacuum-tube industry. This is only one of its advantages. Another feature that is especially valuable in certain applications is that the depth of penetration may be controlled by varying the frequency. As frequency is raised, the eddy-currents generated are confined to an area closer to the surface. Depth of penetration varies inversely as the square root of the frequency.

This is especially applicable to surface-hardening, where it is important that a soft core be left under the hardened surface layer. It is useful also in tin-plating—the full power generated can be confined to the thin layer of tin on the surface, not wasted in heating the whole sheet.

The depth of penetration also varies directly with the resistance of the metal—another reason for the difficulty in heating copper or silver. In magnetic materials, it varies inversely as the permeability, a feature which is used to advantage in hardening the surface of steels.



Replacing one of the high-frequency tubes in a heater unit. Though it is not immediately apparent from the picture, this unit is housed in the same kind of enclosure as the electronic heater pictured on the next page.

INDUCTION HEATER CIRCUITS

Early inductive heating apparatus was often clumsy and wasteful, the circuit of Fig. 1 being typical of an early “electric furnace.” Self-rectification was used, each tube oscillating during half the A.C. cycle. Frequencies ran from 50 to 500 Kc. This range is still used as certain types of work can be done most efficiently at some frequency within these limits.

All modern circuits use rectifiers, supplying the oscillator tubes with (more or less) direct current. Such a circuit is seen in Fig. 2. Values of parts are chosen according to the frequency required. The resemblance to an amateur transmitter of pre-1928 vintage is striking.

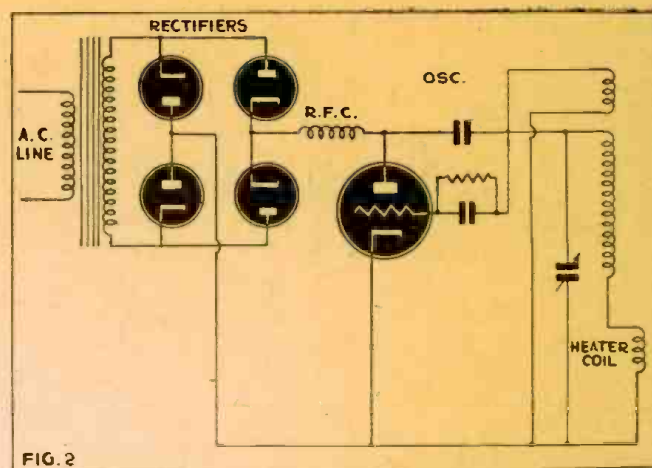
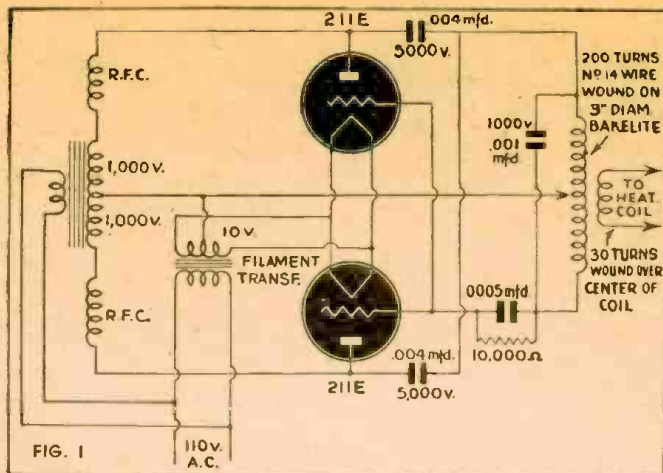
THE ELECTROSTATIC HEATER

Above 500 Kc. skin effect is so marked that it is difficult to heat even metals which offer high resistance to the flow of electric current, and little induction heating is done at higher frequencies.

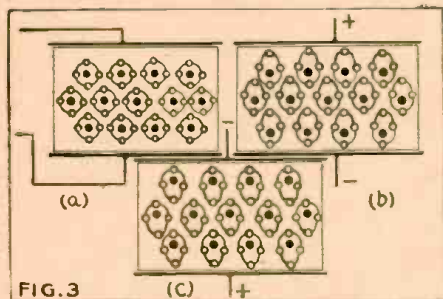
As frequency is increased to a point where it no longer has an effect on conductors, a heating effect on the poorer types of insulating materials is noted. If any insulating substance is placed in an electrostatic field, the molecules of which it is composed are distorted as the polarity of

(Continued on following page)





the field changes. As an example, see Fig. 3. As the top plate becomes positive, the negative electrons of the "dielectric" are drawn toward it. At the same time, the negative bottom plate repels them, adding to the effect. When the polarity of the plates change, the electrons snap down toward the bottom plate. The positive centers of the atoms are impelled in the opposite direction, but because of their greater weight, the effect is much smaller, as far as distance of travel is concerned, though the friction effect of even the slightest displace-



ment of these heavier parts of the atoms has a greater heating effect than large motions of the electrons.

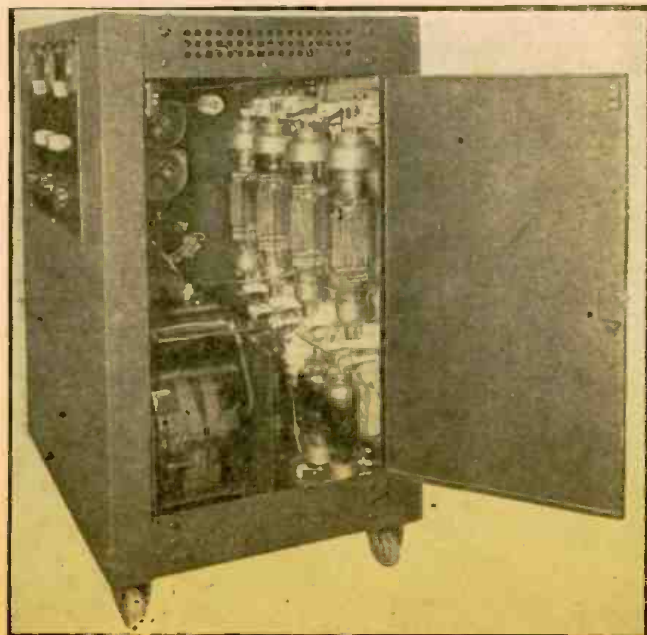
This "molecular friction" is the basis of *electrostatic* (as opposed to *inductive*) high-frequency heating. Materials which are considered poor insulators at high fre-

quencies are most easily heated. What is termed "power loss" in an insulator refers simply to the amount of electric power turned into heat. In other words, the higher the power loss, the quicker and easier it is to raise the temperature of the material. Near-perfect dielectrics such as polystyrene are as difficult to heat electrostatically as are copper and silver by induction. It is supposed that in such dielectric materials the electrons swing back and forth without any great corresponding displacement of the protons, and that therefore little molecular heat is generated.

Due to the molecular nature of the heating, the center of the material becomes as hot as the surface. It actually becomes slightly hotter, as heat is radiated from the surface more rapidly than from the interior. This feature is extremely valuable in plastic molding. With other methods of heating, the process becomes extremely slow for thick pieces, and there is a limit beyond which molding is uneconomical. This limit is greatly extended, if not entirely destroyed, by the electronic heater, which heats even the thickest pieces evenly and quickly.

Inductive and electrostatic heating carry on the traditions of inductance and capacity, in that they are opposite in effect. Inductively heated objects tend to heat at the surface, the interior becoming warm by conduction only. Electrostatically heated objects, on the contrary, heat "from the inside out."

That the electronic heater is a radio transmitter may easily be seen from this photograph. The big oscillators are at the top, and just below are the rectifier tubes. Units of this type are rated from 5 to 15 kilowatts, and considerably larger ones are made. The whole unit, as will be noted, is readily portable, and may be pushed from place to place over any reasonably smooth surface. All adjustments are made and the machine controlled from the small panel on the side, the door being provided with an interlock which cuts off all power as soon as it is opened.



A circuit of an electrostatic heating unit is shown in Fig. 4. The resemblance to a short-wave radio transmitter is even more striking than in the case of the induction heater. It is in fact a short-wave radio transmitter, and this is the reason why such transmitters must use insulation of the very best low-loss type. The radioman wishes to get a maximum of the power into space, and to use a minimum for "R. F. electrostatic heating."

Short-wave diathermy machines are in effect electrostatic heaters, and the writer has used one of them to check up on short-wave insulating materials. A number of pieces of the materials to be tested were placed between the applicator pads, and the current turned on for a few minutes. Inferior material could readily be picked out, being noticeably warmer than the better insulators.

(Continued on page 686)

Radio Over the Side

(Cover Feature)

FORCES swarming down to landing rafts in the Mediterranean or the South Pacific might well be depicted by this scene. Actually the picture was taken at the Signal Corps Replacement Training Center, Fort Monmouth, New Jersey.

Trainees of the Signal Corps are drilled in getting their radio apparatus "over the side" on the network shown. (Inspection will reveal piling behind, not the side of a ship.) Once the boys learn to get up and down without being embarrassed by their radio equipment, they are competent to repeat the performance on the side of a transport off enemy shores, under fire.

The familiar "handy-talkie"—carried down by the sergeant in the foreground with its aerial telescoped—was featured in a page of pictures in the December, 1942, *Radio-Craft*. As a means of coordinating the action during the kaleidoscopic maneuvers of a landing action, the walkie talkie has become invaluable, and Signalmen are always among the first groups in the initial phases of combat operation.

IGNITRON

CHIEF of all the new industrial electronic tubes is the Ignitron. A simple and sturdy rectifier, it does not seem at first glance to rate all the attention it has received. These have been well known in radio for years—the first vacuum tube was a rectifier. Neither is there anything new about using mercury vapor in such a tube. Mercury-arc rectifiers have done some of the jobs that Ignitrons are now doing, and the small members of the family, using filaments, even found places in home radios.

The Ignitron is no ordinary mercury-vapor rectifier. Its secret is in the little third electrode, called the ignitor, from which the tube gets its name. This element permits the tube to deliver more voltage at higher currents than any of its ancestors. It also controls the point in the cycle at which current starts to flow, giving this rectifier some characteristics of a three-element tube.

The methods used to start the so-called arc in pre-Ignitron types of mercury-vapor rectifiers made it necessary to employ multi-anode tubes. There was no means of controlling the instant at which current would start to flow. Arc-overs (flow of current in the reverse direction) was easy, and as a consequence ratings were limited and very large tubes had to be used when heavy currents were to be carried.

The ignitor changed all that. By applying a suitable voltage to this third element at the desired instant, mercury could be vaporized and the arc be struck within 100 microseconds. Once struck the arc needs no more assistance from the ignitor, providing that average anode current is at least 3 amperes. When the direction of current changes, the arc goes out, remaining out through the non-conducting half of the cycle, and until again struck by ignitor action. Thus the possibility of arc-back is cut down as compared with tubes which are filled with ionized gas throughout the whole cycle.

Supplied with its ignitor, the Ignitron can be started by purely electrical means, can be cut out of operation on any reverse half-cycle and started again many times a minute. Control of the output can be secured by varying the instant of starting. This fits the tube for work as an instantaneous heavy-current switch, and for voltage-controlled circuits, as well as for other

jobs impossible to earlier mercury-vapor tubes. Viewed from the field of application, it resembles them much as the present multi-element radio tube resembles the Fleming valve—the similarity being confined to the principle of operation.

In spite of these advantages over its predecessors, the Ignitron is simpler than they were. Fig. 1, an actual photograph of a cut-away tube, shows the construction. The heavy anode lead, which indicates the size currents this tube may be called on to carry, is at 1. The glass seal which insulates the anode from the metal shell of the Ignitron, is at 2, the carbon anode at 3, and the mercury-pool cathode at 4. The cathode terminal, which also serves as a support for the tube, is at 5. The ignitor lead and ignitor are shown at 6 and 7. The tip of the ignitor is immersed in the mercury pool, and the lead goes to the timing device which controls tube operation by setting the instant of firing. Nos. 8 and 9 are the water jacket and one of the hose connections for cooling water. The other connection is seen at bottom right.

The principle of operation is the same as that of the older mercury arcs. When mercury is heated to the point where it vaporizes, electrons are emitted very freely and a current may be set up between the surface of the mercury and any point which has a positive charge relative to it. Electrons travelling at high speed through the mercury vapor knock more electrons off the mercury atoms in their path, giving these atoms a positive charge and thereby reducing the negative space charge in the area between cathode and anode. Thus, as in other mercury-tubes, the tube voltage drop is low, not exceeding 20 volts in normal operation.

Cathode current will continue as long as the "hot spot" is maintained on the surface of the mercury pool and the anode is at a relative positive potential. The anode current itself maintains the "hot spot." When the line current reverses, cathode current stops, the conducting cathode spot disappears, and the tube remains non-conducting in either direction until again "fired" by the production of a hot cathode spot by the ignitor.

Two main methods have been used to secure ignition. The most important is the use of a thyatron tube with its grid so connected in an inductance-capacity circuit as to permit current to flow in its plate circuit at the right instant, thus firing the ignitor. The thyatron plate voltage, used for ignitor excitation, is usually taken from the anode voltage.

The grid of the thyatron can be employed to determine the time of starting the arc, thus acting to control the output voltage under a given load. This feature is particularly useful in large control circuits, where constant voltage is required under conditions of widely variable loads.

A capacity-inductance circuit, something in the nature of a relaxation oscillator, may also be used to fire the ignitor. By proper selection of the constants, the tube may be made to fire at any given instant of the

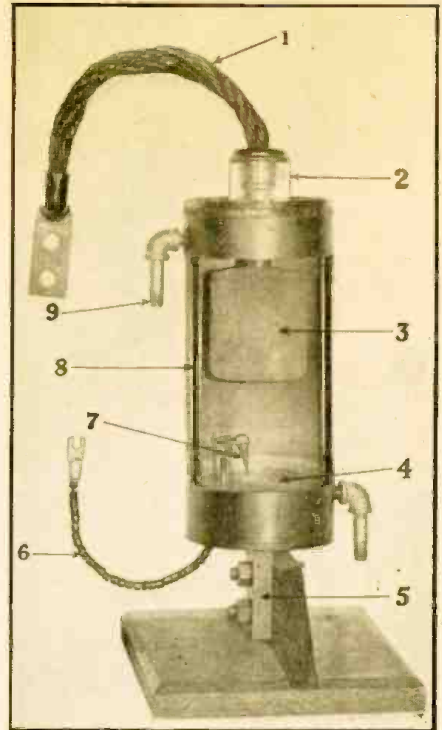


Fig. 1.—Ignitron control for resistance welding.

cycle. This circuit lacks the variable phase control of the thyatron ignitor hookup. Dry-plate rectifiers are used to prevent reverse current in the ignitor circuit, when this firing arrangement is used.

With the exception of the smallest sizes, ignitron tubes are water cooled. Maintenance of the tube at a constant temperature keeps the vapor pressure constant, and a drop below the minimum specified temperatures should be guarded against.

Although a straight rectifier, in one of the commonest applications of the Ignitron two tubes are hooked up "back-to-back" so that both halves of the current are passed. Hooked up in this fashion, the Ignitron ceases to be a rectifier and becomes a switch in which extremely heavy currents can be broken more efficiently and rapidly than by any other means yet devised. This circuit is used for contactors in resistance welding, which often requires many pulses per minute of very heavy current. The circuit is shown in Fig. 2. The timer contacts shown in the figure may be a thyatron control circuit, a rectifier-capacitor type, or a mechanical timer. The best timing systems are, of course, electronic.

Ratings of some of the commoner Ignitrons are given in this article. Since the

(Continued on page 684)

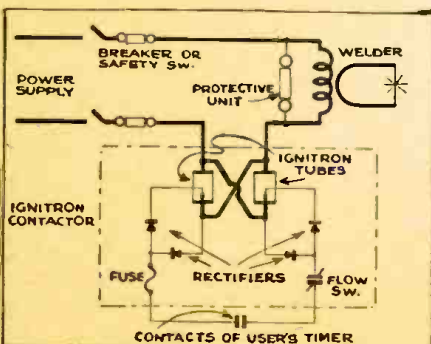
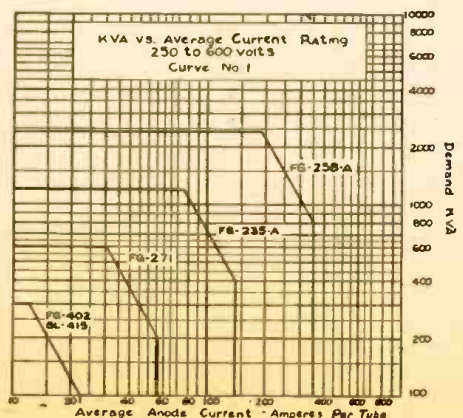


Fig. 2.



Power-current ratings for five G-E Ignitrons.

Wired Wireless USED

By PERRY E. WIGHTMAN

WIRED WIRELESS or carrier-current is not new. For a good many years, it has been used by power companies for switching, relay protection and voice communication over high lines and by the telephone companies for multi-channel communication on telephone and telegraph lines.

It is possible to transmit the voice over many hundred miles of wire, covering a large area, when a 20-watt transmitter is properly connected to the high voltage distribution system. The signal can be picked up by a car radio, tuned to the proper frequency, while the vehicle is travelling under the power lines, or by a radio in the house.

The system is generally useful where the power distribution lines are of the overhead type. This type of distribution is usually found in small towns or cities and suburban areas. Where underground distribution is encountered considerable difficulty will be experienced in making use of such circuits.

The writers started experimenting with Wired Wireless for control purposes in 1934. Not having access to the high voltage lines, they made tests by connecting the output of a lowpower transmitter into the convenience outlet in their homes. These tests were made on broadcast station frequencies. The signal was received under the wires for seven and a half miles, with a car radio receiver. The transmitter employed used a type 45 tube as an oscillator and another as a modulator. Harmonics were bad but radiation from the power lines was low, the signal being lost one hundred feet from the power lines. This showed that radio frequency would go out over the house wiring, through the meter on to the secondary lines, and in this way distribute itself over the overhead primary and secondary system.

A friend, who knew what was being accomplished, asked if a transmitter could be put in a Fire Chief's house so that the siren on the fire house a mile and a half away could be started and stopped. A transmitter, using again a 45 type tube as an oscillator, was connected into the convenience outlet in the Fire Chief's home and a receiver

The Maryland Council of Defense has had many requests for a complete article on the working of Wired Wireless in Prince George's County. Much information has been disseminated in publications.

I wish to express my appreciation to Mr. Percy E. Wightman, who, in addition to being Radio Aide for Prince George's County, is State Procurement Officer for the War Emergency Radio Service, and to Mr. Henry H. Lyon, Chief Engineer of Station WCL, Washington, and Chief Technical Advisor to the Prince George's County War Emergency Radio Service system, for their additional effort in writing the following article.

(signed)

COLONEL HENRY S. BARRETT
State Director, ARP Services

with a relay in place of the loudspeaker started and stopped the siren at the fire house.

From then until the war, tests were made on various frequencies up to 3000 kilocycles. It was found that radiation increased with frequency and was very noticeable from about 1200 kilocycles on up to 3000 kilocycles. At 3000 kilocycles very little of the signal travelled over the power lines, most of it radiating directly into space at the point of transmission.

When war was declared in December, 1941, there arose a need for an auxiliary communication system in addition to the established telephone lines. A type of communication was required that would not radiate into space so that enemy planes could pick up the signal or use it for direction finding. Wired Wireless seemed to be the answer. Tests were made with this in mind. The results of the tests indicated that lower frequencies should be used to over-

come some of the difficulties. Two transmitters were set up—one at the Control Center in Hyattsville (Prince George's County, Maryland) and one at a Report Center in Mt. Rainier, a distance of 1½ miles airline, 10 miles wireline, using 150 and 160 kilocycles. Two-way communication was carried on from these two points.

Receivers were put in the following Report Centers and Fire Houses for one-way communication: Hyattsville, Cottage City, Bladensburg, Tuxedo, Cheverly, Riverdale, Riverdale Heights, Berwyn Heights and Branchville. The signal was good at all but the Branchville location. The line noise at this point was high and the signal was not strong enough to overcome it.

The 150 and 160 kilocycle frequencies overcome line radiation and were found suitable for this type of transmission. The signal passed from the secondary to the primary of distribution transformers and back again from primary to secondary into the home through the meter and over the house wiring. Care should be taken that the carrier-current system does not interfere with established broadcast systems or telephone or power company systems.

Receivers for frequencies below 550 kilocycles are not readily available, under the present wartime conditions. However, it is not hard to convert a superheterodyne receiver to operate on 150 kilocycles by making simple changes to the oscillator and the radio frequency stage. The following diagrams with explanations will help to construct transmitters and convert receivers. Diagrams are also shown on how to connect the output of the transmitter and receiver to the house wiring.

TRANSMITTER CIRCUITS

Figures 1, 2 and 3 are diagrams of the circuits used. Figure 1 is the transmitter. It will be noted that conservative standard practice has been used throughout. An electron-coupled circuit is used for the oscillator, as crystals of the frequency required would be practically impossible to secure by the WERS units using the apparatus.

The oscillator, a 6C5, is followed by a 6SK7 buffer, which is coupled to the 2 802 output amplifiers through coils L2 and L3.

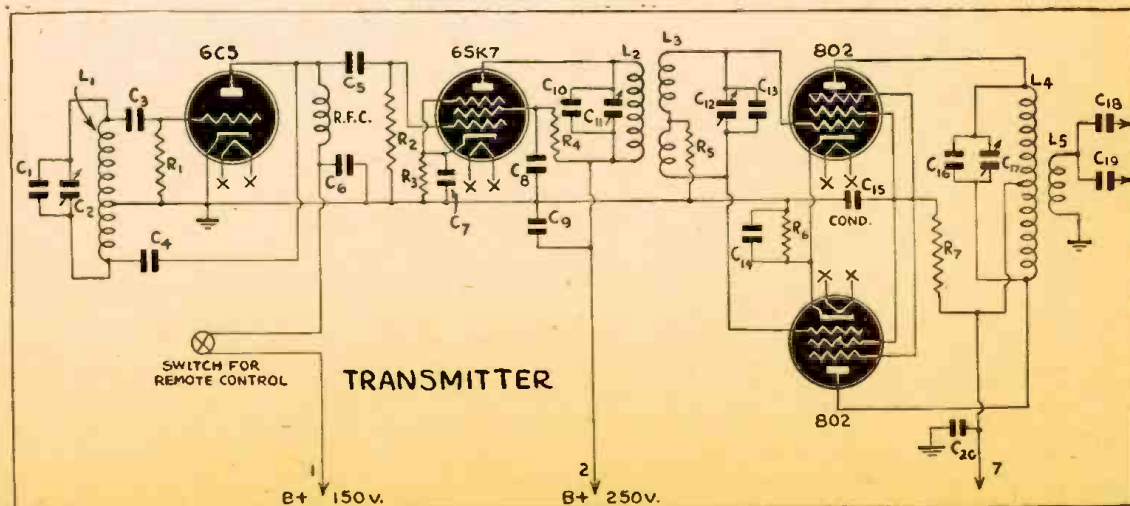


Fig. 1—The wired-wireless transmitter. Commercial technique is seen in the design of this set, which provides for frequency stability with a buffer stage, and for a surplus of radio-frequency power with the two 802's in the output stage. Constructors will be well advised to follow these design features, even though the 802's may have to be replaced by 6L6's (or even 47's from an abandoned broadcast receiver).

FIG. 2

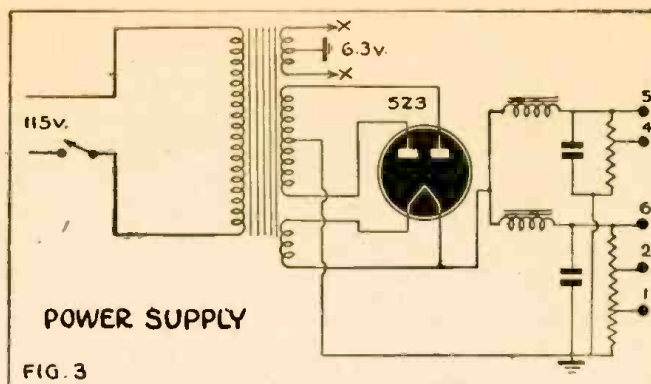


Figure 4 consists of four schematic diagrams labeled (a), (b), (c), and (d), each showing a different electrical service configuration. Each diagram features a transformer with primary windings L_1 and L_2 , and secondary windings L_3 and L_4 . Capacitors C_1 and C_2 are connected across the primary windings. A meter is connected to the secondary windings. The load line is connected to the secondary windings. The neutral line is connected to the secondary windings. The line is connected to the secondary windings.

- (a) 115v. SERVICE: Shows a transformer with primary windings L_1 and L_2 , and secondary windings L_3 and L_4 . Capacitors C_1 and C_2 are connected across the primary windings. A meter is connected to the secondary windings. The load line is connected to the secondary windings. The neutral line is connected to the secondary windings. A 6 AMP. FUSE is connected to the load line.
- (b) 115v. SERVICE: Shows a transformer with primary windings L_1 and L_2 , and secondary windings L_3 and L_4 . Capacitors C_1 and C_2 are connected across the primary windings. A meter is connected to the secondary windings. The load line is connected to the secondary windings. The house neutral load is connected to the secondary windings. The line is connected to the secondary windings.
- (c) 230v. SERVICE: Shows a transformer with primary windings L_1 and L_2 , and secondary windings L_3 and L_4 . Capacitors C_1 and C_2 are connected across the primary windings. A meter is connected to the secondary windings. The load line is connected to the secondary windings. The neutral line is connected to the secondary windings.
- (d) 230v. SERVICE: Shows a transformer with primary windings L_1 and L_2 , and secondary windings L_3 and L_4 . Capacitors C_1 and C_2 are connected across the primary windings. A meter is connected to the secondary windings. The load line is connected to the secondary windings. The neutral line is connected to the secondary windings. The line is connected to the secondary windings.

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SERVICING NOTES

Trouble in

.... PHILCO 16 CODE 126

This radio had me guessing for some time. It became inoperative on the high frequency end of the dial. By tuning toward the low frequency end of the dial it cut in about on 1000 kc. and tuned satisfactorily to the end of the dial. By tuning it back toward the high frequency end of the dial, it cut out at about 1200 kc. to the end of the high frequency end of the dial.

After routine checking of the tubes, D.C. voltages, paper condensers and resistors, it was found that the oscillator grid current as well as the oscillator cathode voltage, became abnormally high. The defect was found in the oscillator plate coupling condenser, (No. 38-800 mmf. mica). This condenser (No. 38-800 mmf. mica). This condenser 30,000 ohms.

ALEX BRZUCK,
Detroit, Michigan.

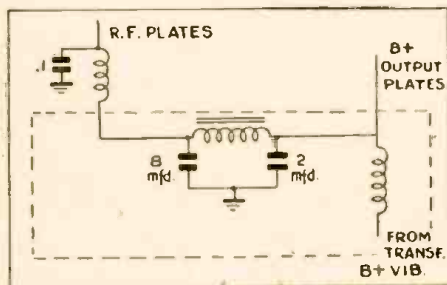
.... ZENITH CHASSIS 5635

This chassis is used in Models 6B164, 6B129 and 6B107.

Trouble: Vibrator hash.

The trouble was cleared up perfectly by putting in an additional R.F. choke in the leads to the R.F. plates, as shown in the accompanying diagram.

K. S. BABBS,
Wellington, Texas.



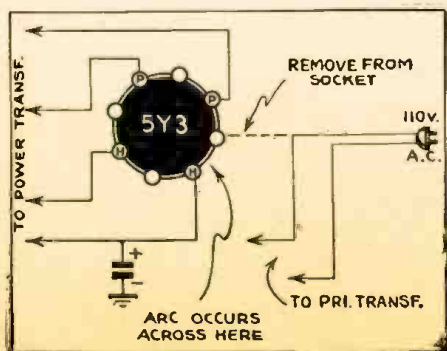
.... RCA 5Q55

Common trouble with this model: Rectifier socket burns up.

Permanent cure: Remove line cord from rectifier socket—replace filter condenser, as it shorts out.

I have had this trouble with a number of these sets, and the above procedure always effected a satisfactory repair.

W. W. ROBERTSON,
Oak Grove, La.



.... CANADIAN WESTINGHOUSE 410

Several times recently, in my service work I have encountered a number of Canadian Westinghouse model 410 receivers which had a rather annoying hum only when tuned to a carrier. This trouble has always been eliminated by connecting two 0.05-mf. condensers in series across the power transformer primary and grounding the center connection to the receiver chassis. This receiver uses a type 6X5 rectifier connected half-wave.

STANLEY DAVIS,
Vancouver, B. C., Canada.

ATTENTION SERVICEMEN!

Do you have any Servicing Notes available which you would like to bring to the attention of the readers of *Radio-Craft*? If so, send them along and if they are published a one year's subscription to *Radio-Craft* will be awarded you.

.... ARVIN MODEL 818

Oscillation or code signals riding in with signal when tuning from station to station. Check to see if long coil spring is connected from tuning condenser to coil shield can on front corner of chassis.

CLIFTON S. KRUMLING,
Blue Earth, Minn.

.... RESISTANCE TABLE

A resistance table, giving point to point tests is very valuable in quickly locating trouble. Make a "case history" of a number of sets, and catalog these resistances: K to Gnd., P to Gnd., Screen to Gnd., Screen to Plate and Control Grid to Gnd. These will help in quickly locating the trouble.

W. H. UPDEGROVE,
Carterville, Mo.

.... AIRLINE 525, 526

Numbers of these sets come in dead due to open field coil.

Replace with PM speaker and use a 1200-ohm resistor in place of the field coil.

EARL LASKE,
Chicago, Ill.

.... OPEN FILAMENTS (?)

Before discarding tubes with "open filaments" push a needle-point test prod into each filament prong. If the ohmmeter shows continuity, the trouble may be due to corroded joint between filament lead and tube prong. Several tubes have been saved by this method. While it might not be worth while in ordinary times, it may prove a valuable practice now because of tube scarcity.

Poor grid cap connections have also been found responsible for intermittent volume and noise, especially on auto sets.

JAMES N. GILBERT,
Knoxville, Tenn.

.... GENERAL ELECTRIC G-106

Trouble in Electric tuning: if dial pointer moves toward 550 kc. at normal speed, but moves very slowly or not at all towards

1,500 kc. at the right-hand side of the dial, first check the pushbutton contacts at the rear of the tuning condenser. Clean the selector rim and contacts with a brush dipped in carbon tetrachloride. Clean the rim with the solution by saturating a cloth, holding the cloth against the rim and turning the bakelite wheel on which the selector is mounted.

If the above fails, check the rubber drive bushing on the electric tuning motor's shaft. Loosen the set-screws of the rubber bushing and slip it forward so that it exerts pressure on the drive wheel associated with the tuning condenser. If the action is squeaky, oil the condenser bearings and use a light grease on the horizontal members supporting the dial pointer runner.

If no motor response is had, check the high-capacity electrolytic condenser across the windings of the motor.

.... SOCKETS USING RETAINER RINGS

Trouble which sounds like loose connections in recent RCA, Silvertone, Firestone, etc., in which ground connections are made to a soldering lug on the metal retainer ring.

Solder a wire from each ring to ground for a permanent cure.

T. PAYNE,
Bessemer City, N. C.

.... PHILCO MODEL 37-116 CODE 122

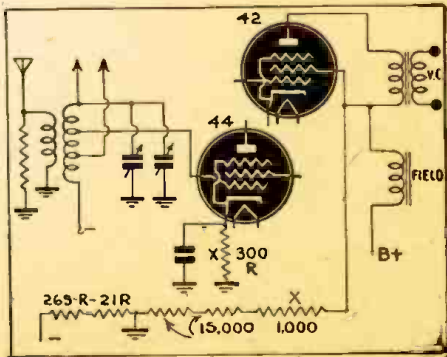
For intermittent operation when loss of signal occurs and there is also oscillation which increases as the i-f control is turned to the fidelity position, look for the following: A signal voltage will be evident at the second detector, disappearing as the tuning condenser is turned to the closed position. The remedy is to replace the filter condensers in can (8-3-2 mfd.). They usually check OK for leakage, but have poor power factor.

J. E. LANDIN,
Chicago, Ill.

.... PHILCO MODEL 19

Weak reception in the Model 19, Code 128, has been caused by the R.F. cathode resistor changing value. This is the 300-ohm resistor marked X, and is No. 7 on the Philco schematic. The 1,000-ohm resistor in the voltage divider (No. 49 in the diagram) connecting to the screen grid resistor, has also been found to change value.

C. J. TABER,
Bluefield, Va.



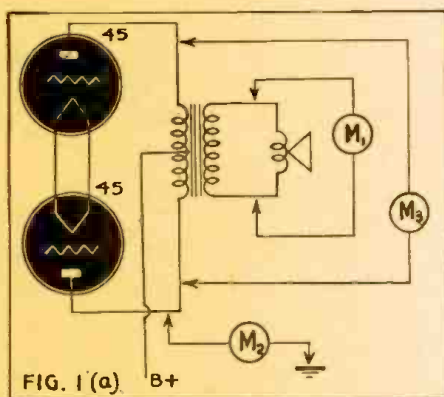
OUTPUT METERS ARE USEFUL

By JACK KING

It is quite true that the ear, alone and unaided, is a sensitive output meter. It is equally true that the hearing of no two individuals is alike. For this reason, amongst others, radio engineers and manufacturers specify that meters are to be used in alignment.

Sounds produced by noise sources or arriving at the ear as the result of some person talking or shouting in the immediate vicinity of the man doing the alignment work cause masking effects and inaccuracies. In addition, there is little doubt that a good vacuum tube voltmeter will show differences, even at low signal output levels, that the most sensitive ear cannot detect. At high intensity sound levels, the

Advantages of output meter as compared to "ear" alignment"; what types of meters may be used, and where they may be inserted in circuit; construction of a simple type of universal output meter; some of the expected and unexpected results of meter alignment—all these are discussed in this article.



ear is wildly inaccurate as an output meter, and signal input and output should always be weak when the ear is being used as a meter.

Alignment is one of the more important jobs of the radio serviceman. It is important because much of the sensitivity, selectivity and fidelity of the receiver depend on alignment being performed properly.

In Fig. 1 (a) the usual output connections are shown. Meter M1 may be a copper-oxide rectifier type instrument or an A.C. vacuum tube voltmeter. For ordinary radio receiver requirements the meter may be set to read 0.5 volts and after the preliminary adjustments it can be set to read 0.1 volt. It is possible, using the vacuum tube voltmeter shown in Fig. 1 (c), to get

a reading of 2 volt during alignment and to notice small changes of level that are not heard easily, if at all, by the ear. Visual alignment definitely lends a precision touch to the job, and I have found in my own experience that I can do much better work using meters than using my ear alone. On short wave, listening to the hiss, it is possible to get a delicate adjustment not observed at all with a meter, but on the broadcast band—in ordinary alignment—the meter is tops.

AN EFFICIENT OUTPUT METER

In using the simple but effective vacuum tube voltmeter shown, the instrument is first set to read full scale current of 1 ma. with no input signal, switch S being in position 1 and R adjusted for 1 ma. current. Application of a signal to the input causes a downward deflection of the meter. About 1 volt input will cause 2 ma. reading when set on position 5. In order to use the instrument on higher voltages, switch S is set to positions 2, 3 or 4, which are adequate for the usual run of service work.

In Fig. 1 (a), meter M2 and Meter M3 may be copper-oxide rectifier types or vacuum tube voltmeters. At the start of alignment the instruments can be set to read 0.25 volts and the range lowered in each case as the circumstances warrant. Using the VTVM set for 0.1 volt, and a very weak signal input to the receiver, critically sharp alignment can be carried out. Note that it is particularly important that the input be maintained at a continuously low level and that, as the gain of the receiver is brought up, due to resonating of the various trimmers, the output control of the generator must be adjusted for lowered

voltage output. In some cases, the writer has found that a set, after being aligned so critically, will have sufficient gain to go into oscillation. The regeneration can be controlled by adding additional filtering capacity or by-pass capacity in plate and screen return circuits. Regeneration itself will have the further effect of sharpening the selectivity curve, but because of the instability of regenerative action we want to avoid using any form of feedback.

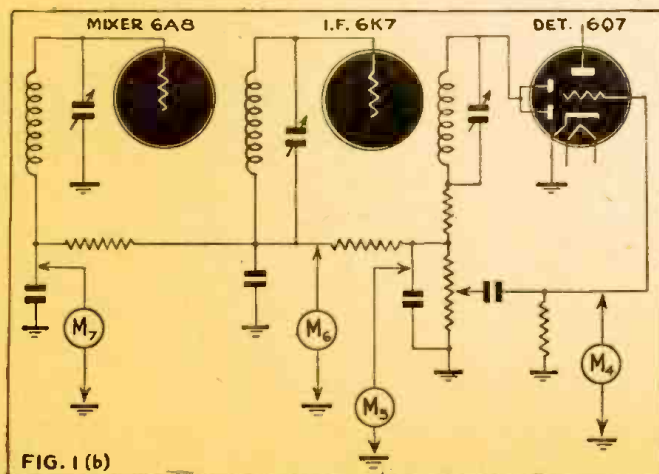
EFFECT OF A.V.C. ON ALIGNMENT

The effect of carrying out this form of alignment is well worth while. In some cases there is noticed a tendency for the set to broaden out slightly when tuned to a strong local station. The reason for this is that the a.v.c. bias developed when tuned to a strong local causes a change in the effective input capacitance of the R.F. or I.F. amplifier, particularly when not too large tuning capacities are used in shunt with the amplifier inputs. Thus, at the high end of the receiver dial, when the tuning condensers are at minimum mesh, and the shunt capacities are small, the a.v.c. detuning action is noticeable. In some cases the effect is not pronounced, where the designers have used relatively large minimum capacities by forethought or accident.

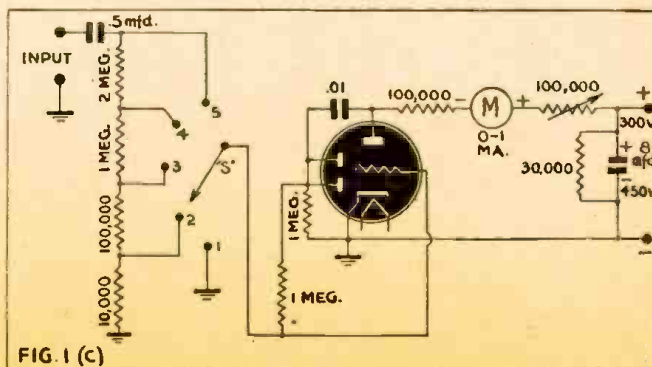
USING METERS ON THE A.V.C. LINE

This is mentioned to bring out the point that it is better to align in the conventional way and not worry about adjusting the trimmers on the set using an a.v.c. meter or tuning eye as an indicator, unless the alignment is carried out first in the weak signal manner and any minor adjustments

(Continued on page 696)



A vacuum-tube voltmeter, such as the one below, has many advantages in measuring output. Adjustable over a wide range of voltages, it can be used in most of the positions discussed. An interesting safety feature is the reversed response. Applied voltages cause a reduction in meter current.



326

Radio Service Data Sheet

ZENITH MODELS 22H698 AND 22H699 22-TUBE SUPERHETERODYNE



These Zenith 22-tube models are radio-phonograph console combinations with provision for the Zenith carrier-communication type "Fantasia" remote speakers.

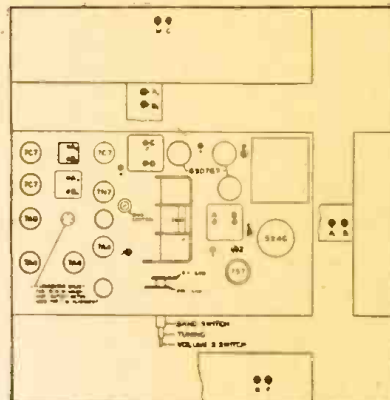
Amp. Mod. I.F. Frequency 455 Kc.
 Freq. Mod. I.F. Frequency 8.3 Mc.

TUNING RANGES

540 to 1620 Kc.
5.6 to 18.5 Mc.
42 to 50 Mc. (F.M.)

STAGE GAINS

B.C. and I.F.
Ant. to R.F. grid 5 at 1000 Kc.
R.F. grid to conv. grid 5 at 1000 Kc.
Conv. grid to I.F. grid 41 at 455 Kc.
Overall audio 1286 at 1 watt.



Receiver tube and trimmer location.

ALIGNMENT PROCEDURE

[illegible]

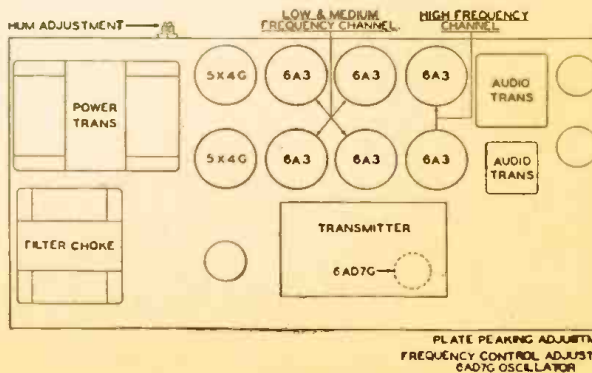
An unusual feature has been built into the chassis whereby additional special speakers may be plugged into any electrical outlet of the room and, by arranging one or more of these "remote" speakers around the room, a unique tonal effect may be obtained. These remote speakers may also be used in other rooms of the home to pick up and reproduce the program or record being carried on the radio.

The maximum audio output power of this receiver is 50 watts. Separate amplifiers for the high and low frequency components of speech and music guarantee a minimum of distortion at a maximum of frequency range.

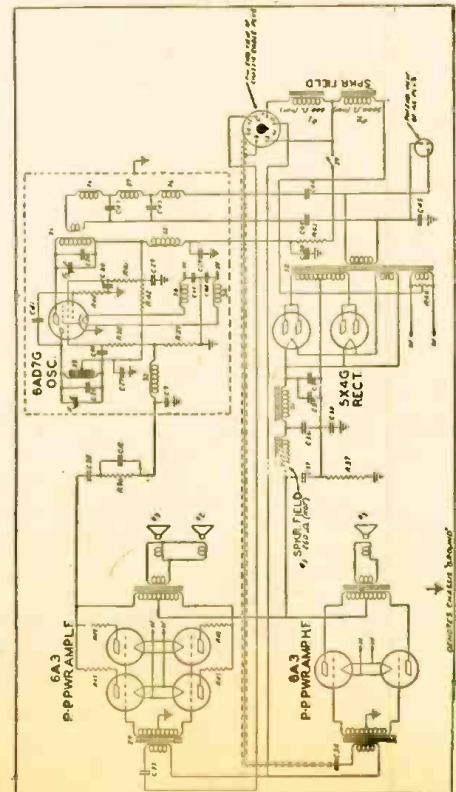
Power consumption is 325 watts—a 5 watts additional when the phonograph motor is in action.

AMPLIFIER PARTS LIST

DATE	DESCRIPTION	DIAM IN	DESCRIPTION	DIAM IN	DESCRIPTION
1	1.000	1.000	1.000	1.000	1.000
2	1.000	1.000	1.000	1.000	1.000
3	1.000	1.000	1.000	1.000	1.000
4	1.000	1.000	1.000	1.000	1.000
5	1.000	1.000	1.000	1.000	1.000
6	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000
15	1.000	1.000	1.000	1.000	1.000
16	1.000	1.000	1.000	1.000	1.000
17	1.000	1.000	1.000	1.000	1.000
18	1.000	1.000	1.000	1.000	1.000
19	1.000	1.000	1.000	1.000	1.000
20	1.000	1.000	1.000	1.000	1.000
21	1.000	1.000	1.000	1.000	1.000
22	1.000	1.000	1.000	1.000	1.000
23	1.000	1.000	1.000	1.000	1.000
24	1.000	1.000	1.000	1.000	1.000
25	1.000	1.000	1.000	1.000	1.000
26	1.000	1.000	1.000	1.000	1.000
27	1.000	1.000	1.000	1.000	1.000
28	1.000	1.000	1.000	1.000	1.000
29	1.000	1.000	1.000	1.000	1.000
30	1.000	1.000	1.000	1.000	1.000
31	1.000	1.000	1.000	1.000	1.000
32	1.000	1.000	1.000	1.000	1.000
33	1.000	1.000	1.000	1.000	1.000
34	1.000	1.000	1.000	1.000	1.000
35	1.000	1.000	1.000	1.000	1.000
36	1.000	1.000	1.000	1.000	1.000
37	1.000	1.000	1.000	1.000	1.000
38	1.000	1.000	1.000	1.000	1.000
39	1.000	1.000	1.000	1.000	1.000
40	1.000	1.000	1.000	1.000	1.000
41	1.000	1.000	1.000	1.000	1.000
42	1.000	1.000	1.000	1.000	1.000
43	1.000	1.000	1.000	1.000	1.000
44	1.000	1.000	1.000	1.000	1.000
45	1.000	1.000	1.000	1.000	1.000
46	1.000	1.000	1.000	1.000	1.000
47	1.000	1.000	1.000	1.000	1.000
48	1.000	1.000	1.000	1.000	1.000
49	1.000	1.000	1.000	1.000	1.000
50	1.000	1.000	1.000	1.000	1.000
51	1.000	1.000	1.000	1.000	1.000
52	1.000	1.000	1.000	1.000	1.000
53	1.000	1.000	1.000	1.000	1.000
54	1.000	1.000	1.000	1.000	1.000
55	1.000	1.000	1.000	1.000	1.000
56	1.000	1.000	1.000	1.000	1.000
57	1.000	1.000	1.000	1.000	1.000
58	1.000	1.000	1.000	1.000	1.000
59	1.000	1.000	1.000	1.000	1.000
60	1.000	1.000	1.000	1.000	1.000
61	1.000	1.000	1.000	1.000	1.000
62	1.000	1.000	1.000	1.000	1.000
63	1.000	1.000	1.000	1.000	1.000
64	1.000	1.000	1.000	1.000	1.000
65	1.000	1.000	1.000	1.000	1.000



Tube and trimmer location of amplifier and oscillator.

[illegible]

12-10-41 C46 added
11-13-41 R17 was 63-606
11-05-41 C14 was 22-1193; 19 was
9-22-41 R35 and by-pass added
8-08-41 C32 added; R25 and 63-1204
R26 was 63-1205; No. 21
was 122-15

66!

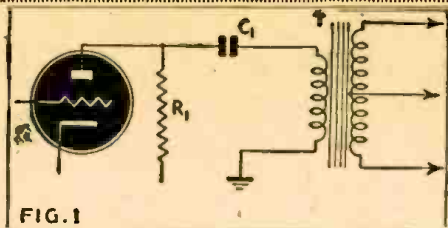


FIG. 1

Figs. 1 to 4 are bass-boosting circuits. Figs. 5 to 8 show various ways of getting more treble response.

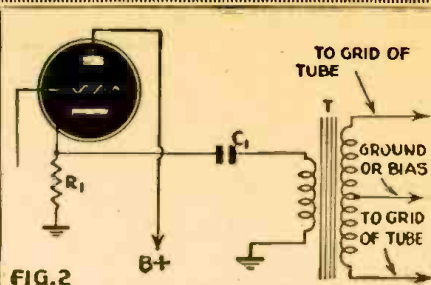


FIG. 2

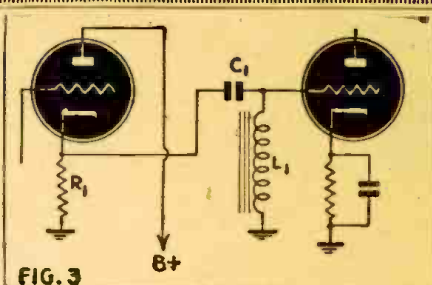


FIG. 3

MORE HIGHS — MORE LOWS

By LEO G. SANDS
PART II

In the first section of his excellent article on bass and treble boosters, Mr. Sands described ways of improving an amplifier's low-frequency response. This section is mainly devoted to a discussion of methods to increase the highs. Some of the systems here described are easy to apply to existing amplifiers.

FIGURE 1 illustrates another resonant type bass booster. This circuit is used in practice by some radio manufacturers. T is an audio transformer. It may drive either a single ended or push-pull stage. In a receiver using transformer coupling, the plate of the preceding stage may be removed from the transformer and a resistor used as a plate load. For triodes, 50,000 to 100,000 ohms will suffice. C1 forms a resonant circuit with the primary of the transformer. This will result in a voltage rise at the resonant frequency. However, this rise will be quite broad over the lower frequency range.

Fig. 2 is a modification and an improvement over the preceding circuit. To use this system, it will be necessary to add another tube unless the audio system has plenty of gain to spare. The additional tube is a triode. In sets with 2½ volt tubes, a 27 or 56 tube will do. In sets with 6.3 volt tubes, a 6J5 or 76 will be excellent. The tube is connected as a cathode follower. R1 is the normal bias resistor for the tube you decide to use. The plate is connected direct to B plus. C1 is selected to form a resonant circuit with the primary of the audio transformer.

The transformer may be a cheap one and the results will be excellent. The reason for this is that we are feeding it from a low impedance source, namely the cathode of the driver tube. In such a case, the primary of the cheap transformer will have sufficient inductance to offer considerable reactance at the lower frequencies. Further, no direct current flows through the primary. In one case the writer found that resonance at the desired low frequency was obtained with 0.75 mfd. for C1. If a very high grade transformer is used and ringing or hang-over is noticed, the circuit may be damped by placing a resistor across the secondary of the transformer.

Fig. 3 illustrates another bass booster using a resonant circuit and a cathode follower tube. In this case too an additional tube is recommended. This circuit is similar to Figure 6 (in last month's article) except that it is fed from the cathode rather than

the plate. L1 is the choke and in this case, it can be one of low impedance. C1 should be calculated from a formula if the value of inductance is known. Otherwise try various values until the desired boost is obtained. R1 is the usual bias resistor.

Fig. 4 illustrates another bass booster using a parallel resonant circuit. If a tube with a high plate resistance is used, such as a pentode or high mu triode, L1 should have a high value of inductance—around 100 henries. With such an inductance, C1 should be .04 microfarads. R1 should be about 100,000 ohms. C2 is the usual coupling condenser and R2 to grid load resistor.

A FEW TREBLE BOOSTERS

There are many types of treble boosters for increasing the high frequency response of the audio amplifier. One of the simplest ways to increase this high frequency response is to bridge any electrolytic cathode by-pass condenser in the audio amplifier with a paper condenser of about 0.1 microfarads. It has been found that the usual electrolytic condenser does not serve as a good by-pass condenser at higher fre-

quencies. Another method is to replace condensers in the R.F. filters at the output of the detector with smaller ones. See Fig. 5. In either type of detector C1 and C2 can usually be replaced by an .0001 mfd. condenser. When frequency response was not an important point in radio manufacturing, large condensers were used to filter the R.F. out of the audio system. This not only by-passed the R.F., but also the higher audio frequencies.

Fig. 6 shows a very effective treble booster. R1 is the volume control when used in the audio amplifier. C1 is a small condenser of 50 or 100 micro-microfarads. In this circuit the very high frequencies are allowed to reach the grid of the tube direct rather than through the voltage divider effect of the volume control. The volume control will still vary the strength of the higher frequencies, it tends to short out the incoming signal at low volume settings.

Fig. 7 represents another treble booster. This circuit is extremely simple and consists of a small inductance in series with the plate load resistor. At high frequencies the inductance will offer a higher reactance than at low frequencies. This presents a higher impedance load to the tube at these high frequencies. For example, a 3 henry choke will offer a reactance of 100,000 ohms at 5,000 cycles. At 80 cycles the same choke will offer a reactance of 1500 ohms. It can readily be seen that a higher voltage will be impressed across the combination of L1 and R1 at 5000 cycles than at 80 cycles. R1 should be of sufficient resistance to offer good frequency response at all frequencies.

Figure 8 presents another treble booster. R1 is the usual plate load resistor, R3 the grid load resistor and C1 the usual coupling condenser. C2 and R2 make up the circuit that provides the treble boost. If R2 were in the circuit and C2 were left out, the signal applied to the grid would be lower. This is because R2 and R3 form a voltage divider. When C2 is placed across R2, and if C2 is a small value such as .001 microfarads, C2 offers a lower reactance to the high frequencies and a very high re-

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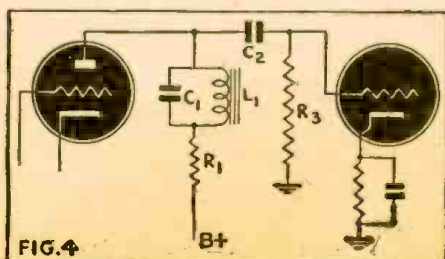


FIG. 4

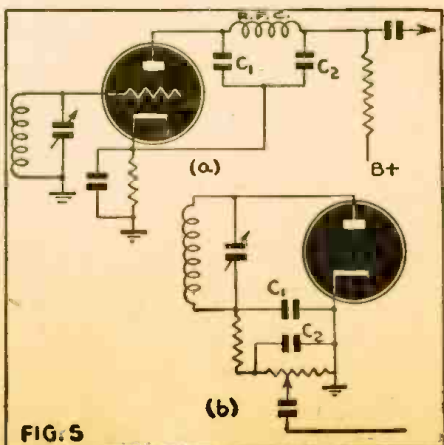


FIG. 5

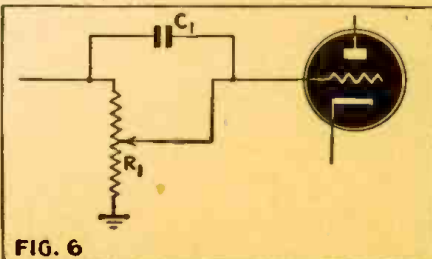


FIG. 6

IMPROVING THE DIODE

By GEORGE A. HAY, B.Sc.

THE widespread use of the diode detector in modern receivers is due to its cheapness, low inherent distortion and ability to provide AVC. It is now realized, however, that it can contribute a large amount of distortion if not used correctly. This may be due either to curvature of the tube characteristic or to the arrangement of the diode in the circuit. The former is easily reduced to negligible proportions by working the diode with a sufficiently large carrier input, so that the curved part of the characteristic forms only a small proportion of the total used. Under normal conditions with a detector efficiency of 80 per cent, the total amplitude distortion in the output has been quoted as 2 per cent, which is relatively harmless.

Amplitude distortion is by far the more important, and apart from any non-linearity in the tube feeding the diode, is always due to the AC load being unequal to the DC load, causing clipping of the negative peaks at all levels beyond a certain critical modulation depth. The theory of this effect has been amply treated elsewhere and it is sufficient to say that the maximum modulation depth handled by a diode detector without

distortion is independent of the RF input for its working conditions. For this reason we can use any value of detector input, making this as large as necessary to reduce distortion due to diode curvature.

The DC and AC loads on V1 are substantially equal for all modulation frequencies, while V2, which we may call the compensator, is only supplying DC to the output, and hence the slight inequality of

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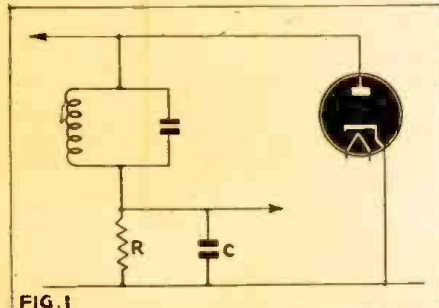


Fig. 1.—A standard diode detector circuit. Arrow usually goes to hot end of volume control.

distortion is equal to the ratio of AC to DC loads. It will be apparent that if the DC load resistance be shunted by other components offering no DC path, the distortion present at 100 per cent modulation will be greatly increased.

Fig. 1 shows a conventional diode circuit. In this the DC and AC loads are equal for all low and medium modulation frequencies; at high frequencies, however, the AC load becomes less than the DC load because of the shunt reactance of C. This cannot easily be avoided, and is a possible source of amplitude distortion in receivers with a wide frequency response. Evidently the choice of R and C is of some importance, and the deciding factor must be C, as this must be large enough not to reduce substantially the RF input to the diode. A reasonable value is ten times the anode-cathode capacitance of the diode, which, in the case of the 6H6 gives a value of approximately 30μF, a value considerably lower than the usually quoted figure. R must now be chosen so that the AC load is nearly equal to the DC load. If we assume a maximum *m* of 0.9 at 5,000 cycles per second, a safe value to adopt will be 0.1 megohm.

So far we have not considered the con-

nection of the detector to an AF amplifier. Such a connection in the normal way requires the interposition of a blocking condenser with accompanying grid resistance, in order that the DC component of the detector output will not alter the bias on the amplifier. This forms another shunt circuit which reduces the load impedance to AC at all modulation frequencies.

There exist several methods of overcoming this, such as operating the diode with positive bias, using a complex reactive load, or applying negative feed-back. It seems to the writer, however, that the only really satisfactory solution lies in abolishing any reactive shunting, and thus removing the trouble at the source.

This is done in the grid detector when used correctly, as the output of the diode, in this case the grid and cathode of the triode, is applied directly to the grid of the AF amplifier. The DC load is thus shunted only by stray capacitance. The great disadvantage of the grid detector is the fact that the working point of the amplifier depends on the value of the RF input, and thus we may find bottom-bend distortion taking place. Even if we fix the value of the input by using an anode current meter and a manually adjusted pre-detector gain control, there still remains the difficulty that the RF input which will bias a tube of the small triode class to its correct working point is too small for the avoidance of distortion due to diode curvature. On top of all this is the fact that it is impossible to obtain satisfactory AVC from a grid detector.

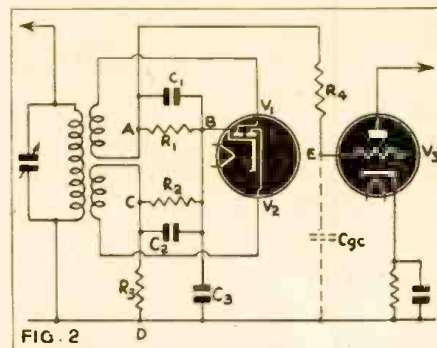


Fig. 2.—A diode detector compensated to cut out amplitude distortion. Values given in text.

AC and DC loads does not matter, as it is insufficient to cause any appreciable distortion in the output of the tube feeding the detector.

If AVC is required, the circuit must be rearranged as shown in Fig. 4, when a negative potential is available from point B without further filtering. This circuit is not so good practically, as the double diode requires separate cathodes, and these are isolated from ground, and thus liable to give rise to hum. If the greatest freedom from background is required, it may be found necessary to use separate heater windings for the two diodes. In any case the AF gain will be low, as the RF input is large, and thus any hum will not be

(Continued on page 688)

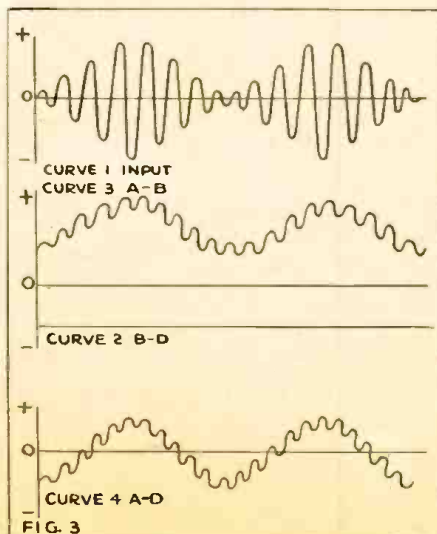
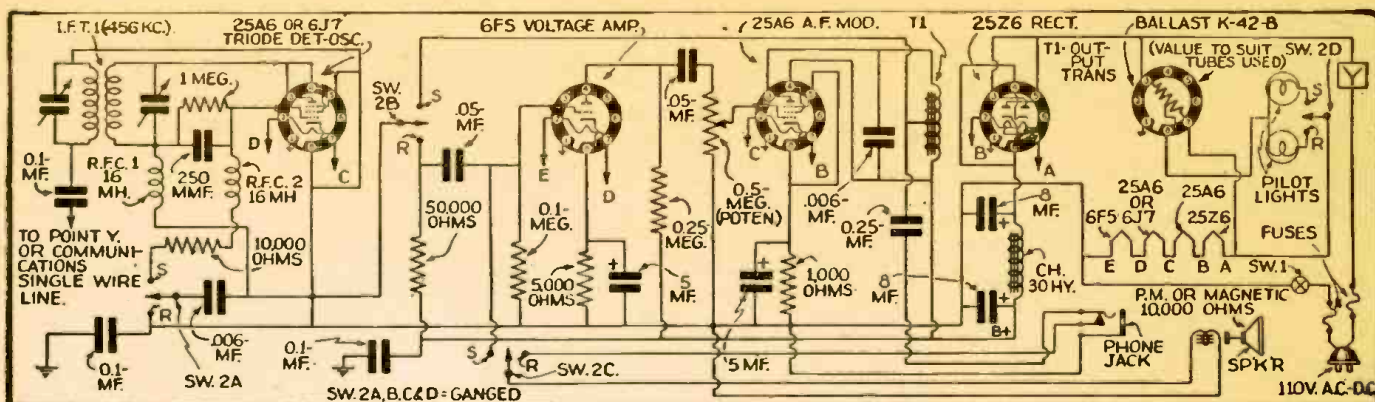


Fig. 3.—How the detector of Fig. 2 works.



Carrier Communicator

INTER-OFFICE telephone systems are being widely adopted, the instruments used for both, talking and listening utilizing radio parts such as tubes, resistors, loudspeakers, etc. The accompanying diagram shows one form of *carrier type* interphone using four tubes and an additional so-called tube containing a ballast resistor.

A dynamic speaker of the permanent magnet type and about 5" in diameter serves very well as both transmitter and receiver, a simple gang-switch being turned to send or receive. (Marked "S" or "R" in diagram.) The power-supply uses a 25Z6 tube and a 300 ohm A.C.-D.C. choke, shunted by two 8 mf. electrolytic condensers. A jack is provided for headphone reception, which is sometimes quite desirable; pilot lights in-

dicating the *send* and *receive* conditions. A gain control is also provided, and the whole affair fits into a 5" x 6" x 9" cabinet, which should be of metal to prevent R.F. radiation.

A 25A6, triode-connected, is used as the detector-oscillator as the diagram shows. I.F.T.1, may be most anything; for example, a broadcast R.F. transformer capable of being tuned to a point below or above the regular B.C. channels. Again it may be an I.F. transformer or a single layer home-made coil, tuned by a small condenser to any desired operating frequency.

The 25A6 tube is used as the modulator power-amplifier and a 6F5 is the voltage amplifier for the loudspeaker when used as a microphone. The ganged "send to receive"

changeover switch is a 4-pole double-throw type. The coil used at T1 is a universal output transformer, the voice-coil of which remains unused. Note that the chassis is connected to B— only through the condenser C16. The return connections for the electrolytic filter condensers and also the bypass condensers are joined to B—.

When the switch is turned to the *send* position the 10,000 ohm resistor is connected to ground. In case difficulty is had with the 25A6 tube as det.-osc., so far as oscillation is concerned, the recommended substitute is a 6J7. When different tubes are substituted, care must be taken to make any required change in the value of the ballast resistor.

ON THE FUTURE OF RADIO

By T. R. Kennedy, Jr.

NOTHING, perhaps, is more amazing these days than the apparent speed with which the radio-electronic wartime world is expanding, or more bewildering than how it all may be tailored to fit tomorrow's world of peace. Proposals to do this with the least confusion and most gain have been submitted by the Institute of Radio Engineers and various other industry groups. A huge job, to say the least, is foreseen. It is interesting to speculate how some of our established radio institutions will be conditioned to don this magical new garment, the true dimensions of which can scarcely be predicted.

Some of the future, however, may be partly forecast. Post-war television from the engineering standpoint is more than likely to be a brand new structure. So rapidly are ideas changing, according to authorities, that "little of the current structure is likely to remain completely intact." World-wide radio-beam navigation by air and sea will become possible without the aid of the stars or compasses. Trains will be universally dispatched and controlled from city to city by micro-wave radio.

RADIO "TRAFFIC COP"

It is more than probable that millions of automotive drivers, some time soon after the war, will begin to hear about and use "stop," "go," "slow," "danger," "cross-roads," "service station two streets ahead,"

and similar audible driving instructions over novel radios adapted to automobile instrument boards. Such units would be capable of serving entertainment, too, when not otherwise employed, as tourists speed over super radio-equipped highways. The traffic and entertainment signals will leap to the car's pickup system from roadside cables, energized from spaced traffic stations.

Car radios are foreseen with built-in "red-green" lights to supplement the aural instruction. Warning signals might be interspersed with music to help keep sleepy tourists awake and alert, and oft-repeated instructions would guide drivers over specially dangerous pieces of roadway. Neither night nor fog nor storms would lower the system's efficiency.

Home radio apparatus—certainly well within a year after the cessation of hostilities—may be expected to take on aspects scarcely dreamed of now except by the country's radio designers. And as there is likely to be scant rest for the experts in tomorrow's huge assortment of radio and electronic tasks it seems important that a good, sound, workable radio servicing plank be inserted in the post-war radio platform now in the making.

Several competent radio industry observers have revealed their thoughts on this matter during the past week. A cross-section of their collective opinions is that the future of civilian radio servicing should be

"more adequately and specifically provided for among the post-war radio proposals so far submitted."

NEW WAVE IDEAS

The servicing problem is bound to get more difficult as new radio-electronic things are brought out. Radio trends are toward higher and higher frequencies. Wave shifts appear to be inevitable if the world is to benefit fully from current wartime advances in the art—if more space is to be made available for vital communication services and new industrial uses of the electron tube. Such shifts will bring extensive changes in radio design, and many projects cannot even be started until such new radio bands for civilian radio's use are established. But the foundation of the new radio service organization of the country, along with other vital post-war needs of the industry, should be planned now, radio men believe.

There will be plenty of jobs for the expert serviceman. It is conceivable that the industry will expand so rapidly that FM, television, broadcast sets and perhaps facsimile will be only a minor part of the home-appliance fixing problem. One thing will be certain. The men who do the work will be informed. Guesswork will be taboo. Cathode-ray instrument tests may figure largely in every radio trouble diagnosis.

Reprinted from *The New York Times*.

THIS NEON-TUBE TESTER AIDS WARTIME SERVICE

By ALFRED ROSE*

It is now practically impossible to get new testing equipment here in England, and we are compelled to be exceedingly careful with what we have. For the engineer who has not access to good test apparatus, or who would rather not take such gear as he has on outside service, the neon tube is an inexpensive yet valuable asset to radio testing.

TYPES AND CIRCUITS

The usual neon test arrangement is shown in Fig. 1. Various types of neon tubes may be used. Many outside service engineers use the $\frac{1}{2}$ -watt indicator type—others carry the fountain-pen pocket type. Although the $\frac{1}{2}$ -watt and pen types are convenient for outside service, they will not replace the 5-watt "bee-hive" (coiled-grid) type on all tests. The reason is that the glow in this lamp oscillates more freely than in the smaller types.

The indicator type will show a glow with a resistance as high as 7 megohms in circuit, while some pocket types will glow with only 10 Ma. applied.

By adding a pair of headphones in circuit, as in Fig. 2, many extra tests can be made and a chassis can be run over with the test prods without the operator having to keep looking at the neon.

Use a D.C. supply for the neon lamp. The voltage should be suited to it. We are able to obtain 220-240-volt lamps here. These are very useful for filter condenser tests, where the voltage is too high for 110-volt neons. In some tests, a neon with the resistance removed is best.

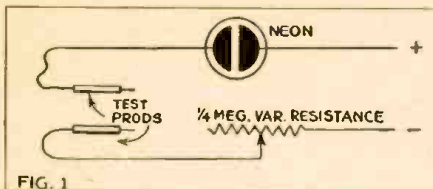
If the supply is of the A.C.-D.C. type, make sure that the chassis of the radio is not grounded, either direct or through the A.C. mains. Probably the best system is to use a special power supply for the neon, isolating it from the mains and other grounding.

TESTS WITH CIRCUIT OF FIG. 2

For checking the high-voltage line, make the test between the rectifier cathode and chassis. Make sure there is no low-resistance component across your test circuit, such as

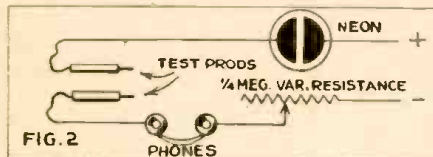
*Radio Consultant, London, England.

a bleeder or speaker field connected between high voltage and ground. The neon should show a bright glow, which should die down as the tube discharges, until little or no glow is showing. (This apparently describes a test with a 240-volt lamp in a high-voltage supply of less than 240. A 110-volt tube would show a steady glow.—Editor)



To check for A.C. or D.C. supply, it is only necessary to plug the prongs into a convenient receptacle. Only one element of the neon will glow on D.C. while on A.C. both glow equally.

The neon tube is especially convenient for a rapid check of socket voltages. By becoming acquainted with the glow obtained with the test prods between each socket prong and chassis with any particular type of set, a quick check which will show up open resistors, shorted condensers, etc., may be made. Under some circumstances it is better to make this check with the tubes out of the socket, in which case it may be done from the top of the chassis.



CHECKING THE A.V.C. LINE

Locate the a.v.c. line and connect the test prods across the circuit. The usual result is a continual flicker. If this flicker can be compared with that obtained in a normal set of the same type, it can tell you a great deal about the a.v.c. For example, if the flicker of the neon—applied to the a.v.c. line of a faulty set—is much quicker than

normal, suspect a leak. If the flicker is too slow, suspect an open-circuited condenser or a dry joint on one.

This test has brought to notice such faults as a smear of soldering flux on a resistance-mounting panel, as well as many a faulty condenser, also leaky tubes. A bright, slight flicker may be due to a resistor of too low a value.

Condensers may be tested for insulation with a D.C. supply, but to test for open circuit in a condenser of capacity approximating 0.1 mfd. connect it in parallel with a $\frac{1}{4}$ -megohm resistance and apply the test prods. The neon should then show a flicker or if phones are being used a popping sound may be heard.

Alternatively, an A.C. supply can be used for condenser testing. The neon should show practically a full glow if the condenser is not open. An insulation test on a D.C. supply must still be made, however.

A "TOUGH ONE" SOLVED WITH NEON

The writer was called to rectify a complaint of poor results on the long-wave band of a superheterodyne receiver. The aerial was a good one, using efficient insulators, and the ground was direct to earth.

The fault was discovered with the help of the special 5-watt "trouble" neon lamp, protected by a metal screen, which he carries on all outside jobs. One prod was inserted in the "hot" side of the electric light line and the ground wire connected to the other. The neon showed a full glow, as it should do. Next, the prong was applied to the aerial. There should not have been any glow, but actually the tube lighted up to about quarter brilliancy.

Investigation showed that twin flex had been used for a part of the aerial and earth lead-in. On running separate leads the volume on the long wave increased to a satisfactory level.

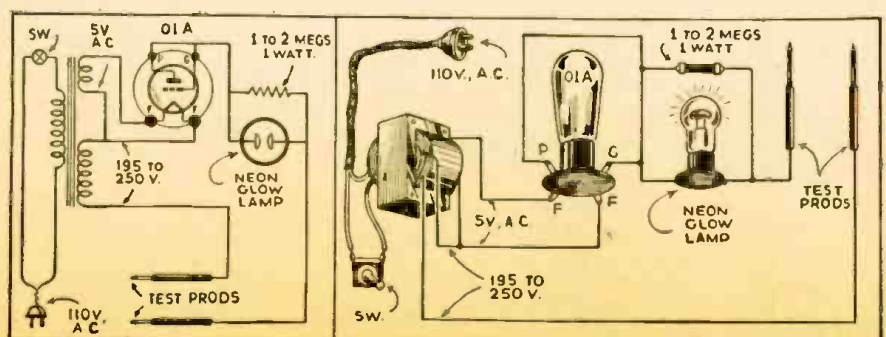
One final note on testing electrolytics with the D.C. neon. Be certain that the voltage used is not higher than the working voltage of the condenser under test. It would be no use testing a 25-volt cathode biasing condenser with 250 volts, and a suitable resistance must be inserted in series.

An Inexpensive Condenser Tester

By JACK GEIER

HERE is a condenser test device which is very useful. A leaky condenser will cause spasmodic operation of the neon tube. A shorted condenser will show a continuous light; an open, no glow; a good unit will flash very slowly. Discard as "poor" or "leaky" any condensers which flash two or three times per minute. This is a good test with fairly high voltages. It works well with all except electrolytic condensers. Use a $\frac{1}{4}$ -watt 110 V. A.C.-D.C. neon glow lamp.

You can use any old transformer in the junk box for a power transformer. The 01A will work on a 6.3-volt winding, or a 6.3-volt triode can be used in its place.



HOW WE CONSTRUCTED *A Versatile Unit Which*

By NATHAN H.

OUR shop Ohmmeter had sunk to the level of the ancient Continuity Meter, used so many years ago. We could determine "open circuits" and "closed circuits". But could not measure resistances with any degree of accuracy. Replacing the 4½-volt and 45-volt batteries which powered our ohmmeter would have solved the problem—if batteries had been available. But all the battery dealers talked was "War Shortages!"

Since our ohmmeter had no room for the Power Supply we first thought of building, we decided to build a complete A. C.-powered ohmmeter, starting from scratch. Our battery-powered ohmmeter read up to only 3 Megs, which was not high enough anyway. Too many leaky paper condensers tested "good"; and too many 15 Meg. resistors barely showed on it, now that batteries had served out their usefulness.

We first reviewed the ohmmeter circuits with which we were acquainted. The circuit shown in Fig. 1 is the one we used. Having chosen the circuit, our next job was to find a suitable meter, as all resistor and power supply data depends upon the characteristics of the meter used in this circuit. As ohmmeter scales of the desired type are seldom available, and would have to be made by hand, we decided to use as large a meter as we could find. Calculations showed us that almost any meter, preferably

not more than 5 mils sensitivity, could be used.

Like most of our brethren of the soldering iron, we had a couple of large meters, taken from obsolete tube testers. After removing them from the circuits in which they had been used, and taking out shunts, we checked their sensitivity. The circuit shown in Fig. 2 was used. The 6-volt storage battery we use when working on auto radio receivers, supplied the power. R1 and R2 were 1200 and 5,000 ohms, respectively. The 9-inch meter read 3.7 mils; the 7-inch meter read 1.2 mils. As we may eventually make a multimeter of the ohmmeter described, herein, we used the 1.2 mil meter.

Now came the matter of determining what voltages to use. As we had a VR150-30 Voltage Regulator Tube, this problem almost solved itself. And we had a No. 6 dry cell for our lowest, (R1) range, which requires 150 mils—too much for our supply. Design problems were simplified by using it on R10 as well. The power supply shown in Fig. 3, supplies all other needed power.

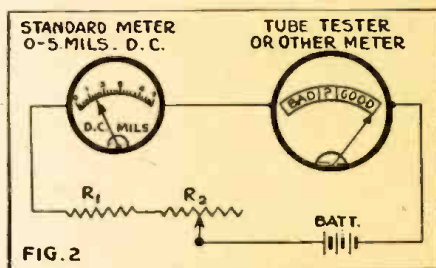
The SPDT switch permits using the R100 range with battery or power supply. This feature was added so that the instrument could be used when checking auto radio aerials, and other work, while radio is still in the car. The No. 6 dry cell is, obviously used in this work.

We are going into detail, to show how all resistor values were calculated, in order that the reader may learn how to calculate the values needed when he uses a meter that has a sensitivity that differs from the 1.2 mil meter we used. Shunt values can, of course, be readily calculated—down to umpteen decimal points. Then what? If the reader could measure these shunts—accurately—would he be reading this article? So, we use the By-Guess-and-By-Gosh System—the cut-and-try method, which, with a little patience, results in surprisingly accurate results.

(So many things we "know", just aren't so. To give one example that applies here—a 1½-volt dry cell reads about 1.6 volts, when fresh. This data is needed when we build our zero adjustment.)

In the ohmmeter circuit we are using,

(Fig. 1), the twin features: One zero adjustment for all ranges; and greater accuracy than in the ancient circuits, are available because we vary the meter sensitivity, by means of the zero adjustment—which is in reality a variable shunt across our meter. When our new No. 6 dry cell supplies 1.6 volts, our zero adjustment is set so that our meter is 1.6 mils. When our No. 6 supplies a lower voltage, we simply use the



zero adjustment to change meter sensitivity. If, for example, we have a voltage of, say 1.2345678 volts, we let our zero adjustment make a 1.2345678 milliammeter of our meter.

We do not have to know the exact battery voltage, as zero adjustment is made simply by shorting our test leads, and setting zero adjustment to the point where full-scale reading is obtained. This is the same procedure used in all except back-up scale ohmmeters, and hardly needs mention, except for the benefit of readers who are new in radio.

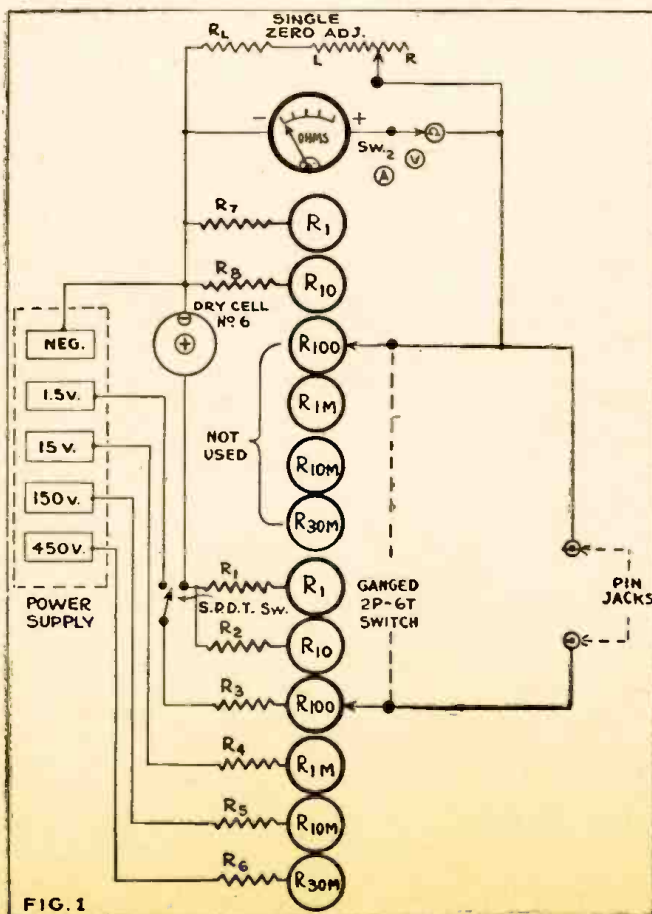
It is best to mount the meter on the panel with which it is to be used. If the panel is steel, this is most imperative, as steel panels decrease the sensitivity of meters. The magnetic effect does it. Mount the meter and the panel securely. Connect only the limiting resistor, RL, and the zero adjustment, as shown in Fig. 4 (a). Connect the standard (0-5 Mil D.C.) meter, R1 and R2 and battery, as shown. Make sure both meters are at "0" when no current is on.

With minimum resistance supplied by the zero adjustment, as in Fig. 4 (b), the limiting resistor RL shunts our 1.2 mil meter, and reduces its sensitivity to 1.6 mils. This is the setting when the No. 6 dry cell is brand new, and supplies 1.6 volts.

We guessed our meter had an internal resistance of 50 ohms. We knew this was doubtless far from correct. But it served our purpose.

The sensitivity of our meter—when shunted by RL, (and the minimum resistance of the zero adj.), should now be 1.6 mils. Since we know only 1.2 mils flow through the meter, it is obvious that the remaining current—1.6 mils minus the 1.2 mils through the meter, or .4 mils—flows through RL, which is shunted across our meter. What is the resistance of RL? (Assuming zero adjustment is at "0" ohms—which we know it will NOT be!)

At a glance, we see that it is greater than that of the meter—three times as great



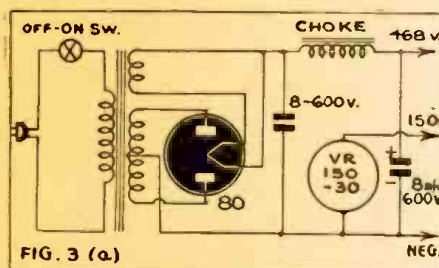
A WARTIME OHMMETER

Uses that Old Meter

SILVERMAN

—as one-third as much current flows through RL as through the meter. (1.2 mils through meter; .4 mils through RL.) This is simple Ohm's Law.

Having assumed meter resistance is 50 ohms, we can now assume RL is 150 ohms. Try different values near that resistance for RL, until standard meter reads 1.6 mils when ohmmeter meter is full-scale. We happened to have quite a collection of Tru-volt resistors, so simply soldered a lead to



one end of a suitable piece of resistance wire, and slid a bare wire over the other end, until meter indicated that we had the correct adjustment. Then this loose end was soldered. That was all there was to it! We still don't know the value of this resistance—and don't care. The ohmmeter works satisfactorily, so why worry? . . . Fig. (b) shows what happens with zero adjustment on zero setting.

In Fig. 4 (c) the zero adjustment is at maximum resistance, and in series with RL. The total resistance of this shunt should make our meter have a sensitivity of 1.28 mils. Since meter draws 1.2 mils, this shunt draws the remaining .08 mils. Still guessing—we know the ratio between the current through our meter and RL plus zero adjustment will determine the values of RL (which we now "know" is 150 ohms), and zero adjustment which we do not yet know. The ratio between the 1.2 mils through meter, and the .08 mils through RL and zero adjustment is 1.2/.08, or 15. If meter resistance is 50 ohms, total resistance of RL and zero adjustment will be 15 times 50 (meter resistance), or 750 ohms. As resistance of RL has been assumed to be 150 ohms, this value is subtracted from the total resistance of RL plus zero adjustment and 750 — 150, or 600 ohms is the assumed value of zero adjustment. So, let's try a 600 potentiometer for zero adjustment.

More than likely, this value is not available. Wartime! Suppose a 1,000-ohm potentiometer is the best nearest value available. If you use it "as is", only 60% (if our guesses are correct!) will be useful to us, making for critical adjustment. So we shunt a fixed resistor across our potentiometer, as indicated in Fig. 4 (d). This shunt can be across "L" and the Arm of the potentiometer—as indicated by "R_s No. 1." Or, between "L" and "R" of the potentiometer, as indicated by "R_s No. 2." This latter is the one we used. Finding, by formula, the value of a resistor, which, shunted across 1,000 ohms, gives us a resultant resistance

of 600, we find we need a shunt of 1,500 ohms. The shunts in Fig. 1, "R7" and "R8", are also made by means of the "Cut-and-Try Method." The circuit shown in Fig. 2 is again used; the Standard Meter must be a Multi-Range affair, capable of accurately reading 15 mils and 150 mils. RL and the zero adjustment are left across the meter, making the circuit look slightly different from Fig. 4. We left our zero adjustment on the setting that made the meter read 1.5 mils, as this would be the most-used setting—assuming our power supply would supply the correct voltages. It did! . . .

Connect terminal "R1" and "R10" to the 2-gang, 6-point switch, using only "R7" and "R8"—one end of each shunt to Meter; other end to proper terminal on the switch. With the switch on "R1"—and using the circuit shown in Fig. 5, with the standard meter set to range that will accurately read 150 mils—adjust "R7" so that full-scale reading on the meter used in the ohmmeter, will make the standard milliammeter register 150 mils.

This will require a certain amount of patience. But accuracy of this shunt and of "R8" will determine the accuracy of the whole ohmmeter. So let's get "R7" and "R8" . . . "right on the nose"! With the 2-gang, 6-point switch on "R1" meter sensitivity must be exactly 150 mils. Let zero adjustment alone, once it is set. On "R8", Meter sensitivity must be exactly 15 mils.

If the reader lacks the experience and equipment required, he may be able to find a fellow-experimenter, or a Serviceman to help him do this job of making accurate shunts.

Fig. 3 is the power supply we are using to supply voltage for all, except the lowest, (R1, R2) ranges. The "R1" range requires 1½-volts at 150 mils, which our power supply cannot supply. The power transformer we used, rated at only 50 mils, is too small.

The only problem in building the power supply is the voltage divider. In designing a voltage divider, one really starts at the bottom—and works up. In view of the available power transformer used, we had a 20-mil "bleeder" current. Now let's take a look at Fig. 5B. In our voltage divider, "R1" carries the "bleeder" current; it has the voltage we want on our first tap—1.5 volts, in this case.

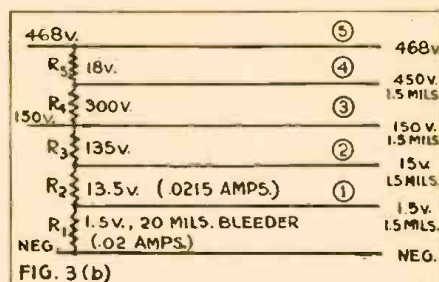
Since we want our bleeder to carry 20 Ma. and we also want a voltage of 1.5 at Tap 1, R1 should have a 1.5-volt drop at .02 ampere. According to Ohm (again), it must have a resistance of 75 ohms.

R2 must have such a resistance that its top end will have a voltage of 15. As we already have a voltage drop of 1.5 across R1, the drop across R2 will only be 13.5. Our current will be a little bigger, as we now have the 1.5 Ma. for tap 1 as well as the 20 Ma. bleeder current to consider. Thus our problem is to find a resistor that will give us a 13.5-volt drop at .0215 ampere. This is roughly 630 ohms. The next resistor represents a drop of 135 volts. Obviously 6,300 ohms will be required here. For the 300-volt drop, R4, approximately 14,000 ohms will be required. 840 ohms covers R5, and our bleeder is complete.

We have calculated all our voltages on the basis of a .0215 current flowing from the tap directly below each. As only one tap will be drawing current at any one time, the voltage under no-load condition will be slightly different. The VR150-30 at the 150-volt tap must help out here—the voltage difference is not measurable.

Wattage was calculated as approximately 10. So we used a 20-watt voltage divider, except for R1, which was a 5-watt variable resistor.

Now for our resistors R1 to R6. On R1, our lowest range, we expect to have 150

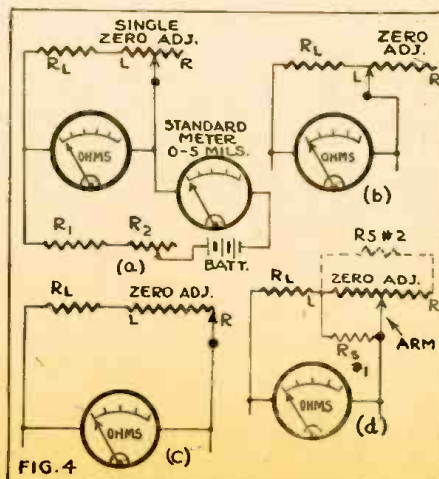


Ma., or 0.15 ampere, with a voltage of (around) 1.5. Again by Ohm's Law (wonder what we'd do with that Law?), we find we need 10 ohms. R2 carries 15 Ma. with the same voltage, a current one-tenth as large, so we need a resistor ten times as great, or 100 ohms. Substituting the correct voltages and currents required for each of the other ranges, we find something any experienced radioman would have guessed—R3 is 1,000 ohms; R4, 10,000; R5, 100,000; and R6, 300,000 ohms.

Range R6—our 30M range—was included because we had the necessary 450 volts this range requires. Experience with the range was a pleasant surprise. Probably because of the VR150-30, readings were surprisingly accurate. The original reason for including this extra range was to test paper condensers for leakage—and because we had that extra sixth terminal on our 2-gang switch.

Now for that final task—Calibration!

(Continued on page 698)



3-TUBE SUPERHETERODYNE

for Advanced Trainees

By HARRY BERGQUIST

This little radio is an excellent training project, containing as it does all the features of a larger superheterodyne. The finished job may be counted on to give results not far short of those obtainable from a set with several more tubes.

THIS three-tube superhet is an interesting project for the advanced newcomer, inasmuch as the shortage of parts does not interfere with its construction.

It features plug-in coils, single-control tuning, a.v.c. and low-drain, battery-operated tubes. The latter should interest those living far from power lines. Where A.C. is available, simple power-packs of the types described in recent issues of *Radio-Craft* can readily be constructed for it.

In spite of the small number of tubes, the circuit is a straightforward one. The 1A7-GT acts as mixer, followed by a straight I.F. amplifier, the 1N5-GT, and by the diode detector of the 1D8. The triode and pentode sections of the same tube act as the first audio and power output stages respectively.

The author's set has plenty of sensitivity and pulls in foreign broadcasts. Selectivity may be made as great as the design of the I. F. transformers will permit.

CONSTRUCTING THE SET

The chassis on which all parts are mounted was used as it came from the junk box. Further searching in the same place brought forth a two-gang condenser suitable for the job. Air-core I.F. trans-

formers, tuned to 456 kilocycles, were taken from an abandoned receiver. Thus it was unnecessary to buy any new parts.

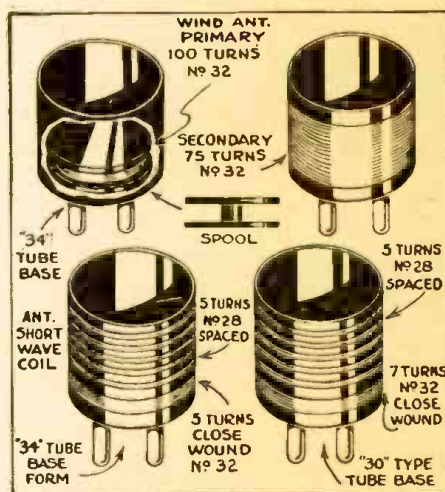
The variable condenser, C_2 , a 35-mmfd. midget type, is wired in parallel with the antenna tuning condenser. This helps to keep both sections tracking over the whole dial, and adds to both the sensitivity and selectivity. When using plug-in coils, it is inconvenient to provide for this tracking with separate padding condensers for each band, so in this case a padder was provided for the broadcast range alone.

The broadcast oscillator padder was made to mount in the top of the coil form as shown in the diagram. The capacity is 400 mmfd. The other bands needed no padder, the 35-mmfd. variable on the R.F. coil being more than sufficient to keep the tuning circuits in line. This was the reason for the mounting of the padder. By removing the broadcast coil, it is also taken from the circuit.

THE COILS AND COIL FORMS

Tube bases from burned-out "34"s were used as coil forms for the broadcast oscillator and antenna coils. They were constructed as shown in the diagram. The antenna primary is wound on a spool which fits snugly inside the coil form. 100 turns

of No. 32 wire was used, though probably neither the number of turns nor the size of the wire is very critical. Other wire



Details of the broadcast antenna primary and secondary, and the shortwave antenna and oscillator coils.

could be used if No. 32 should be unavailable. The secondary was wound with 75 turns of the same wire, the turns being close-wound, of course.

The broadcast oscillator coil, called for more careful work. The tickler, 25 turns of No. 32, was first wound, then covered with a wide band of paper tape, secured to the form and the winding below by Duco cement. Then the secondary was wound on top of this, using 42 turns of the same No. 32.

Owing to possible differences in the stray capacities of different sets, the constructor should wind more turns than necessary on these coils. Turns may then be taken off till they track. I left the gang condenser trimmers in place, so that by moving them out and in till they tracked, I could get an idea of the number of turns to remove.

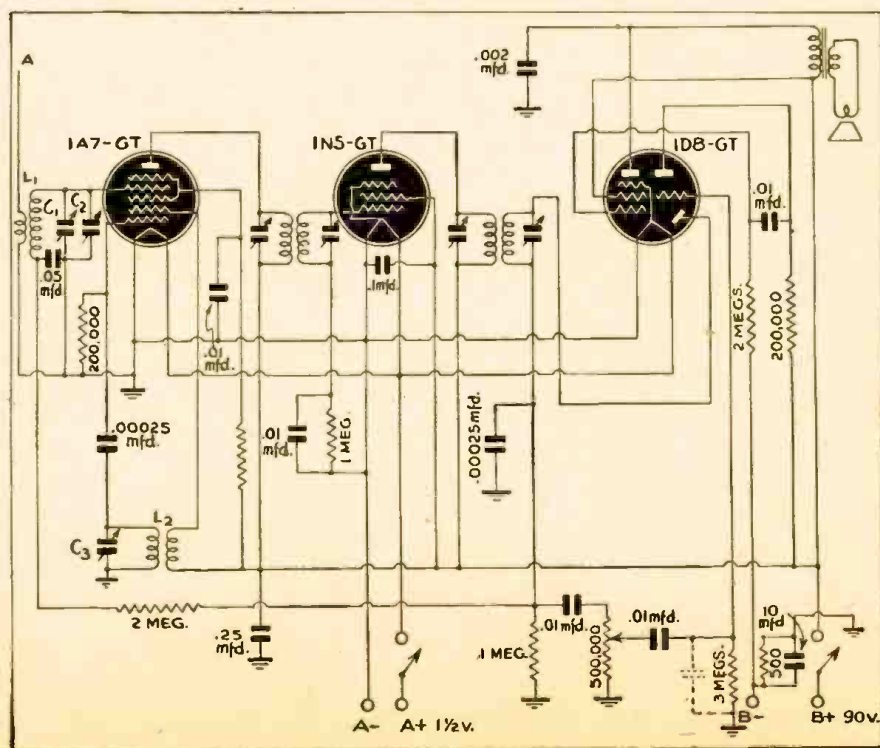
The final adjustment was to move the trimmers all the way out—to add as little fixed capacity as possible to the gang-condensers—and set the padder for final tracking adjustments.

THE SHORT WAVE COILS

The antenna coil form for the short wave band was also a "34" base, and the form for the oscillator was the base of an old "30". With 5 turns of No. 28 wire spaced as shown in the diagram, the difference in size between the two forms made the correct amount of difference for good tracking.

Windings were adjusted, after the rough adjustments were made by removing turns or parts of turns, by slightly moving the top turn, spacing it more or less from the

(Continued on page 692)



Schematic of the 3-tube superheterodyne. The 1D8-GT combination tube makes this the equivalent of a 4- or 5-tube set.

CROSS-MODULATION AS A FACTOR IN INTERFERENCE

By TED POWELL
PART II

CAUSES and effects of external cross-modulation were handled in a general way in the first part of this article, last month. We will now deal with some specific cases of e.c.m. in home receivers. Following are various service and operating notes in issues of *Radio-Craft* published during the last three years and presented with the writer's comments.

Symptom—An obstinate and persistent source of e.c.m. interference of the "tunable hum" type which could not be eliminated by any of the usual methods.

Cure—The source of the trouble was tracked down with a portable receiver and a loop antenna. It was found to be completely external to the house receiver and its antenna system. A loose, corroded joint in an A.C. line conduit run in a nearby building undergoing construction was the cause. Tightening of the offending joint cleared up the trouble.

Comment—The transmitter signals circulating in the conduit pipe runs and the 60 cycle current induced in them by the A.C. power lines were cross-modulated at the corroded conduit joint. They were either re-radiated by the conduit runs as a localized interference field and picked up by the receiver antenna directly or else the intermodulation products were induced back into the A.C. lines within the conduit runs and then carried into the receiver amplifier circuits through the receiver power supply transformer. The interference may also have been re-radiated within the building housing the receiver by the A.C. lines and picked up by the receiver antenna system, especially the vertical lead-in.

Symptom—Table model and midget receivers often develop "tunable hum" trouble at the owner's homes but behave normally at the serviceman's test bench.

Cure—The cures vary since they necessarily depend upon the cause of the trouble. Using a three-wire power cord, with the third conductor as a ground lead between the receiver chassis and the wall plate of the 120 volt outlet (and the power line BX armor) tends to "ground" the chassis to the power line armor. This balances the receiver "ground" circuit system with respect to the power-line "ground" and tends to reduce sum-and-difference frequency products in them. This in turn will reduce e.c.m. interference effects, especially tunable hum.

PRACTICAL APPROACH TO THE PROBLEM

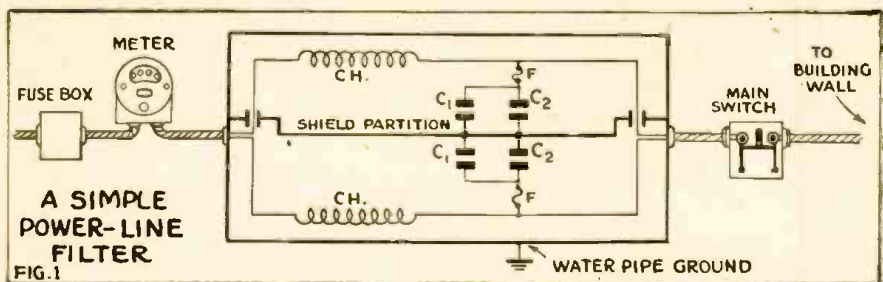
Cleaning up and tightening power line, ground, antenna and receiver input circuit connections eliminates resistance-rectification joints and their cross-modulation effects.

Renewing or else shunting the filter condensers with mica condensers will eliminate corroded resistance contacts between lead-in and foil in dried out or defective electrolytic condensers and their cross-modulation effects between the power frequency ripple and R.F. signals entering the receiver circuits via the power transformer.

Even where normal electrolytic condensers are concerned, cross-modulation effects may take place since such condensers have strongly non-linear dielectric and impedance characteristics at audio and R.F. frequency levels. This fact brings out the possibility of trouble from ionic type earth currents about the receiver or transmitter locations

variation of over-all power line circuit and radiation constants as far as R.F. radiation and re-radiation fields in the vicinity were concerned. The Jones method of eliminating interference would be required here.

Symptom—Intermittent crackling and noise and tunable hum in a receiver.



and the presence of electrolytic lightning arrestors in power transmission lines.

Sometimes the installation of a large ventilated shield about a power rectifier tube reduces tunable hum. Power rectifiers may develop R.F. parasites under certain conditions and radiate them or else defective solder or spot welded joints within them may cross-modulate stray R.F. signals and the power frequency current to create "internal" e.c.m. interference.

Symptom—e.c.m. interference trouble with a receiver.

Cure—Could not be eliminated. However, after all the usual checks and corrections were gone through with, some reduction of the trouble was noted.

Comment—This was no doubt a true e.c.m. interference problem in that the trouble was wholly external to the receiver system and was probably caused by the large corroded metallic structures located in a nearby factory district through which a canal flowed. It was noted that the interference varied in intensity rather abruptly with occasional static crashes during an approximate two hour period between 5 and 7 P.M. This was probably caused by switching operations in the local power transmission system and the consequent

Cure—A check-up of the building wiring uncovered an amateurish lightning fixture wiring job which had a loose connection.

Comment—A simple case of tunable hum and intermittent-noise static caused by a loose and oxide-corroded joint. R.F. and power frequency currents in the 120 volt A.C. lines were cross-modulated intermittently by this defective connection and either conducted to the receiver power transformer or else radiated to the antenna—or possibly both actions took place simultaneously.

"INTERNAL CROSS-MODULATION"

Symptom—Simple case of tunable hum in a receiver.

Cure—A filter consisting of two condensers across the line with center connection grounded, at the power transformer primary. See Fig. 1 in Part I, last month.

Comment—The serviceman implies the fact that this symptom is common to this particular receiver model. Evidently there is some circuit non-linearity in the receiver which either exaggerated true e.c.m. or else wholly created it. The required rectification effects could be brought about by factors

(Continued on page 688)

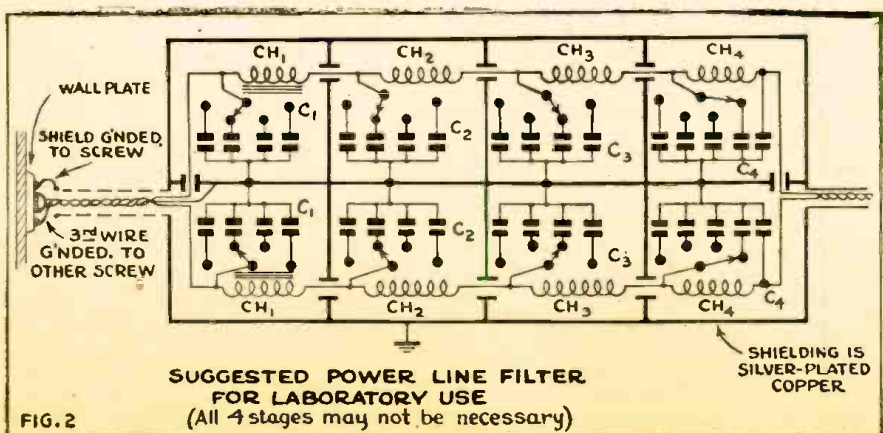


FIG. 2

SUGGESTED POWER LINE FILTER
FOR LABORATORY USE
(All 4 stages may not be necessary)

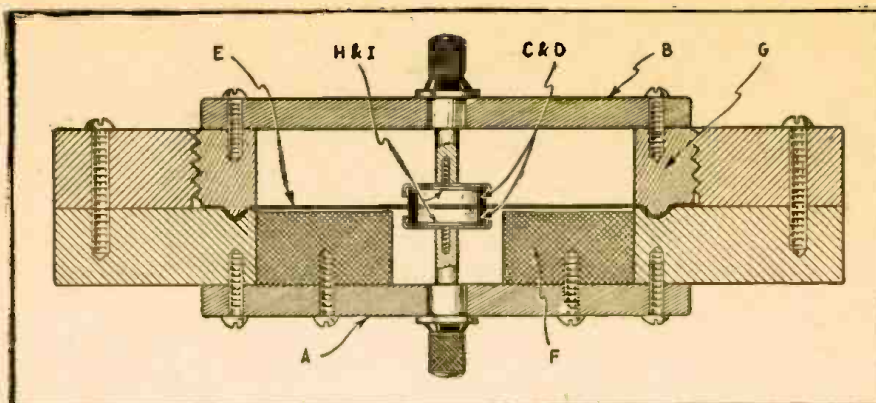
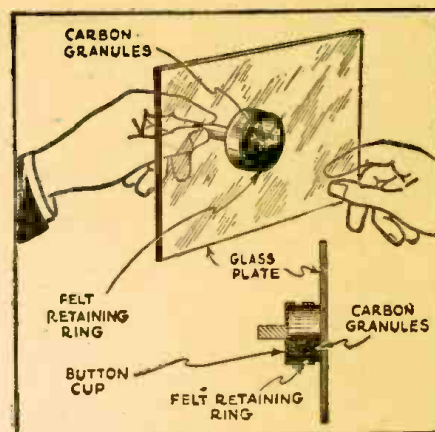


Fig. 1, top.—Cross-section of a two-button microphone.
Fig. 2, right.—The method of measuring carbon grains.



REPAIR AND MAINTENANCE OF CARBON MICROPHONES

Now that war demands have brought the carbon microphone back into prominence again, the following suggestions as to its maintenance and repair may be found useful.

WHEN microphones were rare, expensive and costly, they were treated with respect—almost with reverence. Performers were cautioned to keep their hands off, current was cut before a mike was shifted even the slightest distance, and the microphone was carefully packed in a box before being moved from one set-up to another.

Now it has lost its mystery, and is often handled in a way that would give the impression that the microphone and not the handler, had changed. This is not the case, as any sound serviceman can assure you. Some of the modern microphones are as delicate, or more so, than the earliest carbon and condenser types.

The velocity microphone, for example, depends on a thin ribbon strung between the faces of two magnets. Jars which cause the ribbon to get even slightly off center will cause it to strike one of the faces, rendering it inoperative. The crystal microphone is more rugged, but once damaged, the crystal cannot be repaired, but must be replaced.

The carbon microphone, used in so many low-cost applications where transmission of speech only is required, is probably susceptible to more kinds of injury or damage than any other type. It is, however, more repairable than most of the other types.

Knowledge of how such repairs may be effected may be very useful, especially in emergencies, as in the armed services, where human life may depend on its proper operation. Less dramatic are the cases in ordinary life where—replacement being impossible—a microphone must be repaired or the apparatus associated with it be retired from service for the duration.

Fortunately, the life of a microphone can be renewed by the replacement of grains, in most instances. If the instrument has had long periods of high current or been subjected to extremely hard usage, the replacement of buttons and diaphragm is necessary.

In use, the button current is applied to a double-button carbon microphone through a center-tapped microphone input transformer primary. The current flows from

the buttons through the grains to the diaphragm which is at ground potential. While operating, the grains are moving constantly, being actuated by the diaphragm or by the shaking of the microphone, itself. This movement of the carbon grains causes a microscopic arc which will, in time, burn the polish from the surface. The greater the movement and the higher the current, the faster the wear. Unless the microphone has been used at high values of button current, the diaphragm and buttons will not burn in this manner but will gather a film of corrosion. All of this tends to reduce the sensitivity and output and increases the noise level. It is sometimes difficult to get sufficient current through the microphone and to get the buttons to "balance."

The method of replacing the grains depends, somewhat, upon the design of the instrument. Figure 1 illustrates the conventional method of construction. The buttons are held in place by a front and back bridge, A and B, both of which are removed by taking out the screws holding them to the frame. The old carbon is then discarded. Taking extreme care not to injure the felt carbon-retaining rings, C and D, clean the buttons well with carbon tetrachloride, ether or chemically pure alcohol. Use cotton or a soft cloth for this operation to insure freedom from scratching the surfaces. In the event that the felts are injured, new ones may be cut from a cheap grade of cotton batting if care is taken to get the same thickness as the original.

The diaphragm, E, next gets attention, and is cleaned in the same manner as the buttons. Care must be taken not to rub through the gold coating in some makes of diaphragms.

If the buttons are burned or have lost their polish beyond use, it is good policy to replace them with new ones. When doing this, maintain the original distance between the button face and the diaphragm, as this has a very definite bearing on the sensitivity and quality. The retaining felt should have no real pressure on the diaphragm but should just touch it firmly enough to prevent the grains from dropping out.

If an examination discloses that the diaphragm is burned, dented or otherwise in bad condition, this too, should be replaced. As shown in Fig. 1, the outer edge of the diaphragm is clamped by the frame. Stretching-ring G exerts a pressure on it and holds it in a stretched position. The degree of stretch depends upon the diaphragm material used. Steel, which is used in some of the lower-priced instruments, needs little as the weight of this material helps to damp the movement. Duralumin needs more stretching because of the lightness and is in the order of three-quarters of its elastic limit. In other words, a diaphragm can be overstretched and cause a reduction of the sensitivity, especially on the lower register. For one not having access to equipment determining optimum stretch, "cut and try" is the best method.

The carbon cups, H and I, are filled half full of carbon grains, the grade dependent on the use to which it is to be put. Number 60 is recommended for hard usage; No. 80 is used for general work and is selected in most instances; No. 100 is best for extremely high quality reproduction. The latter packs quite easily and has a slightly higher background noise; and is suitable for use where the microphone is thoroughly protected from bumps and vibration.

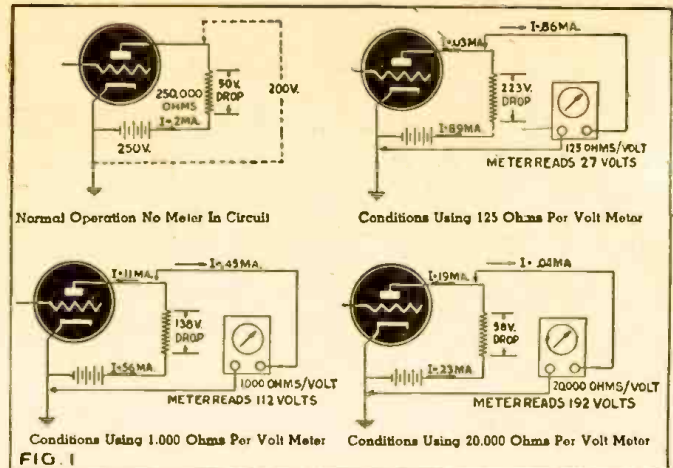
Figure 2 shows the procedure in filling the button cups. A flat piece of glass is held vertically across the front of the button and the button tapped lightly to settle the carbon. The amount of grains can be viewed and the same amount put in each one. If the pressure of the button felts on the diaphragm is equal, the buttons will be balanced, electrically.

The damping plate (F, in Fig. 1) is spaced from one to two thousandths of an inch from the diaphragm. If several grains of carbon or dust are permitted to remain on this, it is obvious that they will touch the diaphragm and damp the movement. The damping plate should be cleaned immediately before assembling.

The buttons are replaced and the microphone is again ready for neglect, overload, an excited orchestra leader or a bouncing jeen to start it on its downward path.

VOLTAGES and YOUR METER

By M. N. BEITMAN



EVER since the advent of the vacuum tube, high resistance and high impedance circuits have been required in receiver design. This type of circuit is essential for use with a vacuum tube as the tubes themselves are extremely high resistance devices and must work into circuits of this same type. In nearly all receivers today circuits with 50,000, 250,000 and 1 megohm resistances are found.

This fact has given the Radio Trainee and more than one new Serviceman, considerable trouble. A voltmeter inserted into a circuit which should show 100 volts may actually show only 33. The trainee has learned that the voltage drop along a resistor increases with the current flowing through it. He also knows that his voltmeter is essentially a resistor and a milliammeter in series, and that, applied to any voltage, it draws current.

Possibly he does not put these known facts together, or (more likely) he looks at the voltage as originating at the point measured. The correct way to look at it, in the majority of cases, is as a point in a resistance network. The voltmeter then becomes an additional resistor to ground, in series with any resistors between it and the source of high voltage, and in parallel with any resistor (or resistance) between

the point whose voltage is being measured and ground.

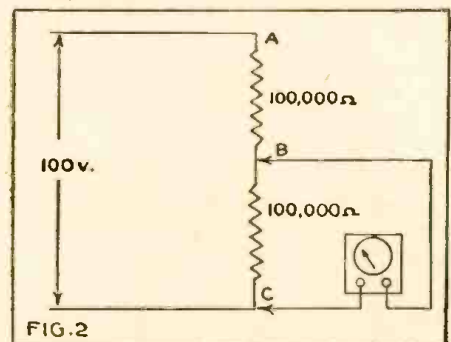
To measure the plate voltage (for instance) in a circuit of this type, best accuracy would be obtained with the most sensitive instrument. Any current drawn by the voltmeter will pull the voltage down considerably and will, therefore, cause an appreciable error in the reading of plate potential. Figure 1 shows four diagrams giving a comparison in readings between voltmeters of 125 ohms per volt, 1,000 ohms per volt, and 20,000 ohms per volt.

The first diagram shows the normal plate circuit of a resistance-coupled tube under operating conditions. The second diagram shows voltage conditions when the 125 ohm per volt meter is inserted in the circuit. Note that the instrument reads correctly the potential while it is in the circuit, but also note how badly it upsets the conditions. The third diagram indicates conditions with a 1,000 ohm per volt meter, this being considerably better than the first old style instrument. The fourth diagram gives the readings that would be obtained with a new supersensitive instrument. In comparison to the current drawn by the tube, the instrument drain is small, and does not upset the potential conditions in this circuit to any appreciable extent. These diagrams

illustrate the value of a 50 microampere instrument in taking potential readings in all types of receivers.

With modern receivers using a.v.c. circuits and low current tubes the 50 microampere tester is extremely valuable in making all kinds of low current measurements. Take for instance measurements of diode current in detector circuits. Diode currents vary from 1 microampere to approximately 40 to 50 microamperes. On a 1 milliamper instrument these readings are hardly perceptible whereas in this model the first scale division is .5 microampere. Therefore, a very definite and accurate reading can be taken of all a.v.c. and detector diode currents.

The worker who has an old-type meter and no access to a better one can measure voltages correctly, if he understands how to interpret his readings and knows the conditions in the circuit he is testing. Take the network of Fig. 2. Here we have 100 volts applied across two 100,000-ohm resistors in series. It is easy to see that under the circumstances, the point B will have a voltage of 50.



Now a meter with a full-scale reading of 100 volts and a sensitivity of 1,000 ohms per volt, is connected between point B and ground. The resistance of the meter (100,000 ohms) is connected in parallel with the lower resistor of the figure. The resistance between point B and ground is now 50,000 ohms. Two-thirds of the resistance in circuit now lies between A and B, and one-third between B and C. The voltage to be expected would be about 33 volts. A little calculation will give the correct voltage when the meter is taken away.

While such calculations are too time-consuming for ordinary service work, the intelligent worker will find it possible to allow for the resistance of his meter in many applications, and if he understands why he gets the readings he does, he will not be alarmed by an apparent out-of-the-way reading.

The material for this article was obtained from Supreme Publications, Chicago.

FAULT LOCATOR

By G. C. WILKINS

HERE is a brief description of the construction and use of an instrument which has saved us many hours of labor, and shortened the time required to locate and repair "outages" of our multiple low-voltage underground street-lighting circuits. In practically every case of trouble,

whether an open- or short-circuit, these circuits show grounded. Therefore, an instrument that will show the spot where the circuit is grounded, without digging, is certainly of great benefit to the troubleshooter.

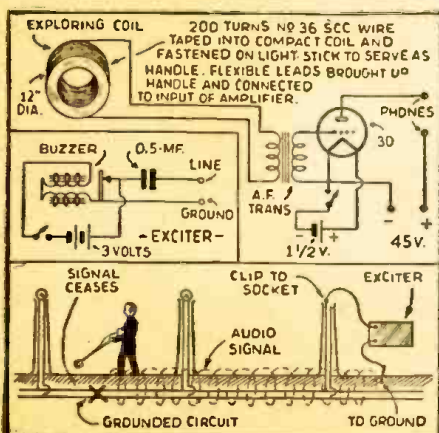
I devised a system, using two units, an exciter and an exploring coil connected through a small amplifier to a headset.

As shown by the accompanying sketch, the exciter consists simply of a buzzer driven by two dry-cells. Output binding-posts connect across the contacts through a blocking condenser, which prevents a short across the output from putting the buzzer out of commission.

One side of the output is connected to the circuit in trouble at any convenient point, which may be at the socket of any street lamp near where the trouble might be expected. The other side is connected to ground through an iron stake or in any way convenient.

In operation this causes an audio frequency note to travel along the underground circuit to the point where the

(Continued on page 692)



"MINUTE" OSCILLATOR FOR RECORD PLAYERS

By B. W. EMBREE

THIS phono oscillator is built on a chassis base 5" long, 2 1/8" wide, and 1 1/4" high. It is very compact and extreme care must be taken or it will not be possible to get all the parts mounted in the chassis. A 35Z4 tube is used as a rectifier and a 12SA7 as oscillator. The original unit was mounted in the base of a record player and connected with the record player switch. If the unit is to be controlled with separate switch it would be advisable to use a 35Z5 tube and use a pilot lamp with a jewel. I may also advise that the 500 ohm resistor was mounted under the chassis, but if the unit is likely to be in operation for long periods it would be well to mount this above the chassis. Same could be accomplished by two holes 1/4" diameter through the chassis at the required distance apart. Insert two rubber grommets and have the resistor leads run through the two holes.

The coil is wound on $\frac{1}{2}$ " diameter tubing, 1" long. The length of winding is $\frac{1}{2}$ ". I used

No. 40 enamel wire, 140 turns, tapped at 100 turns. For tuning I used a 25-75 mmfd. padder in parallel with 50 mmfd. mica. The tuning range was 1320 to 1740 K.C. I tried a 75-225 mmfd. padder first but found that there was considerable distortion when the frequency was below 1300 K.C.

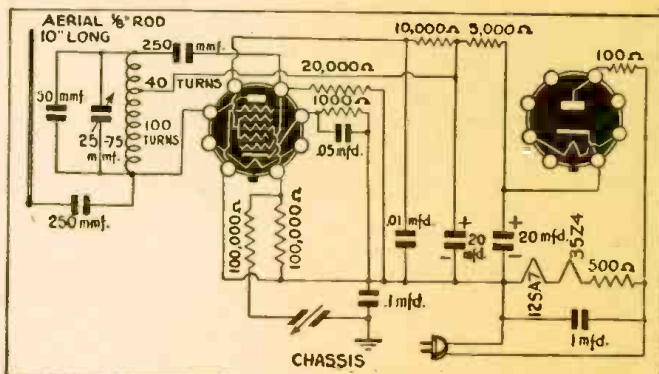
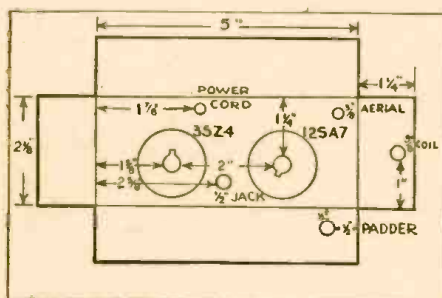
NOTE: If the builder does not wish to use the No. 40 wire he may wind the coil with No. 36 enamel wire. In this case he should wind 80 turns and tap at 50 and the padder will need be a 250-plus mmfd. The 25 to 75 mmfd. padder could be used along with a 200 mmfd. condenser in parallel. The winding length of the coil will still be $\frac{1}{2}$ "

The aerial was made with a piece of $\frac{1}{8}$ " rod 10" long. One end was threaded down so as to fasten it tight in the chassis, of course being insulated, and it was bent so as to run around the top of the chassis about 1" above same. The rod had a piece of spaghetti pushed over it so it would not short if it happened to touch one of the tubes.

The following is a list of parts used, and brands as well as

dimensions of some parts.

- 2—Octal sockets
- 1—100 ohm res.
- 1—1000 ohm res.
- 1—5000 ohm res.
- 1—10,000 ohm res.
- 1—20,000 ohm res.
- 2—100,000 ohm res.
- 1—500 ohm 25 watts Ward Leonard $\frac{5}{8}$ x 2 in.
- 2—250 mmfd. mica con.
- 1—50 mmfd. mica con.
- 1—.01 mfd. 200 volt con.
- 1—.05 mfd. 200 volt con.
- 2—.1 mfd. 200 volt con.
- 1—20-20 mfd. 150 volt con. $1 \frac{3}{16}$ x $2 \frac{1}{4}$ in.
- 1—Padder con. 25 to 100 mmfd. Meissner No. 22-7002 $\frac{3}{8}$ " x $1 \frac{1}{4}$ "



Mr. Embree's phonograph oscillator. To get all parts into the space provided, careful layout is necessary, and the constructor will be well advised to assemble all the parts in place before starting to wire. Properly constructed, it may outperform many larger units.

P. A. AMPLIFIER WITH MIXER

By CHAS. H. THIGPEN, JR.

I built this amplifier entirely from parts from the "junk box," with the exception of the tubes, which I was lucky enough to get

before the "crisis" began, and tubes became almost unobtainable.

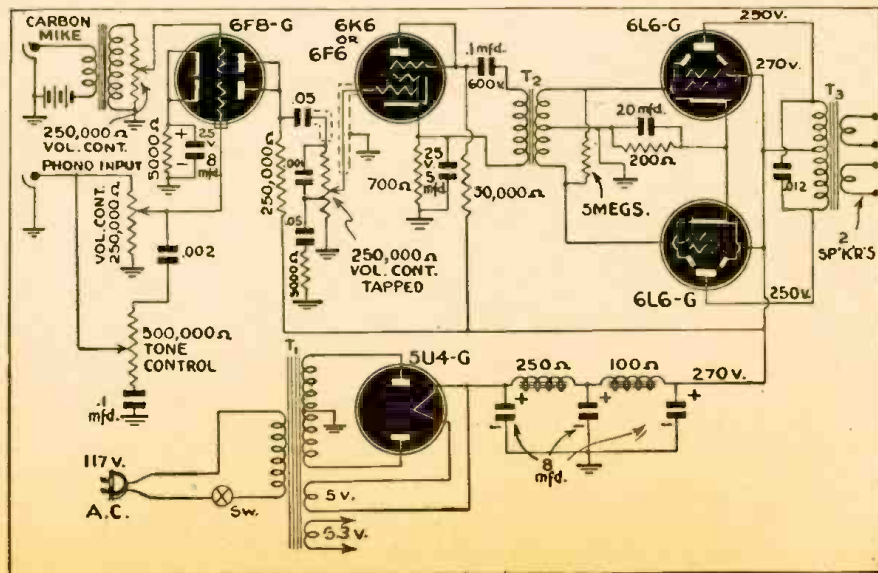
The tube complement is not critical, and

other types may be substituted with a minimum of circuit change. For example, the 6F8-G may be replaced with two individual triode tubes, and the 6K6 with a 6F6 or with a triode, by supplying the correct grid bias. I tried 6F6-G's instead of the 6L6-G's and found they worked very well.

The three volume controls make the amplifier very flexible and permit mixing of voice and phonograph if desired. The tapped volume control and the principle of plate resonance used in the 6K6 circuit accounts for the superior tone of the system. It will be necessary to experiment with the condenser in the 6K6 plate till you get the resonance at the right joint to build up low notes and give the amount of bass boost you want. The size of the condenser depends to some extent on the audio transformer. A 0.- mfd. condenser was found about right with the transformer used on this set.

The two chokes may be replaced by the two speaker fields. However, since I had an extra power pack I operated the speakers with their own current supply independent from the set.

The output of the entire system is between 10 and 15 watts with 6L6's as output tubes.



THE LISTENING POST

Edited by ELMER R. FULLER

ANOTHER month has rolled around, and the response by our readers is even greater than we anticipated when this department was started a few months ago. We have heard from many new listening posts as well as several left from the old RADIO & TELEVISION days. Seven fine business reports were received last month. These proved very valuable in correcting and extending the scope of our short wave station list. Reports were received from Robert A. Grim, Macon, Missouri; Conrad Boehnke, Boulder, Colorado; Robert Hoiermann, Alliance, Ohio; Gilbert L. Harris, North Adams, Massachusetts; Frank Heiss, Cranston, Rhode Island; Robert K. Cobb, Erie, Pennsylvania; and Joe Miller. This is the best response we have had yet, but we hope that it will be the best only until next month.

To start off with, unknown stations are the talk of the day, and three or four were reported to us this month. The most popular one seems to be "Gustav Siegfried Eins" which is heard on 9.64 mcs., even-

ings from 7:50 to 7:57, and on 9.545 from 8:49 to 8:58 pm. They give no hint of their location, but are certainly anti-nazi, and are probably located somewhere in Germany.

An unknown station on 14.500 mcs., ends at 6 pm after relaying the program of WBOS (Boston) and then calls New York. Another one is heard on 15.650 mcs. and leaves the air about 5 pm after an Italian transmission. An unknown freedom station on 9.835 is still being heard from 2:15 to 2:27 pm, and at times from 7:15 to 7:27 pm.

LRU (15.29) and LRX (9.66), Buenos Aires, Argentina, are both off the air at the present time. No explanation has been forthcoming as to the reason for this.

Another stranger this month announces himself as STATION DEBUNK, or station of the all free. They broadcast on 10.380 mcs. and are usually heard from about 8:30 to 9:30 pm. He says that he is in the United States, but he does not sound like a local transmitter.

Most of the new broadcasts published a few issues back are still good, and we hope to have a revised schedule ready for publication next month. We will try to make it more complete than the last one, which only gave one or two frequencies, when the stations actually were using several, all of which came in fine business. Also, there seems to be some doubt about the times given. All time mentioned in this department will be EASTERN WAR TIME, until this is discontinued nationally.

Please note in the station list that we have several of the Russian transmitters listed with their schedules. We have checked these schedules as closely as possible. The frequencies of the British Broadcasting Corporation and the Canadian Broadcasting Corporation have also been completely checked and revised.

For convenience, we are listing the stations in the opposite order from which we have been doing. Henceforth, we will start with the low frequency end of the short wave bands.

Mc.	Call	Location and Schedule	Mc.	Call	Location and Schedule	Mc.	Call	Location and Schedule
4.70	ZQI	KINGSTON, JAMAICA. Sundays, 6:15 to 6:55 pm; daily 6:15 to 7:15 pm.	6.070	CFRX	TORONTO, CANADA. Sundays, 9 am to 12 midnight; Monday to Friday, 7:30 am to 12:05 am; Saturday, 7:30 am to 12:45 am.	6.19	—	"GUSTAV SIEGFRIED EINS". Variable times of evening.
4.785	HJAB	BARRANQUILLA, COLOMBIA.	6.080	WLWO	CINCINNATI, OHIO. European beam, 12:15 to 6 am.	6.210	—	"DEUTSCHER KURZWELLEN SENDER ATLANTIC". Evenings, variable times; thought to be anti-nazi station.
4.835	HJAD	CARTAGENA, COLOMBIA.	6.082	OAX4Z	LIMA, PERU. "Radio Nacional."	6.235	—	"GUSTAV SIEGFRIED EINS". Variable times of evening.
4.865	HJFK	PEREIRA, COLOMBIA.	6.09	ZNS2	NASSAU, BAHAMAS. Evening transmissions.	6.4.80	TGWB	GUATEMALA CITY, GUATEMALA. 7 am to 8:10 pm daily, except Sunday.
4.885	HJDP	MEDELLIN, COLOMBIA.	6.090	CBFW	VERCHERES, CANADA. Daily, 7:30 am to 11:30 pm in French.	6.485	HI2T	SAN FRANCISCO, DOMINICAN REPUBLIC.
4.905	HJAG	BARRANQUILLA, COLOMBIA.	6.095	OAX4H	LIMA, PERU. "Radio Mundial."	7.15	GRT	LONDON, ENGLAND. 10:45 pm to 12 midnight.
4.92	YV5RN	CARACAS, VENEZUELA. Evening transmissions.	6.098	ZRK	CAPETOWN, SOUTH AFRICA. Day and night transmissions.	7.171	XGOY	CHUNGKING, CHINA. East Asia beam, 7:35 to 9:55 am; 2:30-4 pm; European beam, 11:35 am to 12:30 pm; 4 to 5 pm; Asia-Australia-New Zealand beam, 6 to 6:30 am; East Russia beam, 6:30 to 7 am; Japan beam, 7 to 7:30 am; North American beam, 10 to 11:30 am.
4.925	HJAP	CARTAGENA, COLOMBIA.	6.11	GSL	LONDON, ENGLAND. American beam, 7 pm to 12:45 am.	7.22	VLI-4	SYDNEY, AUSTRALIA.
5.44	—	MOSCOW, USSR. 6:48 to 7:25 pm.	6.120	—	BERLIN, GERMANY. North American beam, variable times.	7.230	—	ROME, ITALY. Day and night transmissions; news in English every hour.
6.005	CFCX	MONTREAL, CANADA. Sunday, 7:30 am to 12 midnight; Monday to Saturday, 6:45 am to 12 midnight.	6.12	—	"GUSTAV SIEGFRIED EINS". Variable times of evening.	7.23—KWID	SAN FRANCISCO, CALIFORNIA.	
6.007	ZRH	JOHANNESBURG, SOUTH AFRICA. Evening transmissions.	6.122	ZFA2	HAMILTON, BERMUDA. Mondays, 7 to 7:45 pm.	7.25—KGEI	SAN FRANCISCO, CALIFORNIA.	
6.010	CJCX	SYDNEY, NOVA SCOTIA. Monday to Friday, 7 am to 11 am; Saturday, 6:45 am to 11 am; Sundays, 8 am to 11 am.	6.130	CHNX	HALIFAX, NOVA SCOTIA. Sundays, 8 am to 6:55 pm; Monday to Thursday, 6:45 am to 10:15 pm; Friday, 6:45 am to 11 am; Saturday, 6:45 am to 11 am.	7.290	DJX	BERLIN. Variable times, North American beam; news in English at 7 pm and other times.
6.020	—	GEORGETOWN, BRITISH GUIANA. 7 am to 7 pm.	6.145	HJDE	MEDELLIN, COLOMBIA. Evening transmissions.	7.31	2RO19	ROME, ITALY. Day and night transmissions; news in English every hour.
6.02	—	"GUSTAV SIEGFRIED EINS". Variable times of evening.	6.148	ZRD	DURBAN, SOUTH AFRICA. Day and night transmissions.	7.345	—	GUAYAQUIL, ECUADOR. 9 to 11 pm.
6.030	HP5F	COLON, PANAMA. 11 pm to 7 pm.	6.150	CJRO	WINNIPEG, Canada. 6 to 11 pm.	7.35	WBS	Opens at 1 pm.
6.03	DXP	BERLIN, GERMANY.	6.160	CBRX	VANCOUVER, CANADA. 10:30 am to 2:30 am.			
6.030	CFVP	CALGARY, CANADA. Sunday, 10 am to 1:30 am; Monday to Saturday, 8:30 am to 2 am.						
6.040	WRUW	BOSTON, MASSACHUSETTS. European beam, 6 to 7 am.						
6.04	COBF	HAVANA, CUBA. Relays CMBF.						
6.060	WCDA	BRENTWOOD, NEW YORK. Central American beam, 7:15 pm to 2 am.						

•LISTENING POST•

Mc.	Call	Location and Schedule	Mc.	Call	Location and Schedule	Mc.	Call	Location and Schedule
7.495	—	CAIRO, EGYPT. 3:15 to 6 pm.	9.626	ZRL	CAPETOWN, SOUTH AFRICA. Daylight transmissions.	11.150	PRL8	RIO DE JANEIRO, BRAZIL. Afternoons and evenings except Sundays. Off at 11 pm.
7.565	WDJ	North Africa beam, 11:45 pm to 2 am.	9.635	XGOY	CHUNGKING, CHINA. East Asia beam, 7:35 to 9:55 am; 2:30 to 4 pm; European beam, 11:35 am to 12:30 pm; 4 to 5 pm; North American beam, 10 to 11:30 am.	11.37	—	CROATIAN FREEDOM STATION. 2:30 to 2:40 pm.
7.660	YNDG	LEON, NICARAGUA. 7:30 pm to ?	9.637	—	"GUSTAV SIEGFRIED EINS". Variable times of evening.	11.6	—	RUMANIAN FREEDOM STATION. 1:45 to 1:55 pm, 4:15 to 4:25 pm.
8.030	FXE	BEIRUT-LEBANON. 6:30 to 6:45 pm; irregular.	9.64	COX	HAVANA, CUBA. 1 to 11:15 pm.	11.623	COK	HAVANA, CUBA. 3:30 pm.
8.035	CNR	RABAT, MOROCCO.	9.64	KZRH	MANILA, PHILIPPINES.	11.675	OPL	LEOPOLDVILLE, BELGIAN CONGO. 3:15 to 3:30 pm; 4:30 to 4:45 pm.
8.484	XPSA	KWEIYANG, CHINA. 7:30 am to 12 noon.	9.645	LLH	OSLO, NORWAY.	11.68	GRG	LONDON, ENGLAND. 5:15 to 7:15 pm.
8.955	COKG	SANTIAGO, CHILE. Evening transmissions.	9.645	—	"GUSTAV SIEGFRIED EINS". Variable times of evening.	11.70	HB5A	PANAMA CITY PANAMA.
8.96	AFHQ	ALGIERS. 6:30 to 7:45 pm; irregular.	9.650	VLW2	MELBOURNE, AUSTRALIA. 7 am to ?	11.705	CBFY	VERCHERES, CANADA. 7:30 am to 11:30 pm.
9.04	—	FRENCH EQUATORIAL AFRICA. "Radio Club"; 9 to 10:20 am; 2 to 3:20 pm; 5 to 5:30 pm.	9.650	WGEO	SCHENECTADY, N. Y. Australian beam, 7:15 to 8 am; evenings.	11.705	SBP	MOTALA, SWEDEN. 12 to 2:15 pm.
9.125	HAT4	BUDAPEST, HUNGARY. 9:15 to 9:30 pm; 10:15 to 10:30 pm.	9.650	WCBX	BRENTWOOD, NEW YORK. Latin American beam, 1 to 11:30 pm.	11.705	CXA19	MONTEVIDEO, URUGUAY. Evenings.
9.437	COCH	HAVANA, CUBA. Evenings.	9.670	WNBI	BOUND BROOK, NEW JERSEY. European beam, 2 to 4 am, 5:15 to 7:30 pm. Central American beam; 7:30 pm to 8 am.	11.705	—	FRENCH INDO CHINA. "Radio Saigon"; 8 am to 12 noon.
9.47	JZHA	HONG KONG	9.670	WVBI	HAVANA, CUBA. Evening transmissions.	11.71	VLG3	SYDNEY, AUSTRALIA. North American beam.
9.48	—	MOSCOW, USSR. 6:48 to 11 pm.	9.670	WVBI	PERTH, AUSTRALIA. 9 am.	11.71	WLWO	CINCINNATI, OHIO. European beam, 1:15 to 5:15 pm.
9.465	TAP	TURKEY.	9.670	WVBI	GUATEMALA CITY, GUATEMALA. Night transmissions.	11.715	PRL8	RIO DE JANEIRO, BRAZIL.
9.480	WCBX	BRENTWOOD, NEW YORK. Latin American beam, 8 to 11:30 pm.	9.670	WVBI	BUENOS AIRES. Afternoons.	11.720	CJRX	WINNIPEG, CANADA. Noon to 4:30 pm.
9.482	—	"GUSTAV SIEGFRIED EINS". Variable times of evening.	9.670	WVBI	LONDON, ENGLAND. 10:45 pm to 12:45 am.	11.72	HSP5	THAILAND.
9.50	—XEWV	MEXICO CITY, MEXICO. Evening transmissions.	9.670	WVBI	BOSTON, MASSACHUSETTS. 5:15; 7:30 pm to 2 am. pm to 2 am.	11.72	PRL8	RIO DE JANEIRO, BRAZIL.
9.505	JLG2	TOKYO, JAPAN. 7:30 to 7:45 am; 8 to 8:45 am.	9.670	WVBI	CHUNGKING, CHINA. 7 am to 1 pm.	11.73	WRUW	BOSTON, MASSACHUSETTS. Afternoons.
9.520	—	GENEVA, SWITZERLAND. 9 to 10:45 pm.	9.670	WVBI	LISBON, PORTUGAL.	11.73	KGEI	SAN FRANCISCO, CALIFORNIA. Evening transmissions.
9.52	DZD	BERLIN, GERMANY. North American beam; evenings.	9.670	WVBI	ROME, ITALY. Day and night transmissions.	11.74	HBJ	VATICAN CITY.
9.523	ZRH	JOHANNESBURG, SOUTH AFRICA. Daylight transmissions.	9.670	WVBI	DURBAN, SOUTH AFRICA. Day and night transmissions.	11.74	HP5Q	PANAMA CITY, PANAMA. Evenings to midnight.
9.535	HER4	GENEVA, SWITZERLAND. North American beam. 9:30 to ? pm, except Saturdays.	9.670	WVBI	"2 FREEDOM STATION." 2:15 to 2:27 pm, 7:15 to 7:27 pm; speaks German.	11.760	TGWA	GUATEMALA CITY, GUATEMALA.
9.535	JZI	TOKYO, JAPAN. 2:15 pm; 7 to 9:30 pm; 7:30 to 7:45 am; 8 to 8:45 am.	9.670	WVBI	MOZAMBIQUE.	11.77—DJJ	—	BERLIN, GERMANY. North American beam, evening transmissions.
9.535	SBU	MOTALA, SWEDEN. 12 to 2:15 pm.	9.670	WVBI	MADRID, SPAIN.	11.775	MTCY	MANCHURIA.
9.540	VLG2	MELBOURNE, AUSTRALIA. 8 to 8:45 am.	9.670	WVBI	WEST SOUTH AMERICAN beam, 8 pm to midnight.	11.78	GVU	LONDON, ENGLAND. North American beam, 6:30 to ? pm.
9.54	HER4	GENEVA, SWITZERLAND.	9.670	WVBI	FRENCH EQUATORIAL AFRICA. "Radio Club"; 9 to 10:20 am; 2 to 3:20 pm; 5 to 5:30 pm.	11.78	—	FRENCH INDO CHINA.
9.543	XEFT	MEXICO CITY, MEXICO. Evenings.	9.670	WVBI	"VOICE OF FREE ARABS". Sundays, 3:15 to 3:30 pm. irregular.	11.785	OIX3	LAHTI, FINLAND. 9:15 am.
9.545	—	"GUSTAV SIEGFRIED EINS". Variable times of evening.	9.670	WVBI	CAIRO, EGYPT. Afternoons; irregular.	11.790	HP5G	PANAMA CITY, PANAMA. 10:30 pm to ?
9.545	—	KOMSOMOLSK, SIBERIA, USSR. 7:40 to 8:20 am; 10:15 to 10:30 am.	9.670	WVBI	Australian beam. 7:15 to 8 am.	11.79	WRUL	BOSTON, MASS. 5:15 pm.
9.562	OAX4T	LIMA, PERU. "Radio Nacional" 2 to 8 pm, daily.	9.670	WVBI	RIO DE JANEIRO, BRAZIL. 8:15 to 8:30 pm.	11.79	KGEI	SAN FRANCISCO, CALIFORNIA.
9.565	JRAK	TOKYO, JAPAN. 7 to 9:30 pm.	9.670	WVBI	PEIPING, CHINA. 10 am to noon.	11.80	JZJ	TOKYO, JAPAN. 7 to 9:30 pm.
9.57	KWID	SAN FRANCISCO, CALIFORNIA. Evening.	9.670	WVBI	"STATION DEBUNK": Station of all free. 8:30 to 9:30 pm; says he is in the U.S.A.	11.805	COGF	MATANZAS, CUBA. Afternoon transmissions.
9.580	GSC	LONDON. North American beam, 5:15 pm to 12:45 am.	9.670	WVBI	MOSCOW, USSR. 7:40 to 8:20 am.	11.81	2RO22	ROME, ITALY. North American beam, 8:30 pm to midnight.
9.59	WLWO	CINCINNATI, OHIO. East South American beam, 7 to 12 pm.	9.670	WVBI	SYDNEY, AUSTRALIA. North American beam.	11.830	WCDA	BRENTWOOD, NEW YORK. European beam, 6 am to 6:30 pm daily.
9.59	—	"VOICE OF FREE INDIA." 9 to 11 pm.	9.670	WVBI	BERLIN.	11.83	WCRA	BRENTWOOD, NEW YORK. Latin America beam, 7:30 pm to midnight daily.
9.59	—	"NATIONAL CONGRESS RADIO". 11:15 to 11:55 pm.	9.670	WVBI	BELIZE, BRITISH HONDURAS. 9 to 9:15 pm.	11.83	VLI12	SYDNEY, AUSTRALIA.
9.595	—	ATHLONE, IRELAND. "Radio Eireann." 7:10 to 8 pm.	9.670	WVBI	CHILE. 7:30 to 8:15 pm; irregular.	11.84	—	MALAYA. "Radio Shonan." Controlled by the Japanese.
9.600	2RO3	ROME, ITALY. Day and night transmissions.	9.670	WVBI		11.84	VLG4	MELBOURNE, AUSTRALIA. Southeast Asia beam.
9.615	VLI	SYDNEY, AUSTRALIA.	9.670	WVBI		11.845	—	VICHY, FRANCE.
9.620	—	VOICE OF FRANCE". 4 to 5 pm; 9:45 to 10:15 pm.	9.670	WVBI		11.87	VLI2	SYDNEY, AUSTRALIA. British beam.
9.62	—	VICHY, FRANCE. North American beam, 9:45 pm.	9.670	WVBI		11.893	WRCA	BOUND BROOK, NEW JERSEY. European beam, 1 to 4:45 pm, 4 to 8:45 am; Latin American beam, 5 to 11:30 pm.

(Continued on page 694)

THE EXECUTIVE WHO STOPS TO THINK . . .



Knows that "10% for War Bonds isn't enough these days"

Workers' Living Costs going up . . . and Income and Victory Tax now deducted at source for thousands of workers . . .

Check! You're perfectly right . . . but all these burdens are more than balanced by *much higher FAMILY INCOMES* for most of your workers!

Millions of new workers have entered the picture. Millions of women who never worked before. Millions of others who never began to earn what they are getting today!

A 10% Pay-Roll Allotment for War Bonds from the wages of the family bread-winner is one thing—a 10% Pay-Roll Allotment from each of several workers in the same family is quite another matter! Why, in many such cases, it could well be jacked up to 30%—50% or even more of the family's new money!

That's why the Treasury Department now urges you to revise your War Bond thinking—and your War Bond selling—on the basis of family incomes. The current

War Bond campaign is built around the family unit—and labor-management sales programs should be revised accordingly.

For details get in touch with your local War Savings Staff which will supply you with all necessary material for the proper presentation of the new plan.

Last year's bonds got us started—*this year's bonds are to win!* So let's all raise our sights, and get going. If we all pull together, we'll put it over with a bang!

This space is a contribution to
America's all-out war effort by

RADIO-CRAFT



you've done your bit
... now do your best!



THE QUESTION BOX

QUERIES

All queries should be accompanied by a fee of 25c to cover research involved. If a schematic or diagram is wanted please send 50c. to cover circuits up to 5 tubes; for 5 to 8 tube circuits, 75c; over 8 tubes, \$1.00.

Be sure to send the fullest possible details when asking questions. Give names and MODEL NUMBERS when referring to receivers. Include schematics of your apparatus whenever you have such. Serial numbers of radios are useless as a means of identification.

All letters must be signed and carry FULL ADDRESS. Queries will be answered by mail, and those of general interest reprinted here. Do not use postcards—postmarks often make them illegible. No picture diagrams can be supplied.

No picture diagrams can be supplied.

Back issues 1942, 25c each; 1941, 30c each; 1940, 35c each.

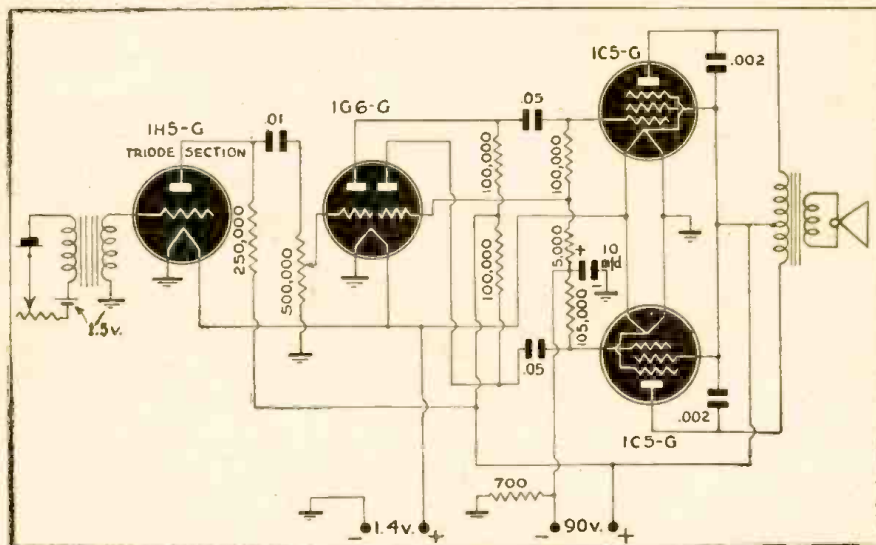
Any issue, prior to 1940, if in stock, 50c per copy.

PUSH-PULL AMPLIFIER WITH 1.4-VOLT TUBES

? *I want an amplifier to use 1.4 volt tubes with resistance coupling and push-pull output, to work like a small P.A. system from a single-button microphone.*

A. Herewith the desired circuit. The variable resistor in the microphone circuit may have a value of from 200 to 500 ohms maxi-

mum. The diode of the 1H5 can be left floating or grounded. The 1G6-G acts as a phase inverter to drive the two 1C5-G's. The .002 condensers in the output circuit may have to be made bigger or smaller, or omitted, depending on the characteristics of the output transformer.

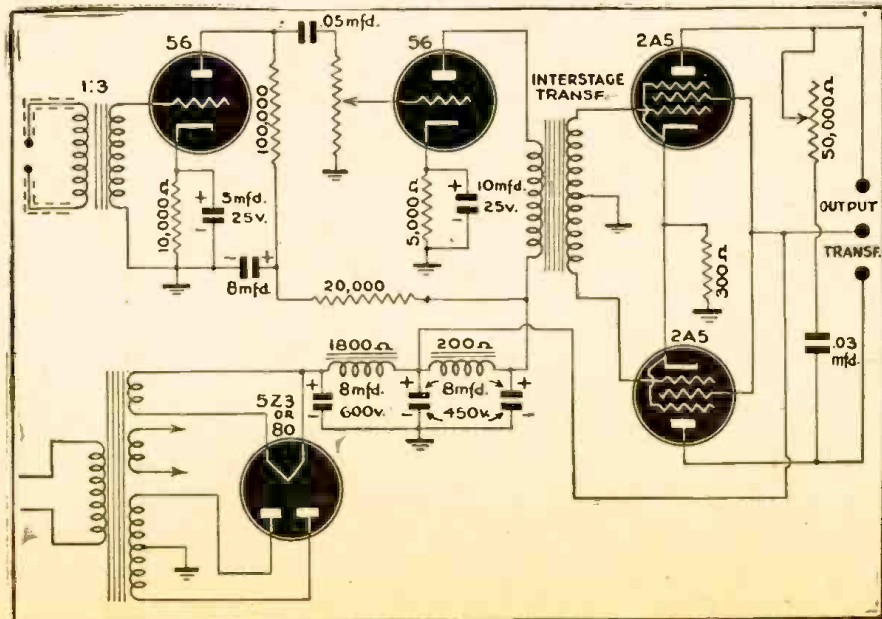


AMPLIFIER FOR MAGNETIC PICKUP

? I have two old amplifiers, of which the following parts and tubes are good. (List given.) Can you show me how to use these to build a fairly good amplifier? I

want to use this with a magnetic pickup.
—J.F.U., New York City.

A. The best amplifier for your apparatus will probably be along the lines of the



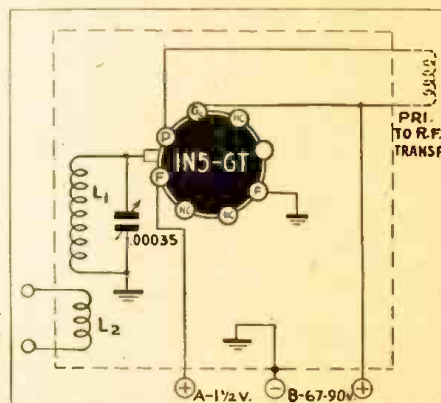
accompanying diagram. With a 400-400-volt winding on your transformer secondary, you should be able to use the 1800-ohm speaker field as choke and still get plenty of voltage on the 2A5's. For a lower transformer voltage, it would be necessary to reverse the position of the chokes, then add a bleeder to draw sufficient current for proper magnetization of the speaker field.

Since you have no pickup coupling transformer, use one of your 3 to 1 audio transformers between the pickup and the first grid. A higher ratio would have been better. Shield leads in the pickup circuit.

PRE-AMPLIFIER FOR BATTERY SET

? Will you kindly print a diagram of a pre-amplifier I can use on a battery set? I want to build this on a separate chassis and use an independent power supply.—A.H., Thompson, N. D.

A. Such an amplifier works best with an independent power supply. L1 in the diagram is 90 turns of No. 30 enamelled wire, close-wound on a 1½-inch form. L2 may be



about 50 turns of No. 32, wound in a ¼-inch space at the ground end of L1. The dotted coil is the aerial coil primary of the receiver with which the amplifier is to be used. If the receiver does not have a two-winding aerial coil, the dotted coil may be an R.F. choke, and a 100 mmfd. condenser may be connected direct from the preamplifier plate to the aerial post.

CAPACITY BRIDGE

There was a brief mention of a Capacity Bridge on Page 412 of the April Radio-Craft. The author gave no values whatever, and I would like to know them as I am interested in making the bridge.
—R.S., No address given.

A. The item in question, as you have no doubt noted, came from England, and any attempt on our part to give the various values would be mere guesses. There is however another Capacity Bridge diagram on Page 426 of the same issue, in which all values are given.



**GRAB YOURSELF A COPY
OF THIS BRAND NEW MANUAL
BOYS! ITS JAM PACKED WITH
DATA, CIRCUITS AND ALL
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UP TO DATE OF GOVERNMENT
SHUT DOWN APRIL '42.**

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MORE LISTINGS: This 1942 Radio Circuit Manual has nearly 400 more listings than the last edition of a similar manual. Covers receivers manufactured up to time of Government shut down order in April 1942. The set you're looking for here when you need it!

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SPECIAL REFERENCE CHARTS: Special late edition charts on tube and battery interchangeability, pilot lights, ohms law, color codes. The information you often search for is here. Also a special article by F. L. Sprayberry to make your wartime service job easier.

COMPLETE DATA: The big pages feature not only Schematics, but quick reference IF spot, Parts Lists, Dial Stringing diagrams, tuning range and data, tube locations, voltage charts, trimmer locations, push button set-ups, alignment notes and procedures, rec-ord changer details.

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Diagrams for

THE RADIO EXPERIMENTER

If you have a new Hook-Up, send it along; a pencil diagram will do. Be sure to include a brief description.

All diagrams and descriptions accepted and published will be awarded six-month subscription. Diagrams may be for receivers, adapters, amplifiers, etc. Send them to Hook-Up Editor, RADIO-CRAFT, 25 W. Broadway, New York 7, N. Y.

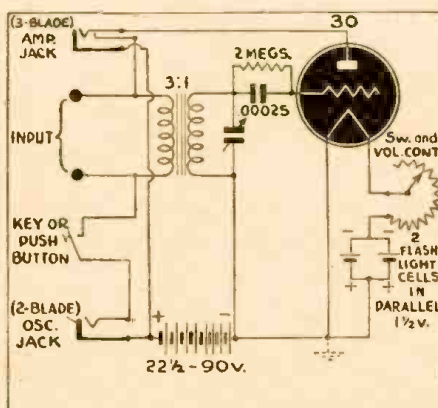
COMBINATION OSCILLATOR-AMPLIFIER

This oscillator and amplifier can be built in an ordinary deep cigar box, batteries and all.

The tube should be mounted on the bottom of the box, and the rheostat, jacks and binding posts on one end. The key can also be mounted on the bottom of the box, if desired, though mounting on a table will make better code practice possible.

A 22½-volt "C" battery can be used for the "B" supply. This can be mounted in the box, and serves the purpose very well. The tube I used is a 30, though a 1.4-volt tube could be used. Two flashlight batteries in parallel supply the filament. They seem to give a smoother flow of current than does one cell, and last much longer. The 30 does not light bright on account of the low voltage, but works very well anyhow. Any variable condenser, or a trimmer, may be used across the audio transformer secondary. By changing the capacity, the note of the oscillator may be varied. With the help of the rheostat, it can be made anything from a low-pitched note to a high squeal. Code practice is not so monotonous when the note is not always the same.

Plugging the phones into the amplifier jack and pulling them out of the oscillator jack makes this an audio amplifier. The condenser across the secondary makes no difference to its strength or quality.



Following is the list of parts needed to build this set:

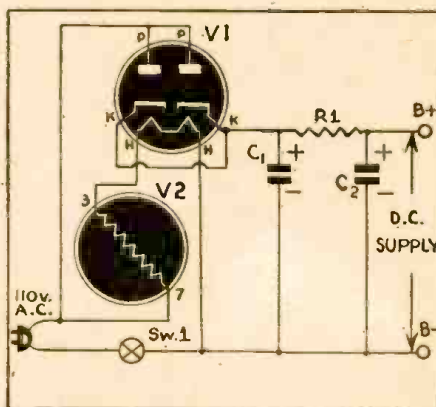
- 1 No. 30 tube (or other)
- 1 Socket for the tube
- 1 Rheostat, rather high resistance
- 1 Fixed condenser, .00025 mfd
- 1 Grid leak, 2 megohms
- 1 Variable trimmer condenser
- 1 Audio transformer, 3 to 1
- 1 3-blade jack
- 1 2-blade jack
- 1 22½-volt "C" battery
- 2 Flashlight cells
- 1 Code key

DONALD GILLET.
Owosso, Mich.

TRANSFORMERLESS B SUPPLY

Here is a transformerless power supply which will provide sufficient "B" voltage for a small receiver.

The 20,000-ohm, 50-watt wire-wound resistor, R1, provides ample filtering, when used with the two 20-mfd., 200-volt electrolytic condensers. For higher voltages on the receiver, with not quite so good filtering, a lower resistor value may be used, and some of the receivers sold commercially have filter resistors as low as 2,000 ohms.



The ballast tube, V2, is an automatic voltage regulator, type K92A, and drops the voltage to 25, for a 25Z5 or 25Z6 tube. Other values of ballast might be used for 35-volt or higher-voltage rectifiers. When in use the ballast gets hot. This is normal.

FRED MARKERT,
Rochelle Park, N. J.

OLD OUTPUT TRANSFORMER FOR FILAMENT OR MIKE

The average experimenter usually has several output transformers from old broadcast receivers. If the windings are good, they may be put to use on jobs requiring hard-to-get transformers.

Most of these transformers are designed to work out of 71-A's or 45's and are usually about 800 ohms center-tapped. If the full plate primary is connected to a 110-volt A.C. line, a voltage of about 3.2 volts will appear across the secondary (see Fig. 1). If half the center-tapped primary is used on the A.C. line, the voltage delivered by the secondary will be about 6.4 volts. Sufficient current to run several 6.3-volt receiving tubes can be obtained without appreciable voltage drop.

Almost any transformer will handle one or two tubes, but for several tubes pick one that is fairly heavy, since it will have to dissipate considerable power.

By reversing the windings of the transformer, it may be used as a single button

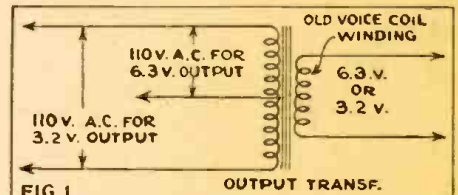


FIG. 1 OUTPUT TRANSF.

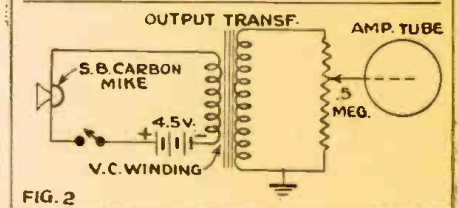


FIG. 2

microphone transformer with good gain. The voice coil secondary is used as the mike primary, and the transformer primary is then the grid secondary. (See Fig. 2.)

BILL BENNER, W9PTO
Webster Groves, Mo.

(A somewhat better mike transformer may be made by stripping off the voice coil winding and winding in its place about 200 turns, using wire a little smaller than the original in order to have room.)

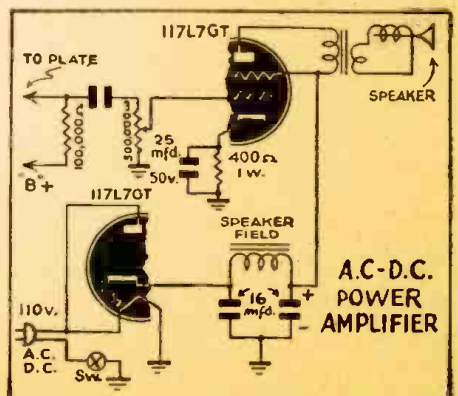
Other uses for the units suggest themselves. They make splendid coils for Hartley type audio oscillators, the cathode being connected to the center-tap. They also make fair chokes for A.C.-D.C. midget radios. —Editor)

POWER AMPLIFIER

Following is a diagram of a simple, compact A.C.-D.C. power amplifier which I have found very useful when using it with S.W. receivers giving headphone output.

It is entirely self-contained, from the power pack to the speaker and is attached directly to the receiver output, through the phone jack. If the receiver's first audio stage does not provide it, R1 can be a potentiometer for volume control.

RICHARD JEFFREY,
Dorchester, Mass.

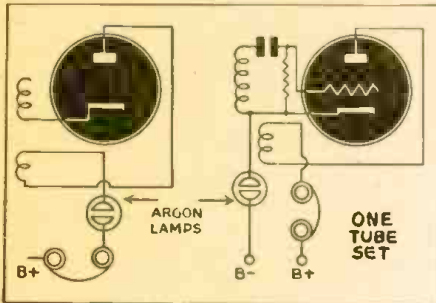


ONE TUBE SET

I have found that when a $2\frac{1}{2}$ -watt argon or neon bulb is connected between B+ and the phones or B—and the power supply, the regeneration will control much easier.

The volume and tone are considerable. The bulb apparently acts as a voltage regulator.

WRIGHT PULLEN,
Doraville, Georgia.



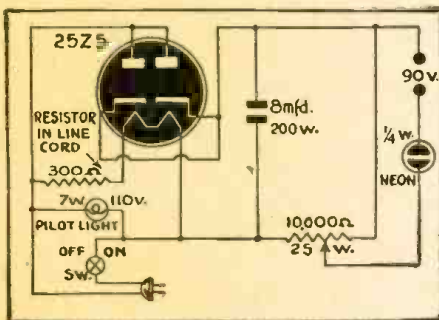
25Z5 POWER SUPPLY

This circuit may be of interest to those experimenters who may be finding it hard of find "B" batteries.

It will be noticed the 25Z5 is used, one of which can be found in the experimenter's junk box. However, the 25Z6 tube may be used also, by changing the socket from a 6-prong to an 8-prong, and by changing the wiring. (See tube manual for proper connections.)

Due to the high price of resistance line-cords, a forty-watt bulb is used in series with the filament.

BOB FENSTERMACHER,
Upland, Ind.



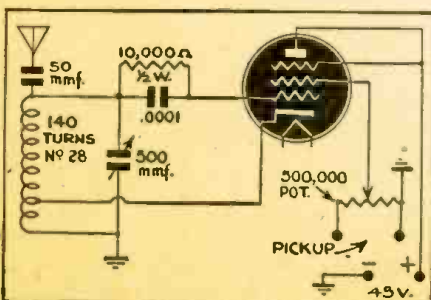
PHONO OSCILLATOR

Herewith is a diagram of a simple one-tube phono-oscillator which any novice can easily construct.

It uses any tube such as the 6K7, 6SK7, 57, 58, etc.

The antenna consists of a piece of wire about 8" long. Do not connect this oscillator to an outside antenna, as it would increase the range of the set and constitute a violation of the Federal Communications Commission Rules 2.101 to 2.104.

JACK E. DEPEW,
Vallejo, Calif.



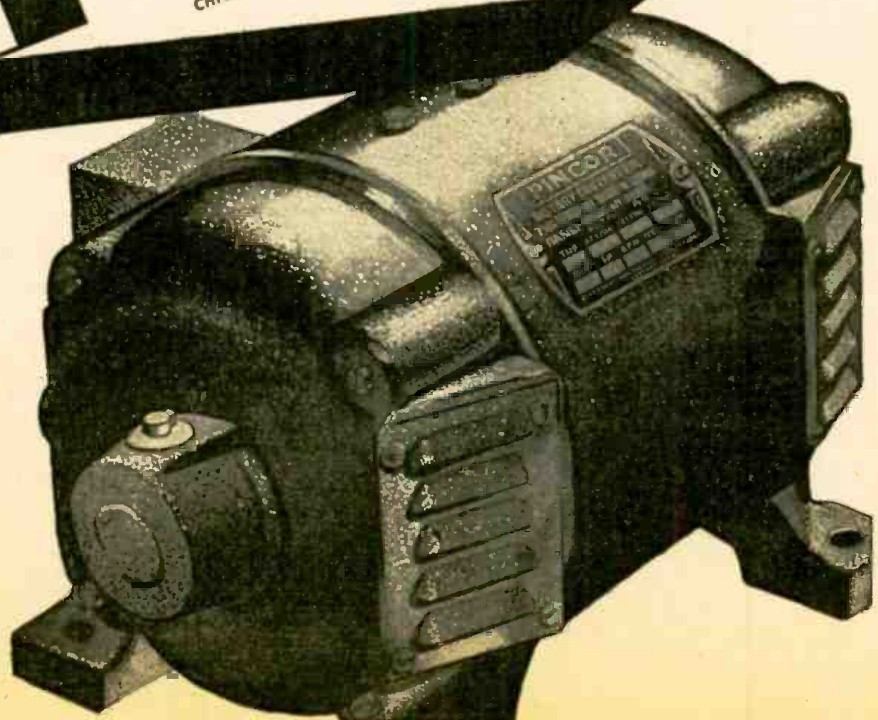
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RADIO KINKS

TEST FOR GROUND

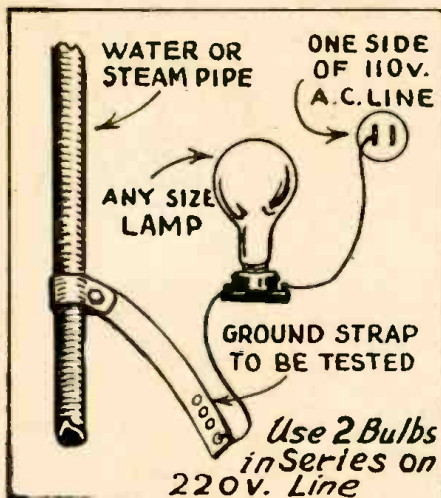
This is a handy kink for testing the effectiveness of a ground connection.

By using one side of the A.C. line as one terminal and the ground clamp or strap to be tested as the other, one can determine whether the ground connection is good or not.

If the bulb flickers and is not steady, the ground connection is poor, but if it burns brightly, (as it should), the ground connection is OK.

If one side of the A.C. line does not light the lamp at all, try the other one.

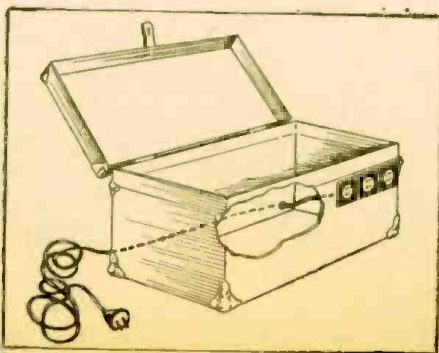
JEROME MULBERG,
Bronx, N. Y.



OUTLETS IN RADIO TOOL BOX

This Kink came about as a result of difficulties when trying to keep a soldering iron, tube tester and the customer's radio all plugged into different outlets in widely separated parts of a large room. The confusion nearly resulted in an accident to the customer's set and made me look very foolish.

The first thing I did was to buy a forty-foot extension cord and three flat outlets. Then I fastened the outlets to the box as shown in the illustration, drilled a hole in the back lower corner and led out the end of the extension that was to go to the wall outlet. Now I have a triple outlet without any more trouble than plugging in a solder-



Do you have any interesting and novel kinks which you would like to bring to the attention of RADIO-CRAFT readers? If so, send them in addressed to the Kink Editor. A seven-month subscription to RADIO-CRAFT will be awarded for each kink published.

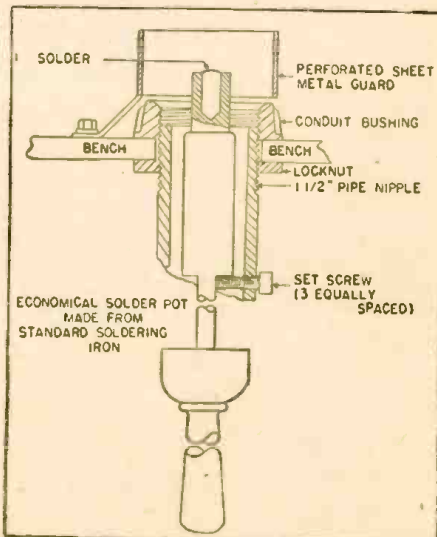
ing iron, and the cord is long enough so that I don't have to go crawling behind furniture or under sofas to plug in.

JOHN GLENNEV,
Houston, Texas.

SOLDERING IRON MAKES USEFUL SOLDERING POT

The use of standard soldering irons especially adapted as small soldering pots has facilitated the production of small instrument-type motors in one of General Electric's Works. Because they present only a very small area for oxidation, the irons are saving materials.

The improvised solder pot, which was developed by R. H. Bainbridge, a foreman, is easily built. A standard medium-size soldering iron tip is faced off flat and drilled with a 1/4-inch diameter hole, 3/4-inch deep. This tip is reassembled to the soldering iron. The iron is then mounted vertically in a hole in the bench so that the tip projects about two inches above the top.



The mounting is made permanent by the use of a standard pipe nipple locked from the top with an electrician's conduit bushing and from the bottom with an electrician's lock nut. The iron is held in the bushing by three setscrews which clamp the body of the iron proper.

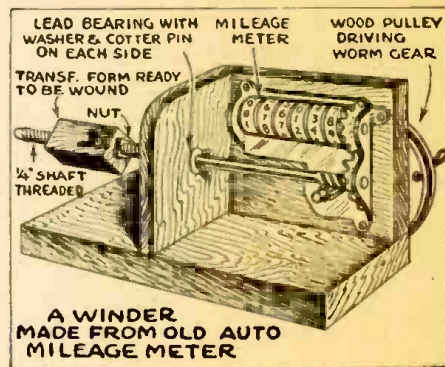
Only the insulation contained in the iron itself is required for efficient operation. A perforated sheet-metal guard which encircles the exposed tip permits free circulation of air about the tip, eliminating the possibility of overheating the solder, and at the same time assures complete operational safety by guarding against accidental contact with the heated tip.

REVOLUTION COUNTER FROM ODOMETER

This winder is constructed from an old automobile mileage meter. The picture tells practically the whole story. Most of the stuff in it comes from the meter and associated parts. It is very handy to have a winder like this for odd repair jobs, and when you use a winder, a counter is almost necessary.

A cover could be put over the disc counters so that only the numbers to be read would show.

DONALD ANDERSON,
Middle Sackville, N. B.



COMBINED S.W. SWITCH AND MOUNT

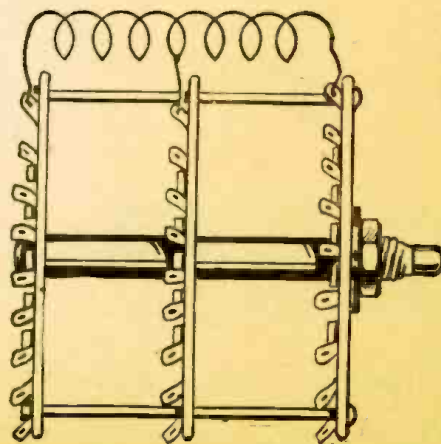
This is a three-deck circuit selector switch. I have five coils—wound as shown in the drawing—that lap each other and cover from about 12 meters to 2 meters.

To get away from dead spots I had to have a variable choke from the cathode of the detector to ground.

At present I am using a 20-ohm filament rheostat that works just as well. The plate RFC must also be correct, as it is very critical. Use a special UHF type or experiment for the best results.

I have got a lot of pleasure in these bands. The receiver is a superregenerative type with a 76 and a 42.

ALBERT L. VAUGHN,
Indianapolis, Ind.

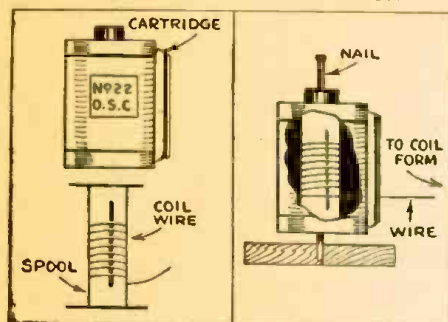


WIRE ON OLD FILM SPOOLS

Daylight-loading film cartridges (the 35-mm. kind) make good spools for small quantities of wire. They keep the wire intact while storing and prevent it from unwinding too fast when winding coils.

The picture tells the whole story. I make labels of adhesive tape and mark the wire size, so that I can find the kind of wire I want at a glance.

ROBERT NAVARRO,
San Francisco.



SIGNAL GENERATOR

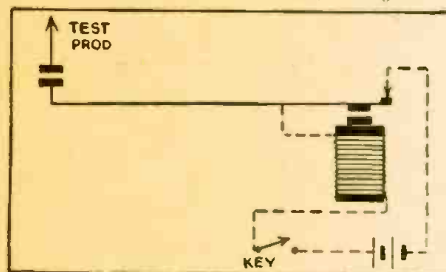
My kink consists of a signal generator made from a purchased code practice set, preferably the kind with batteries enclosed.

The basic design of the code practice set is shown by the dotted lines, whereas the addition is shown by black lines.

The only connection needed is to solder one side of an .02 mfd. condenser to the vibrator of the buzzer, and the other side to the test prod.

This signal generator is used in the same manner as an ordinary one is used.

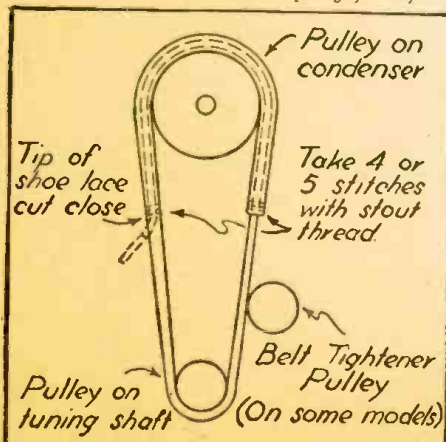
PAUL COPSER,
Corvallis, Oregon.



SUBSTITUTE DIAL DRIVE BELT

This dial drive belt is made of a pair of 2 for 5c shoelaces. It is a very quick repair and shoelaces can be found around almost any home.

HARRY KINGSLAND,
Diamond Springs, Calif.



CONNECTICUT POLICE USE FM

War industries will get greater protection and law enforcement will be speeded up in eleven Connecticut cities and towns which are now installing two-way FM police radio systems developed by General Electric.

It is explained that the new equipment incorporates many new features, some of them suggested by police users in many parts of the country. "Iron-core" or inductive tuning (the closely controlled movement of an iron core in and out of a small form-wound coil) is widely used. This permits easier and more accurate tuning, and reduces the effects of car vibration on tuning adjustments. Receiver battery drain has been reduced 35 per cent and a material improvement made in the effective communication range.

Commenting on these installations, D. L. Chesnut, development engineer, explains that police officials generally agree that because of the added responsibilities placed upon them by the war, two-way radio communication greatly increases the efficiency of their departments.

Many departments who operated in peacetime with one-way communications equipment now find they need two-way apparatus to deal efficiently and quickly with increased law enforcement problems.

The WPB has set up a radio reserve pool which enables manufacturers to produce specified amounts of this required police equipment for those police departments who can prove the equipment is needed.

RADIO FACTS—FOR YOUR FUTURE



Radios in 28,700,000 homes and 6,800,000 cars must be kept operating.

Radio trained men get interesting assignments, higher ratings and more pay.

Television, now perfected, will be a boom industry requiring many experts.

Get into RADIO now!

YOU'LL BE IN BIG DEMAND FOR YOUR SERVICES!

Here is part of a typical help-wanted advertisement which appeared recently: "ELECTRONICS ENGINEERS, LABORATORY ASSISTANTS, PRODUCTION MEN—Well Paying War Job Plus Peacetime Career! Ideal working conditions with expanding manufacturers now at war work and planning peacetime developments. Unlimited opportunity for an important place in a New World of Radio."

FREE TRIAL LESSON
PROVES YOU CAN LEARN QUICKLY

TRAIN YOUR BRAIN—AND LET IT WORK FOR YOU!

DID YOU KNOW?

The Radio Industry is part of the Electronics group of over 10,000 establishments which design, manufacture, purchase and sell a BILLION dollars' worth of equipment annually.

Radio-trained technicians are needed in all these lucrative, high-pay fields: Radio and Broadcasting Industry, the Sound Picture and Public Address Business, Communication by Radio, Wireless and Wire, Facsimile Reproduction, Television, and in many industrial plants.

After the War, many now secret devices employing the electron tube will be revealed to the Public and will have great money-making possibilities.

YOU GET HOME TRAINING from a real, established Trade School

For 38 years National Schools has trained ambitious men for Top Pay Trades in Los Angeles. The same technique, the identical shop methods that are so successful in training Radio men at the School, are now available to you by National's Plan of Home Training. You are assigned a progressive series of instructive lessons and you learn step-by-step. It's the Shop-Method Training Plan, developed for men who want practical, easy-to-grasp instruction in Radio.



TRAIN FOR FULL RICH REWARDS in these Jobs
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H. Schroeder, U. S. Navy.

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You can keep your present job and learn RADIO in all its fascinating branches without further delay. National Schools of Los Angeles has provided an amazing method of training which brings instruction to you right in your home.

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Mail me FREE, without obligation, Trial Lesson and Opportunity Book, with full details about RADIO Training at home.

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ADDRESS _____
CITY _____ STATE _____

REQUEST FULL DETAILS

•LATEST RADIO APPARATUS•

GAS-TIGHT TERMINAL

Victor J. Andrew Co.
Chicago, Illinois

THIS is a 100% gas tight terminal, developed for use on radio coaxial cables, but equally applicable in many other places where an insulated terminal is required for equipment in a sealed container.

The seal is obtained by fusion of glass to metal. A metal alloy of suitable coefficient of expansion is used, so that expansion and contraction of the bond will not set up strains which might cause a defective seal. Thus a completely gas-tight seal for the life of the unit is assured.

The unit shown is installed on the end of a $\frac{3}{8}$ " coaxial cable. Other sizes are available.—*Radio-Craft*



PLANT BROADCASTING UNIT

Operadio Manufacturing Co.
St. Charles, Ill.

THE "Plant Broadcaster" operates 20 to 40 loud speakers and covers an area of up to 100,000 square feet. The attractive cabinet occupies only 22 inches of floor space and comes ready to "plug in". Height is 68 inches and depth 18 inches.



In addition to broadcasting music to maintain or increase production with fewer workers or untrained personnel, it can be used to provide plant-protection alarm and air-raid warning.

The voice-paging feature of this equip-

ment enables management to page and locate executives and other employees literally "in a flash".

The control cabinet can be located near the telephone switchboard, or placed in any convenient location with connection to the microphone and key cabinet at the switchboard. Paging calls may be sent over the system while music is being played by means of an automatic control which decreases the music volume. This permits the paging call to be heard clearly and yet continues the thread of the music melody.—*Radio-Craft*

PHOTO-ELECTRIC CONTROLS

United Cinephone Corp.
Torrington, Conn.

A SERIES of four controls is provided to meet varying types of applications. Where, due to the construction of machinery or for other reasons, separate mounting of photo-cell and control unit is necessary, Model 70 is used. 72 and 74 are medium and high-sensitivity units, with a minimum light rating of 4 and $\frac{1}{2}$ -foot candles respectively. For applications requiring extreme sensitivity, the model 76, using a two-tube amplifier, is employed.



A light source to actuate any one of these controls is provided in the Model 18A, which is made up in a case styled like that of the controls. Light may be adjusted to high or low intensity.

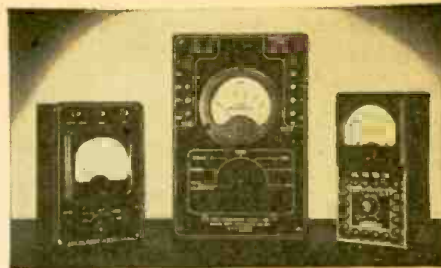
Rugged construction and low maintenance cost have been the object of the designers of these units. Life expectancies claimed are: Light-source bulbs, 2,000 hours; amplifier tubes (6J5) 3,500 hours; photo-cell tubes up to 10,000 hours and practically indefinite life for the other components.—*Radio-Craft*

3 NEW TEST INSTRUMENTS

Radio City Products Co.
New York City

MODEL 442 is a compact multitester with a 200-microampere movement and a sensitivity of 500 ohms per volt. Four D.C. milliammeter ranges: 0-0.3/6/30/150 (with a first scale division of 5 microamperes). Four D.C. voltmeter ranges: 0-6/150/300/1500 (with a first scale division of 0.1 volt). Four A.C. voltmeter ranges: 0-6/30/150/600 (with a first scale division of 0.1 volt). Four output voltmeter ranges: 0-6/30/60/150/600. Four decibel ranges from -6 to +50 db.

Model 481 is a test meter with a meter sensitivity of 50 microamperes. Equipped with precision wire wound resistors accurate to 1%. D.C. voltmeter readings from 0.1 to 1000 volts. D.C. milliammeter readings from 0 to 100 milliamperes. Resistance measurements from 0.1 ohms to 10 meg-



ohms. Energy for resistance measurements is supplied from self-contained batteries.

Model 471 is an output meter with a constant impedance of 4000 ohms. All resistors are precision wire wound, and are accurate within 1%. 471 is a rectifier type A.C. voltmeter. Five voltage ranges are available by turning a selector switch: 0-1.5/6/15/60/150. A self-contained condenser for blocking any D.C. components is connected to separate terminals.—*Radio-Craft*

FREQUENCY METER

Hewlett-Packard Co.
Palo Alto, Calif.

THE Model 500A is an electronic frequency meter designed to measure any alternating voltage from zero to 50 kilocycles.

The frequency meter consists of a wide band amplifier with a limiting circuit, and electronic switch, a constant current supply, a frequency discriminating circuit, and an output meter and rectifier. The input signal is amplified and used to switch the constant current source to alternate load resistors. The voltage developed across these resistors is applied to a condenser, and the output meter indicates the average value of the rectified charging current. The circuit is designed so that each pulse of charging current has the same average value, making the meter reading proportional to the number of charges per second, and hence proportional to the frequency of the input signal. The meter is therefore calibrated directly in cycles and kilocycles.



Instruments for measuring frequency including secondary frequency standard and electronic frequency meters. Model 500A Electronic Frequency Meter above

Ten ranges, switched by the knob under the meter, cover the full frequency range of 0 to 50 Kc. An input voltage of at least 0.5 is required. Variation from 0.5 volts to 200 volts will not affect the reading of the meter by more than 1%.

The instrument uses 9 standard vacuum tubes and is available for use on 105-125 volt, 60 cycle circuits. The panel size is 8 3/4 by 19 inches, and the depth is 12 inches.—*Radio-Craft*

POPULAR ELECTRONICS

(Continued from page 649)

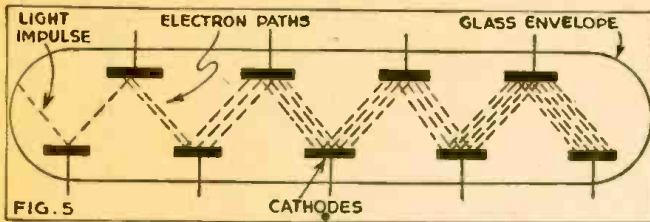
even a coal fire, the surface of the copper will become gradually black through the formation of cupric oxide, which has a chemical formula expressed by CuO . In the construction of photo-voltaic cells, the

meter as shown. Inasmuch as the cell is polarized, it will be necessary to connect the meter as shown in Fig. 7. The lights should then be turned out and the testing lamp lighted. As the testing light is

brought near the photocell, the meter should start to register. At a distance of six or seven feet a faint current should be noted, and by the time the light has reached a distance of three to four feet from the cell the current generated by the light should have reached at least one milliamperere. When the cell has been brought to within a few inches of the light, the current should reach about three to four milliampereres if the cell has been correctly made and the solution of lead nitrate, which should be made up of one ounce of crystals to one gill of water, is of the correct proportion.

To use this cell, it will be necessary to obtain or build a small relay which will be sensitive to a change of a milliamperere or two in the output of the cell. Such a relay may be made from the parts or magnets of an old 1000-ohm telephone receiver, equipped with an armature and contacts. This relay must be used to operate a sec-

(Continued on following page)



builder is not interested in the formation of cupric oxide as such, but he must tolerate it, because it must be formed during the formation of cuprous oxide, which is the light-sensitive coating that is desired on the surface of the copper plate or electrode. Underneath this surface of cupric oxide there is a surface of cuprous oxide.

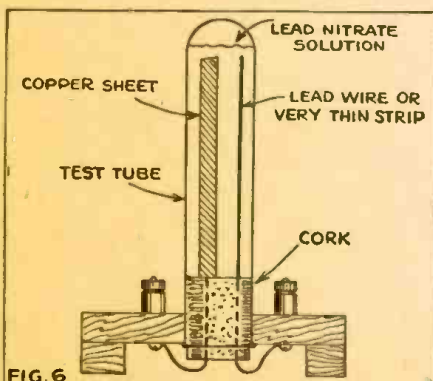
This upper surface of cupric oxide is disposed of by rubbing it off with emery paper or by dissolving it off chemically with nitric, sulphuric or hydrochloric acids. Ammonia may also be used to dissolve this film. The oxide will have a golden color and be in a rather crystalline state. After the film of cupric oxide has been removed, the copper electrode with its photo-sensitive surface should be given a thorough rinsing with water.

After the copper electrode has been so treated, its back is coated with asphaltum and the terminal is added. To do this properly and to form a good electrical connection, it will be necessary to solder. Naturally, the cuprous oxide film will have to be removed at the point the soldering is done. The lead electrode is held in place by simply drilling a hole in one and running the machine screw of the binding post through the cork.

To prevent corrosion and leakage of the electrolyte, it will be necessary to immerse the whole end of the unit in hot tar or asphaltum. Then, after the cork has been driven in place, hot tar is poured over to form a perfect seal.

HOW TO TEST THE PHOTOTUBE

With this done, the device is ready for testing and, if the tests turn out satisfactorily, is ready for general use. To test the cell it will be necessary to have a fairly powerful electric light, ranging in rating anywhere between 60 and 100 watts. It will



also be necessary to have a good milliammeter reading about 1 to 5 milliampereres. The testing light should also be arranged in a reflector, which may be a dishpan if nothing else is available.

The cell is connected directly across the

WHEN THE LIGHTS COME ON AGAIN



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JOHN MECK INDUSTRIES
PLYMOUTH, INDIANA



FOR THAT
MARCH
HEADACHE

SYLVANIA SERVICEMAN SERVICE

by
FRANK FAX



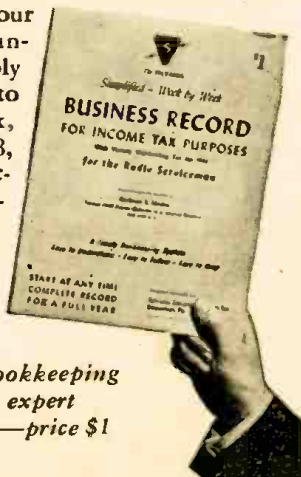
Is the memory of income tax day still painfully fresh? Was the preparation of the form almost as hard as digging up the scratch to pay?

Well, this is just the time to tell you about the new Sylvania Business Record Book. It's a simple week-by-week book-keeping system, specially designed for your business. Layout was directed by Rodman L. Modra, who was formerly Chief Deputy Collector of U. S. Internal Revenue. This tax expert tells how to use it.

Use it in conjunction with Sylvania's 3-in-1 daily Service Forms, and you have a complete record of daily business dealings for the year.

And it's useful not only for tax purposes. These are days of reports, questionnaires and affidavits that must be filled out. The Sylvania Business Record Book enables you to answer any quiz the experts give.

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SYLVANIA

ELECTRIC PRODUCTS INC.
RADIO DIVISION

POPULAR ELECTRONICS

(Continued from previous page)

ond and heavier relay if a heavy current is to be controlled by a light beam. It would be a little unreasonable to expect a relay small enough to come from the parts of a telephone receiver to be able to handle the 250-watts of a one-quarter horsepower motor. It will be found that a second relay, which is really an automatic switch, might be made from an old telegraph sounder provided with a couple of heavy contacts which may be used in connection with 110-volt lighting circuits.

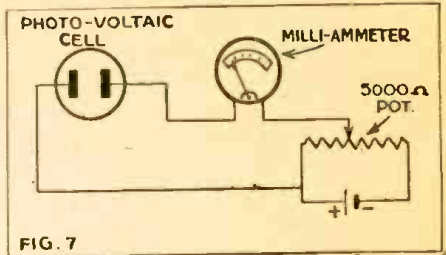


FIG. 7

IGNITRON

(Continued from page 655)

smaller types find their widest application in the welding field, the ratings for this type of operation are given. A few terms may be introduced which are unfamiliar to the reader, or old terms used in a way which may be puzzling.

Maximum demand current refers to the current which flows during the weld period with heat control (if any) full on. "Maximum time of averaging current" is also an expression important chiefly in welding work, where currents for short periods may be many times above the average. The case can arise where, though average currents are not exceeded, as calculated over a long period of time, periods of high current may be sufficiently prolonged to damage the tube. The period of operation is therefore chopped up into short periods, during no one of which the current may be over the average. For example, should the average current rating be 10 amperes and

the averaging time 30 seconds, a current flow of 20 amperes could be permitted for 15 seconds, but not for 30 seconds, even though no current flowed during the next 30 seconds. In the first case, the current averages 10 amperes over an averaging time of 30 seconds, in the second case it is necessary to extend the time over which the average is calculated to one minute longer than the averaging time permitted in the specifications.

Surge current is defined as a current value which will not immediately destroy the tube, but which will greatly decrease the safety factor in the tube rating at each occurrence. It represents a current value which should never be permitted to flow, as far as this can be prevented by circuit design and ratings, but which will not immediately destroy the tube should it by accident flow momentarily. Other terms are self-explanatory.

General Electric Ignitron Tubes FG-235-A, -258-A, -271, GL-415—Description and Rating

The ability of these tubes to carry very high peak currents for short periods renders them particularly adapted to welder-control service. These tubes may also be used for conversion in low-power circuits. Ease of installation, economical use of space, and reliability of operation are assured by design and construction features inherent in these all-metal tubes.

TECHNICAL INFORMATION

These data are for reference use only. For design information see the specifications. Ratings are alike for all types except where separate values are given.

	FG-271	FG-235-A	FG-258-A	GL-415
GENERAL DESIGN				
Tube Voltage Drop at 300 Amperes				
Maximum	20	20	20	20
Minimum	8	8	8	8
Net Weight, pounds approx.	12	9	20	1½
Shipping Weight, pounds approx.	12	17	41	5
Type of Cooling	Water GEH-1015	Water GEH-1015	Water GEH-1015	Air-Cooled* Water-Cooled
Installation and Operation				
MAXIMUM RATINGS				
Welder Control Service, ratings are for any voltage from 250 to 600 volts rms † ‡				
Maximum Demand, kva	600	1200	2400	105
Corresponding Avg. Anode Current, amp	30.2	75.6	192	3
Maximum Average Anode Current, amperes	56	140	355	5.6
Corresponding Demand, kva	200	400	800	35
Maximum Time of Averaging Anode Current, sec ‡				
At 500 volts rms	9	7.1	5.6	15.5
At 250 volts rms	18	14	11	31
Max. Surge Current, peak amperes	280	280	280	280
per cent of maximum rms demand current				
Ignitor Potential, volts (Ignitor Ratings Are Alike for All Types)				
Max. Instantaneous Allowed, ignitor pos.	900			
Max. Instantaneous Required, ignitor pos. §	200			
Max. Instantaneous Allowed, ignitor neg.	5			
Ignitor Current, amperes				
Max. Instantaneous Allowed	100			
Max. Instantaneous Required §	40			
Max. Average Allowed	1			
Ignitor Ignition Time, max., microseconds §	100			
Ignitor Current Averaging Time, seconds	5			
Maximum Outlet Water Temperature, C	40			
Minimum Flow, gallons per minute	1	1.5	3	75
Cooling Clamp Maximum Temperature, C				50

† With the use of log-log paper, straight line interpolation between the two points tabulated may be used to determine other detailed ratings.

‡ Rms demand voltage, current, and kva are all on the basis of full cycle conduction (no phase delay) regardless of whether or not phase control is used. For voltages below 250 volts, use the 250-volt current rating.

§ Ignition will occur if either maximum required instantaneous positive potential is applied or maximum required instantaneous current flows for the rated maximum ignitor ignition time.

* At these ratings mercury condensation in the anode seal must be prevented by suitable heating devices.

RADIOTHERAPY ON SHORT WAVES

(Continued from page 651)

18 meters one will rarely use a current in excess of 2,500 milliamperes. The maximum energy in the secondary circuit is sufficient to light a 300-watt incandescent lamp to full brilliancy.

A continuous radio-frequency output with continuous heating effect must be had, if an immediate temperature equilibrium is to be reached in the tissues. This is possible only when rectified current is applied to the plates of the oscillator tubes. If alternating current, unrectified, were to be used, there would be 120 intervals in each second (two for each cycle per second) during which no plate voltage would be applied. This means that 120 times each second there would be no radio-frequency output and of course, no heat. One can readily see the advantages of applying direct current to the oscillator plates, by the use of rectifier tubes, where time required for a treatment is to be economized.

For a general utility short-wave therapy generator, as distinguished from one designed for special or research work, portability and simplicity of operation combined with abundant power reserve, were considered as prime requisites. In a properly designed machine a layman may operate and control the output, and the emitter must be so designed that it is impossible to cause injury to the instrument by careless operation. In practice the emitter must be reliable and the operator must be assured of continuous uninterrupted service. It must be capable of operating for many hours continuously, without danger of breakdown. It must be so fool-proof that the doctor may leave his patient while treatment is in progress without danger, although we by no means recommend such practice.

THE PHYSICAL EFFECTS

That persistent daily use greatly increases the value of the short-wave treatment is an established fact. According to Pilomni's researches the short-wave hyperemia² differs from ordinary heat hyperemia. The vaso-dilation cannot in any way be influenced by adrenalin, and lasts for hours. A strong migration of leucocytes to the parts treated can be observed, with a considerable rise of the phagocytic index. The surface changes in the cell membranes are probably the cause of the increased absorption. A German authority is of the opinion that anti-toxins are activated, that the dead and dying bacteria give rise to a sort of auto-inoculation. However, there appears to be insufficient evidence to justify this view as an established fact.

It is well demonstrated that in addition to some possibly favorable electrical influence on focal sepsis, we are able now to develop sufficient heat, controlled as to locale, degree and time, to actually destroy many types of bacteria. The localized controlled tissue hyperemia associated is more beneficial than that heretofore possible by any physio- or hydro-therapeutic procedure.

The short waves here generated have a warming action on organic tissue, but as above stated there may be very probably also a specific electrical action on the living protoplasm, due to the discharge of the minute electrical charges induced therein, at the rate of many million times a second. This discharge apparently involves the larger single molecules and cell combinations. Inasmuch as the veins contain the conducting carbonates of the blood stream, it is reasonable to assume that these vessels convey the

major portions of the high frequency electric currents. This results in a dilatation thereof, with enhanced circulatory activity.

The use of these high-frequency modalities, it is believed, stimulates the elimination of carbon dioxide, with disintegration of the calcareous deposits on the arterial walls. Veins contain the conducting carbonates, thereby offering preferred paths for the high-frequency currents. Venous congestion, even when deep-seated, is relieved because of this marked activity of the arterial circulation. The result is relief of venous and visceral congestion. On this account, as

(Continued on following page)

On a Bigger Scale

FOR THE WAR EFFORT TODAY

and

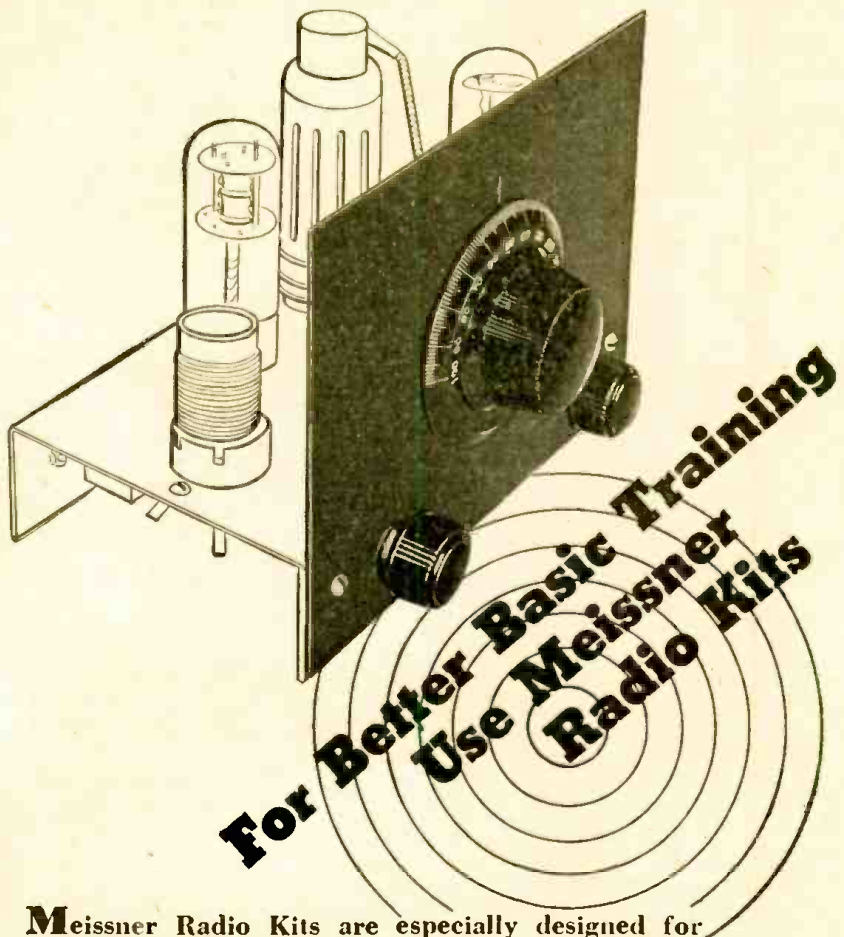
THE PEACE TOMORROW

Amplifier Co. of America has moved to
396 BROADWAY

We have expanded our facilities in our all out War effort during the past year. Now with new and larger quarters and the greatest staff of Engineers in our history (under the direction of A. C. Shanley), we are in a better position than ever to speed War Production for today. With the same experienced team we will be all set to meet the peace needs when unconditional surrender takes place. It won't be long—we hope!

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Meissner Radio Kits are especially designed for classroom use in basic radio training. The "add-on" feature permits the conversion of the one tube to a two tube and the two tube to a three tube receiver. Meissner Student "Midget" Kits are being widely used in schools for defense radio training. Simplified assembly! . . . Meissner wiring diagrams enable the beginner to quickly assemble the Kit and aid in quick radio training! . . . see your Meissner distributor, or write.



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RADIOTHERAPY ON SHORT WAVES

(Continued from previous page)

well as from the internal heat generated, short-wave therapy is generally indicated whenever there is infection, congestion, or suppuration. Its effects on inflammatory and purulent processes can no longer be questioned.

EFFECTS NOT DUE TO HEAT

When employing not merely ultra-short-wave radiations, from 4 to 8 meters, but even with the more generally applicable, less specific wave length of 15 meters, Liebesny, Groag, Schliephake, and most Continental authorities advocate separation distances of 2 to 20 centimeters, preferably employing glass and open-air dielectrics instead of rubber, felt, and the like. Thereby the patient experiences little surface heat sensation, and therefore is frequently under the erroneous impression that he is not being sufficiently treated. However, the almost unbelievable results recorded by these learned and well-skilled authorities, in numberless cases of lung and prostatitis, gonorrhea, arthritis, eczema, always treated so as to avoid any notable rise in temperature, seem convincing evidence that the undoubtedly great benefits attained are not primarily

the result of heat generated within the tissues.

The number of cases which have been successfully treated where other forms of treatment have given negative or less satisfactory results, constitutes persuasive evidence that short-wave or radio therapy, as a generic instrumentality, possesses unique therapeutic usefulness. The use of this modality is indicated for all cases wherein the conventional diathermy would be indicated. It would also seem that radiotherapy adds to the indications for high-frequency therapy certain conditions inaccessible with conventional diathermy. Short-wave diathermy has been found efficacious in the treatment of such conditions as arthritis, prostatitis, epididymitis, salpingitis, sinusitis, bursitis, and the like. This modality has been proven of value in pneumonia cases, colds, inflammatory conditions of all sorts, infected areas, fractures, carbuncles, abscesses, and in many cases too numerous to list here. Unquestionably, in the entire field of physical therapy modalities, none can approach in its wide field of indications short wave and ultra-short wave therapy.

(Photos of Dr. DeForest by Wide World)

ELECTRONIC HEATERS

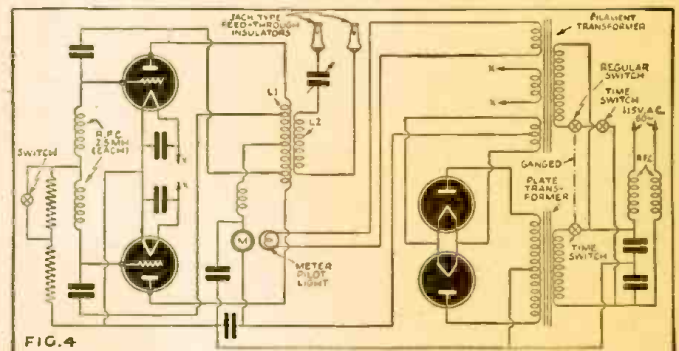
(Continued from page 654)

APPLICATORS FOR INDUSTRIAL JOBS

Applying the heat is a problem in itself. The first induction heaters used a simple coil of more or less fixed shape. This was brought as close as possible to the object to be heated. Where the object was small, it was surrounded entirely by the heating coil. It was soon found that heat was wasted by this method of application, and coils were designed for each specific operation.

One of the most remarkable of these is a coil designed to solder seams in sheet metal, such as tin cans. It is necessary to concentrate the heat directly over the seam, to avoid overheating the thin metal near the joint. The coil of Fig. 5 is used to keep the heat where it is needed. Other specially shaped coils for definite applications will be seen in the same figure.

In electrostatic heating, the object is to get the electrostatic plates as near the material to be heated as may be. Any air gap means a waste of power, and plates are often shaped to follow the form of the object being heated.



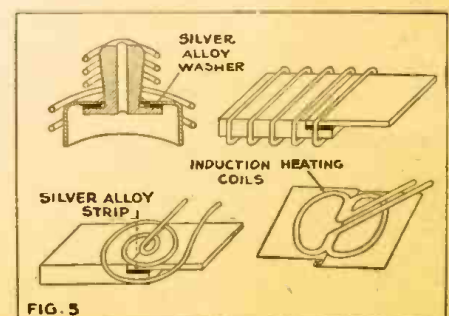
plastic will without doubt cause plastic moldings to be used for a wide variety of parts for which other materials are now employed. This will in turn react on the demand for electronic heating.

While prophecy in such cases is dangerous, no one will deny that the electronic heater will open up a new range of methods of dealing with materials, at the very least as important as the advance made with the introduction of electric welding. It would be a venturesome engineer indeed, who would dare to guess at the maximum possibilities of electronic heating!

(Photos courtesy of General Electric Co.)

THE FUTURE OF R.F. HEATING

There is little question that the present increasing importance of electronic heating in industry is merely a preview of the real show to be put on after American manufacture swings back into peace-time production. More than one of the applications of this revolutionary method will bring about changes in the methods of doing things, which will in their turn increase the usefulness of the heater. As an example, the possibility of molding larger pieces of



ELEMENTARY ELECTRICAL ACTION FOR THE BEGINNER

By RALPH W. MARTIN

Current flow and Electron flow are ONE. Correctly speaking, there is no flow of electric current, separate from electron movement, in any portion of an electric circuit.

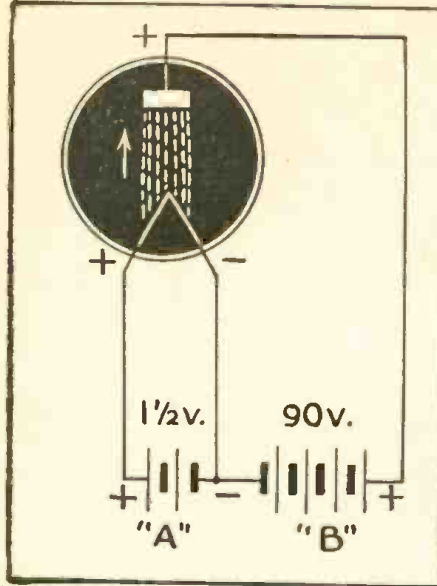
There is no flow of any kind through the fixed metal conductors of an electric circuit—the one and only flow takes place in those portions of the circuit that are capable of movement, such as gases, liquids, or in parts capable of physical or mechanical motion. In fine, *electronic* flow is the one and only flow encountered in any electrical application, whatever its form or nature.

To further explain, we refer to the simple diagram here shown:

The simple diode vacuum tube is equipped with two electrodes, an anode (plate) and a cathode (filament). The "B" battery places a positive potential upon the plate, not by means of any flow in the wire, but merely because of the metallic connection used. Likewise, a negative potential is placed upon the filament of the tube.

The resulting electronic emission from the cathode is in the form of a gas, which, being capable of being set in motion, has been observed to have a movement from cathode to anode, or from negative to positive.

The only other portion of the "B" circuit capable of sustaining motion, is the liquid or semi-liquid of the "B" battery; and here again, the direction of flow is electronic in nature, or from negative to positive.



In the "A" circuit, used for heating the filament, the only flow which occurs, besides the flow through the battery, is in the envelope of heat (a gas) which surrounds the filament, and which is also from negative to positive.

RECORD DISC LIMITATION PROTESTED BY INDUSTRY

Under Limitation Order L-265 and those immediately preceding it, recording discs of all kinds have been classed as *electronic* equipment and their sale or transfer limited to priority orders of A-3 or better.

This has tended to create an anomalous situation in the case of the popular small home recording discs, which have practically no applications in fields which would be covered by preferred orders, and which under the present limitation orders cannot be obtained by the general public.

It is the contention of manufacturers of this type of disc that the limitation order was entirely justified as applied to the larger professional type recording or transcription disc. In times of shortage, the priority rating protects broadcast stations and other services important in the maintenance of public morale, who might find themselves seriously hampered should they be unable to obtain these discs.

Such reasoning, according to Sidney S. Gould, president of The RecorDisc Corp., does not apply to the amateur paper "home-recording" type of disc. These are made on a cardboard base with coating materials which are entirely priority free. It is pointed

out by Mr. Gould, whose company is one of the largest manufacturers of these items, that the most critical materials used in home recording discs are less scarce and valuable than the materials now being used in ordinary phonograph records, which are unaffected by the order. This applies to the new wartime formulas for the aforesaid phonograph records. It seems unreasonable that these should be unrestricted while home recording discs are kept off the market. The same lack of reason is seen in the unrestricted sale of ordinary phonograph needles, whereas "playback" needles may be obtained only under priority, though in some cases the only difference is in the printing on the envelopes.

The home recording disc, it is pointed out, has a number of uses worth considering even under present critical conditions. Such are their use in schools, libraries, commercial institutions, police departments and institutions for the blind, to mention only a few applications. In view of these points, an appeal is being made by manufacturers of such record discs for a review of Limitation Order L-265 insofar as it affects home recording discs.

Now that the "hams" of the United States can no longer use their transmitters, they have turned their ingenuity to non-radio forms of "wireless" communication. They are using induction, "earth currents" and carrier waves along the local electric light lines, and have set up some records for message relaying which compare with those of the old spark days.

The peak of effective non-radio wireless

message transmission has been reached by a Long Island ham. Annoyed by a neighbor's hens, who scratched up his newly-planted garden, he drilled small holes through grains of corn, threading them with strings about eight inches long, to which were attached tags bearing the message, "Keep this chicken home!"

These wireless messages are said to have been more effective than lawyers' letters.

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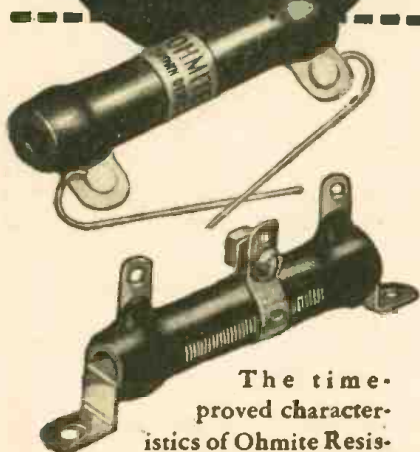
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MORE HIGHS—MORE LOWS

(Continued from page 662)

actance to the low frequencies. For all practical purposes, C_2 is a short circuit at the high frequencies and allows the full voltage to be applied to the grid. At lower frequencies, the voltage divider effect of R_2 and R_3 takes place.

Other ways of improving frequency response include replacing the output transformer in poorly designed sets with one of a newer and better type. Even the inexpensive universal type is a big improvement over the original transformer in many receivers. The correct impedance match between the output tube and the loudspeaker is very important.

The treble and bass boosters described in this article have been tried by the writer and have given very satisfactory results. With parts salvaged from the junk box, it is possible to make that old radio sound "amazingly" better.

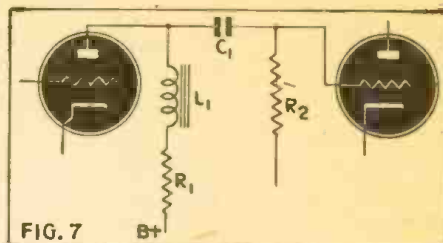


FIG. 7

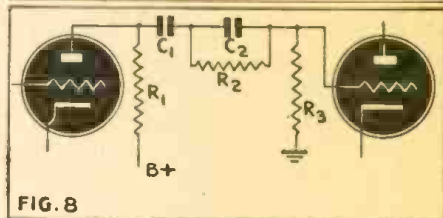


FIG. 8

IMPROVING THE DIODE

(Continued from page 663)

amplified greatly. Delayed AVC is impossible with this arrangement, as the two diodes must always be working under identical conditions. This is perhaps just as well, as it has been shown that excessive distortion takes place when the carrier input is equal to the delay voltage. The most promising arrangement appears to be some sort of DC amplified AVC using the positive output from point B in Fig. 2.

The coil design calls for some comment. Best results were obtained when each secondary section was given half the number of turns of the tuned primary. The voltage stepdown is therefore 2:1, and if we require 5 volts input to each diode the pre-detector amplifier must give 10 volts RMS, which corresponds to about 28 volts peak for a fully modulated signal. This is relatively easy to arrange. The input resistance of each diode is $R/2n$ where R is the DC load and n the efficiency. Thus the load imposed by each diode on the secondary is about 50,000 ohms (taking a as unity) which, reflected into the primary, becomes $4 \times 50,000$ ohms or 0.2 megohm. The total load on the tuned circuit is therefore 0.1 megohm which is not excessive. It is advisable to construct the coil to be as symmetrical as possible, in order that the stray capacitances and voltage outputs of each secondary should be equal. It may

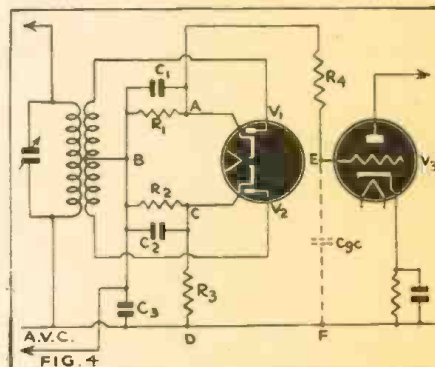


Fig. 4—The circuit of Fig. 2 modified to give A.V.C. action. Delayed A.V.C. is impractical with this system.

even be an improvement to ground the center of the tuned primary where circuit arrangements will allow of this.

The circuit shown in Fig. 2 has been in use for some time in a pre-tuned local station receiver, and while critical judgment is difficult under war-time conditions, it is believed that the quality represents a distinct advance on any other detector so far tried.

—Wireless World (London)

CROSS MODULATION AS A FACTOR IN INTERFERENCE

(Continued from page 669)

already mentioned. We may have here, paradoxically enough, a case of "internal" e.c.m. interference.

Symptom—A reader's letter stated that when a certain mail-order house electric light bulb was turned on in a table lamp, a nasty tunable hum made itself evident.

Cure—Replacement of the offending bulb.

Comment—Again, this is a source of e.c.m. interference usually overlooked in literature. Defective solder or spot welded joints in light bulbs or vacuum tubes rectify and cross-modulate power line R.F. and power frequency currents. These intermod-

ulation products either are re-radiated to the receiver antenna system, reach the receiver amplifier circuits directly through the power transformer or are generated within the receiver circuits themselves. (The writer answered this letter in a later issue.)

Symptom—An "inverted" tunable hum which disappeared when a transmitter signal was tuned in.

Cure—Replacement of a defective electrolytic filter condenser.

Comment—Evidently more than one hum source was involved here and when a carrier was tuned in, the two sources were out

of phase and canceled out. In other words, an automatic Jones effect was present. Again, the fact must be emphasized that e.c.m. interference problems may be rather involved under certain conditions.

Symptom—A fellow serviceman complained of a customer's accusations of "ruining" a receiver. She claimed that since he repaired the receiver "it had a nasty hum in it." Questioning disclosed the fact that one of the things he had to do was to replace the low-priced ballast tube which was blown out. The writer suggested that he replace it with another ballast tube of a better make. The tunable hum disappeared. The guess was correct and a "cluck" joint in the cheap ballast tube supplied the non-linearity factor necessary for the cross-modulation effect.

The following are the writer's own notes on e.c.m. interference.

FROM AN ENGINEER'S NOTE BOOK

Cathode-ray examination of a power line's wave-form showed up higher frequency components which looked like inter-modulation products rather than harmonics. Judging by the apparent frequency of the components, some of them appeared to be the "dial tone" or "ringer" frequency currents of the phone lines strung along the telephone poles below the power transmission lines. When a radio receiver was turned to a spot on the dial between stations and the receiver gain control turned up, abrupt changes in the wave forms of the higher frequency components could be observed coincidentally with static variations and crashes issuing from the receiver speaker.

If the dial phone earpiece is lifted from the hook and dialing operations are performed, momentary transients and momentary changes of the higher component wave shapes can be observed on the scope screen. These wave-form alterations take place coincidentally with the phone contactor and relay operations and the static crashes in the radio receiver. This simple check definitely establishes the radiation and reactive coupling between the phone and power transmission lines strung along the telephone poles.

Oscilloscopic checks of telephone lines, building wiring, ground wires, building metallic sections, pipe lines, receiver antennas, etc., all show evidence of induced 60 cycle currents. The checks are made by simply connecting a mica condenser between the vertical amplifier input post and the circuit to be tested. These checks show up the radiation and reactive coupling between the building power line and building circuits and metallic sections. The scope operator has merely to put a finger on the vertical amplifier input post, turn up the vertical gain and bring his toe near an A.C. line shielded by conduit or BX armor which is supposedly grounded and a healthy 60 cycle sine wave distorted by intermodulation dips will appear upon the screen. If a condenser is tied between each of the two sides of the power line and the input post, it will be found that the amplitudes and wave forms of the two lines signals differ. This is to be expected, since one side of the line is usually a grounded e.t. of a three-wire 220 volt A.C. Edison system. However, if a H.F. check is made, it will be found that one, two or three R.F. carriers exist in the power line system and that they are of about equal intensities in the BX armor and the two sides of the A.C. line. There will usually be one strong R.F. carrier. This check can be made by using a water pipe "ground" connection to the ground post of the scope and a mica condenser connection between

(Continued on following page)

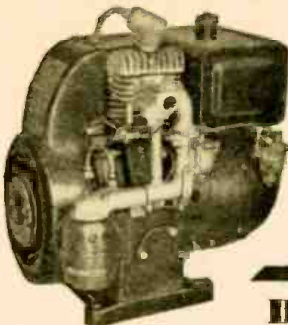


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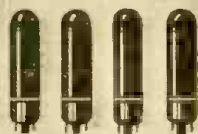
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CROSS MODULATION AS A FACTOR IN INTERFERENCE

(Continued from previous page)

the vertical amplifier post and each of the sections of the power line. A parallel-tuned coil-and-condenser combination is used across the scope posts in order to select each carrier for examination. If the scope is of a high-grade type and the frequencies can be determined, this will determine if the power line is causing e.c.m. interference.

SIMPLER RESEARCH APPARATUS

If a regenerative detector connected to a good receiver's audio system, is adjusted to the oscillation point and tuned to a fairly distant station so that a beat note is produced, an interesting fact can be noted. If, somewhere at the other end of the building, a lead is run from a radiator pipe to a water pipe or a 120 volt line's BX armor or any other so-called "ground", a change in the pitch of the oscillating detector can be heard. In other words, by simply cross-connecting two "grounds" anywhere within the building, the tuning of an oscillating detector in another part of the building is altered—(a circuit which already has its own ground). This simple experiment illustrates the fact that the word "ground" is purely relative.

Exploration with an auto radio fed by a whip antenna disclosed the presence of a highly localized e.c.m. tunable hum field on WABC's carrier close to a residential building. When the car was driven down the garage run-way a few feet, the tunable hum field disappeared but another one appeared on WEAF's carrier. They were probably caused by vertical BX or pipe runs within the building walls. Defective joints in these possessed resonance and directional circuit and radiation constants which may well have caused the peculiar highly localized interference fields.

Exploration with this same auto receiver along elevated transmission lines disclosed the presence of strong, localized, spherical, tunable-hum radiation fields about some street lighting illumination lamps. Thus again we have another example of this source of e.c.m. interference overlooked in radio literature—defective solder, spot-weld, riveted or crimped connections within illumination or amplifier tubes.

POWER LINES AS A FACTOR

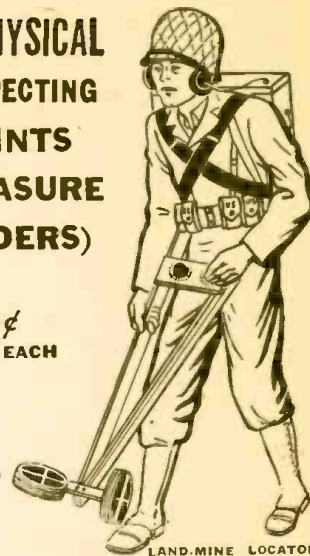
Further exploration along power transmission lines brought out the existence of localized spherical e.c.m. fields about some power transformer banks atop transmission line poles. Either oxide or chemically corroded splices or else non-linear iron core or dielectric losses of various types may be the trouble-making non-linearity factors.

Localized tunable hum fields were also found to exist along certain power lines. The odd feature of these fields was the fact that there were no signs of these fields directly under the transmission lines. They could be detected only within small sectors on each side. This was probably due to the fact that the neutral was either directly over or under the polyphase lines. Just what non-linearity factors caused them was not determined. They were no doubt radiated by the neutrals and their phase unbalance currents for the most part. The presence of neon signs in the vicinity of such lines sometimes exaggerated the trouble and added a buzzing "hash" modulation to the tunable hum radiation effects.

In one Long Island locality where tunable hum radiation fields of several power lines were detected on WEAF's carrier, it was found upon a check-up of local maps that

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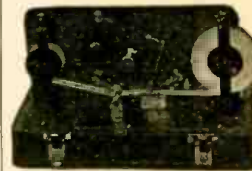
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these overhead transmission lines lay along roadways which pointed in the general direction of WEA's transmitter antenna, located on Long Island. This directional effect is to be expected.

In "talking out" wires with telephone test sets on interior communications circuits during test routines, a weak 60 cycle power system hum could be heard on the test phones. Power supply cables running along the interior communications circuit cables induced the power frequency hum into them. It did not interfere with speech and was heard merely as a soft, musical background hum. When a test phone lead was touched lightly to an old corroded lug on one of the wires, the soft musical hum became an unpleasant buzz which cross-modulated the speech frequencies and interfered with the speech. Thus the oxide coating on the old lug supplied a non-linearity factor which caused the intermodulation products. When the test phone lead was scratched through the oxide coating, the buzzing intermodulation products disappeared and intelligible speech with a soft, musical, 60 cycle hum was again obtained. This simple observation points out the need for clean and tight wiring connections in any communications system in order to prevent the appearance of trouble-making rectification effects.

Since strong signals from transmitters within a limited radius are the ones involved in e.c.m. interference problems, it can be surmised that the ground wave component is the one to be suspected as being the chief trouble maker.

OTHER RECTIFYING CIRCUITS

Electrolytic lightning arrestors on power transmission systems may be a source of e.c.m. interference in that they may pass R.F. signals through capacitance and leakage effects and at the same time rectify them through their electrolytic films.

If sensitive earphones are shunted across ground circuits or grounding connections, hums, static and cross-modulated signals can usually be detected. Amplifier and cathode-ray equipment may also be used to detect and analyze such ground circuit interference-producing signals. Motor commutator whines and buzzing, communication system signals, power line hums and static signals can often be plainly heard, or seen on the cathode-ray screen. Occasionally, drain pipes, pots on stoves, roofing, mechanical equipment, etc., in the vicinity of powerful transmitting stations will rectify the strong induced signals within them at corroded joints and then "sing" out the station program so that it can be plainly heard several feet away. These simple checks indicate the rather empty significance of the word "ground" and the need for the careful cross-bonding of ground circuits.

The use of iron-core chokes in conjunction with the usual air-core units in the suppression of power line interference in radio work is—for some strange reason or other—overlooked. They are effective for two reasons. One reason is the fact that usually detrimental laminated-core loss effects are useful here since the greater the frequency passing through the choke, the greater the losses and the more effectively are the higher frequency static signals suppressed. (These core effects are eddy currents, magnetic hysteresis, eddy current skin effect and magnetic viscosity or lag.) The other reason is the fact that static signals in power lines are largely due to transients set up within them by switching operations and sparking electrical equipment. These transients are fundamentally low-frequency signals with very steep wavefronts and highly complex wave form with

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EARTH CURRENTS AND E.C.M.

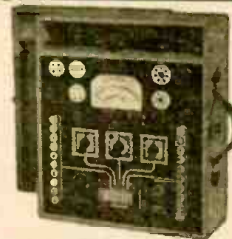
Electrolytic-ionic types of earth currents, especially those flowing from and to corroded metallic bodies or mineral deposits, may have some relationship to e.c.m. interference, especially where ground return currents flowing between grounded "Y" neutrals of polyphase power transmission systems are concerned. This brings out the possibility of e.c.m. interference generation right at the transmitter antenna tower and ground wiring system as well as at the receiver location. It would seem that the use of copper grounds and chemical saturation of the surrounding earth for increased earth conductivity may increase corrosion of the copper grounding system and also create ionic type earth currents and thus increase rectification cross-modulation effects. The use of silver or gold plated copper ground networks or "Aqua-Dag" colloidal graphite coated grounds, graphite

(Continued on following page)

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Advertisements in this section cost 20 cents a word for each insertion. Name, address and initials must be included at the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency. No advertisement for less than ten words accepted. Ten percent discount six issues, twenty percent for twelve issues. Objectionable or misleading advertisements not accepted. Advertisements for September, 1943, issue must reach us not later than August 15, 1943.

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WANTED: TEST INSTRUMENTS AND METERS. State price and condition. LeRoy Green, Tupelo, Mississippi.

WANTED: CROSLY CHATTERBOXES. PLEASE state what condition and list price. Korrol Mfg. Co., 350 Greenwich Street, New York City.

CROSS MODULATION AS A FACTOR IN INTERFERENCE

(Continued from previous page)

or amorphous carbon saturation of the earth about the grounds, the use of stainless steel grounds, carbon electrode grounds, etc., etc., might be of some advantage here.

When electronics laboratories are being set up or newly built, it may be worthwhile to use BXL wire run in copper conduit for power wiring, install a four-section, multiple-tap, fully shielded power line filter at the point where the power feeders enter the building, line all the room walls with both soft-iron magnetic and copper radiation shielding and to set up an elaborate cross-bonding system between all grounded circuits and metallic bodies within the building. This will eliminate interference trouble where electronics research work is being conducted. The use of a shielded local power supply and isolation transformers with electrostatic shields between windings will also help somewhat.

Diagram 1 shows a simple power line filter which can be used at the main feeder switch within a building. Diagram (2) is a theoretical power line filter which may be of use in the laboratory.

A short article may be presented in the future which will contain experimental data on interference detection and analysis.

CIRCUIT CONSTANTS

Fig. 1—A simple power-line filter.

CH—Space-wound choke coils. No. 14 enamelled wire on 1 or 1 1/2-inch ceramic form, 10-40 turns.

F, F—Protective fuses.

C1—High-frequency mica shunt condensers. 400-volt.

C2—Paper tubular condensers. 400-volt.

Fig. 2—Power-line filter for laboratory use.

CH1—Low-resistance laminated core chokes.

CH2—40 turns space-wound No. 14 enamelled wire on 1 or 1 1/2-inch ceramic form.

CH3—20 turns, same as CH2.

CH4—10 turns, same as CH2.

C1—4, 2, 1, 1/2 mfd.

C2—5, .25, .2, 2 mfd.

C3—05, .05, .04, .03 mfd.

C4—02, .01, .006, .004, .002 mfd.

Note: All condensers individually shielded. Shielding is silver-plated copper.

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FAULT LOCATOR

(Continued from page 671)

ground has occurred, thence back through the ground to the exciter.

The locator unit consists of an exploring coil wound with approximately 200 turns of No. 36 S.C.C. wire into a twelve-inch ring, the turns being tightly taped together and then fastened by tape or otherwise to a light wooden handle about three feet long, for convenience.

Flexible leads are brought from the ends of the coil up the handle and connected to the small portable amplifier. By using two flashlight cells connected in parallel for the filament supply and the smallest size 45 volt "B" battery, the whole thing is not much larger and weighs about as much as a

box camera.

Signals from the exciter may be picked up for surprising distances but when the coil has passed over the grounded point in the underground circuit, the signal stops at once, indicating that you have found, or are very close to the point of trouble.

Needless to say, the regular lighting supply current should be cut out during this procedure.

For tracing underground circuits in service, the pick-up coil amplifier and phones do a good job, without the exciter.

When tracing any line keep the plane of the pick-up coil in a line with the wire to be followed.

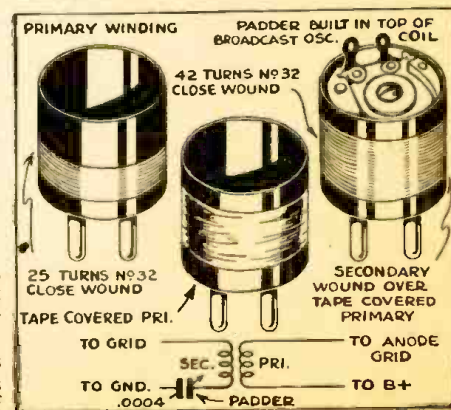
3-TUBE SUPERHETERODYNE FOR ADVANCED TRAINEES

(Continued from page 668)

one below it. The antenna coil was wound near the base of the form, with 5 turns of No. 32, and the oscillator tickler with 7 turns. The number of turns needed in the oscillator tickler also depends to some extent on the rest of the wiring in the set, and should be adjusted for best results.

The size of the aerial will also have an effect on the best number of turns in the antenna coil primary. With a short aerial, more turns may be used with good results. If the aerial is very long, on the other hand, the number of primary turns may be cut down, with a noticeable improvement in selectivity.

The actual construction of the set offers no particular problems. The I.F. trimmers should be adjusted for peak performance, of course, if best results are to be obtained

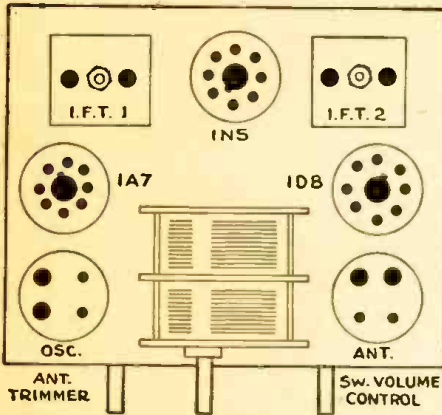


How the broadcast oscillator coil is put together.

or foreign stations tuned in. This requires a signal generator, and may have to be done by a serviceman who has such an instrument, if the constructor has none of his own.

It was noted that noise in this set, heard when the volume control was turned up, was eliminated by putting a .00025 conden-

ser (shown in dotted lines in the schematic) across the 3-megohm grid-leak of the first audio stage. This may seem to be a much cruder system than trying to insert it further back in the diode return circuit, but it was discovered while trying to locate the noise, and worked so well that no change was ever attempted.



Chassis layout of the 3-tube superheterodyne.

Parts List

- C1, C3—450 mfd. 2 gang variable condenser
- C2—.00003-.00005 variable condenser
- C2—.00025 mfd. micas
- C1—.00025 mfd. tubular
- C5—.01 mfd. tubulars
- C1—.1 mfd. tubular
- C1—.0001 mica
- C1—.002 mfd. tubular
- C1—10 mfd. electrolytic
- C1—.25 mfd. electrolytic
- C1—.0004 padder
- C2—200,000 ohm resistors
- C1—50,000 ohm resistor
- C1—500 ohm resistor
- C2—1 meg. resistor
- C2—2 meg. resistors
- C1—3 meg. resistor
- C1—500,000 ohm volume control
- C1—D.P.S.T. switch on volume control
- C3—Octal sockets
- C2—456 Kc. I.F. transformers
- C3—"34" tube bases
- C1—"30" tube base
- C1—1A7 GT
- C1—1N5 GT
- C1—1D8 GT

Hook-up wire, speaker, chassis, etc.

WAR PRODUCTION BOARD OPENS SUPPLY AGENCY

THE new Electronic Research Supply Agency, formed to supply critical materials and components not readily available from commercial sources to laboratories engaged in radio and radar research and development for the Armed Services, has been "opened for business" by the War Production Board.

Set up by the Defense Supplies Corporation at the request of the armed services, the Office of Scientific Research and Development and the War Production Board, the new agency carries inventories purchased with the assistance of preference ratings assigned by WPB or extended by its customers. Operating profits or losses

accrue to the Defense Supplies Corporation.

In placing orders with the agency, laboratories must certify (1) that requested items are needed for research projects or for pre-production models for the services or OSRD, (2) that the items are not ordered for inventory and (3) that no part of the order has been placed with another source of supply.

Wholesale distributors, buying for account of approved laboratories, must certify that they have not in inventory the items being sought and that they have not placed purchase orders for them elsewhere.

Orders are accepted with or without priority ratings.

NEW PIGMENTED RUBBER CONDUCTS ELECTRICITY

Conductive rubber, long a prominent feature of "technical" articles in April issues of radio magazines, now takes its place in the world of reality. Developed by the United States Rubber Company for safety reasons, the new product is used in munitions works and other places where containers, trays or bench tops must be of a soft substance. Previously the danger of sparks due to static charges reduced the advantages of rubber as a material for such applications. Now these charges are immediately dissipated due to the conductive nature of the new rubber, and danger from both static sparks and mechanical shock is obviated.

The secret of the new material's conductivity lies in an impregnating pigment—largely composed of carbon—with which it is impregnated.

Instead of building up high voltages of static electricity as on ordinary rubber, charges spread over the surface of the new product, leaking off at all possible points, and it remains substantially at ground potential.

It may now be confidently expected that the Serviceman's dream of a flexible chassis, which can be squeezed around loudspeakers and past cabinet projections, is on the point of realization!

WPB ACTION STOPS CIVILIAN TUBE LEAK

The War Production Board moved last month to stop a leak through which tubes intended to keep civilian sets playing were finding their way into military orders, or were being snapped up by contractors who could have obtained the same tubes with slightly more difficulty through their high priority ratings.

While tubes for civilian use have been released from time to time, there has been no restriction on their sale, with the result that many were purchased by contractors on war orders, or by military buyers. Thus many "civilian replacement tubes" never reached the service shop or the consumer.

The latest order requires that all tubes put out for civilian use be plainly stamped with the letters MR, for "Maintenance and Repair." In the wording of the Order: "... No person shall use radio receiving tubes which are marked 'MR' to fill any preferred order. No person shall transfer or accept transfer of such tubes on any preferred order or any other order bearing a preference rating, except rated purchase orders for export. No producer shall transfer for export in any calendar quarter a quantity in excess of fifteen (15%) percent of his production of such tubes during that calendar quarter."

Manufacturers may exchange stamped tubes among themselves without restriction, to complete their lines or round out their stocks.

This plugging of leaks in the dyke, together with the recently-announced increases in the plan for civilian tube production, gives reason for hope that the civilian tube famine will not become more severe, and that it may even slack away a little before the end of the year.

The new provision is issued as an Amendment to Limitation Order L-265.

SERVICEMEN HAVE LIBRARY

Radio servicemen of Vancouver, B. C., are banded together in a group, The Associated Radio Technicians, (ART). The organization, besides looking after the interests of its servicemen members, prints a magazine, arranges technical features, and even operates an annual picnic.

Not the least of the advantages of this association is the excellent library. The latest radio and electronic books are purchased and made available to the members. Those not in the city itself receive and return their books by mail.

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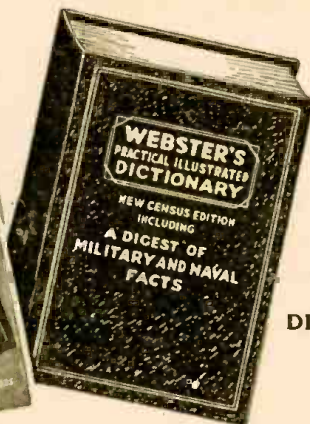
THE LISTENING POST

(Continued from page 674)

Mc.	Call	Location and Schedule	Mc.	Call	Location and Schedule	Mc.	Call	Location and Schedule
11.910	2RO	ROME, ITALY. Day and night transmissions.	12.115	ZNR	ADEN, ARABIA. 1 to 1:30	14.925	PSE	RIO DE JANEIRO, BRAZIL. North American beam, daily 7 to 8 pm.
11.947	—	MOSCOW, USSR. 7:30 to 11 pm.	12.19	—	MOSCOW, USSR. 6:48 to 7:25 pm.	15.105	JLG4	TOKYO, JAPAN. 7 to 7:45 pm. fades out about 10 pm.
11.970	FZI	FRENCH EQUATORIAL AFRICA. "Radio Brazzaville"; 3:45 to 4 pm; 11:30 pm to midnight.	12.210	TFJ	ICELAND. 7 pm; irregular.	15.11	DJL	BERLIN, GERMANY.
12.11	—	ALGIERS, NORTH AFRICA. 1 to 5:30 pm; "Radio France".	12.455	HCJB	QUITO, ECUADOR, "La Voz de los Andes" (The Voice of the Andes) in English daily at 8 am and 6 and 9 pm. At other times in Spanish.	15.11	—	KOMSOMOLSK, SIBERIA, USSR. 7:40 to 8:20 am; 5:15 to 5:40 pm; 6:48 to 7:25 pm; 9:15 to 9:40 pm; 11:15 to 11:40 pm.
			12.97	PPH	BRAZIL. 5:45 to 6:15 pm.	15.129	—	ATHLONE, IRELAND. "Radio Eireann." 2:30 to 5 pm.

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15.11	DJL	BERLIN, GERMANY.
15.11	—	KOMSOMOLSK, SIBERIA, USSR. 7:40 to 8:20 am; 5:15 to 5:40 pm; 6:48 to 7:25 pm; 9:15 to 9:40 pm; 11:15 to 11:40 pm.
15.129	—	ATHLONE, IRELAND. "Radio Eireann." 2:30 to 5 pm.
15.150	WNBI	BOUND BROOK, NEW JERSEY. European beam. 8 am to 5 pm daily.
15.155	SBT	MOTOLA, SWEDEN. 12 to 2:15 pm; morning transmissions.
15.170	TGWA	GUATEMALA CITY, GUATEMALA. Daytime transmissions.
15.175	—	EL SALVADOR. 1 pm to 2 pm.
15.19	OIX4	LAHTI, FINLAND. North American beam; 9:15 to 9:45 am.
15.20	DJB	BERLIN, GERMANY. North American beam; 7 to 9:45 am; 5:50 to 8:30 pm.
15.200	XGOY	CHUNGKING, CHINA. Asia-Australia-New Zealand beam, 6 to 8:30 am; East Russia beam, 6:30 to 7 am; Japanese beam, 7 to 7:20 am.
15.210	WBOS	BOSTON, MASS.
15.220	—	"VOICE OF FREE INDIA". 10 am to 12:05 pm.
15.220	—	"NATIONAL CONGRESS RADIO". (INDIA); 12:15 to 12:53 pm.
15.230	VLG-6	MELBOURNE, AUSTRALIA. 9:40 to 11:50 pm; 11:55 to 2 pm or am.
15.230	—	KOMSOMOLSK, SIBERIA, USSR. 7:40 to 8:20 am; 10:15 to 10:30 am; 5:15 to 5:40 pm; 6:45 to 7:25 pm; 9:15 to 9:40 pm; 11:15 to 11:40 pm.
15.250	—	VICHY, FRANCE. 11:15 am to 1:30 pm.
15.250	WLWO	CINCINNATI, OHIO. Latin America beam; 4:15 to 7 pm.
15.270	WCBX	BRENTWOOD, NEW YORK. European beam, 6 am to 4:30 pm. Rio beam. 5 to 7:45 pm.
15.29	KWID	SAN FRANCISCO, CALIFORNIA.
15.300	2RO6	ROME, ITALY. Day and night transmissions.
15.315	VLI-3	SYDNEY, AUSTRALIA. S. E. Asia beam.
15.330	WGEO	SCHENECTADY, NEW YORK. Afternoons.
15.345	FGA	DAKAR, SENEGAL, AFRICA. 3:15 to 5:20 pm.
15.350	WRUL	BOSTON, MASSACHUSETTS. European beam, 9:15 to 9 am.
15.430	—	ACCRA, GOLD COAST. Heard testing at 2:20 pm.
15.465	PRE9	FORTALEZA, BRAZIL; 5 to 9:08 pm; variable.
15.750	—	MOSCOW, USSR. North American beam, 7:40 to 8:50 am; Sundays, 8:20 to 9:30 am.
15.850	WCW	European beam. 6:45 to 9 am. 5:15 to 6:15 pm.

Mc.	Call	Location and Schedule
15.980	AFHQ	ALGIERS, NORTH AFRICA. 8 to 9:45 am.
16.025	AFHQ	ALGIERS, NORTH AFRICA. Variable times.
17.0	WLWO	CINCINNATI, OHIO. Afternoons.
17.72	LRA5	BUENOS AIRES, ARGENTINA. Fridays only, 5 to 5:30 pm.
17.765	—	VICHY, FRANCE.
17.775	OPL	LEOPOLDVILLE, BELGIAN CONGO. 2:15 to 3:45 pm; 4:15 to 4:30 pm.
17.780	WRCA	NEW YORK CITY. European beam. 9 am to 12:45 pm.
17.800	WLWO	CINCINNATI, OHIO. European beam, 10 am to 1 pm.
17.800	TGWA	GUATEMALA CITY, GUATEMALA.
17.830	WCRC	BRENTWOOD, NEW YORK.
17.830	WCBX	BRENTWOOD, NEW YORK.
17.840	—	ATHLONE, IRELAND. "Radio Eireann." 8:30 to 9:30 am, 1:30 to 2:15 pm.
17.850	PRL8	RIO DE JANEIRO, BRAZIL.
17.915	CR7B1	LOURENCO MARQUES, MOZAMBIQUE.
18.45	HBF	GENEVA, SWITZERLAND.
18.48	H8H	GENEVA, SWITZERLAND.
20.040	OPL	LEOPOLDVILLE, BELGIAN CONGO.
21.46	WRUL	BOSTON, MASSACHUSETTS.
21.52	WCAB	PHILADELPHIA, PENNSYLVANIA.
21.57	WCBX	BRENTWOOD, NEW YORK.
21.50	WGEA	SCHENECTADY, NEW YORK.
21.54	WBOS	BOSTON, MASSACHUSETTS.
21.59	WGEA	SCHENECTADY, NEW YORK.
21.63	WNBI	BOUND BROOK, NEW JERSEY.
26.5	—	RIO DE JANEIRO, BRAZIL; Radio Nacional; nightly to N. A.

THE NEW YORK TIMES IS SLIGHTLY BEHIND THEM

DRIFTING through the sacred pages of *The New York Times* the other day, we came upon a brief notation in the business column, quoting Arthur Freed, vice-president and general manager of Freed-Eisenman, a firm which used to make FM sets for civilian use back in the happy days when manufacturers could do things like that.

Anyhow, this column quoted Mr. Freed as saying 5% of the radio audience, and no more, really knows what frequency modulation is . . . a figure we're willing to accept, since we haven't a more authentic one to put forward, and since that term "really knows" is capable of assorted interpretations.

What gave us something of a turn, though, was the *Times'* blithe remark—attributed (erroneously, we're sure) to manufacturer Freed—that "FM is recognized by the trade and the Department of Commerce as on its way to be the post-war radio."

We're glad to have the Department of Commerce feel that way. We'd even like the Departments of Agriculture, Interior, Justice and Labor to share this reaction. And, particularly, would we like the Federal Communications Commission to feel the same optimism. But someone should take the dear old *Times* aside and whisper into its ear the news that the Department of Commerce itself doesn't regulate radio any more in this country. Hasn't in fact, for nigh onto fifteen years.—*FM Broadcasters*

FREE CATHODE-RAY TUBE MANUAL

What is possibly the most complete Cathode-Ray Tube Manual yet issued has recently been published by the Allan B. Du Mont Laboratories.

The Manual has a large section devoted to cathode-ray theory and design considerations. There are a number of pages devoted to the listing and specifications of cathode-ray tubes. The Z-axis amplifier is discussed, and time-sweep amplifiers are fully covered. There is also an application note on phase and frequency determination, showing the Lissajou patterns for the various checks.

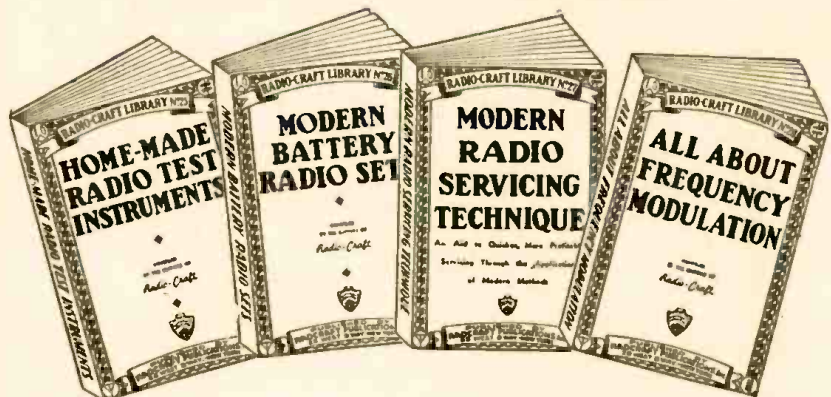
In the catalog section all Du Mont cathode-ray apparatus and tubes are described, with unusually complete specifications on each piece of apparatus.

A fine colored insert is included, showing 36 figures in the natural green of the cathode-ray trace, illustrating many different uses of the cathode-ray oscilloscope.

The book, printed on excellent paper in 8½" x 11" size and bound in loose-leaf form with flexible blue leatherette covers, is one of the most handsome as well as useful volumes which has come into this office for some time. Every manufacturer, research worker and designer will welcome it to his library. The book contains 114 pages.

The book may be obtained free upon request on a company letterhead. Send all requests to Cathode-Ray Tube Manual, c/o Radio-Craft, 25 West Broadway, New York 7, N. Y.

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THE four latest books of our well-known RADIO-CRAFT Red Books—Nos. 25, 26, 27 and 28—recently published. These four books are all on timely subjects and we recommend every one of them to you strongly. Now, more than ever, radio education has become a burning question. If you are to be in the National Service, in the Army, Navy or Air Force—practical radio knowledge is of paramount importance. **YOU CAN GET BETTER RATINGS AND ADVANCE QUICKER IF YOU HAVE A GOOD RADIO BACKGROUND.** Conversely, if you are not with the armed forces, there is a whole of a job to be done at home. With more and more men going into the service, the demand for practical servicemen becomes greater each day. Therefore we say: **PROFIT BY THESE UNIQUE BOOKS, WHICH ARE PRICED SO LOW THAT THEY ARE WITHIN THE REACH OF EVERYONE'S PURSE.**

No. 25—Home-Made Radio Test Instruments

Outline of Contents: A Low-Cost Signal Chaser—Signal Tracer Test Unit—Simplified Practical Signal Tracer—A Home-Made Infinite Resistance Tube Checker—Build This Direct-Reading V.-T. Voltmeter—How to Make a Modern V.-T. Voltmeter—Measuring High Values of A.C. Voltage and Current With a Low-Range Meter—How to Make a Meter-Range Extender—How to Build a Practical Tube Tester and Set-Analyzer Adapter—The Beginners' Simple Volt-Milliammeter—Build This Simplified Neon-Type Test Unit—Midset Oscilloscope—How to Make and Use a Frequency Wobbler—Double Tracing Your Oscilloscope—Home-Made Frequency Modulator.

No. 27—Modern Radio Servicing Technique

Outline of Contents: Elementary Servicing Technique—Correct Procedure for the Serviceman Beginner—Elementary Procedure for Servicing Radio Sets—A.F.C. Alignment Made Easy—Dynamic Servicing—Dynamic Testing Simplifies Servicing—Modern Receiver Test Requirements—Servicing Universal A.C.-D.C. Receivers—Servicing "Orphans" and Private-Brand Sets—Emergency Servicing Without Test Meters—Servicing Coils—Servicing R.F. Coils—Servicing Oscillator Coils—General Information—RMA Transformer Color Code—What Causes Echo, Fading?—Radio Service Puzzlers.

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Outline of Contents: Beginner's 1-Tube High-Gain All-Wave Receiver—Beginners' Build This 1-Tube Loop Receiver—A "3-in-1" Battery Portable—An Easily-Built "Fleewheeling Superregenerative" 2-in-1 "Card File" Battery Set—A 2-Tube Superhet. With Pentagrid Regenerative 2nd-Detector—The 4-Tube Superhet. Vacation Portable—The "Lunchbox 5" Battery Portable—The "Seafarer" Loop-Type Boat Radio Set—4-Tube Permeability Portable—An All-Purpose Portable—A Typical Commercial 3-Way Portable (Pilot Models X-1452 and X-1453)—Switch for Varying "Q"—Bias on Battery Radio Sets—Making a Simple Portable Aerial—Making a Pilot-Light Fuse—Old Auto Sets for New Cars—Using a Loop Portable in Cars—Quasi-Electric Soldering Iron—Lamp Bulbs as Resistors.

No. 28—All About Frequency Modulation

Outline of Contents: The ABC of F.M.—Frequency vs. Amplitude Modulation—Basic Facts About F.M.—Broadcasting—Construction—Build This Practical F.M. Adapter—Audio Amplification—F.M. Audio Amplifier, Part 1—F.M. Audio Amplifier, Part 2—F.M. Audio Amplifier, Part 3—F.M. Service—Part 1, Antenna Installation and Service—Part 2, Receiver Alignment and Diagnosis—Part 3, Test Equipment for F.M. Servicing—Engineering—Part 1, The How and Why of F.M.—Part 2, The How and Why of F.M.—Theory and Design Considerations of R.F. and I.F. Coils in F.M. Receivers.

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OUTPUT METERS ARE USEFUL

(Continued from page 659)

made in the customer's home under the actual operating conditions of the special location. A great deal is dependent upon the location, the field strength of the stations in the area and the efficiency of the receiving antenna, in the consideration of developed a.v.c. bias and the detuning effect of the bias change with signal variations.

It is possible to align using a D.C. vacuum tube voltmeter, set to read values of 1 volt or less, as M5, M6 and M7 in Fig. 1 (b). The a.v.c. bias is proportional, amongst other things, to the gain of the set, and since the gain will be greatest as we approach peak alignment, the a.v.c. bias voltage can be used as an indication of resonance and resonant step-up.

There is one other type of voltmeter not mentioned so far—the cathode ray oscilloscope. It can be used as an output meter by setting the sweep at one-half the modulation tone of the signal generator and the vertical plates of the scope can be connected through a blocking condenser to the plate-cathode or plate-ground points on the output stage of the receiver. It usually is not satisfactory with the average scope (because of somewhat limited sensitivity), to connect across the voice coil leads of the receiver's loudspeaker for the purpose of obtaining output voltage.

The scope has no peer, of course (no pun intended), in alignment involving the use of a "wobulated" generator. Flat top curves of over-coupled I.F. transformers can be obtained, I believe, only by using such equipment.

METERS IN THE DIODE CIRCUIT

It would also be possible to insert a D.C. microammeter, 0-50 or 0-100, in series with the diode detector load and measure the rectified current, which would serve as an output indication. In aligning frequency modulation receivers, the limiter grid current can be checked, as in the class C amplifier stage of a radio transmitter, and you tune for maximum current. The D.C. vacuum tube voltmeter can be connected to the two cathodes of the push-pull detector in the F.M. set and adjustments carried out for minimum potential difference between cathodes. It is also possible to use the A.C. vacuum tube voltmeter across the voice coil in the F.M. receiver and to use the generator amplitude modulated, tuning for minimum deflection on the output meter or lowest output sound. In the case of the vacuum tube voltmeter shown in the sketch, we would look for the reverse of standard amplitude alignment with regard to meter deflection. We would first get an indication on the instrument and then adjust the trimmers in the F.M. detector transformer for maximum deflection of the meter needle. Read this discussion carefully, since it is easy to get balled up due to the reverse action of the vacuum tube voltmeter in the sketch, a VTVM that gives lower meter readings, down scale, as the signal input voltage becomes larger. In F.M. alignment, using the indicated method for the detector, we want minimum signal at resonance since there is a balancing or bucking out action.

An incidental point is that M5, M6 and M7 will give practically the same readings if the VTVM is used. The A.C. VTVM can be set at 1 volt and placed across the audio input. When this connection is used, the receiver volume control will affect the voltmeter reading, and the control should be set at maximum as a general rule. In place of the VTVM for D.C. measurements indicating a.v.c. action, a plate circuit milliam-

meter may be used in series with the plate of an a.v.c. controlled tube.

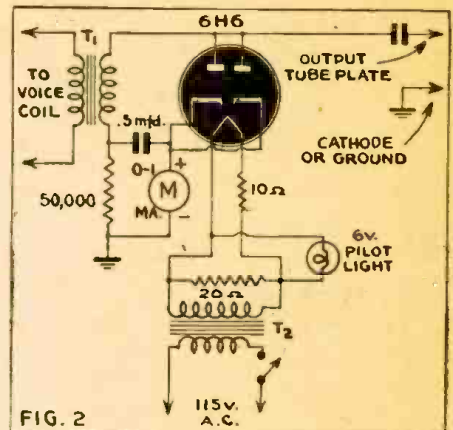


FIG. 2

OTHER TYPES OF OUTPUT METERS

Still another form of output meter is shown in Fig. 2. Transformer T1 is a simple bell transformer having a 6-volt primary which is connected to the voice coil and a 115-volt secondary which is connected to the diode rectifier. An ordinary output transformer may be used. The meter is an 0-1 Ma. standard type. The sensitivity is quite good on the voice coil connection and fair on the plate connection. Transformer T2 is a 6-volt filament transformer. Alternative connections to the output plate instead of the voice coil are shown. In Fig. 3 the neon output indicator type is shown. The transformer may be of the bell type. It gives fair results but is not much better, not as good in many cases as a good ear. The potentiometer may have a resistance of 100,000 ohms and the neon lamp can be a 1/4-watt type.

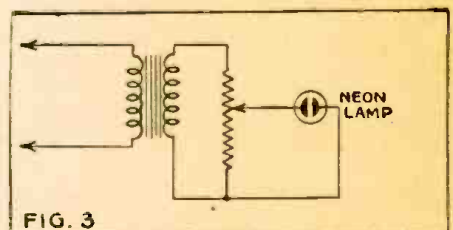


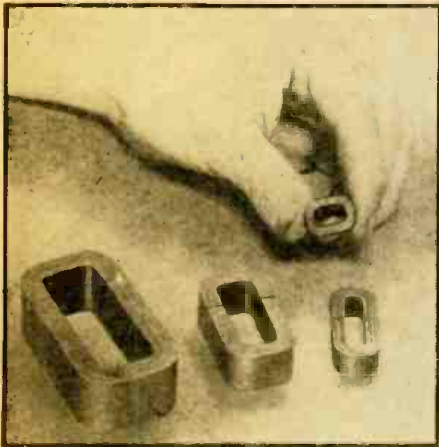
FIG. 3

There are many other variations. For example an electron-ray tube can be used as an output indicator, with the grid-cathode connected across a diode detector or rectifier load. But the circuit in Fig. 2 or in Fig. 1 is recommended if you have burned out your copper-oxide rectifier in your output meter and still have the D.C. meter available for service. Rectifiers, naturally, are out of the question at the present time because of the war and this hint should be the answer to many a serviceman's query of what to do about unobtainable rectifiers.

Sometimes an A.C. meter will measure D.C. more accurately than a D.C. meter. In cases where the output (unfiltered) of a rectifier or the input to a vibrator is measured, a D.C. meter measures the average value of the pulsating current, introducing an error. The A.C. meter measures effective values, and gives practically correct results on such pulsating currents.

NEW TRANSFORMER CORES

A notable step forward in transformer design has been made in the introduction of *Hipersil* cores, it was announced last month by Westinghouse. *Hipersil* is a compound word, formed from the first letters of High PERmeability SILicon steel. The new material has many of the advantages of special high-permeability alloys without their low magnetic saturation point. The new cores have important mechanical advantages as well. Because of their con-



struction, a whole core is slipped into the coil in one piece, greatly simplifying both assembly and mounting problems and cutting production costs.

The secret of *Hipersil* lies in the polarization of the steel crystals that compose it. In ordinary silicon steel, these are arranged in haphazard fashion. By a special treatment through heat and rolling, the crystals in the new medium all lie in the direction of easiest magnetization, giving the magnetic flux a smooth path. Naturally this results in a greatly increased permeability.

Construction of these cores is entirely different from that of the old laminated type. The steel is rolled in a thin continuous strip. This strip is wound around a mandrel of the size required to produce the desired window. When the core has reached the correct size, it is annealed, then vacuum-impregnated with a plastic compound which makes it a solid unit. The core is now cut into two segments. These are inserted in a form-wound coil and secured by means of a clamping strip. The labor of building up a core, lamination by lamination, is obviated, as is the necessity for clamping screws, wedges, etc., formerly needed to keep the laminations tight and avoid vibration.

The butt joint does not increase core losses, having been experimentally proved to be equivalent to an air-gap of only .0005 inch. It does, however, make a 2-piece core practical, and thus opens the way to a cheaper and more efficient method of transformer assembly. This secondary advantage, while unimportant in comparison with the greatly increased permeability of the core material, is by no means negligible in times of labor famine.

Hipersil cores should have a wide application in combat radio equipment, where greater flux-carrying ability and lower core losses make possible smaller transformers and chokes. A saving in weight of from 30 to 50% has already been reported by one manufacturer of radio transformers.

A special thin-strip core has a frequency range far above that of any previous solid core material, extending into the field now occupied solely by the powdered-iron core materials.

EXPERIMENTERS

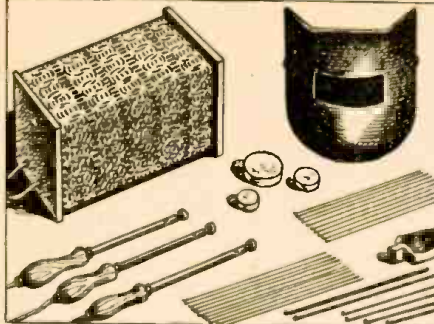
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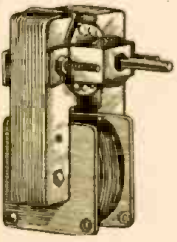
Sturdily constructed to precision standards, this self-starting shaded pole A.C. induction motor is powerful enough for a large variety of uses. Some of these are: Automatic Timing Devices, Current Interrupters, Electric Fans, Electric Chimes, Window Displays, Photocell Control Devices, Electric Vibrators, Small Grinders, Buffers and Polishers, Miniature Pumps, Mechanical Models, Sirens, and other applications.

Consumes about 15 watts of power and has a speed of 3,000 r.p.m. When geared down, this sturdy unit will constantly operate an 18-inch turntable loaded with 200 lbs. dead weight.

Dimensions: 3" high by 2" wide by 1 1/2" deep; has 4 convenient mounting studs; shaft is 3/16" diameter, and runs in self-aligning oil-retaining bearings. Designed for 110-20 volts, 50-60 cycles, A.C. only.

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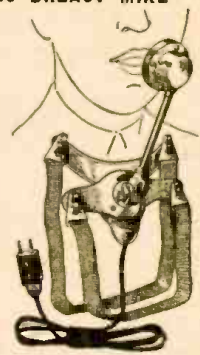
This is a fine light-weight aircraft carbon microphone. It weighs only 1 lb. Mike comes with breast-plate mounting and has 2-way swiveling adjustment so that it can be adjusted to any desired position. There are 2 woven straps: one goes around neck, the other around chest. Straps can be snapped on and off quickly by an ingenious arrangement.

This excellent mike can be adapted for home broadcasting or private communication systems. By dismounting breastplate, it can be used as desk mike. Comes complete with 6-foot cord and hard rubber plug. Finished in anodized plate, non-rustable.

THIS IS A BRAND NEW MIKE. IT HAS NEVER BEEN SOLD AT SUCH A LOW PRICE BEFORE. ORIGINAL LIST PRICE \$15.00. Shipping weight, 2 lbs.

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Here is an excellent rheostat especially designed to regulate speeds of small motors, such as our Handy Workshop Outfit. This rheostat can be used in connection with motors up to 1/20 h.p.

This fine rheostat is wire-wound on porcelain insulation. The black enamel steel casing is perforated for ventilation. Adjustable handle regulates speed of motor easily and smoothly. Size 5"x3 1/4" overall. Ship. Wt. 2 lbs.

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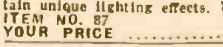
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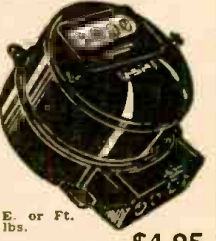


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(Continued from page 657)

Fig. 5-d shows the change made in the oscillator. C2 is the series tracking condenser usually found in the oscillator tracking circuit. It is removed and connected in parallel with C1, the oscillator tuning condenser.

While a parts list is given below, it must again be emphasized that this apparatus may readily be modified to use available components, and the list is given more as a reference than with the expectation that constructors will use the exact components listed.

Parts List

TRANSMITTER

Condensers

- C1—0.002 mfd. mica
- C2—350 mmfd. variable
- C3—250 mmfd. mica
- C4—0.02 mfd. paper, 600 volts
- C5—0.002 mfd. mica
- C6, C7, C8, C9—0.1 mfd. paper 600 volts
- C10—0.002 mfd. mica, 2500 volts
- C11, C12—350 mmfd. variable
- C13—0.002 mfd. mica, 2500 volts
- C14—0.1 mfd. paper, 600 volts
- C15—0.002 mfd. mica, 1000 volts
- C16—0.002 mfd. mica, 5000 volts
- C17—350 mmfd. variable
- C18, C19—These condensers correspond to C3 and C31 Figure 2C
- C20—0.002 mfd. mica, 1000 volts

Resistors

- R1, R2—50,000 ohms 1 watt
- R3—500 ohms 1 watt
- R4—25,000 ohms 1 watt
- R5—6,500 ohms 10 watts
- R6—200 ohms 10 watts
- R7—6,000 ohms 10 watts

Coil Data

- L1—160 turns No. 28 enam. on 1½ inch form, taped 50th turn from bottom.
- L2—90 turns No. 22 enam. on 3 inch form.
- L3—90 turns No. 22 enam. taped at center on same form as L2, half on each side of L2.

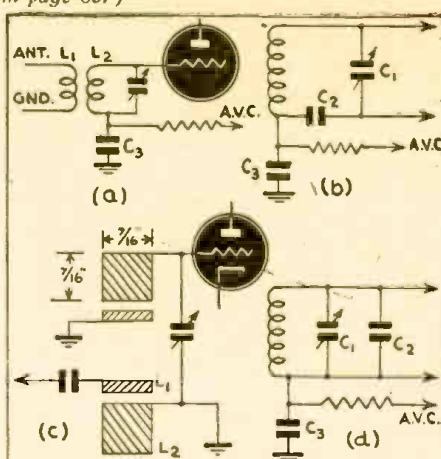


FIG. 5

L4—80 turns No. 18 enam. on 3½ inch form, taped at center.
L5—Adjustable; see text.
RFC—30 mh. choke.

MODULATOR CIRCUIT

Condensers

- C1—10 mfd. electrolytic, 25 volts
- C2—8 mfd. electrolytic, 450 volts
- C3, 10 mfd. electrolytic, 50 volts.

Resistors

- R1—0.5 megohm volume control
- R2—1000 ohms, 1 watt
- R3, 125 ohms, 10 watts

Miscellaneous

- T1—Single-button microphone to grid transformer
- T2—Interstage audio transformer
- T3—Modulation transformer, 5000 ohm plate-to-plate to 3000-ohm load.

HOW WE CONSTRUCTED A WARTIME OHMMETER.

(Continued from page 667)

There are two ways of doing this. One is to select a good range—say R100—measure a flock of resistors known or hoped to be reasonably accurate, and use the calibration thus made. This is more accurate than it sounds, and has the advantage of being quick—if you have the resistors at hand.

There is a way of calculating the scale, if you want to be more scientific. Whatever method you use, first mark out a scale. If possible, make 100 even divisions. Don't worry about calibration in ohms. That comes afterward.

Now, with our 100-division scale on the meter, which we will set on the R100 range, we will measure a few resistors. Let us suppose that resistor A measures 1 division; resistor B, 50 divisions; and C, 99 divisions. With no resistor being measured and the terminals short-circuited, our meter is at full scale, drawing 1.5 Ma. at 1.5 volts. Resistor A drops us back to 1/100th of that, or .000015 ampere. Thus we must have (Ohm again!) 100,000 ohms in circuit. But part of this resistance is R3 of our meter, which measures a thousand ohms. Thus Resistor A must measure 99,000 ohms, B and C 1,000 and 10 ohms respectively.

This can be put into the formula:

$$R_x = \frac{R_m}{\% \text{ of full-scale}} - R_m$$

where R_x is the resistance of the resistor to be measured, R_m is the total resistance of the meter, and % is the reading expressed as a decimal fraction of full scale reading. (Thus A read .01; B, .5; and C, .99 in our previous example.)

If this looks involved, think of it this way: With 1,000 ohms (the meter's own resistance) in circuit, total current drawn is 1.5 Ma. With resistor B inserted in series, current drops to half that. Obviously the resistance in the circuit has been doubled, as the voltage is unchanged. Therefore the resistance of B is equal to that of the meter—1,000 ohms. Resistor C adds 10% to the meter resistance, and is therefore 10 ohms.

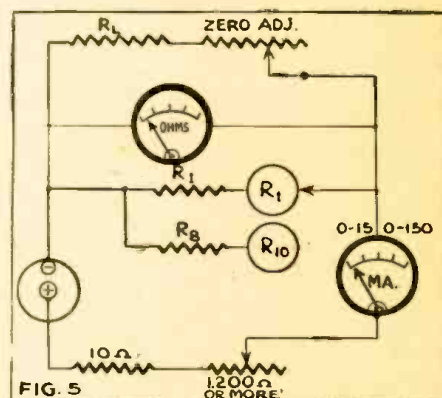


FIG. 5

Mark up your scale according to this formula, or use it to check results of calibration with resistors, then draw it in carefully and neatly with India ink, and you have what we promised you in the first place—A WARTIME OHMMETER.

By using the methods of calculation given here, the constructor can make an ohmmeter with almost any low-range meter as a foundation unit, and wartime conditions are likely to make him very glad he "done" it.

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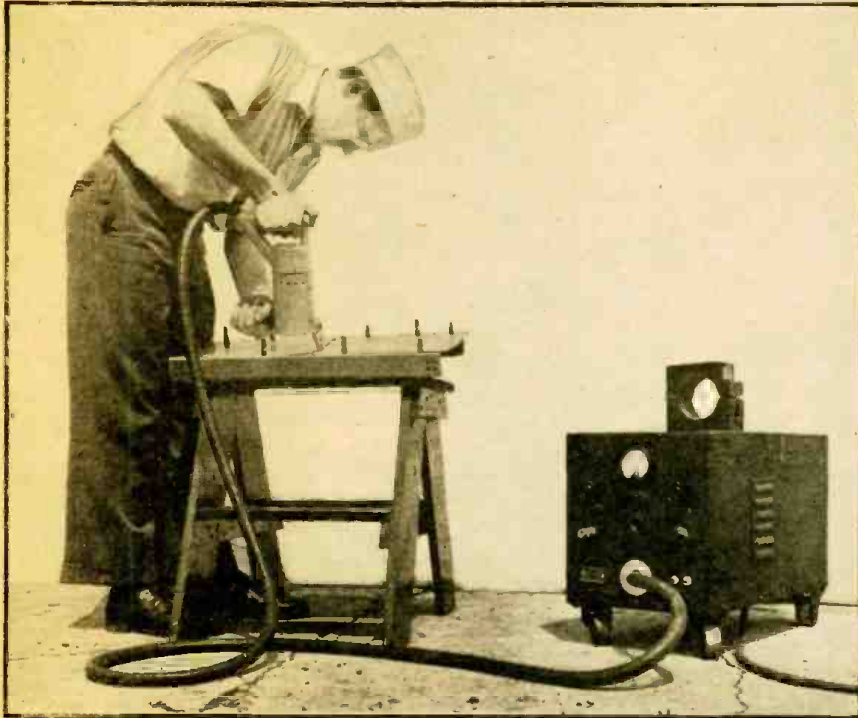
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RADIO RIVETER ON THE JOB

In a photograph released last month by Du Pont, the public has a chance to see how the Radio Frequency Detonator explodes rivets and speeds up construction of airplanes, ships and all other types of wartime construction in which rivets are used.

creates fires the charge. Radio energy not only gives instant temperature control but prolongs indefinitely the life of the firing tip, which is always cool, an important safety factor. The same tip is used for all kinds of rivet heads.



The new Radio Frequency Detonator in use, exploding rivets.

(See "Electronics Explodes Rivets and Glues Plywood," in February *Radio-Craft*.)

The workman, above, is holding the detonator on the head of a rivet, one of a line previously set in place. Radio frequency is turned on, and the field heats the rivet up to a point where the explosive tip fires, fixing it in place.

The photograph above shows how these rivets are made, and why the explosive rivet holds better than any other type. The hollow near the tip is filled with a high explosive, which when fired expands the tip. Thus rivets can be inserted and riveted from one side entirely, making it possible to rivet in many hitherto "unaccessible" places.

This system cuts down labor to a small fraction of the former figure through the saving in man-power required in heating the rivets, tossing them to the job, and "bucking" the rivet head as the hammer is applied to the tip.

The effect of the explosive tends to expand the shank out against the hole in the metal, making a much tighter job than was possible by older methods. Thus not only is the speed of work increased—the quality is improved at the same time.

As compared with the "blind" fasteners previously used in places where it was impossible to work from both sides, the improvement in quality is enormous. The advantage in speed is retained, the new rivets being installed at the rate of 15 or 20 per minute, as compared with 2 to 4 for most of the "blind fasteners."

Engineers of Radio Corporation of America and of Du Pont developed the radio unit, which consists of an oscillator together with a specially prepared applicator to concentrate current directly into the rivet head. As current is induced in the head, the heat it

FM "OUT" ON A TREE LIMB

ONE of the facts Joyce Kilmer never mentioned about trees is that they are tough on FM reception. We have a report from Walter J. Damm, president of FMBI and head of the *Milwaukee Journal's* W55M (also WTMJ), describing observations made there during the past year. In synopsis, it boils down to this—keep your FM receiving antenna clear of trees.

"Last fall," he says, "we noticed sudden increases in our field intensity at spotty locations. We were getting stronger signals than we had in the summer. We passed it off at the time, presuming it was due to changes and corrections being made on the W55M antenna.

"During the winter, however, Phil Laeser, our chief FM engineer, began thinking about this and studying it. He came to the conclusion that the cause was not as we had supposed but that it had something to do with foliage on the trees. In preparing reports, Mr. Laeser noticed that in each case where a receiver was in a home completely surrounded by trees, the effect had taken place. On the other hand, in buildings that were clear of large amounts of foliage, it had not been noted.

"Mr. Laeser decided to make observations this spring and selected a certain number of locations from which to do so. Now that the foliage is all out, he has arrived at some definite figures that may be interesting: Within our one millivolt line, where there is heavy foliage immediately surrounding the location, a drop in signal strength averages 15%. Outside the half millivolt line, the drop averages 50%. Mr. Laeser made checks periodically as the leaves were coming out on the trees and feels that he has definitely established this fact."—FM Broadcasters

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foremost short-wave authority

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There are thirty-eight charts, of which thirty-six cover the numbers of turns and inductive results for the various wire sizes used in commercial practice (Nos. 14 to 32), as well as the different types of covering (single silk, cotton-double silk, double cotton and enamel) and diameters of $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$, 2 , $2\frac{1}{4}$, $2\frac{1}{2}$, $2\frac{3}{4}$ and 3 inches.

Each turns chart for a given wire has a separate curve for each of the thirteen form diameters.

The book contains all the necessary information to give the final word on coil construction to service men engaged in replacement work, home experimenters, short-wave enthusiasts, amateurs, engineers, teachers, students, etc.

There are ten pages of textual discussion by Mr. Shiepe, graduate of the Massachusetts Institute of Technology and of the Polytechnic Institute of Brooklyn, in which the considerations for accuracy in attaining inductive values are set forth.

The book has a flexible fiber cover, the page size is 9 x 12 inches and the legibility of all curves (black lines on white field) is excellent.

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IS HOME REPAIR NONSENSE

Dear Editor:

I am a subscriber to *Radio-Craft*, which is a darn good magazine.

Among its many articles is one by a Mr. Fred Shunaman. Undoubtedly a good repair man but not a good judge of men.

Radio has always been my hobby, and while working for various manufacturers, I put in some part time going around to repair other peoples' radios. I had cards printed, had about \$150 worth of test instruments and about \$75 worth of tools.

People very often called me back again, because I took my time and *did a good job*. I knew how to trace circuits and read schematics.

I was able to work in the home, and at a fair charge from the customer. I had a stand for my soldering irons, and was careful of other peoples' belongings.

Mr. Shunaman calls such people gyps, possibly because he owns a store and has other expenses. They are not all gyps. Many of us have not the chance of having a store, or possibly there are some who would rather work in a factory, and make a little extra money on the side.

After this war is over, thousands of boys

will be coming out of the Signal Corps, with much additional knowledge, possibly more than the Serviceman who didn't serve in the war. These boys won't have the money to open stores, but they will have enough to buy a few instruments, and will be a great menace to Mr. Shunaman's plans.

There won't be jobs for all of them, and many civilian repairmen will be jealous. Naturally the army man will be able to put on his card the fact that he was in the war as a member of the Signal Corps. He will have certificates to prove it, and people will go to him because they will realize that he knows his stuff.

Have you a solution for this problem?

AN ARMY PRIVATE

(An interesting viewpoint is opened up here. What do our readers think? There is one slight misconception, however. The article, “Home Radio Repair, etc.” did not suggest that all home repairmen were gyps. The stand taken was that repair in the home, suggested as a means of combatting the gyp, actually did no such thing, but that the gyp type of serviceman was the only one who could profit by such home repair.—Editor)

NEW RADIOMEN AND “RUBE GOLDBERGS”

Dear Editor:

After a hard day's study in a school where the temperature varies between 96 and 98 degrees, it gave me great delight (!!) to read Mr. Philip E. Rimer's letter.

How any person in this time of crisis could have the gall to write about such trivia as his “Imps” and then go on to run down the Armed Services is beyond me?

If he thinks the Government's devices are “Rube Goldbergs” why doesn't he spend his time trying to make a simple gadget to do the work?

As long as he only has to worry about flipping the “On” switch instead of the safety on an “M-1”, I hope he can't get his radio repaired!

CPL. F. S. G.
U. S. Air Forces

(Since many radio men have entered the field recently, and may be as puzzled as our correspondent by the term “Rube Goldberg,” a little history is in order:

The expression dates back to an investigation into repair “rackets” run by a large magazine in early 1941. The investigators were strictly honest but sadly non-technical. They found that dishonest servicemen were able to discover good tubes “bad” on test

instruments, and promptly decided that these mysterious be-dialed devices, (which to their simple minds resembled the fantastic inventions of a Rube Goldberg), were constructed for the express purpose of cheating the customer, and expressed some doubt as to whether they had any other use. [See *Radio-Craft*, Sept. 1941 and July, 1942.]

The result was that for months afterward a serviceman could not use a condenser analyzer or check a tube without being practically accused of attempted theft by readers of these “exposés.”

Mr. Rimer did not agree with the point of view of these investigators. No one who has any knowledge of radio test instruments could. He was expressing a bitter and savage joy at the fact that the persons who had been so easily convinced of the uselessness of the “Rube Goldbergs” are now finding out—to their pain and astonishment—that without such instruments their serviceman cannot repair their favorite radios. Every serviceman smarted (as indeed does Cpl. G.) at this characterization of his test instruments, and Mr. Rimer is entitled to a bitter satisfaction over the fact that the layman who scoffed at them is now being convinced—the hard way—that they really are useful and necessary.—Editor)

INTERESTED IN NEW TUBES

Dear Editor:

I have been a subscriber to *Radio-Craft* for seven years, and prior to that I was a subscriber to Hugo Gernsback's old magazine, *The Electrical Experimenter*. My purpose in writing you at this time is to express my interest in and enjoyment of your magazine in recent months—particularly since you have been running the articles on Electronics and Electric Theory. Since you have been running these particular articles I find myself reading the magazine from cover to cover, not wanting to miss a single paragraph. I am interested in radio from the standpoint of the experimenter—

not the serviceman—and consequently I much enjoy articles explaining the basic theory of various electric laws and tube theories.

My profession is Electric Engineering, and I wonder if you can let me have more information on the Lenard Ray tube and the Supervisory Protector Tube, taken from the excellent article by Ira Kamen. I would also like to have more information on the Magnetron, Ignitron and Thyatron tubes.

CLARENCE KLASNER,
Alton, Illinois

WOULD LIKE A TRADING EXCHANGE

Dear Editor:

I am, and have been a subscriber to *Radio-Craft* for the past five years and think that it is the best magazine obtainable for the serviceman. I would like to present to you my personal suggestion, and I am sure that every other serviceman in our nation would back me in making this suggestion:

Due to the fact that our government has priority on most new radio parts and supplies, and full priority on all radio testing equipment, *Radio-Craft* could not serve a better purpose during the duration than to simply edit within its pages, a "Trading Post Section." One where we servicemen can make known our wants and disposals regarding used radio parts and test equipment.

Cornell-Dubilier endeavors to run a similar section in their little pamphlet, but it is not published regularly, at times as long as four months elapse between copies.

I feel sure that much good can be accomplished through just such a section in *Radio-Craft*, because there are many servicemen who are in a condition similar to mine, stranded because of the need of essential testing equipment and some supplies.

HENRY L. MILLS,
Los Angeles, Calif.

(Mr. Mills has possibly overlooked the fact that the Sprague Trading Post [see our advertising pages] runs regularly in *Radio-Craft*, and that therefore any section that might be set up by ourselves would merely duplicate their effort, which was the source from which he obtained this idea.

If Mr. Mills and others send their wants and list their surplus instruments, etc., with the Sprague Trading Post, thereby swelling the amount of material it has to publish, it is probable that it will appear oftener. —Editor)

DIAGRIMPS AT WORK AGAIN!

Dear Editor:

In looking at my article on Page 542 of the June issue I note a mistake in the diagram. The potentiometer R1 should run from its present connection at the neon lamp on the positive side of the line, directly across to the negative line, so that the screen-grid voltage, which varies the sensitivity of the Floating-Grid Relay, may be set at any desired point.

As it is now, this potentiometer is of little use in the circuit, both ends being at the same potential. It merely acts as series resistor, with a maximum but half its rated value.

J. H. SHAY,
South River, N. J.

ERROR IN TEST PANEL DIAGRAM

Dear Editor:

I have just finished building the test panel in the June issue, housed it in an old sloping front radio cabinet, and am very much pleased with it.

In the diagram, a wire goes from the center pole of the SPDT switch to the right-hand binding post of bulb test D. Another wire is shown going without connection from the right-hand binding post of the 6-volt outlet to the left-hand post of the buzzer test. Obviously these two wires should be connected to complete the circuits.

ROBERT C. SANDISON,
Denver, Colo.

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This book contains a number of excellent sets, some of which have appeared in past issues of RADIO-CRAFT. These sets have been carefully engineered. They are not experiments. Not only are these sets described in this book, but it contains all of the illustrations, hookups, etc.

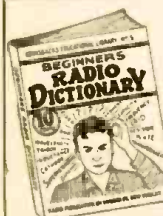


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This book explains the theory underlying the various types of aerials: the inverted "L," the Doublet, the Doublet, etc. It explains noise-free reception, how low-impedance transmission lines work; why transposed lead-ins are used. It gives in detail the construction of aerials suitable for long-wave broadcast receivers, for short-wave receivers and for all-wave receivers.

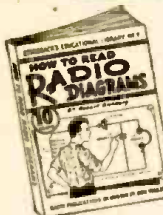


No. 5 BEGINNERS' RADIO DICTIONARY

Are you puzzled by radio language? Can you define Frequency? Kilocycle? Tetrad? Screen grid? Bottle Anode? Triode? Pole? Ionization? Joule's Law? Harmonic? Gravity Cell? If you cannot define these very common radio words and dozens of other, more technical terms used in all radio magazines and instruction books, you need this book in your library.

No. 6 HOW TO HAVE FUN WITH RADIO

Stunts for parties, practical jokes, scientific experiments and other amusements which can be done with your radio set are explained in this fascinating volume. It tells how to make a newspaper talk—how to produce silent music for dances—how to make visible music—how to make a "silent radio" unit usable by the deafened—how to make toys which dance to radio music, etc. etc.



No. 7 HOW TO READ RADIO DIAGRAMS

All of the symbols commonly used in radio diagrams are presented in this book, together with pictures of the apparatus they represent and explanations giving an easy method to memorize them. This book by Robert Eichberg, the well-known radio writer, also contains two dozen picture-wiring diagrams of simple radio sets that you can build.

No. 8 RADIO FOR BEGINNERS

Hugo Gernsback, the internationally famous radio pioneer, author and editor, whose famous magazine, RADIO-CRAFT is read by millions, scores another triumph with this new book. Any beginner who reads it will get a thorough ground work in radio theory, clearly explained in simple language, and through the use of many illustrations. Analogies are used to make the mysteries of radio clear.



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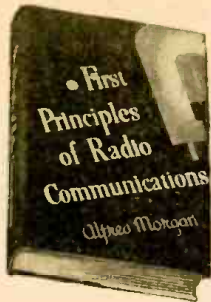
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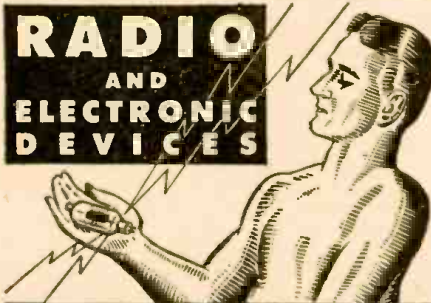


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TIGHTER SPECS RESULT IN FEWER REJECTIONS

A case where tightened specifications by the Armed Services resulted in a decrease instead of an increase in the number of rejections is reported by the War Production Board.

The material in question was high-frequency cable, which had to pass stiff tests. Manufacturers revised designs and manufacturing techniques, and used stronger materials. In this they were aided by the specifications, which gave the manufacturers more leeway in designing their product, while demanding better performance.

"SELL TUBES" ORDER HARMS SMALL SERVICEMAN

THE little serviceman—used to being up against it—has now run into another trouble. He sees ruin, or possibly jail, staring him in the face as the result of a recent OPA order which was designed to do harm to no one but a new and particularly despicable group of racketeers who have recently sprung up in the radio sales and service field.

These individuals, who, like all other types of racketeers, were alert to turn others' distress to their own profit (and to use the national emergency as a means of lining their pockets), ceased selling radio tubes, and demanded that any customer who needed one must bring in his set, paying an extra bench charge for the privilege of obtaining the necessary replacement.

The OPA order, that any store which previously had a policy of selling tubes, must now sell tubes on demand by a customer, was aimed against this practice. If radio store patrons have the guts to enforce their rights, it should have an excellent effect.

The term "policy" in the order has left the small radioman in a hole. He has never displayed or attempted to merchandise tubes. Yet more than nine out of ten such small repairmen would usually sell a tube from his stock to a customer if he was asked for it. Such sales might not amount to a half-dozen a week, but they were enough to fix his policy in the eyes of the authorities. He had a "policy" of selling tubes, but not a "practice" of doing so.

Now, with the shortage of tubes, radio owners are running from store to store, and from shop to shop, looking for hard-to-obtain types, and the little serviceman could sell over the counter far more tubes than he used to need for all his work—if he could get them! He is faced with the alternative of disposing of stock that he always used (and still needs) to help him in his general repair work. With his tube stock depleted, he is seriously handicapped in a time when one more handicap may mean the difference between staying in or going out of business.

The tube-for-tube order makes it more difficult for radio owners to purchase simply to hoard tubes for an apprehended period of greater shortage. That eases his path somewhat, but still does not rectify the main injustice—that he is required to carry on a type of business in which he had not been engaged prior to the order.

There is another possibility for misunderstandings under this regulation. It is not good radio service to sell certain tubes without having the customer's radio on the bench for checking. I have always declined to sell any type of rectifier, pointing out to the customer the likelihood that the new tube would go the way of the old one, and urging that he have his filter condensers checked before replacing it. If he insisted on taking the tube anyway, he was thoroughly impressed that we would not be responsible for the consequences. It is hard indeed to convince many men that the tube which burned out five minutes after being placed in the socket was perfectly good, especially if it replaced one which "worked perfectly for two years."

It would seem that under the circumstances the order should make a sharp distinction between stores—which made a practice of merchandising tubes as a regular part of their business—and radio repair shops; in which the sale of tubes was purely incidental, as an accommodation to the customer, and was practised more for advertising than for the profits accruing from the occasional sale. Thus the racketeer

could be curbed without hamstringing the small repairman on whom the radio public depends to keep its receivers in working condition for the duration.

JUNE INTER-COMMUNICATOR

The parts list for the inter-communicator hookup printed at the bottom of Page 552 in the June issue was inadvertently omitted. Here it is:

T1 Transformer, voice coil to grid.
T2 Output transformer.
(An ordinary output transformer, hooked up backward, can be used for T1.)
R1—5,000 ohms.
R2—1 megohm.
R3—250,000 ohms.
R4—500,000 ohms.
C1—5 to 10 mfd. low voltage type electrolytics.
C2—0.25 mfd.
C3—.05 mfd.

Somewhat better results will be obtained by reducing the cathode resistor of the 56 tube to about 3,000 ohms.

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(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.)

BOOK REVIEWS

ELEMENTS OF RADIO, A Pre-Induction Training Course. By Charles I. Hellman. Published by D. Van Nostrand Co. Stiff cloth covers, 6 x 9 inches, 318 pages. Price \$2.00.

Written to meet the War Department requirements as set out in Outline PIT 201, this is an elementary text which presupposes no knowledge of radio. The language of the text is in keeping, easily-understood phrasing being employed throughout the book. The student is taught to calculate ordinary electrical quantities, but mathematics is kept to the simplest possible forms for the work to be done, and so handled as to be easily grasped by any trainee.

The historical approach, abandoned by many recent texts, is used in the first chapter. A sketch of the beginnings of radio is given, followed by a brief chronography of radio communication from 1865 to 1935. The historical account of antennas as used by Hertz and Marconi develops into an explanation of the use of an antenna, and the trainee is introduced to the broad features of receivers, transmitters and frequency assignments in an equally brief outline which ends with a discussion of radio symbols. This forms an introduction to the actual study of electrical theory which begins in the next chapter.

An interesting feature is the question-and-answer technique which runs through the book. The chapters are divided into short sections, heads of which are in most cases questions, which are answered by the subject matter of the text. Thus the trainee is able to keep the subject of discussion clearly in mind exactly at all times. A number of sections have straight label headings, the question-and-answer method not being carried beyond the point where it ceases to be useful.

A number of questions or projects—of a practical nature—are given at the ends of chapters. In some cases the student is warned that experiments may not turn out exactly as the theory would seem to indicate. He is given the practical reasons why this may be the case. An appendix at the end of the book gives the new student hints on breaking up old radio receivers for parts to be used in the course.

BASIC ELECTRICITY FOR COMMUNICATIONS, by William H. Timbie. Published by John Wiley and Sons. Stiff cloth covers, 6 x 9 inches, 603 pages. Price \$3.50.

One of the chief difficulties of an elementary radio book is that it must devote the first half of its contents to matter not purely radio. Fundamental electrical laws, alternating current theory, and even such subjects as inductance and capacity, belong to electrical theory as a whole, and their treatment in a radio text cannot be handled in a manner much different from that of any electrical handbook.

Timbie's book takes over the task of teaching the fundamental electrical theory needed by the communications student, and being able to devote a book to the job, does it better than a work in which electrical theory is skipped rapidly over in order to introduce the radio angle.

The last two chapters, indeed, are spent in discussing vacuum tubes and communication systems. This is only reasonable,

however, for electric conduction in gases and vacuum has now become an important part of the whole picture of electric conduction, and as such could not be omitted by the electrical student.

An excellent feature of this book is the large number of problems, not only at the ends of chapters, but wherever a few problems would serve to illustrate the point under discussion. This feature, and the general simple and elementary style, should make it valuable, especially to the person who realizes that he must know considerably more about electrical theory before he can reach a complete understanding of radio.

ALLIED'S RADIO CIRCUIT HANDBOOK, published by Allied Radio Corporation. Brown fibre cover, size 8½ x 11, 40 pages. Price 10c.

Following the ancient maxim "One picture is worth ten thousand words," the Technical Staff of Allied Radio have prepared a "course" of 42 radio circuits, graduated in complexity from a simple power supply filter to a communications superhet. Fundamental circuits, such as diode and triode detectors, oscillators, a.v.c. and phase-inverters start the series, followed by receivers with from one to five tubes, amplifiers, transmitters and test devices, as well as others.

Wiring diagrams as well as schematics are given for all receivers and other pieces of apparatus illustrated. Some of the more complicated pieces receive two pages, with the schematic at the top of one and the wiring diagram on the page facing, about one page of text describing and explaining the device.

This booklet will be useful for pre- or post-induction training courses, as well as for the student who may find in a number of circuits well drawn to provide easy reference, a substitute for now unobtainable experimental equipment.

ALLIED'S RADIO DATA HANDBOOK, edited by Nelson M. Cooke. Published by Allied Radio Corporation. Flexible fibre covers, 6 x 9 inches, 48 pages. Price 25c.

This book, say the publishers, was printed to meet the need for a comprehensive, condensed book of formulas and data most commonly used in the field of radio and electronics. It is purely a reference work, only enough text being used to explain the use of the charts given.

There are four sections: mathematical data, radio and electronic formulas, engineering and servicing information, and a complete set of four-place tables of natural trigonometric functions and common logarithms.

A glance at the Index shows such items as coil design, conductance, coupled inductance, decibels, interchangeable tubes, meter formulas (shunts and multipliers), open-air transmission lines, plug-in ballasts, quadratic equations, RMS color codes, susceptance, vertical antenna capacity and wire tables.

The book is beautifully made up on excellent paper, the charts being exceptionally

clear and easy to read. The inductance-capacitance reactance-frequency chart is especially worthy of note. It is continued through 3 pages, covering the field from 0.002 microhenry to 1000 henrys and from 1000 cycles to 1 megacycle.

ALTERNATING-CURRENT CIRCUITS, by Earle M. Morecock. Published by Harper & Brothers. Stiff cloth covers, 6 x 9½ inches, 175 pages. Price \$2.75.

A thorough knowledge of alternating-current principles is necessary to every student of radio. This is one of the books written to cover that ground, and cover it well it does, though written for the general A.C. student, with no particular consideration for the man who is interested in high-frequency circuits.

An encouraging feature to many whose mathematical knowledge is not extensive is the treatment given to all subjects in which calculations are involved. Simple trigonometry is used, all calculations being confined to rectangular and polar co-ordinates.

Another feature of value to the independent student is the set of problems at the end of each chapter. These may be used for self-examination; the correct answers being given in an appendix. Numbers of laboratory experiments are also worked out.

A complete five-place table of natural trigonometric functions is included in one of the appendices. Discussion of the correct method of laboratory report writing and instructions for plotting graphs, as well as a table of square roots, form the contents of others.

This is an especially useful work for the student who desires to obtain—besides his alternating-current theory—a grasp of electric transmission and power systems, including polyphase circuits.

ELECTRICAL TRANSDUCERS AND WAVE FILTERS, by Warren P. Mason, Ph.D. Published by D. Van Nostrand Co. Stiff cloth covers, 6½ x 9 inches, 333 pages. Price \$5.00.

An interesting example of the results sometimes to be obtained by reversing traditional practice is given in this book. The author points out that the early study of electrical theory was helped by mechanical analogies, made possible by the fact that electrical and mechanical motions are governed by the same principles. The path of the electric student was made easier and speeded by the application of principles already known, and which could be demonstrated by mechanical apparatus.

As electrical wave filter and general electrical network theory developed, the study of combinations of electrical networks progressed much farther than studies of similar mechanical or electro-mechanical networks. This book now reverses the practice of the rising period of electrical theory, and applies electrical wave filter and network theory to mechanical systems, drawing from electrical circuits analogies to explain the actions of mechanical combinations.

(Continued on following page)

• RADIO SCHOOL DIRECTORY •

Among the subjects thus handled are acoustic filters; the moving coil loud-speaker; vibration of membranes and plates, and mechanical filters. Resonance in mechanical vibration is considered, as well as practical vibration-reducing circuits and the theory behind them (as in vibration dampers, for machinery and sound-proof walls).

This is no book for the casual reader with a spare afternoon. The approach is

mathematical, and there is more than one sequence of three or four pages of equations, with just enough English to hold them together.

Although all parts of this book will be useful to the radio and electronic technician, he will be particularly interested in the chapters on electromechanical converting systems. The piezo-electric crystal receives the fullest treatment, though space

is also given to magnetostrictive systems, the ordinary acoustic transducer, and even the electrostatic converter, as used in the condenser microphone and formerly in condenser-type speakers. Another chapter is devoted almost entirely to the crystal as an electromechanical element in wave filters, though the magnetostriction type of filter element is also covered as adequately as its relative importance requires.

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The chart is printed in large clear type on a colored background. It is invaluable for radio service shops, manufacturers, schools in which radio courses are given, and to any others who require constant and complete information on resistor and condenser color codes. Compact and easily read, it presents all this material in one place and in ready reference form.

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UNCLE SAM'S FLEET USES SOUND-ON-TAPE EQUIPMENT

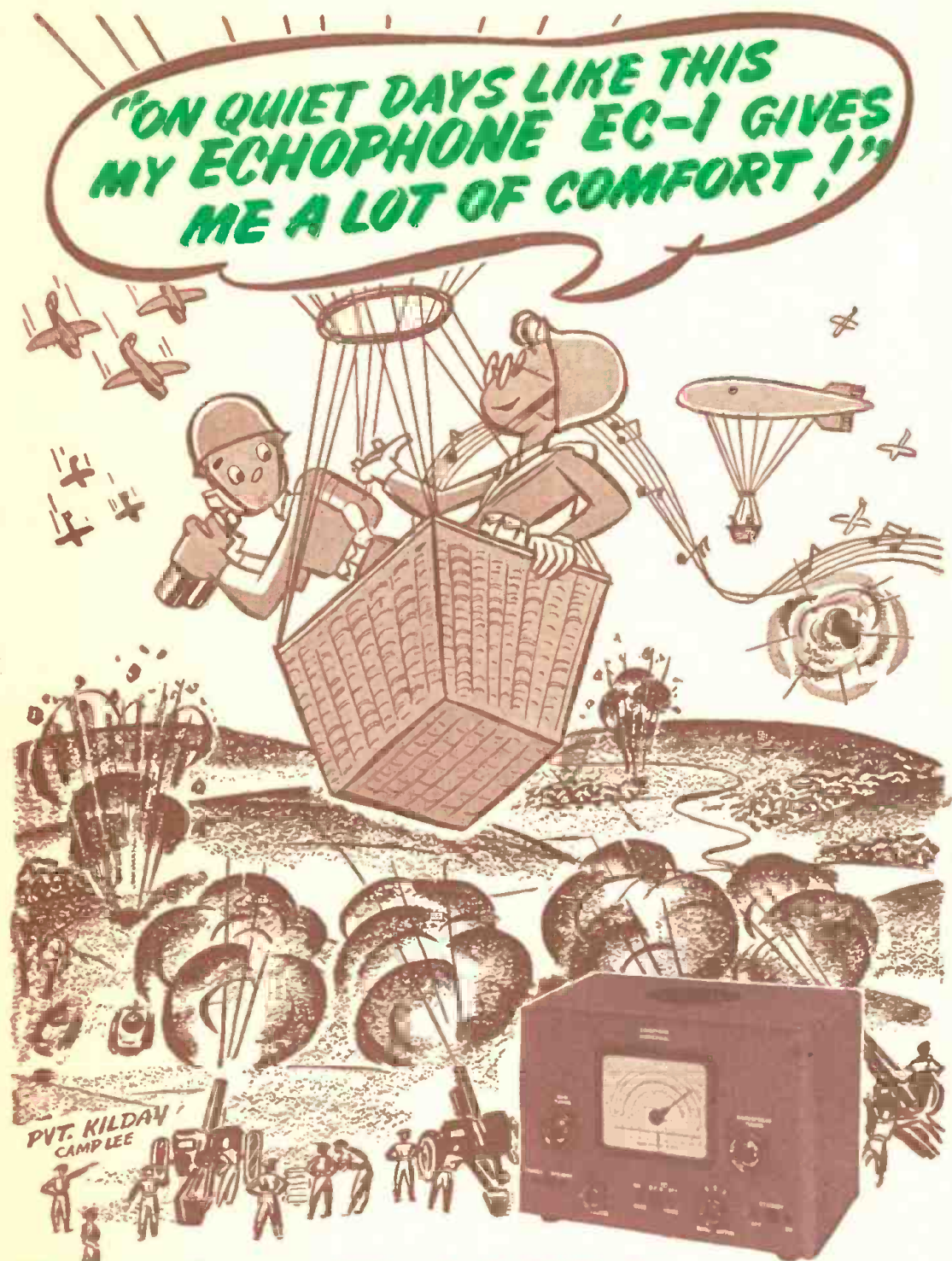
Modern sound-on-wire recording apparatus is now standard equipment on many Navy ships, Commander Clifton G. Grimes, head of the Interior Communications and Fire Control section of the Navy's Bureau of Ships, told radiomen last month. Recording apparatus is also used at Navy shore headquarters.

The most valuable use of the sound-on-wire machines is to record conversations during a battle, thus making a complete log at a time when such a record is most important, but when ships' officers have the least time to jot down entries in a book. During and after the last war, the lack of continuous records during the battles then fought was found to be a serious strategic defect. "A ship's log doesn't amount to much when you start looking around for it after a battle," said Com. Grimes.

Records are also made of all important conferences on board. The machines monitor all radio circuits, and in addition are used as dictaphones. Peculiarly adapted to use under conditions aboard ship, the sound-on-wire recorder is expected soon to supersede disk and cylinder types of dictating machines. Unaffected by the ship's roll, these devices will work perfectly even in an upside-down position.

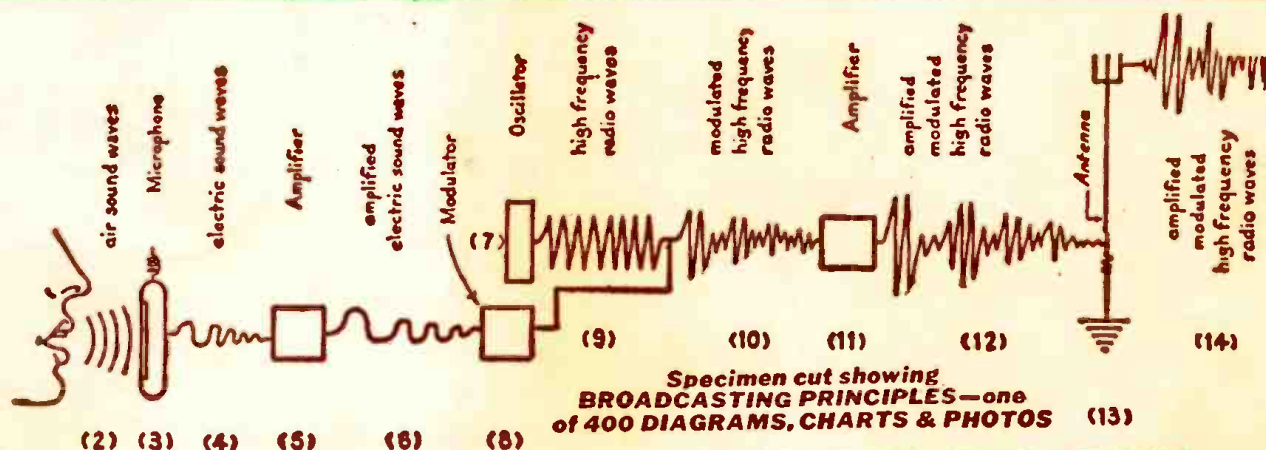
The idea of a magnetic recorder is by no means new. The Navy has experimented with this type of device as long as ten years ago. Sound on round wire systems had many disadvantages, and only after the development of a flat magnetic tape instead of wire as a recording medium did "sound-on-wire" become completely practical. The original sound-on-wire apparatus is the earliest known means of electrical sound recording. The method was patented in Denmark by Valdemar Poulsen in 1857.

(Sound-on-tape recording apparatus was described in the April, 1942, issue of *Radio-Craft*.)



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