RADIO NEWS

MAY
1943
25c
In Canada 30c

AIR RAID ALARM CIRCUITS

RADIO-TELEPHONE FOR MP's ★ WARTIME PROGRESS IN ELECTRONICS

NO. 1 IN A SERIES EXPLAINING THE USES OF ELECTRONIC TUBES IN INDUSTRY

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to show how I train you at home in spare time for Good Jobs in Radio

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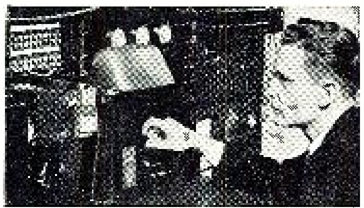

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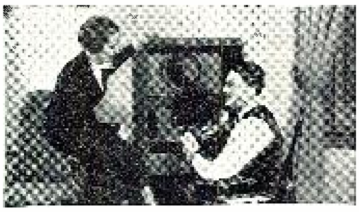

Radio Repairing is a booming business today because no new Radios are being made. Many make $50 a week in full time jobs—others $5, $10 a week EXTRA for spare time work!

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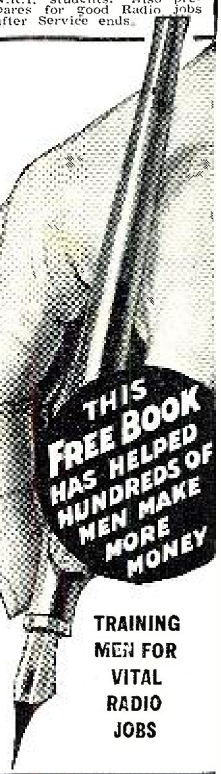

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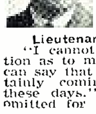

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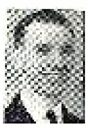

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MAY, 1943

RADIO NEWS

★ *Published Every Month—Since 1919*

Vol. 29, No. 5

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DEPARTMENTS

On The Cover: Army Air Force Radioman Establishes Contact To Plane
AAFTTC Photo

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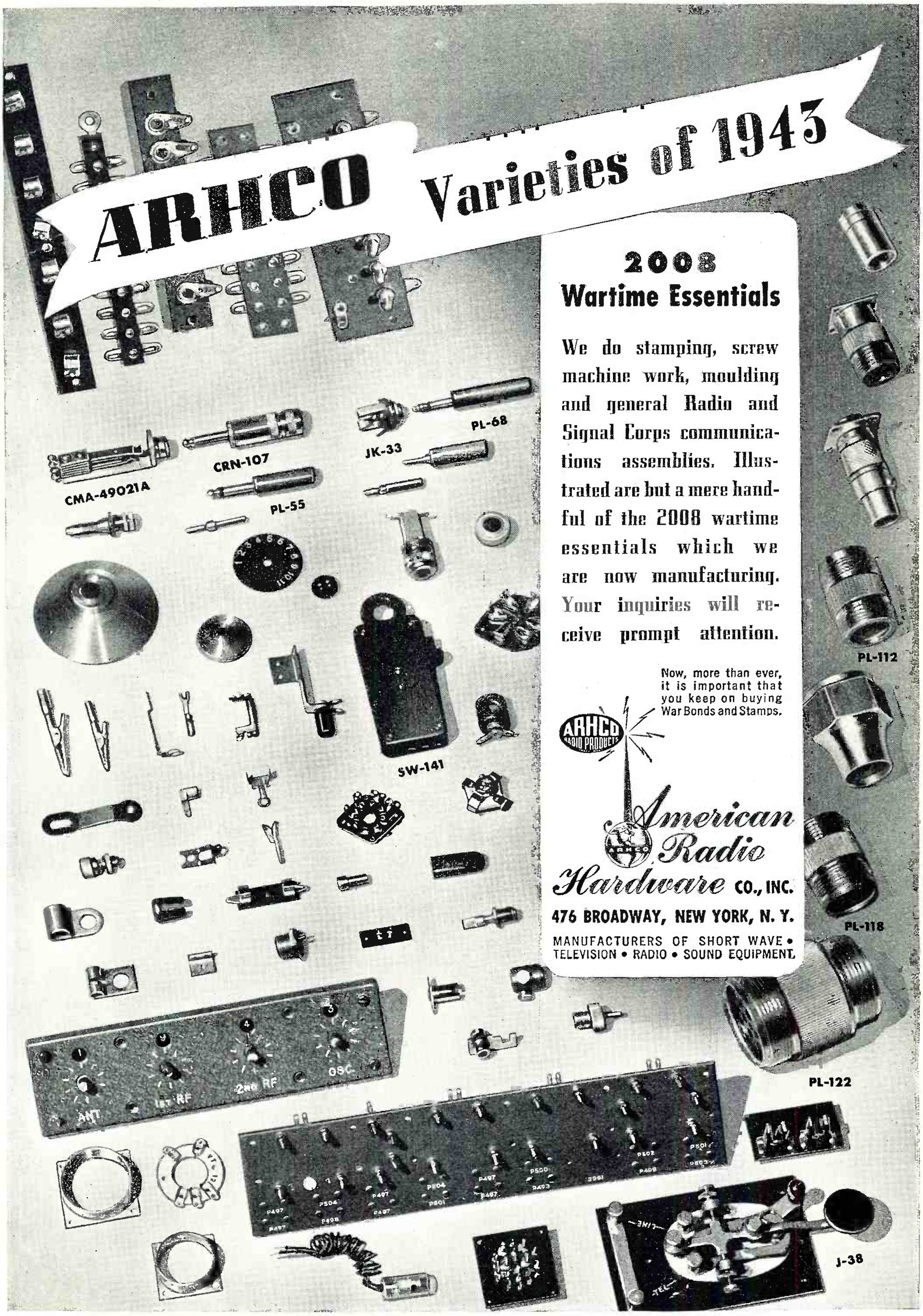
FOR THE *Record* BY THE EDITOR

THERE is considerable misunderstanding regarding the use of two terms used to define one particular science. One is of British origin (electronic), the other is American (radionic). To the casual radio listener, for example, the use of the word "electronic" appears as a term used to describe a revolutionary new art or science. Such is not the case, however. If we accept "electronic" as embracing the entire field of radio, television, etc., the terminology becomes more and more confusing. If sufficient interest is aroused chances are that reference will be made to a dictionary for an explanation of the term. This will add to the confusion, and gradually the word becomes more and more mysterious. When the average person thinks of the radio field and all that it represents he includes such equipment as television, facsimile, radio receivers, transmitting equipment, marine equipment, aviation equipment and all other devices which employ the use of one or more vacuum tubes. Why then would it not be most appropriate and timely to adopt a term which would be more *all-embracing* and one more *descriptive* and more easily understood by laymen? Such a term is "radionics." In its simplest form, radionics would be understood by we Americans as being an all-inclusive term of any equipment or science where the use of vacuum tubes is employed.

Let us consider for a moment new developments in radio communications, frequency modulation, television, photo-electric units, phonographs, hearing aids, diathermy, cosmic ray recorders, the application of magnetrons and klystrons. Add to these the cyclotrons that made atom-smashing and transmutation a reality. In deciding between one or more terms are we to be influenced by precedent? Remember the early physicists believed atoms to be made of protons and electrons. Now scientists have found in nuclear physics a number of other entities, namely, the positron, neutron, deuteron, etc.

(*Continued on page* 74)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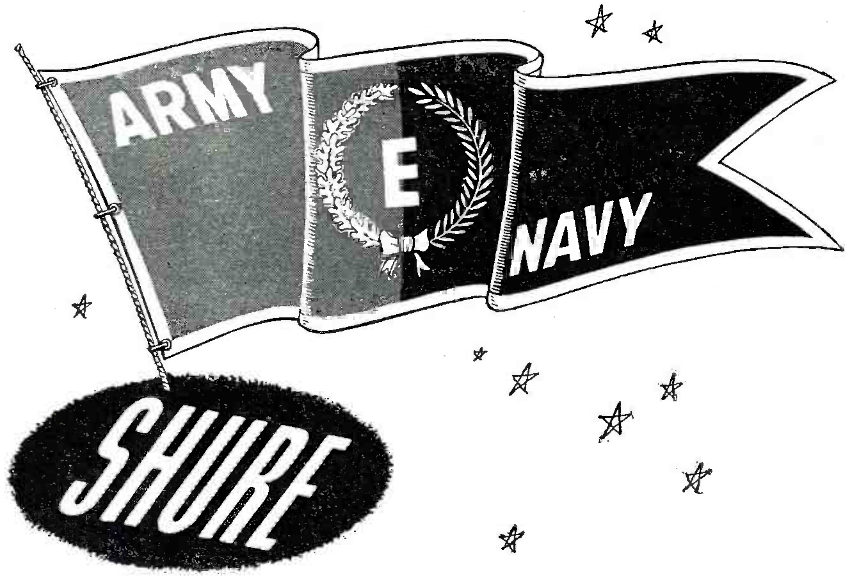

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The Army and Navy "E", symbol of outstanding achievement, has been awarded to Shure Brothers. It is the highest badge of honor for the victories of the soldiers on the production front that must come before the victories of the soldiers at the fighting fronts. Shure Brothers are united in the determination to do their utmost to hasten the day of final victory for the democratic forces.

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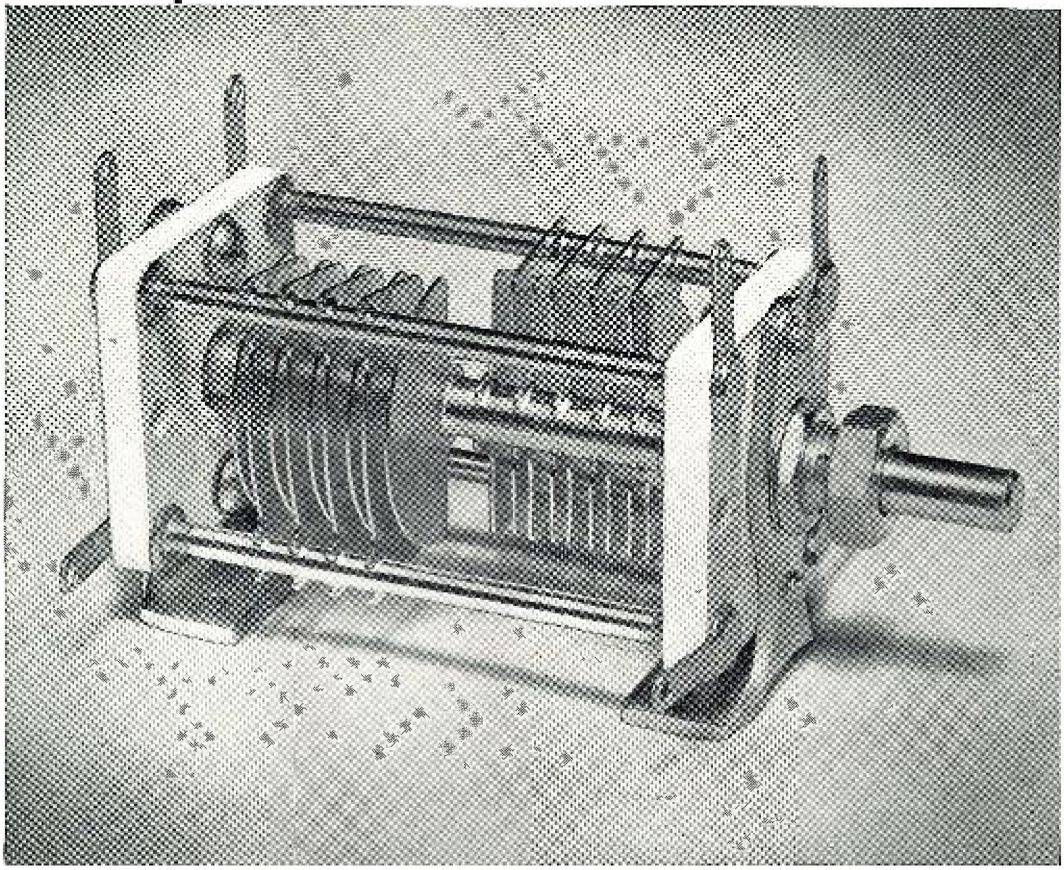

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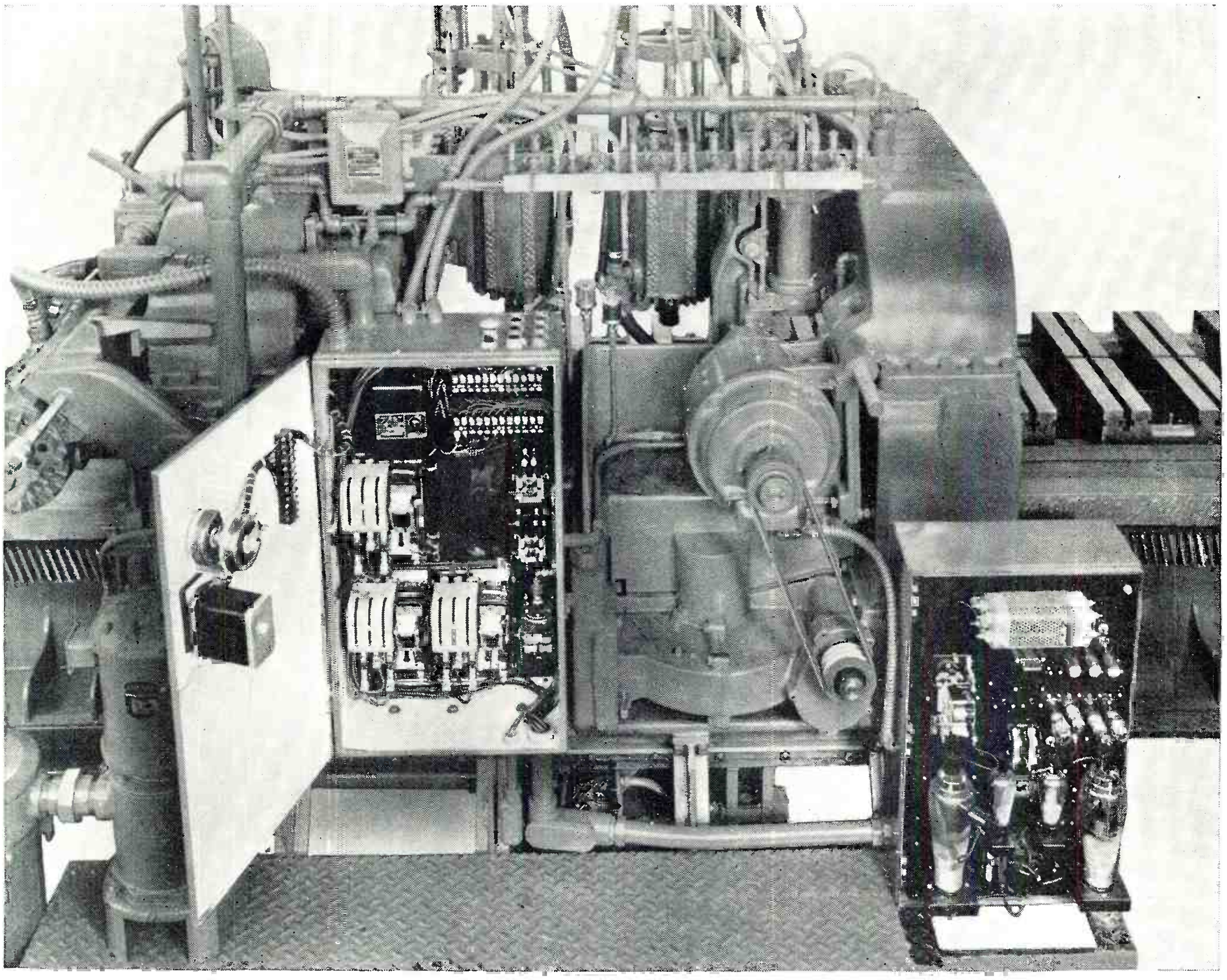


Fig. 6. Standard Thy-mo-trol panel mounted on machine for milling spars for aircraft.

Electronic Variable-Speed Drive

By using an adjustable voltage rectifier system employing thyratron tubes, complete control of large motors is had.

THE experience and knowledge obtained from the use of thyratron-tube motor control for more than a decade have made possible the development by *General Electric* of a new electronic variable speed drive with features and characteristics that make it ideally suited to a vast number of industrial applications. The versatility of this new drive, which has already been applied extensively, is made possible by a new adjustable-voltage electronic control system, called Thy-mo-trol.

To preface the description of how this new control operates and what it consists of, it might be well to review briefly the operation and application of earlier types of electronic motor controls.

One of the earliest applications of electronic motor control was to the operation of an automatic lighting control installed about 1928. In this application, thyratron tubes were used to supply both the field and armature of a small motor to control its speed over a range of approximately 100 r.p.m. to 36 r.p.m. Following this, many thyratron speed-control equipments were furnished for motors of various sizes and for many different applications.

The primary function of practically all of the original motor controls has been to adjust the speed of the motor. The other requirements such as starting, accelerating, etc., have been obtained largely through the use of various combinations of conventional control devices. A few equipments have been supplied for holding the motor speed constant, but in general their principal function has been to supply smooth, adjustable speed.

There are in service a relatively large number of thyratron motor-speed controls and there are many applications in industry for the use of such equipment.

Generally speaking, these equipments consist of an adjustable-voltage rectifier using thyratron tubes to supply the d.c. for the field and armature

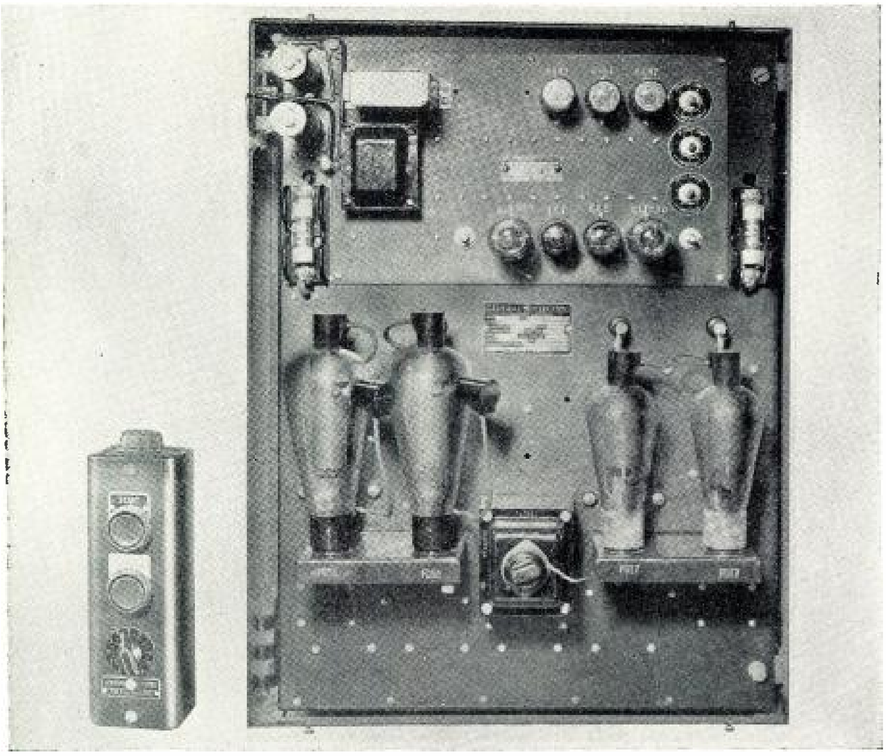


Fig. 2. Thy-mo-trol and push-button station. Note vacuum tubes on top panel.

of the motor. By varying the output voltage of the tubes the speed of the motor can be changed. Some type of feed-back system is employed to do this, and it may be of either the mechanical or electrical type.

The phase-shift method is one of the most common ways to vary the output voltage of a thyratron tube. This employs the use of a resistance-reactance bridge which permits the phase relation of the grid voltage to be varied with respect to the anode voltage. By varying one of the elements in the bridge circuit, it is possible to change the phase displacement of the grid voltage with respect to the anode voltage from a condition where the two are completely in phase to the point where they are 180 degrees out of phase. When the two voltages are completely in phase, the tube will be turned full-on. When they are completely out of phase, the tube will be turned off completely and will not conduct any current. By varying the voltage relation between these limits, the tubes can be turned on to any desirable degree.

Mechanical Feed-back Arrangement

In a mechanical feed-back system, one of the elements in the phase-shifting bridge — usually the reactor — is varied mechanically to change the output of the tubes and thus regulate the speed of the controlled motor. Several arrangements of this type are shown in Fig. 1. In one of these, a loop of material being processed—this may be fabric, rubber sheeting, sheet steel, etc.—is used to operate the movable core of the reactor which thus varies the speed of the motor in proportion to the rise and fall of the loop.

In some instances, where it is not practical to use a mechanical arrangement employing the reactor, the motor speed can be controlled through the use of a photoelectric arrangement as shown in the lower sketch in Fig. 1. A light beam is directed on the loop of material, and as the loop rises and falls it varies with amount of light falling on the phototube. This causes the motor speed to be increased or decreased through the use of the thyratron tubes in the same manner as with the reactor scheme.

The basic circuit for all equipments of this type employs two thyratron tubes to supply direct current to the motor field. The field voltage is varied by changing the position of the core in the reactor. Within the rating of available tubes, similar equipment can be used to control armature voltage.

Typical of the applications employing this type of control is the maintaining of constant tension in the reeling of wire, ranging from fine copper wire to large, heavy cable. Another

(*Continued on page* 76)

Fig. 3. Diagram shows how thyratron rectifiers connect to motor.

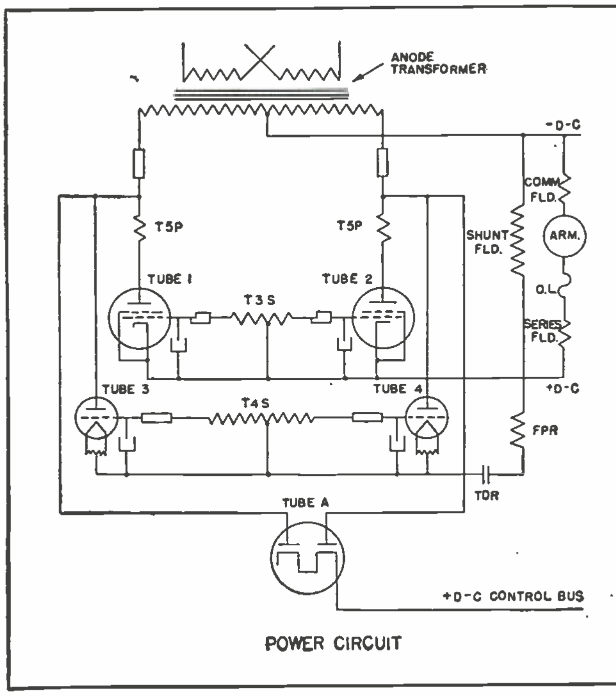
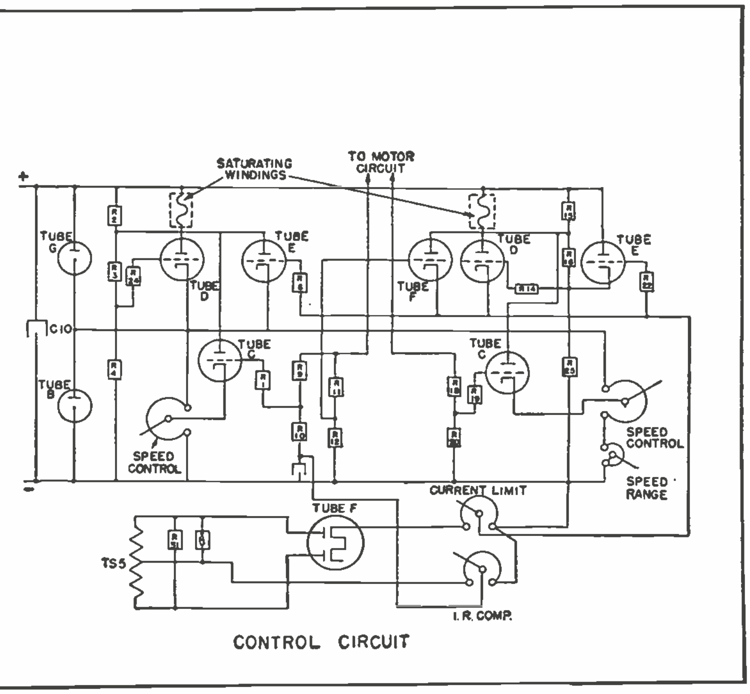


Fig. 4. Elementary diagram showing control circuit.



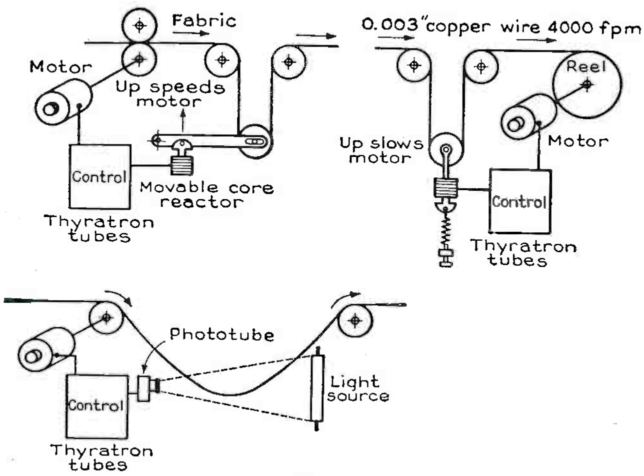


FIG. 1

Various mechanical-feedback arrangements as employed with earlier electronic motor controls. Thyratron tubes were popular.

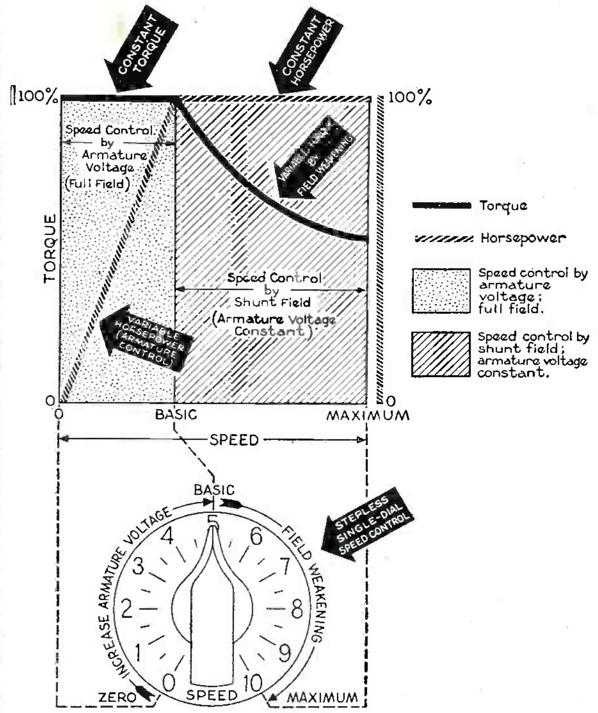


FIG. 5

Above: Showing how motor torque and horsepower characteristics vary with motor speed. Single dial controls armature-field.

ELECTRONIC VARIABLE-SPEED DRIVE AS APPLIED IN INDUSTRY

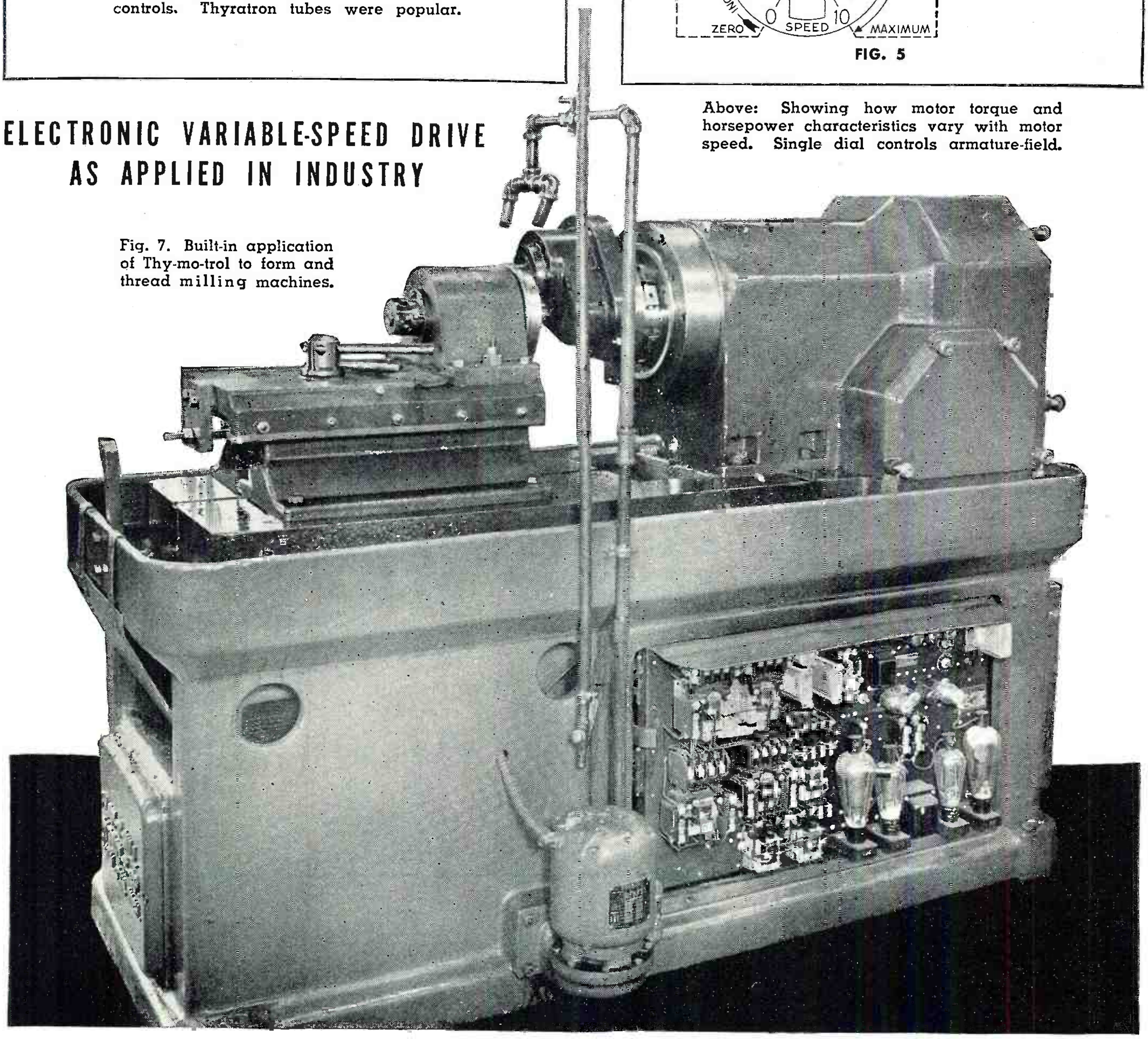


Fig. 7. Built-in application of Thy-mo-trol to form and thread milling machines.

INTRUSION ALARMS

by CLARK E. JACKSON

Fig. 1. Photoelectric light source and receiver.

The following systems may be controlled manually for use as air raid warnings by adding suitable switching device units.

"STOP that saboteur!"—is the cry on our home front. The size of every guard watch, industrial and civilian, has been redoubled since the outbreak of war to trip the fifth columnist in his first step. In this effort to protect our industrial plants, our homes, and our valuables, electrical devices are serving shoulder-to-shoulder with human watchmen.

Radionics has stepped forward to guard home and factory against the intruder and his subversive activities. Radionic alarms operate tirelessly and are quick to respond. Installed and maintained properly, these devices which are not new to radio men possess none of the human tendencies toward distraction, inattention, and absenteeism. Nor do they need to "knock off" after an eight-hour shift. They function equally well alone or in conjunction with human watchmen.

In this article, we present descriptive material concerning a selected number of alarm devices which have earned recognition for alertness and long unattended service. We call attention to these circuits and systems, which are not our invention at all, with the hope that they will be useful to industrial technicians having charge of factory safety, home owners desiring to protect their premises from intrusion, and free-lance radio men and electricians desiring to build and install these alarms as a patriotic and profitable side line.

Types of Alarms

Electrical and radionic intrusion alarms in regular use are generally to be found classified in one of the following groups: (1) Electric-eye systems, (2) Capacity-operated vacuum-tube relays, and (3) Directly-operated d.c. systems which depend upon light-pressure switch mechanisms for actuation. There are numerous other categories; however, a number of the unlisted types, while exceedingly clever in action, are at present so experimental in nature or costly in installation and maintenance as unfortunately to rate the term "gadgets." The ingenious electrical reader will, in reviewing the systems described in this article, think readily of elaborations or simplifications of the schemes shown and will be reminded of applications other than those given.

The photocell or electric-eye type of burglar alarm is perhaps best known to the general public, chiefly because of the wide application and enormous publicity this method of op-

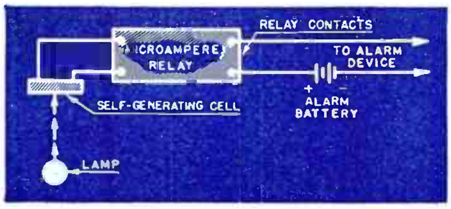


Fig. 2. Simple photocell circuit.

eration has received. However elaborate the photocell system may be made, the fundamental operating scheme remains substantially unchanged—a light source, such as an incandescent electric lamp of proper size directs a light beam upon the face of a photocell located some distance away. Currents generated by action of the luminous energy on the cell may then be utilized, either directly or through a vacuum-tube amplifier, to actuate a relay when the light beam is interrupted, as by the passage of an intruder across the beam. The relay in turn sets off a bell, horn, light, or other appropriate alarm to attract attention of the proper authorities.

The manner in which the feeble light-generated currents from the photocell are utilized for turning on the alarm marks the difference between the various practical systems. Some of these systems will be more readily applicable to a particular installation than will others, this being a matter

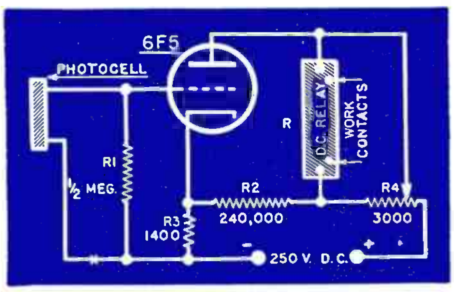


Fig. 4. Single stage photocell amplifier.

to be decided by the authorities in charge of the installation.

The simplest of all cells is the self-generating photocell. This type of unit delivers currents directly from the action of light and requires no polarizing battery or power supply for its operation. Figure 1 shows a rugged photocell alarm unit which is manufactured for industrial application. The light source is contained in one of the heavy metal housings, while the photocell occupies the other. Both light house and cell house are provided with glass or plastic windows, as will be seen from the photographs. This feature is particularly desirable since it prevents damage either to the lamp or the cell. In some outdoor installations where there is likelihood of fogging or soiling of the windows, the latter are provided with automatically-operated wipers of the windshield type.

Figure 2 shows the simplest possible photoelectrically-operated intrusion alarm. The lamp directs a light beam upon the face of the distantly-located self-generating cell. The tiny currents generated by this cell are then fed into a low-current d.c. relay which is designed to close on currents of a few microamperes. The "work" contacts of this relay close a local circuit consisting of a battery (or other appropriate power source) and the alarm device which may be a bell, siren, annunciator, or similar device.

Satisfactory low-current relays for this application are manufactured by General Electric Co., Westinghouse, Weston Electrical Instrument Corp., Sigma Instruments Co., and others.

The type of relay recommended for this alarm is one that is normally open. Interruption of the light beam will then cause this relay to close, thereby setting off the alarm signal.

Figure 4 shows a vacuum-tube circuit for utilizing a photocell of either the self-generating or voltage-polarized type (insert battery at X, Fig. 4, when cell is not of the self-generating type). Here, a larger-sized relay may be employed than in the previous circuit—one drawing several milliamperes. The relay is arranged in a four-arm resistance bridge circuit in the plate circuit of the tube, the tube plate resistance being one of these arms. With no current coming into the circuit from the cell, the system is balanced by adjusting R4. At balance, no current flows through the relay and its contacts are closed. When a light falls on the cell, the latter generates a current which by flowing through R1 sets up a voltage which is applied to the tube grid. The application of this voltage to the grid changes the value of the tube plate resistance, thereby unbalancing the bridge, and current flows through the relay opening the con-

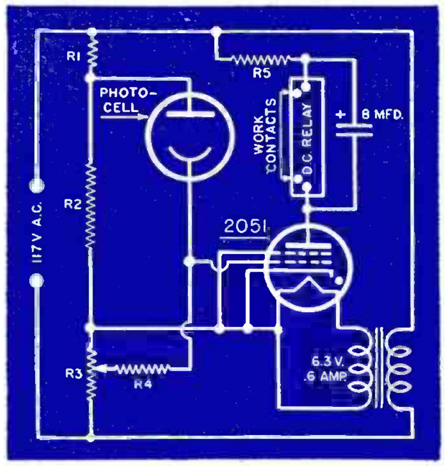


Fig. 3. A.C. operated photocell unit.

Vacuum-type photocell.	*Gas-type photocell.*
R_1—0	R_1—10,000 ohm 1w.
R_2—20,000 ohm 1w.	R_2—9000 ohm 1w.
R_3—1000 ohm 1w.	R_3, R_4, R_5—Same as above.
R_4—5 megohms 1w.	
R_5—See text.	

tacts. By choosing a relay with its contacts normally closed, the relay will be held open as long as the light beam impinges upon the photocell. But as soon as the light beam is interrupted, the plate-circuit bridge becomes balanced, current ceases to flow through the relay, and the relay arm is released to close the contacts and ring a local alarm circuit.

Figure 3 shows a circuit that makes use of a gaseous type tube. Due to the relatively high plate (anode) current with this type of tube, it becomes possible to use directly a relay of larger size than employed in the foregoing circuits. This relay may be rated as high as 25 milliamperes.

When set up, this circuit is adjusted "in darkness" (e.g., without a light beam). The contact on R3 is set to a point where the plate current just ceases to flow and the relay closes. When a light beam is subsequently applied, cell current flows through resistor R4 producing a voltage drop which reduces the negative potential already on the grid of the 2051 tube. This results in the flow of plate current and the actuation of the relay. Resistor R5 is set, after adjustment of R3, to limit the plate current through the relay to a value within the maximum current rating of the relay.

An added advantage of this circuit, which is due to RCA, is the fact that

Fig. 5. Photocell operating 0-30 ma. relay.

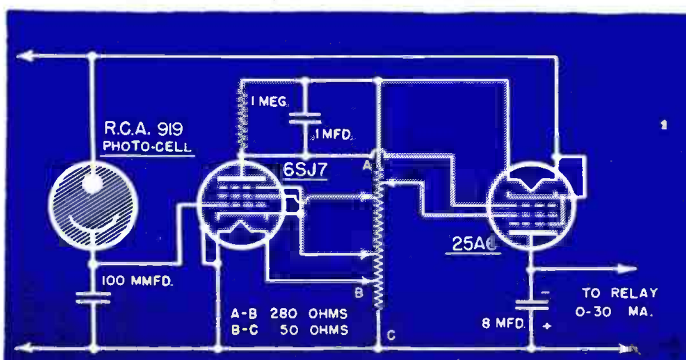
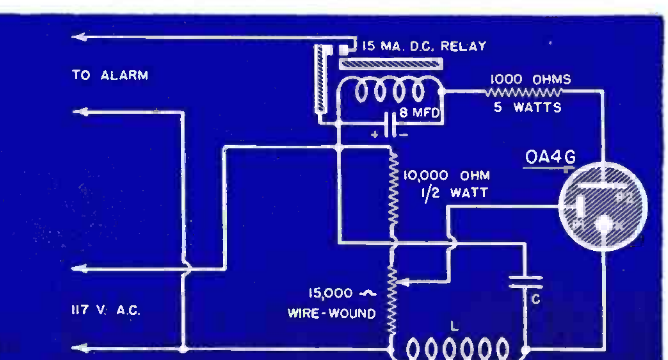


Fig. 6. Circuit diagram for carrier-current receiver.



all operating potentials are a.c. and are obtained directly from the power line without a rectifier-type of power supply. Either vacuum- or gaseous-type photocells may be employed in the circuit.

In any installation where the photocell currents are too feeble to actuate a relay or relay-tube directly, due to remoteness of the light source, a conventional d.c. amplifier employing two or more vacuum tubes may be inserted between the cell and the relay or relay-tube. This applies to any type of cell or relay system.

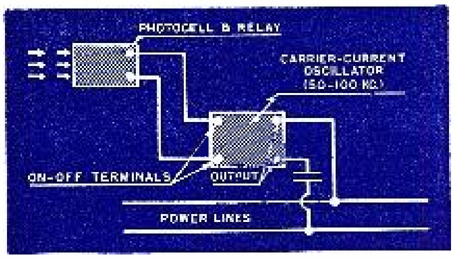


Fig. 7. Carrier-current oscillator.

A complete line-operated system is illustrated in Figure 5 in another RCA circuit. In this arrangement, up to 30 milliamperes d.c. are available for relay operation and vacuum, rather than gaseous tubes are employed. A Type 919 photocell indicated in the input portion of the circuit actuates the grid of the small input pentode. The tubes recommended are 6SJ7 and 25A6 or their equivalents. The voltage divider resistor, shown between the two tubes, supplies both filament and plate potentials to the two tubes, no transformers being required. All the taps along this resistor (a high wattage bleeder type resistor with ring clips), except tap B, are to be adjusted, with the aid of a high-resistance-input d.c. voltmeter, to give the recommended cathode and screen voltages for the 6SJ7 and recommended screen voltage for the 25A6.

Multi-Station Alarm Operation

Most buildings needing automatic alarm protection have several vulnerable points, such as doors, windows, aisles, etc., to guard. Obviously, it is convenient to install a photocell pickup at each of these points and to connect them all to an alarm system at a central guard room. In many cases this is done by the simple expedient of connecting the various pickup stations to the central point by wire lines. However, the running of such special lines becomes a sizeable task, to say nothing of the expense in sprawling buildings.

Where separate lines cannot be run to advantage, the writer recommends the employment of a carrier-current or "wired wireless" system for communication of the pickup station alarm impulses to the central watch room. Figure 7 illustrates one such pickup station, operating by feeding the radio wave into the regular power lines. These systems may be operated at low radio-frequency power at any selected frequency between 50 and 1000 kilocycles with excellent results. Each station may be set permanently, fixed-tune fashion, on its own operating frequency. Simple receivers, one for each station frequency, operate in the watch room from waves coming over the power lines.

The simple r.f. oscillator comprising the transmitter at the pickup station (see Figure 7) is provided simply with two terminals for closing its B-plus circuit. The filaments are kept running continuously at all stations with low current consumption and little impairment of tube life. The oscillator B-plus circuit is closed by the photocell relay, throwing the oscillator into operation and actuating the station signal by way of wired-radio back at the watch room.

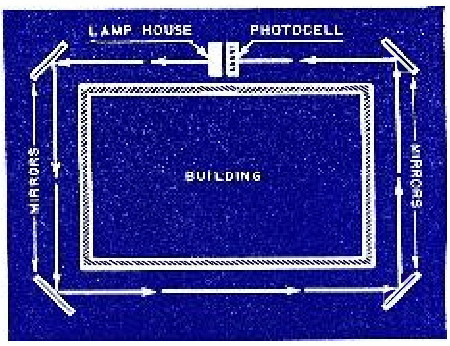
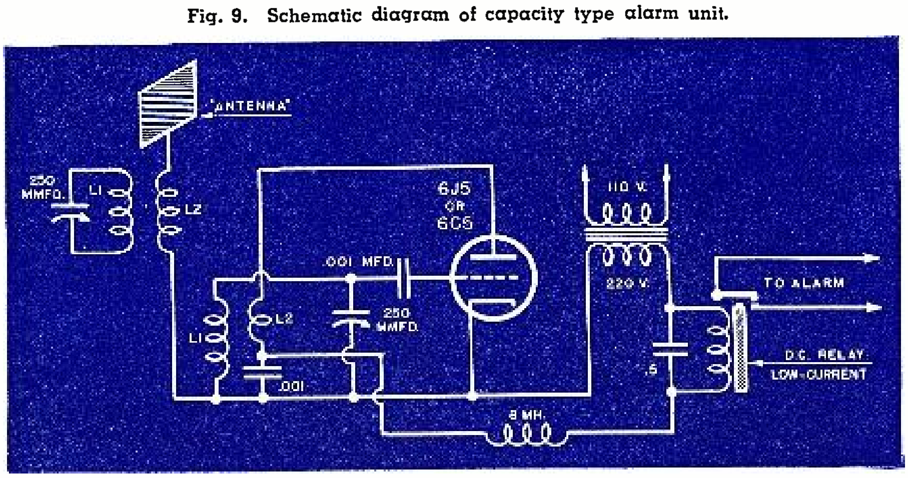


Fig. 8. Photocell-guarded building.

A typical receiving station is shown in Figure 6. This circuit makes use of the type OA4-G gaseous tube which has no filament and thus needs no filament transformer. Coil L and condenser C are chosen in value so as to be resonant at the frequency of the pickup station to which it is to be tuned. When the cold-cathode receiving circuit is placed into service, the line voltage is continuously applied to the tube anode P_1. The carrier voltage drop across coil L is applied in series with the cathode and P_1, increasing the negative bias across the tube. The starter-anode discharge is then initiated, in turn initiating the main discharge in the tube and closing the relay.

Fig. 9. Schematic diagram of capacity type alarm unit.


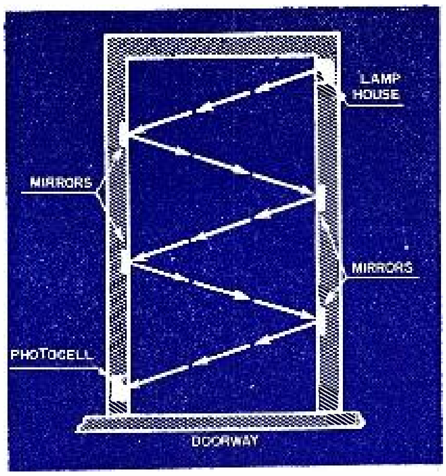


Fig. 10. Doorway protected by photocell.

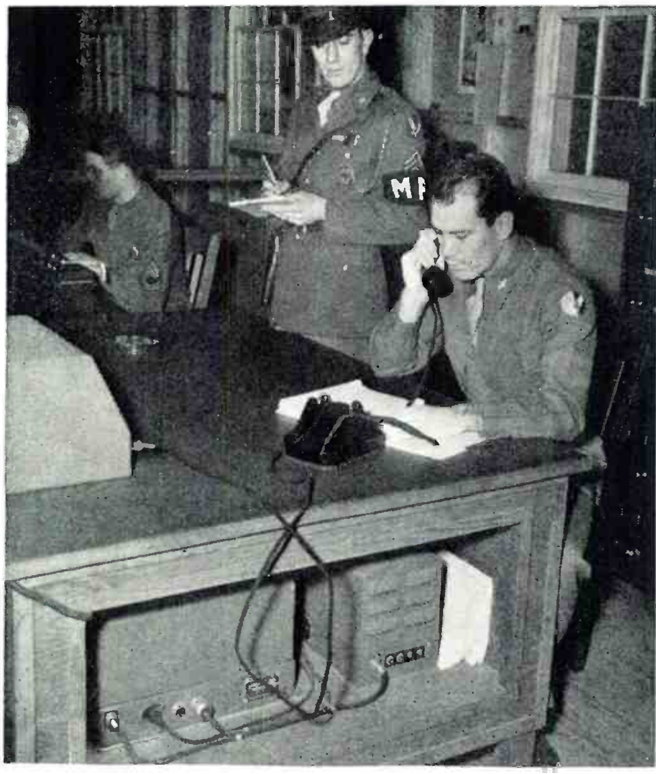
The adjustment of the 15,000-ohm potentiometer is very important. This resistor is set at a point where the OA4-G just "fires," and then the setting is reduced until the discharge is just extinguished. The latter point is correct for continuous operation.

Special Light-Alarm Arrangements

From time to time, we learn of attempts to cover a wide area with the minimum of light-alarm protection equipment. Figure 8 shows one such scheme which has been rather widely used industrially. Here, a single photocell and lamp-house provide protection against intrusion along any door or window at a particular level all around a building. Mirrors placed at an angle at each corner of the building reflect the light beam, causing it to travel along all four sides of the building. The only "blind spot" is directly in the space occupied by the lamp-house and photocell, but this is an area of only a few square inches, being equal to the size of the two units. Further safety, over and above that provided by the thinness of the instrument housings might be obtained by placing the units along a "dead" portion of the coverage area, i.e., at a point where there are no points of entry into the building.

Obviously, the success of any photoelectric alarm system depends upon inability of the intruder to see the light beam and to escape it by stepping over or crawling under it, or to pinch-

(*Continued on page* 52)



SPECIAL DETAIL — Capt. Arthur F. Branstatter, formerly with the Detroit Police Department shown operating two-way communications system.

REPORT FOR INSPECTION—Patrol car reporting to headquarters for an inspection and checkup. Sgt. Teigen with phones, Sgt. Schauf stands by.

RADIO-TELEPHONES FOR MP'S

PATROL OPERATIONS must go on both day and night at the AAF Technical Training Command, Scott Field, Ill. It was one of the first to use short wave patrol.

THE two *Scott Field* MP's in the rakish jeep stared at each other. Then one said:

"It's an order, let's go!"

For the next half-hour the jeep tore around the broad acreage occupied by the parent radio school of the Army Air Forces Technical Training Command, changing directions now and then like a halfback reversing his field.

Finally, the veteran sergeant driving braked the car to a dead stop. "Those guys," he announced, "are completely nuts. They don't know where they want us to go!"

He picked up the radio telephone, newly installed in his machine.

"Car 1x to WVSG," he shouted. The answer came back at once. "WVSG to Car 1x, go ahead."

"Unable to locate traffic jam on Mars street," the MP admitted. "In fact we're unable to locate Mars street."

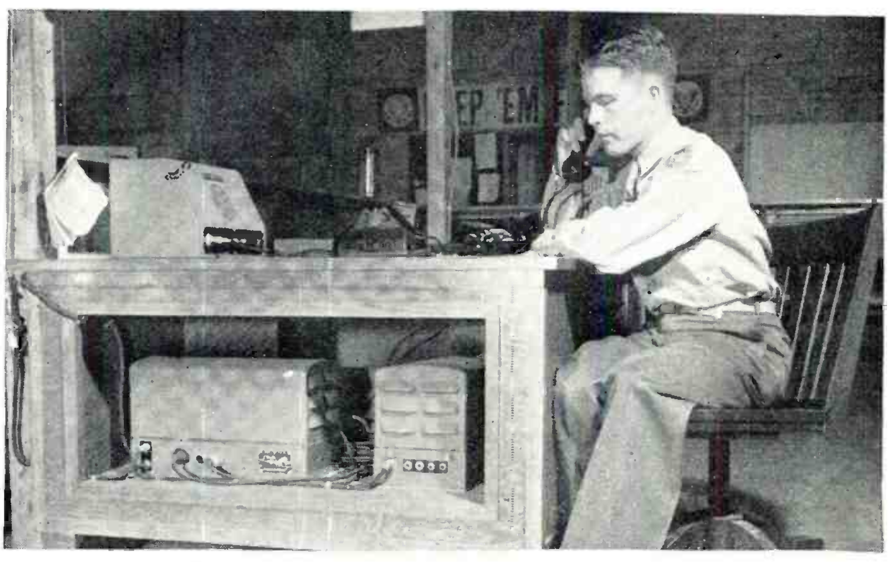
"Well?" came back from the control station.

"Request further instructions," radioed the MP patiently.

"What do you want instructions on?" asked the operator at headquarters. "We haven't given you a radio run in the last half-hour!"

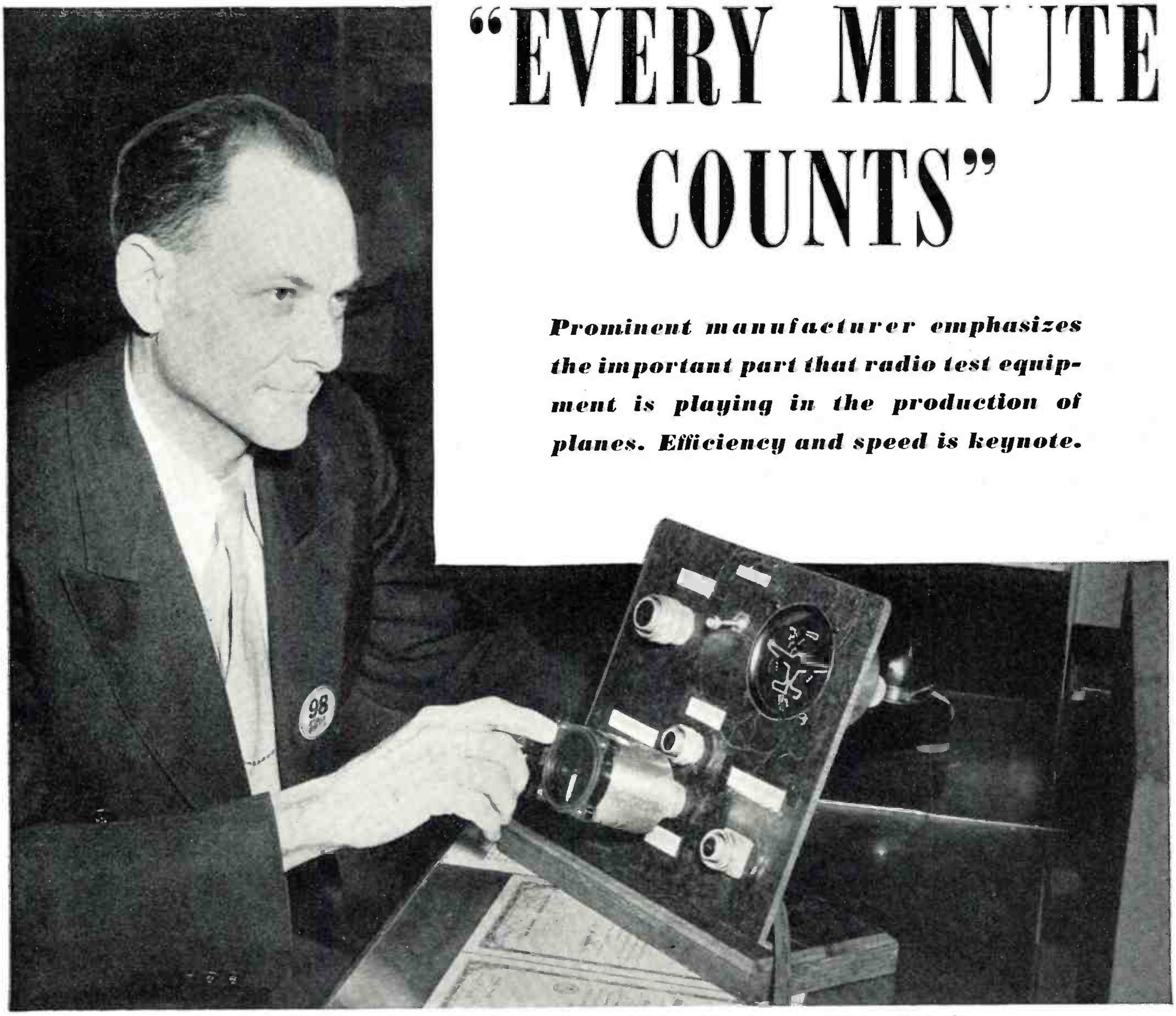
(*Continued on page* 44)

Staff Sgt. George W. Martin sending out instructions to patrol cars. Note neatly racked equipment underneath the desk consisting of 9 tube receiver and 12 tube transmitter.



"EVERY MINUTE COUNTS"

Prominent manufacturer emphasizes the important part that radio test equipment is playing in the production of planes. Efficiency and speed is keynote.



Supervisor of Vultee Radio, Electrical and Instrument Test Dept. tries out new instrument checker.

By

E. H. LEFTWICH

MR. MACK looked up at me, grinned, and motioned me to a seat.

I grinned back and sat down at the desk opposite him, wondering what was cooking. For Mr. Mack had a poorly suppressed twinkle in his eyes, and when he had that sort of twinkle, I had learned from experience, interesting revelations were certain to come forth.

Mr. Mack, you see, is one of the Big Bosses at the mammoth Vultee Aircraft Plant where I put in my seven days, most weeks.

"Ed," he began, "I've got a big deal for you and Sanders . . . I've already told Sanders . . ."

"Fine," I came back. "There's nothing I like better than a big deal."

"Beginning as of now," he went on, "you and Sanders have complete charge of the Radio, Electrical and Instrument, Test and Repair Department. I'm turning it over to you, entirely. It's up to you boys to show us what you can do. You are to design and build Test Instruments and devices for all units on our bombers.

"You are to apply the methods of Work Simplification, which you have learned, in every way possible. You have a free hand . . . so fly into it and let's see what you can do!"

"Gosh!" I exploded. And when I said "Gosh," I really meant, "Gosh!"

Here was the chance of a lifetime! Here, was a radioman's dream . . . come true. Here, the Big Boss was handing Don Sanders and myself an embryo Radio Laboratory on a "bakelite platter," so to speak, and telling us to make of it what we would.

Think of it, fellow radio-servicemen and Hams; a real Radio, Electrical and Instrument lab to organize, plan and put over in a big way. Dozens of Testing Devices to design and build, the way you wanted them designed and built. A chance to do really effective work for our men on the fighting front, by giving them better, more thoroughly tested equipment on their bombers, more quickly!

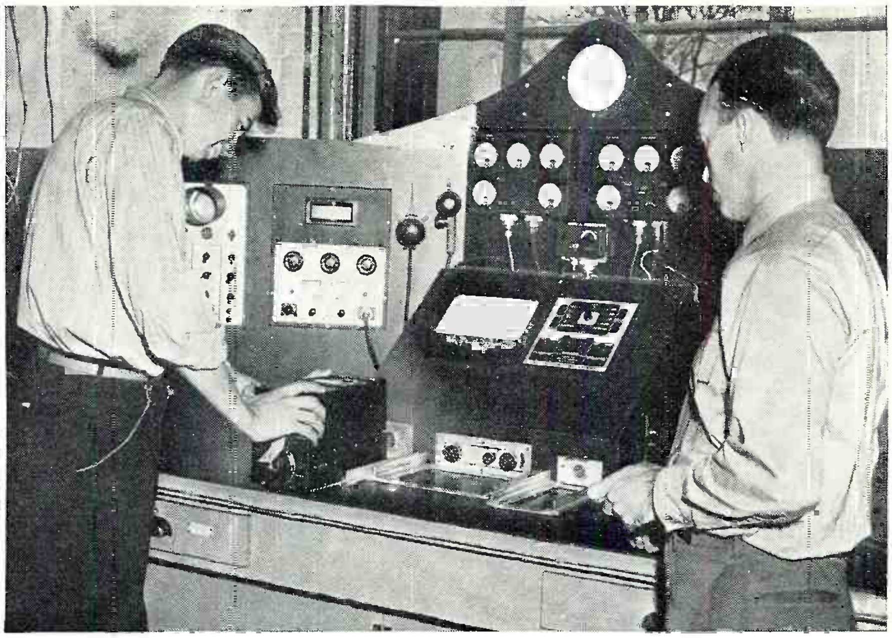
And to top it off, a swell crew of experts, servicemen, Hams and commercial operators, to say nothing of Don Sanders, himself, being an old-time ex-airline commercial operator.

"You can't mean it!" I blurted, having regained my speaking voice. "Something like that couldn't happen to me."

"I do mean it." Mr. Mack smiled. "And it *has* happened." The twinkle had faded from his eyes. Now, he was all business, as he usually is, but even his business-like glare is . . . pleasant. You see, Mr. Mack is really a "right guy" . . . and how!

"What are you waiting for?" he

An elaborate tester which checks 72 circuits with one turn of the switch.



Master radio-unit test bench—engineer, left, shown sliding aircraft transmitter into self-connecting rack for final test.

snapped at me . . . and Don and I flew into the big job ahead of us.

This happened about six weeks ago, and to give you a quick general survey of what has happened since, and what can happen when a couple of old-timers make up their minds to do a job and have a big efficient organization like Vultee back of them, here are a few of the things we have accomplished, to date:

Designed and constructed 13 testing devices, whose net savings in time over a period of a year, figured in dollars and cents is equal to $15,691.20.

Have under construction 7 new testing units.

Designed and completed construction of Master Radio-unit Test bench.

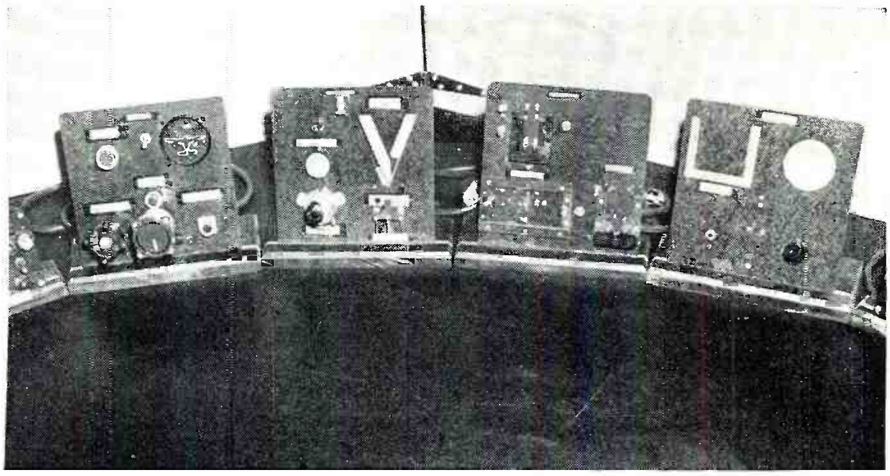
In addition to this, we have, of course kept up our regular schedule on production Testing, Installation and Repair of units.

Some of you may remember my article, "Life Begins at 4:15," in October, 1941, Radio News, wherein I outlined the many advantages enjoyed by radiomen in aircraft plants. I was at that time working in Department 91, Radio and Electrical Sub-assembly, and the Test and Repair Department we now have was a development of the old "Final Test" Department of which I wrote.

In our fight against time, today, the ability to repair many radio and electrical units and get them back into service quickly, is a tremendously important factor, especially since it's difficult to obtain replacements on these units quickly at all times.

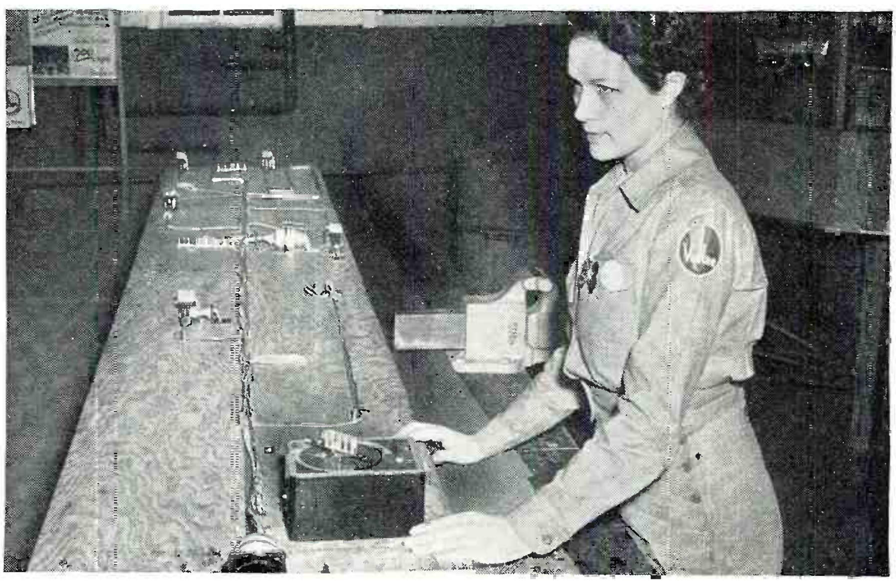
Electrical units are checked for contact operation and continuity, by means of quick-acting test devices, which we have designed and built, before they are installed on the ships. The photos picture some of these devices.

Instead of hooking up a bunch of



A group of specially-designed, high-speed test devices. These four instruments test 20 different radio and electrical units.

Operator about to test a wing-electric cable assembly. Proper equipment and jigs have reduced operation time considerably.



Making final check on the special MULTIPOINT SWITCH for use on wing-electric cable assembly. Accuracy is necessary in its assembly.

wires "haywire" to a multi-point relay and checking each of its various circuits separately, we merely pick up the relay and slide it into the guide track of a specially designed "jig." The relay drops against a smoothly-working group of spring contacts which instantly connect all terminals at the same time through indicating lights which prove that each circuit is okay. Should an indicating light fail to come on, we have a faulty unit which is set aside for the repair man.

This is what we call "Work Simplification."

Classes in Work Simplification have been conducted at the Vultee Plant for over a year under the direction of A. H. Mogenson, nationally-known master of this efficient, time-saving plan, whose aim is summed up as follows:

"A better product . . . in less time . . . at reduced cost . . . through:

"1. Conservation of material, energy, or time.

"2. Elimination or improvement of an existing method.

"3. Elimination or improvement of a tool, jig, fixture or other equipment.

"4. Increasing the output of a machine.

"5. Improving the quality of the product."

Mr. Mogenson, whose classes I attended for a year, is an authority on this method, as well as the author of many articles outlining its amazing results. He travels continuously by airplane to many of the big Aircraft plants, stopping off at each plant only long enough to conduct his classes each week.

What I had learned from Mr. Mogenson was especially valuable now . . . and I made the most of it.

One of the most amazing results of the Work Simplification program is its tendency toward unified thinking. Don Sanders and I were walking through the plant one morning recently, looking for Mr. Mack. We didn't find him, but as we passed my old department (91, Radio and Electrical Sub-assembly) Don's attention was attracted by a long wooden jig, painted with wide red lines and studded with little wooden pegs.

It looked like a cross between a pinball machine and a toy railway system. A couple of operators were stringing a wire cable and plug assembly on the pegs.

"Hey, Ed!" Don yelled. (You have to yell to be heard above the riveting up there.) "Let's see what they have here!"

I button-holed Fred, the foreman. "What've you got here, Fred?" I asked, indicating the jig.

He grinned. "It's a rack for shaping and tying the wing electric-cable assemblies. Pretty hot . . . don't you think?"

"Sure," I agreed. "But how do you check the wiring of the assemblies after they are completed?"

"We pull the assembly off the jig when we've finished and Inspection buzzes them out with a pair of test-leads."

Don grabbed me by the arm, a wild look in his eyes. "You know what I'm thinking?" He shot the question at me.

"Sure," I came back. "Leave the assemblies on the jig and test 'em before you take 'em off."

"Right . . . and make up male plugs to contact every receptacle on the assembly . . ."

"And," I broke in, "mount the plugs on brackets at the same locations as the pegs . . ."

"And run the test wiring underneath the jig."

"And use a double-circuit multi-pole switch to check all circuits in one turn of the switch."

Fred's jaw sagged, and it wouldn't have taken a mind-reader to diagnose the questioning stare he was pouring on us. "Nuts!" was what it meant . . . plain as day.

"Fred," I explained, "we've got ideas about this jig. Mind if we streamline it a bit for you?"

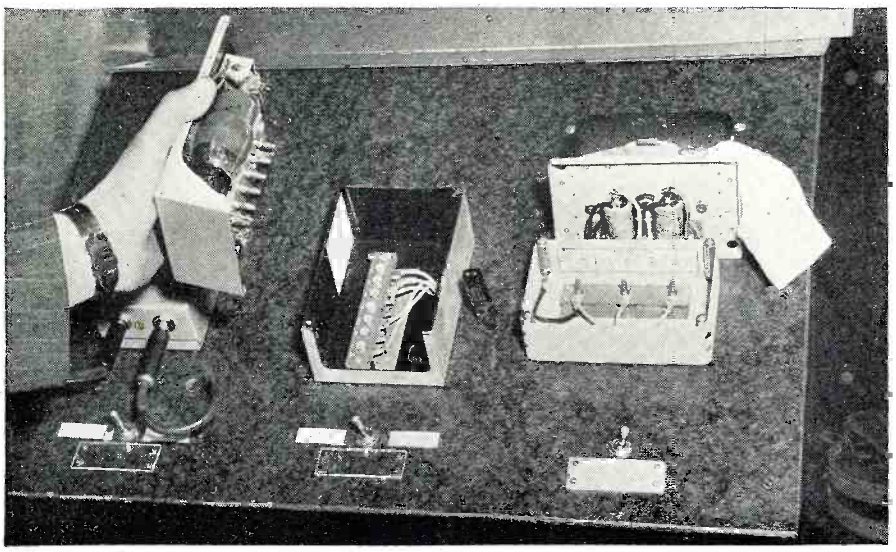
For a moment he failed to answer. I could see that he was a little dubious, rather in doubt . . . about our brand of streamlining. He wasn't as yet familiar with our work and what we were doing in our department.

"Okay," he said, finally . . . and we left.

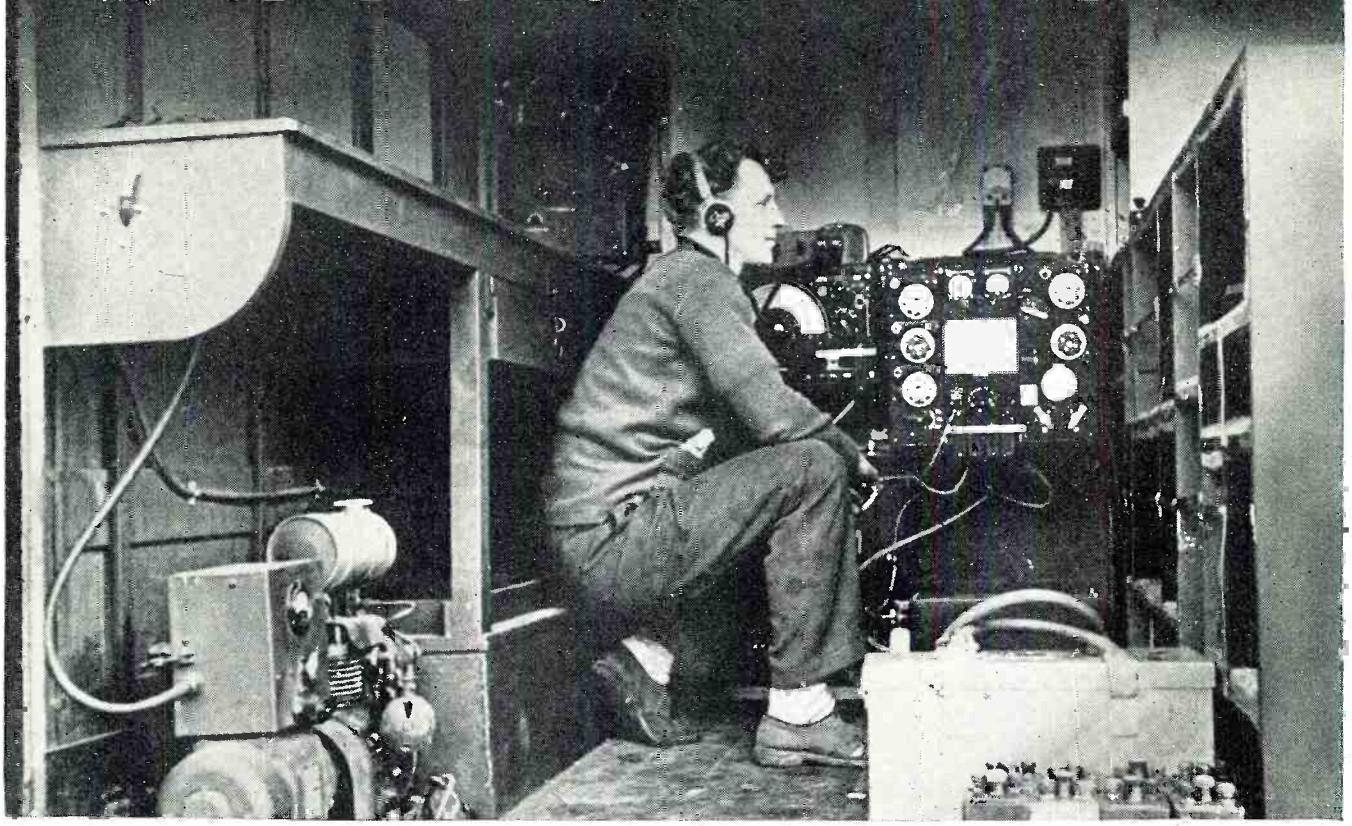
We had no sooner got back to our

(*Continued on page* 64)

Auxiliary radio-unit test bench—preparing to plug an amplifier unit into quick-test jig. A simple power-unit jig is shown at the right.



TRAINING RAF RADIOMEN



Interior of mobile wireless testing van. Maintenance is a vital task of the wireless mechanic.

by Sq. Ldr. A. C. H. PURTHREY

How the RAF trains unskilled recruits into highly specialized radio mechanics and operators.

N wartime an immediate demand arises, both from industry and the fighting services, for large numbers of men and women capable of installing and servicing radio equipment, ground and aircraft.

In Britain's R.A.F. that demand has been, and is continuing to be, met by recruiting and training men and women of 18 to 35 years of age, whose civil occupations range from hairdressing to school teaching. It speaks well for both instructional staff and trainees that the latter have, within a very few months, and without any previous experience, learned to handle radio apparatus whose complexity runs from acorn to cathode ray tubes.

Every British News Bulletin and issue of the daily papers which announces yet further successful Fighter Command daylight sweeps and Bomber command mass bombing raids shows that it is possible to mass-produce this type of tradesman and tradeswoman. The effectiveness of these raids depends mainly on perfect communications by radio—perhaps on the skill of just one man or woman who, less than a year ago, was engaged in an occupation which had absolutely nothing to do with wireless.

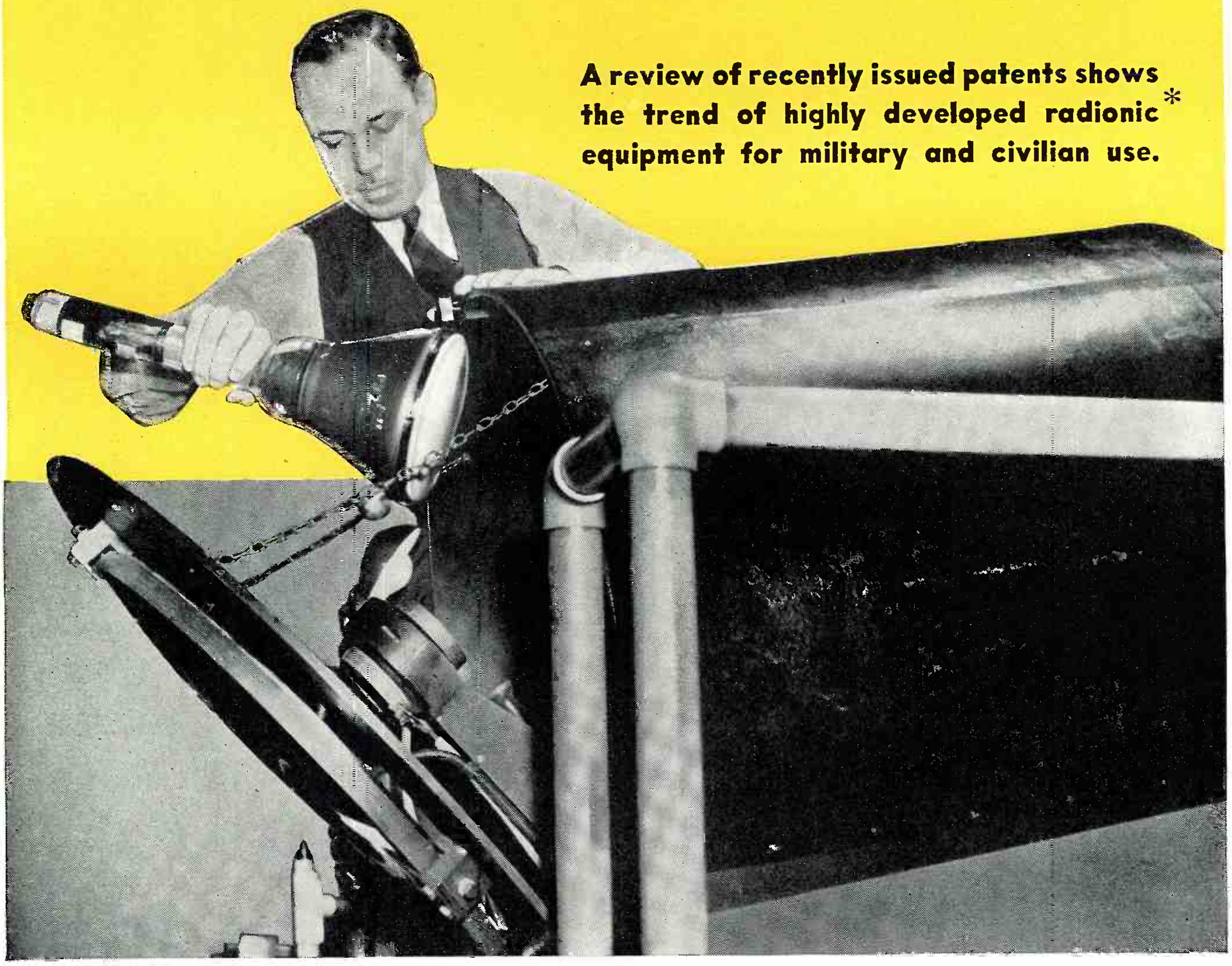
Let us follow the progress of one such airman wireless mechanic, on

(*Continued on page* 67)

Mechanic learning to operate an aircraft communications set.

WARTIME PROGRESS IN RADIONICS

A review of recently issued patents shows the trend of highly developed radionic* equipment for military and civilian use.



RCA engineer inserting a large kinescope tube into video projector. Picture is magnified onto a screen, 60 feet away.

by ROBERT EICHBERG

Radionic Research Engineer

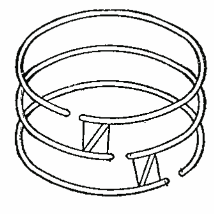
NO series of articles on this subject could be complete without some discussion of the work of the *Alien Property Custodian,* for his office is charged with the duty of seeing that patents are developed and commercialized even though they are owned by this country's enemies, or citizens of the nations which have been crushed by the Axis hordes. Since the beginning of the war, some 50,000 have been vested in the Alien Property Custodian; of these approximately 2,000 have some radionic application in addition to 2,909 which are directly concerned with radio, telegraphy and telephony. The radio patents alone number 1,672, to which may be added 326 supplements and 131 applications. In the work of this office as explained by Alien Property Custodian Leo T. Crowley in a letter to the President of the United States. He wrote: "You have directed the Office of Alien Property Custodian to seize all patents controlled by the enemy, regardless of nominal ownership, and to make these patents freely available to American industry, first for war purposes of the United Nations, and second for general use in the national interest. . . . From the beginning we have immediately seized every enemy patent recognized as of importance to the war and licensed it to American business. . . . In addition, we (will) . . . make these patents readily and freely available forever to American industry, and . . . encourage the research necessary to develop these patents."

According to a pamphlet issued by the Office, while its main responsibility is to the citizens of the United States, its work is also designed to aid the innocent nationals of enemy-occupied countries who are unable to prosecute pending patent applications or

* *See "For The Record," page 4.*

who may be subject to duress (a euphemism for an Axis torture camp).

This dual responsibility is being discharged by making such patents available, upon reasonable terms and a non-exclusive licensing basis, to American industry. Every enemy patent not previously assigned to an American concern has been seized and made available for *licensing*. Title to such patents will not be sold or released; the inventions which they cover will be made a permanent possession of the American people. As for patents owned by citizens of non-enemy countries which are occupied by the Axis, they will be the subject of discussion with governments in exile. Incidentally, among the radionic patents already vested in the Alien Property Custodian are those of Robert Bosch, of Germany, and of Kwaisha Toden Denkyu Kabushiki, a Japanese corporation.



Patent No. 2,308,863.

Operating a portable vibration-velocity meter to measure the vibration of bodies in any direction.

The basis upon which such patents are issued is relatively simple: An application fee of $50 is required for a non-exclusive license for the life of the patent. In the case of enemy-owned patents, there will be no royalty, but those owned by residents of occupied countries will be subject to royalty payments commencing six months after the end of the war.

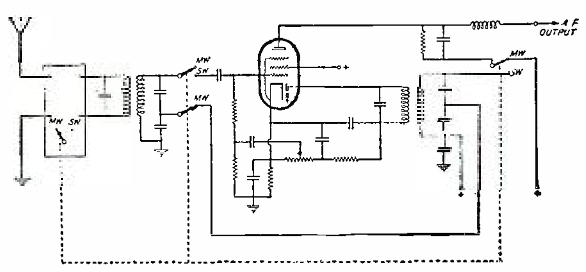
An index of the patents which are offered under this system, and other information are obtainable by writing to: Office of Alien Property Custodian, Chicago, Illinois. Classified lists of available patents may be had for 10c per list, but in the case of Class No. 250, Radiant Energy; No. 178, Telegraphy; and No. 179, Telephony, the charge is 25c, as these are among the nine largest classifications.

But by no means are all alien-owned patents in the hands of the Alien Property Custodian; those which have been granted to the nationals of allied or friendly or neutral countries remain in the control of the persons to whom they were granted, just as in peacetime.

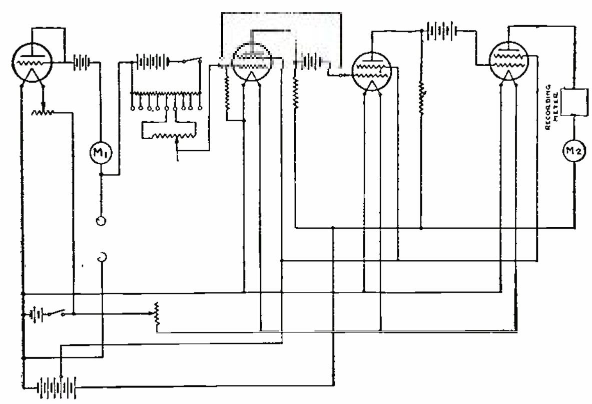
Of this class is a new and ingenious radio receiver circuit invented by A. L. Green of Sydney, Australia, and assigned by him to Amalgamated Wireless, Ltd., of the same city. As described under Patent No. 2,308,280, it embodies a means of utilizing a dual-diode pentode in a new way, a four gang, two-position switch enabling the user to put the signals from the first-detector and I.F. stages directly into the diode detection portion of the tube when broadcast band reception is desired, or to use the pentode part of the tube as an additional amplifier prior to re-detection when short wave signals are being received.

Looking at the diagram, you will see that with the band switch in the MW (medium wave or broadcast band) position, the signals from the preceding stages are fed from the first I.F. transformer directly to the second I.F. transformer and so are impressed upon the

(*Continued on page* 58)



Patent No. 2,308,280.



Patent No. 2,308,933.

GAS DISCHARGE DEVICES

by C. D. PRATER
Bartol Research Foundation

A continuation covering the phenomenon of gas discharge in electronic tubes and devices.

IF the pressure which exists in a high vacuum tube is allowed to rise from 10^{-7} mm. of mercury to 10^{-1} mm. of mercury, it will be found that as the pressure rises, the space charge seems to become neutralized, and the tube will saturate at a lower voltage than before. What has happened is that the electrons coming from the cathode ionize some of the gas in the tube by striking the gas molecules. The electrons will have sufficient energy to knock an electron from the gas molecule leaving a positively charged ion if the plate potential is high enough.

The electron liberated in the process

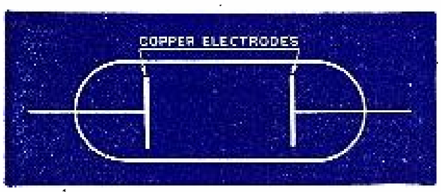


Fig. 1. Special gas discharge tube.

is able to go to the plate since it could only be formed well out of the space charge region. The positive ion then proceeds to the negatively charged space region where it is able to combine with an electron, thus having the effect of neutralizing part of the space charge and enabling an electron to go to the plate. All ions formed in the gas go to the space charge region because there can be little if any recombination of ions with electrons in the gas itself because of the velocity with which the particles are moving. Therefore, at any given voltage below saturation there is a larger current flowing in the tube than would flow if the vacuum were high, and as was said before, the tube will saturate at a lower voltage.

After the tube has reached saturation there is no space charge to neutralize the positive ions, and they are able to strike the cathode with all the velocity they have gained in their journey to the cathode. This causes the cathode to emit more electrons just as the plate emits electrons when the plate is bombarded by fast moving electrons as was discussed in the third article in this series.[1]

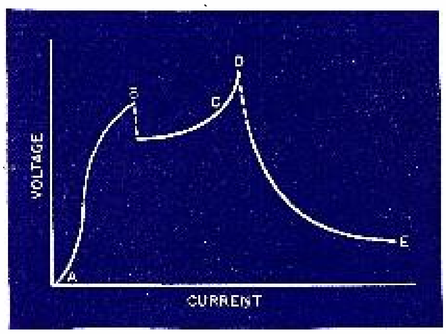
The positive ion bombardment will also increase the emission by raising the temperature of the cathode just as the electrons that strike the plate of the high vacuum tube raise its temperature. This increase in emission by positive ion bombardment will cause an increase of current flowing to the plate. The greater the number of positive ions striking the plate and the faster they are moving, the more the emission will be increased, and the greater the plate current will be. The plate current is therefore determined in a tube in which a gas is present by the following things: (1) the number of electrons emitted from the cathode, (2) the potential of the electrodes and electrodes configuration and (3) the number of positive ions formed.

The number of positive ions formed depends upon the amount of gas present, the amount of energy that an electron must have in order to ionize a gas molecule on striking it, and the potential through which the electron is accelerated, i.e., the plate potential. The amount of energy that an electron must have to ionize a gas molecule on striking it is called the ionization potential and is the voltage through which an electron must be accelerated in order to have sufficient energy to remove one electron from the outer orbit of a neutral atom.

The ionization potential is different for different gases. As the amount of gas in the tube is increased the number of positive ions is increased because the number of collisions between the electrons and gas molecules is increased until the amount of gas is such that all electrons make enough collisions to use all the energy they gain from the electrical field in producing ions, and the electrons arrive at the plate with little energy. As can be seen the number of ions formed at any given pressure is dependent upon the plate potential as well as upon the pressure because this determines how much energy the electrons have available to ionize the gas molecules which they strike.

Before discussing the individual electronic devices and their uses, it will be well to examine the fundamental of electric discharges of gases. If a tube such as shown in Fig. 1 is built and is exhausted until the pressure is about 10^{-1} mm. of mercury and the copper electrodes are connected through a limiting resistance to a source of potential, a curve similar to that shown in Fig. 2 will be obtained when the voltage is raised from zero and the current flowing through the tube is noted at every instant. The part of the curve AB is due to electrons emitted from the negative electrode and from the gas itself by the light falling on the surface of the electrode or passing through the gas. The current due to this cause is very small and is measured in microamps. The voltage across the tube rises very rapidly in this region. When point B is reached the electrons emitted by photoelectric processes have acquired enough energy to be able to ionize a sufficient amount of gas to provide enough positive ions which on striking the cathode cause the cathode to emit more electrons. When this point is reached, the current rises rapidly with little or no voltage rise until point C is reached, at which point the voltage again has to be raised in order to increase the current. When point D is reached there is an increase in current and a fall in voltage. The region AB is called the region of dark or Townsend discharge. The region BD is known as the region of glow discharge

Fig. 2. Voltage-current relation of tube.



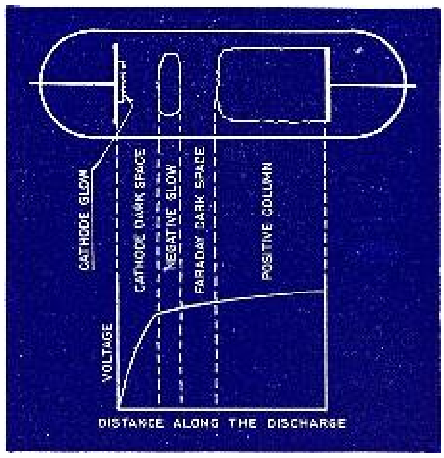


Fig. 3. Gas discharge in a tube.

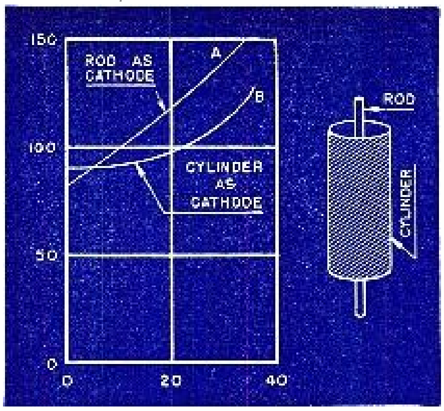


Fig. 4. Voltage regulator characteristics.

and the region DE is known as the region of arc discharge.

The glow discharge is divided into two parts. The region BC, in which changes of current flowing in the circuit does not change the voltage drop across the tube, is known as the normal glow discharge region. The region CD, in which additional rise in voltage causes a rise in current, is known as the abnormal glow region. An explanation for the regions BC and DC will be given later.

Fig. 3 shows the appearance of the gas discharge between the two electrodes of Fig. 1 when the pressure is in the 10^{-1} mm. of mercury range. The dark space just in front of the cathode or negative electrode is known as the cathode dark space. The glow next to it is known as the negative glow. Then comes the Faraday dark space, and then a long luminous glow region known as the positive column. The potential distribution along the discharge is shown in the graph underneath the drawing showing the physical appearance of the discharge in Fig. 3. As can be seen most of the voltage drop is in the cathode dark space.

The diameter of the discharge at the cathode depends upon the current flowing in the tube. When the current is such that the discharge is smaller than the diameter of the cathode the part of the cathode covered by the discharge is a region of constant current density, i.e., the same current passes through each unit of area of the cathode surface covered by the discharge. An increase in current only causes the discharge to cover a larger area of the cathode. When the discharge completely covers the cathode a further increase in current no longer increases the size of the discharge at the cathode, and the current density at the cathode begins to increase. As long as the current density at the cathode is constant the voltage drop in the cathode dark space is constant, but when the current density increases, this cathode drop increases. This accounts for the normal and abnormal glow regions. Since most of the voltage drop of the gas discharge is in the cathode dark space it can be seen that when the discharge does not cover the cathode, the voltage drop is independent or nearly independent of the current, but when the cathode is completely covered and the current density increases, the voltage drop across the tube increases. The first is the normal glow condition and the second is the abnormal glow condition.

If the anode or positive electrode is moved towards the cathode, the positive column seems to move into the anode, but the Faraday dark space, the negative glow and the cathode dark space all remain the same size. The voltage drop observed across the tube will become somewhat less as the anode is moved along the positive column. As soon as all the positive column is used up the Faraday dark space seems to move into the anode as the anode is moved toward the cathode and the voltage continues to fall. As soon as there is no more Faraday dark space left, and the anode moves into the negative glow, the voltage rises and continues to rise as the anode moves along the negative glow until a point is reached where the voltage is equal to the supply voltage, and the discharge goes out.

The voltage which corresponds to point B at which the glow discharge starts is called the ignition voltage of the tube, but the discharge will maintain itself if the voltage is lowered below this value. If the voltage is still further lowered, a point is reached at which the glow discharge can no longer maintain itself, and the discharge goes out. This voltage is called the extinction voltage of the tube.

An important application of the normal glow is the gas-filled voltage regulator. The physical structure is shown in Fig. 4, and the voltage-current characteristic is shown with it for both the rod and the cylinder used as cathodes. It will be noted that when the cylinder, which represents a large area, is used as the cathode the current-voltage curve is flat showing that the voltage drop across the tube is constant for a rather large range of current, but when the rod is used as the cathode, the voltage varies rapidly with the current from the very beginning because of the small area of the rod.

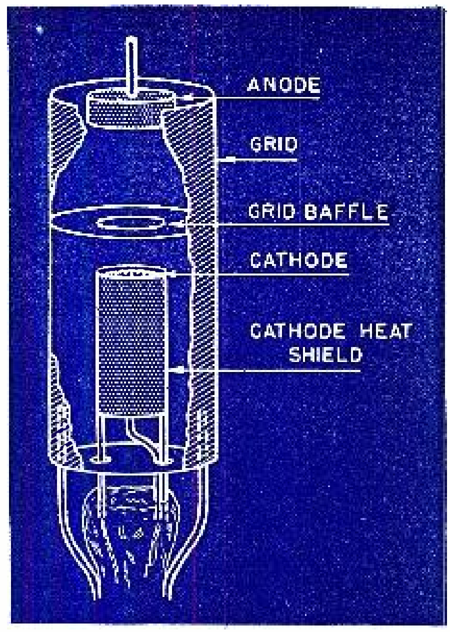


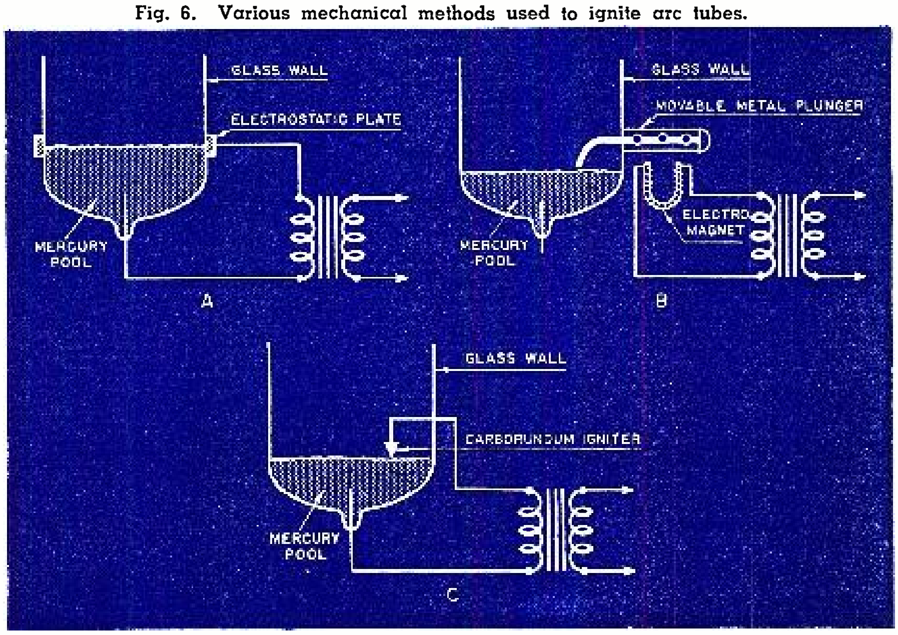
Fig. 5. Internal structure of thyratron.

The positive column has very little voltage drop across it and is of relatively little importance in most applications. An important exception is the neon sign which depends upon the positive column as a source of light. The normal voltage drop depends upon the cathode material, the pressure, the nature of the gas present, and the electrode spacing. It is of the order of hundreds of volts. The pressure and the electrode spacing can be combined into one variable, the product of the pressure and the distance between electrodes. A graph of the product plotted against the normal voltage drop in a typical tube is shown in Fig. 7.

If the pressure is maintained constant and the distance between electrodes is varied, the voltage drop across the tube will vary as shown in

(*Continued on page* 46)

Fig. 6. Various mechanical methods used to ignite arc tubes.



THE SAGA OF THE VACUUM TUBE

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

Part 3 of this series covering the Edison era, illustrating many of his outstanding inventions and the problems encountered.

IN 1851 Professor Heinrich Buff, of the University of Geissen, published a paper[75] on the electrical conditions existing in flames. He came to the conclusion that gaseous bodies which have been rendered conductive by strong heating are capable of exciting other conductors, solid as well as gaseous, electrically. At that time the incandescent lamp was far in the future, and the experiments reported were made using two small strips of platinum introduced into a glass tube which was closed at one end. Experiments involving heating the tube even to the softening point of the glass gave a negative result, but when the strips of platinum were exposed to the direct action of the flame of a spirit lamp, a current flowed between the strips, the flow being from the hotter of the two strips toward the colder.

Edward Becquerel, illustrious son of an illustrious father, in 1853 began a study of the electrical conductivity of gases. His method was to apply heat externally to a platinum tube, down the axis of which were stretched two parallel platinum wires, maintained at a difference of potential by a low voltage battery. This procedure was varied in some cases by using the tube as one electrode and a platinum rod placed axially in the tube, and supported at one end, as the other electrode. From his experiments with this apparatus, and the measuring equipment which had been developed by the work of the men of whom we have previously spoken, he came to the following conclusions:[76, 77, 78]

(1) Gases become conductors only at or above the temperature corresponding to red heat, and as the temperature increases so does the conductivity.

(2) At such temperatures they are conductors even when a low voltage is applied.

(3) The relative dimensions of the electrodes have an effect on the conductivity of the gas, the conductivity increasing rapidly with the surface of the negative electrode.

(4) The resistance of the gas varies with the applied voltage, and with the current through it, that is, it does not obey Ohm's law.

(5) Below red heat the pressure of the gas has little effect, there being no conduction at low voltages. Above red heat rarefaction of the gas increases the conductivity.

We know now that these effects noted by Becquerel were due not alone to the fact that the gas was heated, tending to produce ionic conductivity, but also to the fact that the electrodes were heated, whereby thermionic emission was taking place. The results attained by Becquerel do not seem to be widely known, as little credit is given to him in later treatises on the conduction of electricity through gases.

Gustav Wiedemann refused to concede the possibility of gaseous conduction and attempted[79] to explain away Becquerel's results by attributing them to changes in the conductivity of the cement used in sealing the electrodes in place. Blondlot, in 1881, confirmed[80] the results of Becquerel and disproved the contention of Wiedemann.

Fredrick Guthrie, in 1873, repeated Nollet's procedure of more than a century before, of heating iron white hot and testing it for discharging power as it cooled. He found[81] that at white heat an iron ball would retain neither a positive nor a negative charge of electricity, but that at red heat it could retain a negative charge but not a positive one.

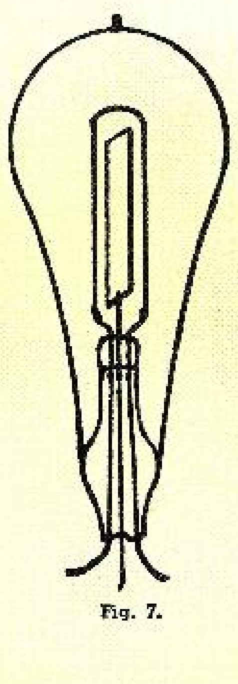


Fig. 7.

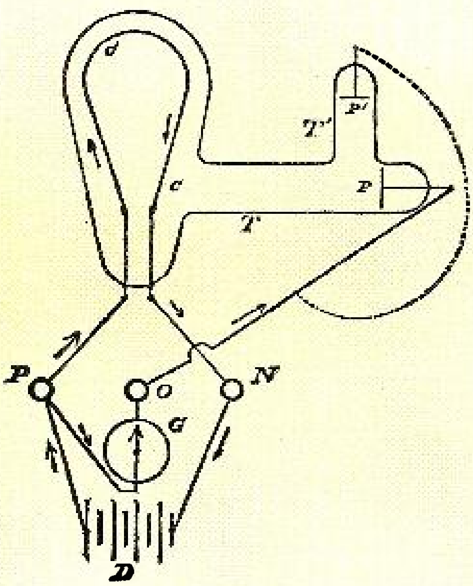


Fig. 8.

The Edison Effect

In 1879 Thomas A. Edison finally succeeded in "subdividing the electric light" when he brought the incandescent lamp to commercial practicability. He was still at work perfecting it

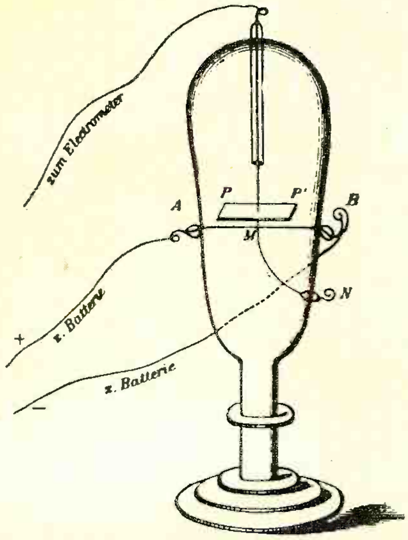


Fig. 9.

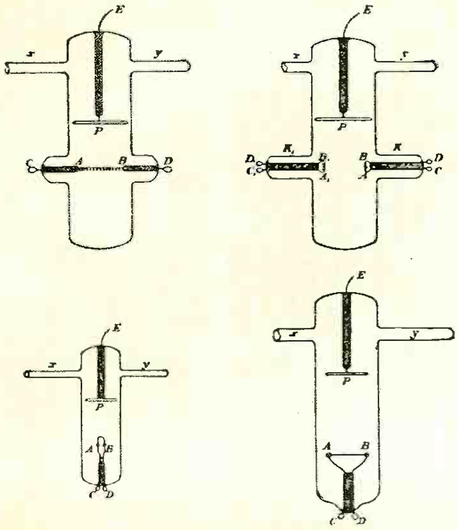


Fig. 10.

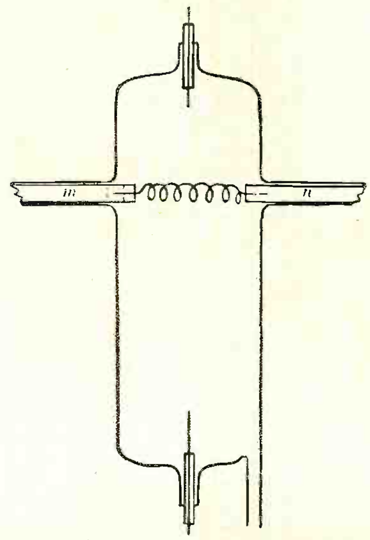


Fig. 11.

some four years later, when he observed and recorded the phenomenon which received the name of the *"Edison effect."*

During his experiments he observed that as the time of operation of his incandescent lamp increased, the light output was reduced by a blackish deposit on the interior of the glass bulb.

In the course of his investigations he noted two other things which were of great importance. The first was that there was frequently to be found on the glass, in the plane of the filament, a line which was not blackened. The second, and this was the more important of the two, was that the leg of the filament which was connected to the positive pole of the circuit was always that which "cast the shadow." It appeared that the opposite side, which was connected to the negative pole, was throwing off minute particles of filament material which traveled outwards and were deposited on the glass everywhere except where the glass was screened by the positive leg of the filament.

In order to study this effect more in detail, Edison had constructed some lamp bulbs containing filaments and, in addition, small metallic shielding plates placed between the legs of the filament. He found [82] that if this plate was connected to the positive end of the filament a current would flow across the vacuous space, but that no current would flow if it were connected to the negative end.

Seemingly the only use which Edison could imagine for this device was as an indicator to show variations of potential on the lighting circuit. In his patent application,[83] filed November 15, 1883, for an "Electrical Indicator," the lamp apparatus used is shown in Figure 7. In this application, however, there is to be found this very significant clause concerning the current across the vacuous space—"This current I have found to be proportional to the degree of incandescence of the conductor or the candle power of the lamp."

Probably because of the work involved in the introduction of the incandescent lighting system, Edison did not have time to carry on further experiments. Even had he done so, and evolved a *"valve"* he would have been at least ten years ahead of his time.

The publication of the *"Edison effect"* aroused interest in many places. In the first paper printed in the first volume of the Transactions of the American Institute of Electrical Engineers, Professor Edwin J. Houston gave "Notes on Phenomena in Incandescent Lamps." In this paper [84] Professor Houston referred to the "peculiar high vacuum phenomena observed by Mr. Edison in some of his incandescent lamps." He then went on.

"The question is, what is the origin of this current? How is it produced? Since we have within the globe nearly a complete vacuum, we cannot conceive the current as flowing across the vacuous space, as this is not in accordance with our preconceived ideas connected with high vacua."

Professor Houston described another of Mr. Edison's experiments which appeared to throw no little light on the matter. The apparatus used in this experiment is shown in Figure 8 (which is Figure 3 of Houston's paper). Instead of placing the cold electrode between the legs of the filament, as had previously been done, he placed two cold electrodes as shown at "P" and "P^1." Edison found that if the galvanometer was connected to the plate "P" as shown by the solid line, a

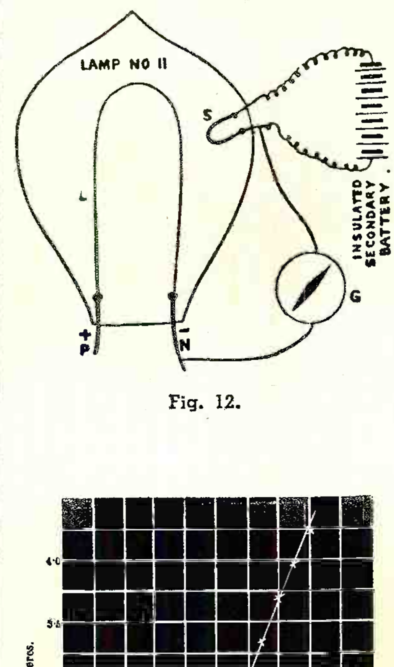


Fig. 12.

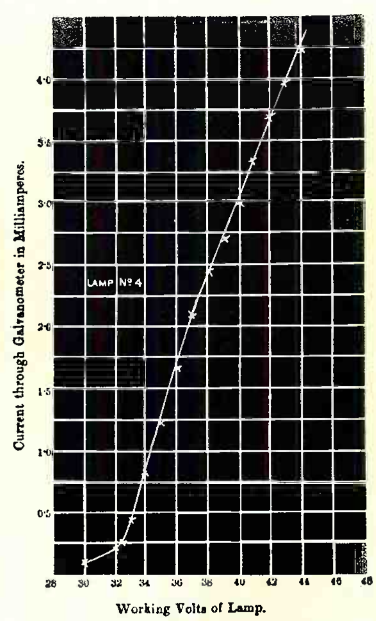


Fig. 13.

current flowed through it, but that this was not the case when it was connected as shown by the dotted line, to "P[1]." Apparently the current could not flow around a corner.

Among those present, and taking an active part in the discussion which followed the reading of this paper was Sir William Preece, who was extremely interested in the new phenomena. He announced that he intended to exercise his persuasive eloquence upon Mr. Edison to induce Mr. Edison to give him one of these lamps and said:

"When I go back to England I shall certainly make an illustration before our society there, and then make careful inquiry into it."

How he succeeded and what he did will be seen later.

Let us now return for a while to Germany. Julius Elster and Hans Geitel, beginning about the year 1880, pursued a series of investigations in that country. The results of these researches were reported in a series of articles beginning in 1882. The first four of these articles[85] deal with the characteristics of flames, particularly with reference to their unsymmetrical conductivity, and in part confirm the earlier work done along these lines. The fifth article[86] which appeared in 1887 is entitled "On the Electrification of Gases by Glowing Bodies." In this article experiments were described involving the use of a glass bulb, which could be exhausted or filled with various gases. Across the inside of this bulb was stretched a platinum wire which could be heated electrically. See Figure 9. Opposite this wire, and very close to it, was placed a platinum plate suspended by a leading-out wire. The vacuum used was described as "the best possible—such as Crookes used in his famous experiments." The results of these experiments of Elster and Geitel indicated that *"Electrified Particles"* were thrown off from the glowing wire uniformly in every direction and that the conductivity was unilateral.

The next paper,[87] published in 1889, is entitled "On the Excitation of Electricity when Galvanically Glowing Wires come in Contact with Heated Gases." In this paper various experiments were described involving the use of glowing platinum wires and glowing carbon filaments in exhausted bulbs, with cold electrodes of platinum placed at various distances from the glowing members. Mention is made of the fact that the carbon filament always excites the cold electrode negatively. The bulbs were so constructed that they could be placed within the poles of a magnet of the horse-shoe type, and the effect of the magnet on the apparent conductivity of the vacuous space was noted.

In the latter part of this paper a theory, first enunciated by A. Schuster, is used to explain the unipolar conductivity. This theory is based on the dissociation of the gas molecules by contact with the glowing body. It is interesting to note that in this paper Elster and Geitel acknowledge that their work was made possible by a grant of American funds, provided by the Elizabeth Thompson Science Fund of Boston.

The last paper of this series was published[89] in 1889 and describes further experiments with various other tubes of the forms shown in Figure 10.

While Elster and Geitel were conducting their investigations another German scientist, William Hittorf, had been for some time working on gaseous conduction. In his work Hittorf made use of high voltages, developed from a large number (2400) Bunsen cells connected in series. This gave about 4000-4500 volts, with which he could observe phenomena of the type seen in the days of static electricity, but which he could reproduce at will, and sustain long enough to permit of taking accurate observations. Hittorf's first paper "On the Conduction of Electricity in Gases" appeared[90] in 1869, his second[91] in 1874, his third[92] in 1879, and his fourth[93] in 1883. In these papers Hittorf describes his work on conduction in rarefied gases, using cold electrodes. It is in his fifth paper, which appeared[94] in 1884, that we first find reference to the use of a cathode which was heated by external means. The apparatus used is shown in Figure 11. He was led to the use of this cathode by the difficulties he experienced with the evolution of gas from the electrodes previously used.

These electrodes became hot, owing to the high energies of the gaseous discharge and the occluded gases which were released impaired the vacuum and affected the discharge. To obviate this difficulty he used a cathode which could be maintained at a high temperature by means which were independent of the discharge. Hittorf's publications are dry, almost repulsive, reading and their value was buried deep in the mass of experimental data which he reported.

The experiments which he performed were essentially those of Becquerel, except that he used higher voltages and better vacua and was able to heat one electrode at a time. He observed that when the spiral platinum cathode was brought to or above a red heat, the conductivity of the gaseous space rose rapidly with the increase of cathode temperature, and that a similar condition was observed if the cathode were made of carbon. He noted[95] (as Becquerel had previously done) that the conductivity increased as the pressure of the gas was lowered.

He also noted that even with the cathode heated by means of an external auxiliary battery it was necessary, in order to maintain the vacuum, to continuously remove, by means of the pump, the gases given off. He observed that the current flowed only when the heated electrode was used as a cathode, at low voltages, that is, that the conductivity of the space was unilateral at those voltages. In this he went a step further than Becquerel, who could not have made such an observation since, due to his experimental arrangement, both his electrodes were heated.

Having thus followed the progress of investigation in Germany up to about 1890, let us now return to England. Early in 1882, after the formation of the Edison Electric Light Com-

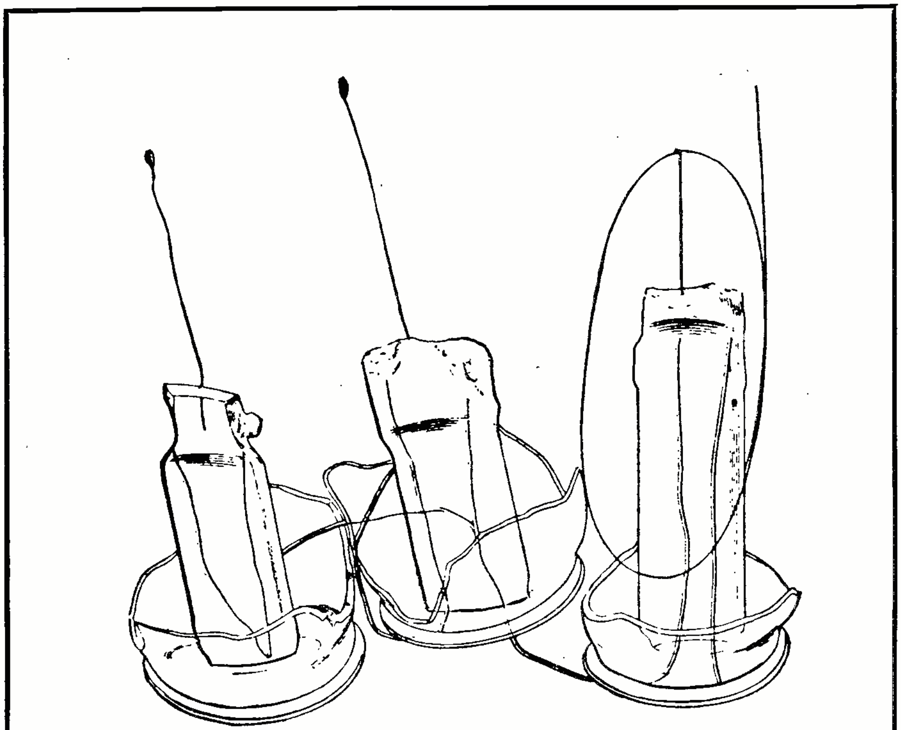
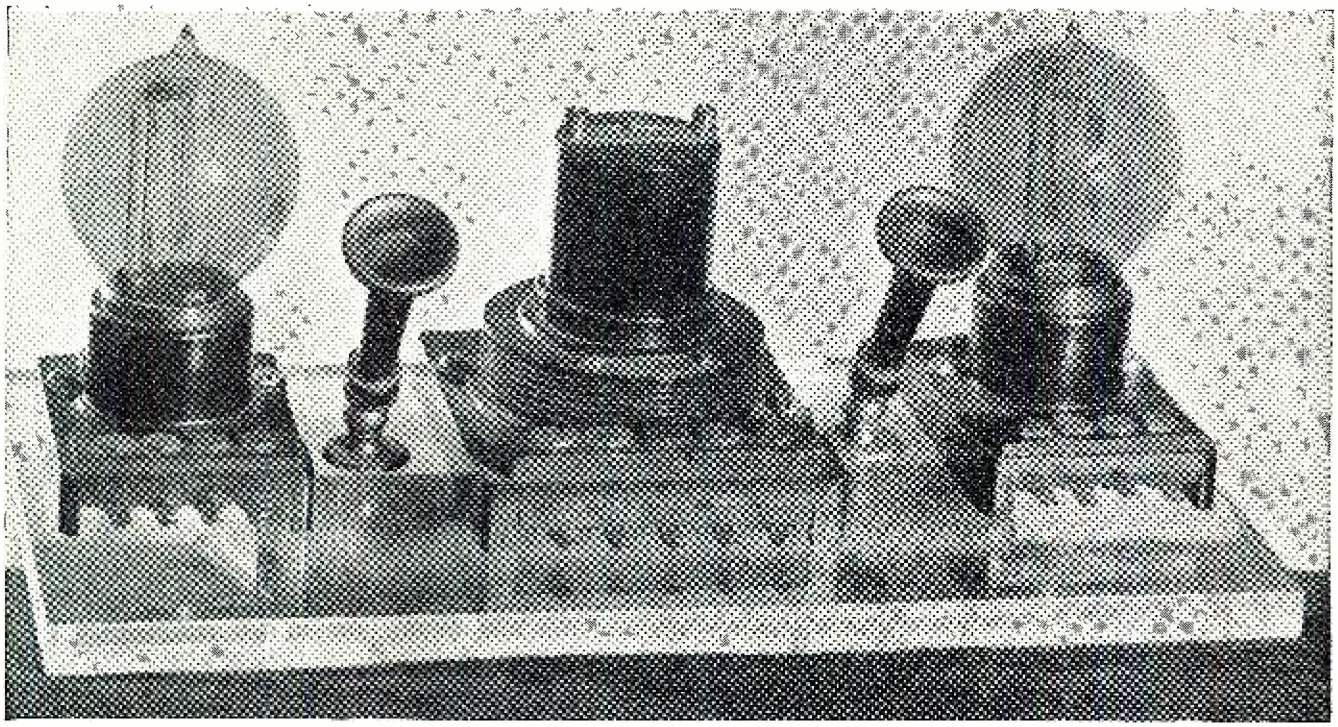


Fig. 14.



A rather odd but interesting desk set made up of Western Electric antique tubes and sockets.

pany of London, John Ambrose Fleming (later Sir John Ambrose Fleming) was appointed electrical adviser to the company. He was thus brought into close touch with the many problems which arose in the use of incandescent lamps. He, like Edison, soon noted that when carbon lamps were blackened in service there sometimes was found on the glass, at a point opposite where the filament had finally burned out, a lighter deposit of the black material than was to be seen elsewhere on the glass.

This he termed a *"Molecular Shadow."* His first mention of it comes in a paper read before the Physical Society of London on May 26, 1883.[96] In this paper he observes that the shadow is found only where there is a copper deposit on the inner surface of the glass bulb, never with the ordinary carbon deposit. This paper was a short one, more or less of a summary, to precede a full discussion. The full discussion, however, did not appear until some two years later, on June 27, 1885,[97] which was some time after the discovery of the Edison effect had been announced. In this latter paper he notes that in some cases where only carbon deposit existed he observed the same molecular shadow as in the case of the copper deposit, wherever both legs of the filament were in the same plane, and the filament had burned out due to the development of a hot spot.

Meantime Sir William Preece had returned from America with the fruits of his "persuasive eloquence" in the form of some of Edison's lamps. With these lamps he proceeded to duplicate the experiments he had observed in America and make quantitative measurements of the Edison effect. The results of these experiments were presented to the Royal Society in 1885.[98]

The paper opens by describing the experiments he had witnessed in America and then goes on to describe his own work using Edison's lamps. It is in this paper that we first find mention of *"blue glow"* or *"blue effect"* (due to the ionization of the residual air) which defied explanation for a long time. This appeared when the lamps were operated somewhat above their rated voltage. In the presence of this *blue glow,* Preece observed that current could be made to flow not only from cold to hot electrode, but also in the reverse direction.

He observed that the current was unaffected by the material of which the cold electrode was composed, but increased rapidly with increasing potential across the lamp. That is, he confirmed Edison's observation that this effect was proportional to the degree of incandescence of the lamp, as stated in his patent which had previously been issued.

On February 14, 1890, Fleming gave a Friday evening discourse before the Royal Institution on "Problems in the Physics of an Electric Lamp."[99] He again discussed *molecular shadows* and the reason for their formation. He also reviewed the work of Preece and repeated his experiments. In addition he showed that a single Clark cell would cause a flow of current across the vacuous space if the positive pole of the cell was connected to the cold electrode, but that if the battery was reversed there was no flow of current. This was in agreement with the results attained by Hittorf in 1884, who showed that even a small voltage was sufficient to send a current across the vacuous space, provided the cathode was a high temperature and the positive pole of the battery was connected to the cold electrode (plate).

Fleming also showed that if the cold electrode is heated to incandescence then the current may be made to flow, by the use of the external battery, in either direction through the vacuous space. Fleming did this by means of the apparatus shown in Figure 12. It should be remembered that this same conclusion was reached by Becquerel, with somewhat poorer vacua, in 1853.

These investigations were carried still further and resulted in another paper before the Physical Society of London on March 27, 1896, and entitled "A Further Examination of the *Edison-Effect* in *Glow Lamps.*"[100] In this paper Fleming repeated some of the quantitative experimental work previously done by Preece and gave a curve (See Figure 13) which showed the relation between the potential across the lamps, and the current through the vacuous space. He also announced that even if alternating current was used to heat the filament, that a unidirectional current was obtained in the cold electrode circuit.

The last important work prior to the application of the vacuum tube as a rectifier of high frequency oscillations in wireless telegraphy is recorded in a paper given before the A.I.E.E. in February, 1897, by John W. Howell.[101] This paper was intended as a discussion of the paper by Houston, previously mentioned. It discusses the *Edison-effect* phenomena which occur in lamps when the *"blue glow"* is pronounced, and states that the presence of the blue glow indicates the passage of electric current across the vacuous space. This paper is remarkable in that it is the first to show that currents of more than a few milliamperes may be made to flow across the space

(*Continued on page* 75)

TECHNICAL BOOK & BULLETIN REVIEW

"EXPERIMENTAL ELECTRONICS," by Ralph H. Muller, R. L. Garman and M. E. Droz. Published by *Prentice-Hall, Inc.,* 70 Fifth Ave., New York City. 322 pp. plus index. Price $4.65.

An effort has been made to present a fairly complete and continuous picture for the general reader. The results of each experiment are given in tables or graphs of original data. In practically all cases, idealized curves have been avoided, and the reader or experimenter can at once learn what may be expected from the transcribed treatment. This book has been written to supply definite practical information on characteristics and non-communication applications of electron tubes. It is an outgrowth of the authors' experience in courses given for students and industrial academic research workers in chemistry, biology and engineering at the New York University. The radio engineer or communications expert may glean from the experiments a point of view or statements of problems rarely encountered in its own specialties which are peculiar to the experiments of other fields of science.

Various subjects are classified in such a manner as to facilitate quick reference. This is of prime importance in these days of hurry-up necessities for learning various subjects in the least possible time. It is an ideal book for those about to enter our communication services as well as the general students of radio phenomena. Much material is included which will furnish adequate background as a preliminary to the expansion of training on radio and electronic techniques.

"ELEMENTS OF RADIO," by A. M. Marcus and Wm. Marcus, prepared under the direction of Ralph E. Horton. Published by *Prentice-Hall, Inc.,* 70 Fifth Ave., New York City. 684 pp. plus index. Price, one volume $4.00; two volumes $2.45 each.

Here is a basic and elementary home-study course on the fundamentals of radio which requires no advance knowledge of physics and mathematics. There is now an acute and growing shortage of skilled radio technicians and operators. An understanding of the contents will lead to operational skills that are basic for such jobs in industry and the armed forces as: radio mechanic and technician, radio operator, Signal Communication Instructor, ground radio repair instructor, and other equally interesting and responsible posts.

The book was written to the exact prescription of the Government officials responsible for training of thousands of new radio technicians. The authors are men who have the ability

(*Continued on page* 81)

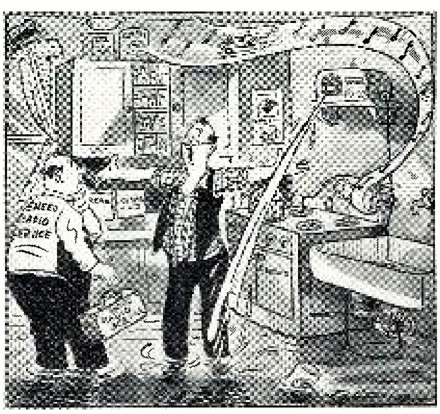
QRD? de GY

by JERRY COLBY

THIS is really not the time to give away the handiwork of some of the brainwaves of various radiops inasmuch as passenger cablegrams are definitely nil, but for future reference here goes: Did youse boys and YLs ever hear of the "Quick Delivery and Bust" society? Or "The Wandering Hand Society"? List awhile to the utterances of Brother Earl F. Widdon and learn. He sez that when the WHS ritual was put in operation on the South American run, the radiops gave Jose Rum Shop up and became members of the Jockey Club in Rio.

The select few ops who made up the roster of these two organizations were men who saw the world through the Big George (KDCL), Martha Washington, Aeolus (transferred to WC as City of Los Angeles), Western World, American Legion and several coastwise crates, most of them seized German ships of 25,000 tons and over. It appears that on the South American Run, WSA at Easthampton, L. I., was THE station. But to make sure that a passenger's message got through, 3000 miles south of New York, the suggested routing would be to radio to a Brazilian coastal, thence across to the West Coast, up the WC via All American Cables to New York City.

However, due to various and sundry reasons, especially static, a msg would remain on the hook all night until WSA would come thru at which time the msg would be dispatched. Incidentally, thru WSA a msg was a dollar less per word. The next problem was to attempt to locate the passenger who filed the msg and give him or her a rebate. After many fruitless quests



"I'm afraid I did something wrong in grounding her!"

it appeared that the passenger had jumped overboard after filing. Most passengers either refused a receipt or threw it in the waste basket planted outside the radio shack. Of course, we hasten to assure the uninitiated that it is doubtful whether any radiop intentionally cheated a passenger. It just happened, sort of. A radiop who made one of the above blunders immediately became a member of the Wandering Hand Society.

The North Atlantic WHS method was performed by sending traffic through WCC, Chatham, Mass., that had been charged for as routed through an English coast station thence via radio or cable to New York City. Often these messages were sent to WCC while the ship was docking in Southampton. Of course, one should work the nearest coast station but many radiops could possibly make the error of believing they were in the middle of the Atlantic. The main point is radio messages were delivered, thanks to Marconi, et al, and someone had to pay for the professional knowledge of the radiop. 'Tis sad, 'tis sad, but the wire companies always received their just dues.

WE were pleasurably surprised to learn that WLO, Mobile, Alabama, is still perking in spite of the closing down of some of the larger stations "after the profit motive ceased to exist," sez Norman Underwood, WLO prexy. "This is a clear case where the FCC's action in granting a license to an unimportant individual has been more in the public interest than some similar privileges granted vested interests. In fact, I have augmented my service to 24 hours a day. It's done in this manner: When the Coast Guard radio station here, NOQ, which maintains a constant watch on 500kc., hears a ship call WLO at other than my published hours, the op 'phones me at my residence. And I have returned to open the station within 30 minutes in every instance.

"I have been called at 4:00 a.m. Sunday morning, but I would be quite willing to work ships at any hour without any additional revenue at all, if in so doing I could help the war efforts. This service is of considerable importance to the local steamship companies, because if a message for Mo-

(*Continued on page* 54)

PRACTICAL RADIO COURSE

by ALFRED A. GHIRARDI

Part 14 of the series, covering important resistance-coupled circuits as employed in present day multistage audio and video amplifiers.

CONTINUING our study of voltage and power amplification by means of vacuum tubes, we are now prepared to learn the various circuit arrangements employed for coupling one voltage amplifier stage to a succeeding one for greater total amplification.

Practically all voltage amplifiers in radio receivers and a.f. amplifiers are operated as Class A amplifiers (the grid bias and signal voltage are selected so that the plate current in a given tube flows at all times throughout the cycle of alternating signal voltage applied to the grid—also so that operation is confined to the linear or straight-line portion of the grid-voltage-plate-current characteristic curve of the tube. In such amplifiers, the wave-form of the output voltage wave is substantially similar to that of the input voltage signal wave applied to the grid of the tube). Therefore, for the remainder of this lesson, Class A operation will be assumed unless otherwise specified. Class AB, B and C amplifiers will be studied later, in the lesson on power amplifiers.

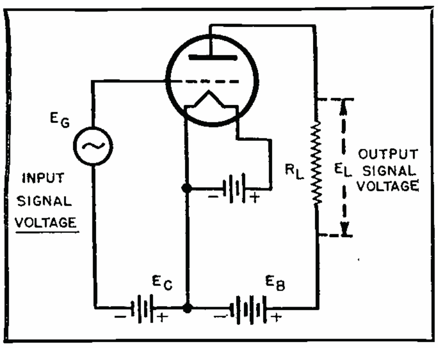


Fig. 1. Simple triode circuit.

Review of Tube Action as an Amplifier

It was learned in the last lesson that an alternating-signal-voltage variation E_g applied to the grid of an amplifier tube will produce a variation of corresponding waveform in its plate current. If this varying plate current is made to flow through a plate load resistor R_L of sufficiently high resistance, as illustrated in Fig. 1, a varying voltage E_L will be developed across the resistor, similar in wave-form to the original signal voltage E_g, except that it is many times greater in amplitude. This larger voltage variation can then be applied to the grid circuit of a second tube to obtain additional voltage amplification by the second tube.

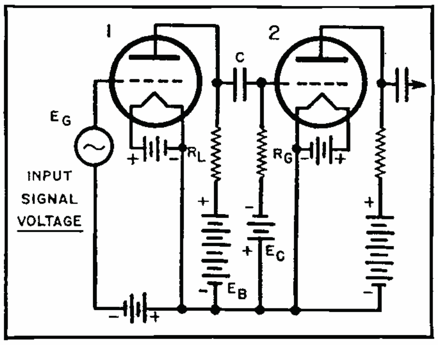
There are several methods used for coupling the plate circuit of one amplifier tube to the grid circuit of the next so that the signal energy will be transferred from one to the other. In general, the type of load that is used to dissipate the plate-circuit energy determines the type of coupling to the following amplifier stage. This plate load might be a resistor, a reactor or impedance coil, a transformer, or a capacitor. The first three types are used widely in radio equipment and will be explained in this series in the order stated above.

Resistance-Coupled Voltage Amplifier

Resistance-coupling between successive voltage amplifier tubes is used extensively for audio-frequency and video-frequency applications because of the low cost and compactness of the circuit elements required, and the fact that it enables pentode type amplifier tubes to be used at high gain efficiency in such amplifiers. It is also used occasionally for certain limited applications in radio-frequency work where an untuned circuit is satisfactory, but objectionable actions which occur at radio frequencies limit its use at high frequencies. Because of the great importance and wide application of resistance-coupled amplifiers in all types of radio work, they will be studied rather thoroughly here.

Fig. 2 shows the basic circuit of a typical two-stage resistance-coupled amplifier. The input signal voltage is E_g, applied to the grid circuit of tube 1. The output voltage of tube 1 is developed across plate load resistor R_L and is applied to the grid of tube 2 through coupling capacitor C. This capacitor serves to prevent the direct battery voltage in the plate circuit of tube 1 from affecting the grid of tube 2, but it does not prevent the alternating signal component to be impressed on the grid. Since it serves to couple the plate circuit of tube 1 to the grid circuit of tube 2 (insofar as the a.c. signal voltage only is concerned), it is usually known as the *coupling* condenser. However, since it also serves to block the d.c. plate voltage of the first tube from the grid of the second tube, it is also often called the *blocking* condenser. Both terms should be remembered.

Fig. 2. Typical two-stage amplifier.



The resistor R_g, generally known as the *grid leak*, provides a conducting path from the grid of the second tube to the C-bias voltage source to maintain the grid at the proper negative bias potential for operation at the mid-point of the tube's operating characteristic (Class A operation). It also serves the very important duty of draining off any electrons collecting on the grid during a momentary positive swing under large signal voltages, as we shall see later.

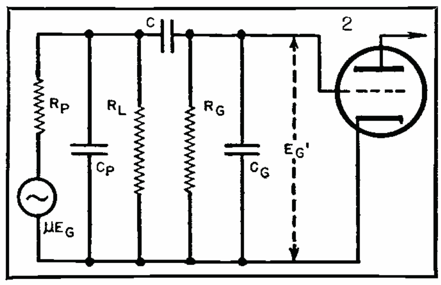


Fig. 3. Equivalent circuit.

Several important matters about the performance of the resistance-coupled amplifier may be understood more clearly by reference to Fig. 3 which shows the equivalent electrical circuit of the amplifier of Fig. 2. The amplified alternating signal voltage acting in the circuit is μE_g, and the internal plate resistance of the tube is r_p. Between the first and second tubes is a circuit network composed of C_p, R_L, C, R_g, and C_g arranged as shown. Capacitance C_p represents the internal and plate circuit capacitance of tube 1. Capacitance C_g represents the comparatively small grid-input capacitance of the second tube plus the capacitance of the connecting wires, tube socket terminals, etc. It is apparent from this diagram that the *total* load actually connected to the first tube is not simply the load resistor R_L but is this load resistor shunted by C_p and a network consisting of C in series with the combination of R_g and C_g in parallel. Therefore, since for good voltage gain

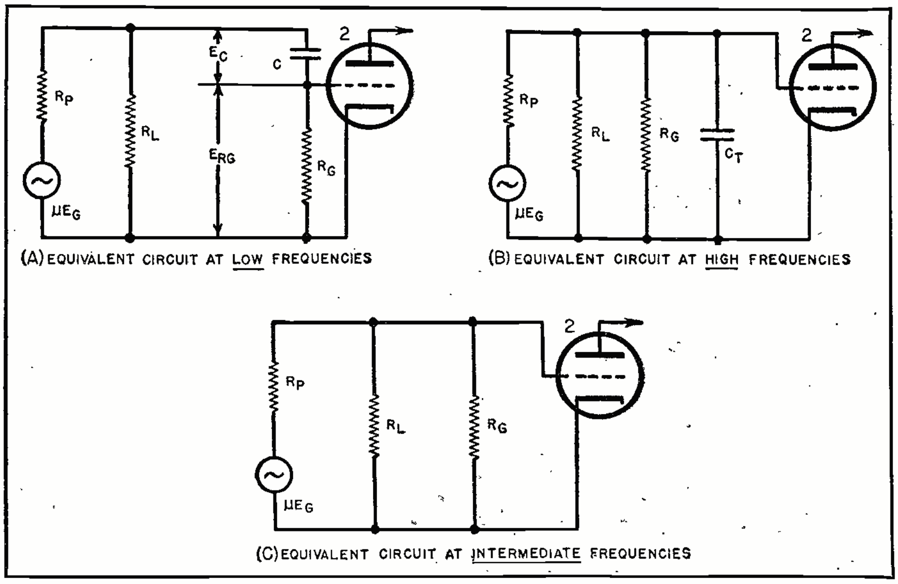


Fig. 4. Typical equivalent circuits at various frequencies.

the effective load circuit resistance must be as high as is practicable, the shunting effect of R_g must be kept low by using a very high resistance for R_g. More will be said about this later.

Frequency Response

Most resistance-coupled voltage amplifiers must meet the following two important requirements:

(1.) They must produce uniform response over a given frequency band.

(2.) They should produce maximum possible gain consistent with securing the desired frequency response characteristic.

Since both the frequency response and the gain are dependent upon the values of circuit constants employed, it is important to understand the effects of each one. Since some constants affect only the response at low frequencies, others affect the response at high frequencies, and still others affect the response at intermediate values of frequency between these, it is best to analyze the conditions at low, high, and intermediate values of frequencies separately.

Reduced Gain at Low Frequencies

At the very low audio frequencies, such as 20 or 30 cycles per second, the reactance of the small capacitance C_g becomes so high that its shunting effect across R_g and the rest of the circuit is negligible. Accordingly, it may be omitted from consideration. Similarly for the capacitance C_p. The reactance of the coupling condenser C becomes appreciable at these low frequencies, and since it is in series with the signal path it becomes important. The equivalent circuit becomes as shown in Fig 4A.

The amplified a.c. signal voltage output of tube 1 which appears across load resistor R_L really acts on the circuit composed of coupling condenser C and grid leak resistor R_g in series with each other (Fig. 4A). Since each presents an impedance to the flow of signal current there will be signal voltage drops E_c and E_{Rg} respectively, across them. These two voltage drops are 90 degrees out of phase with each other. C and R_g therefore form a potential divider across the source of amplified signal voltage. Now it is only the voltage drop E_{Rg} (appearing across R_g) which is impressed across the grid of the second tube. Consequently, the voltage drop E_c represents a total loss of signal voltage insofar as the output of the amplifier is concerned. Therefore, it is important that the capacitor C used be of large enough capacitance so that its reactance at the lowest frequency to be amplified is negligible in comparison with the resistance of R_g. Therefore, correct relative values of C and R_g must be chosen for the amplifier, otherwise the amplification will be decreased at these low frequencies. As additional factors must be considered when choosing these values for an amplifier they will be discussed again later.

Reduced Gain at High Frequencies

At the high frequencies, the reactance of coupling capacitor C becomes negligible, and likewise the voltage drop across it. Therefore, it may be omitted from the equivalent circuit showing

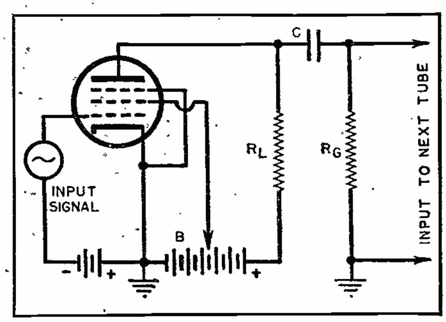
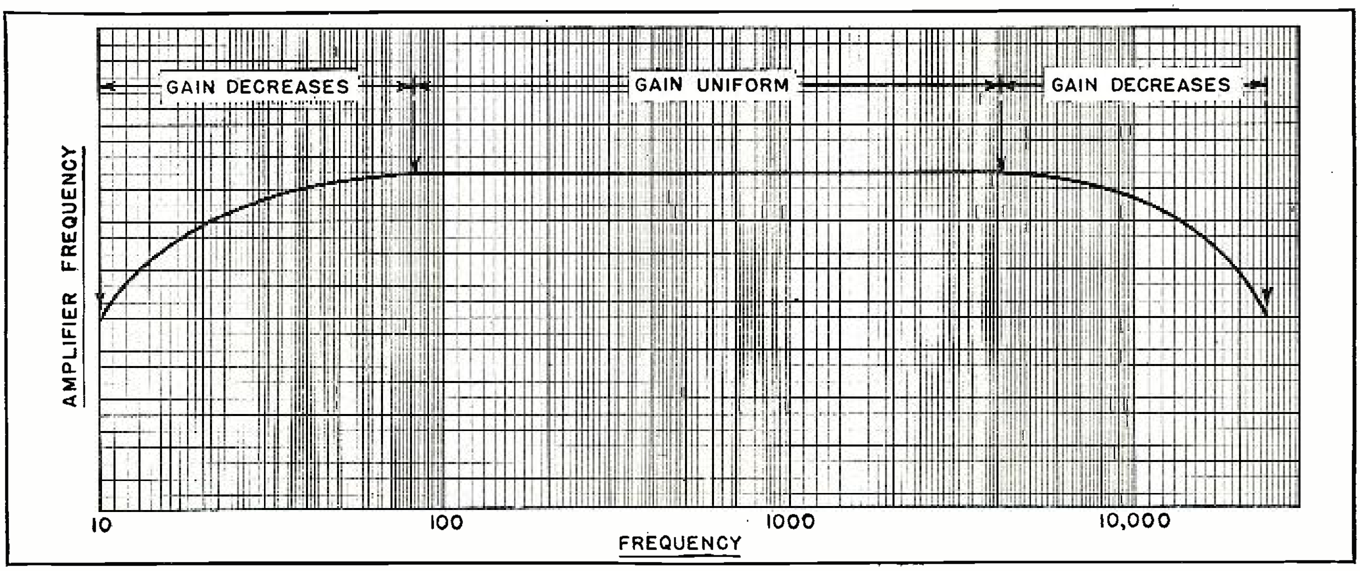


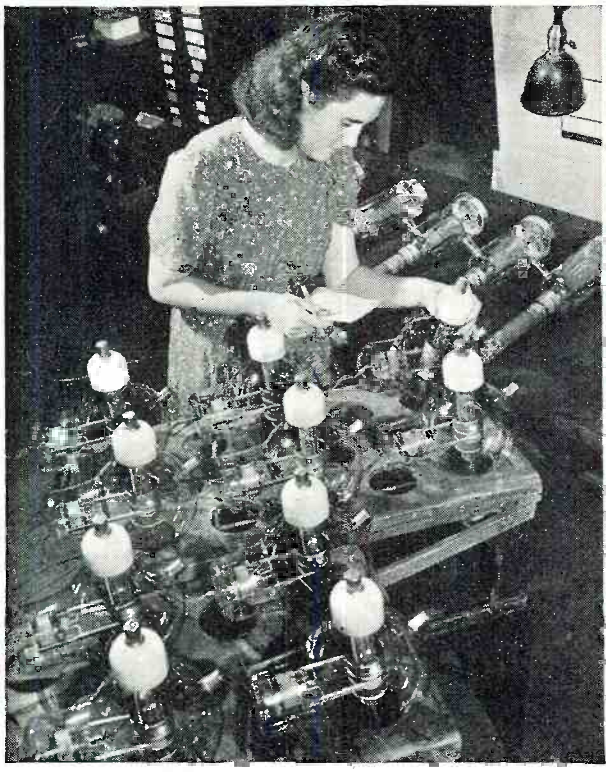
Fig. 6. Pentode amplifier stage.

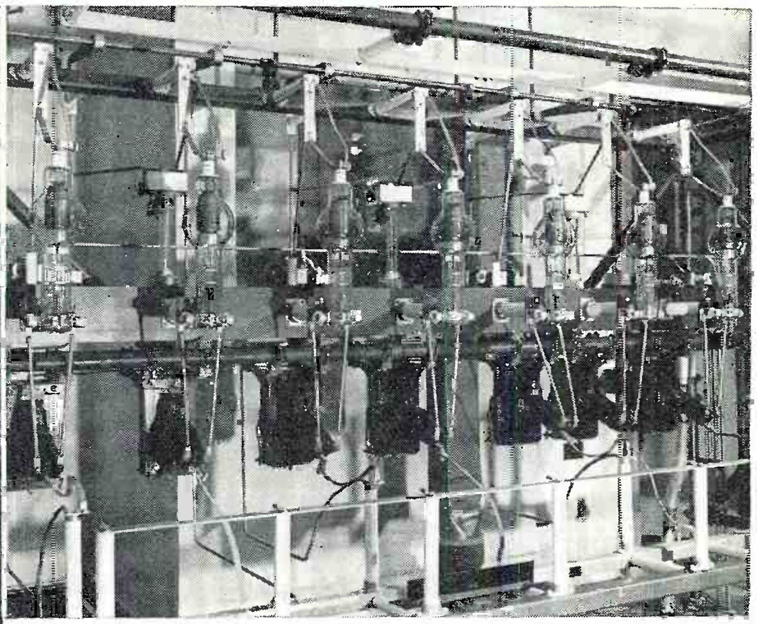
operation at the high frequencies (Fig. 4B). However, since the reactance of C_g and C_p also decreases greatly at high frequency, they exert an appreciable shunting or by-passing effect across R_g and R_L. Their combined to-

(*Continued on page* 56)

Fig. 5. Amplifier output curve showing decrease in gain at low and high frequencies.







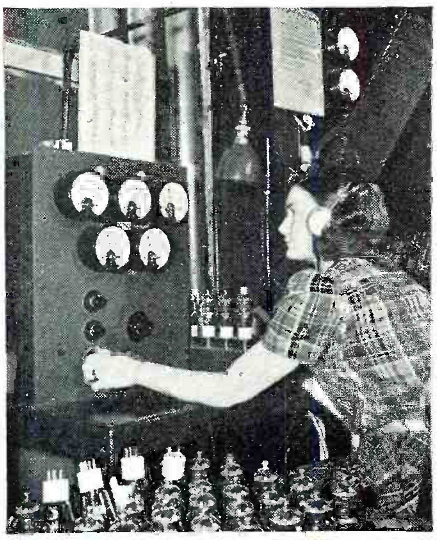
(Above) 50 kw., 18,000 volt output, rectifying tubes for station WHN. To insure safety they are located behind electrically locked doors.

(Left) a battery of high-powered radio transmitting tubes being tested before shipment. Tubes are for naval signal communications.

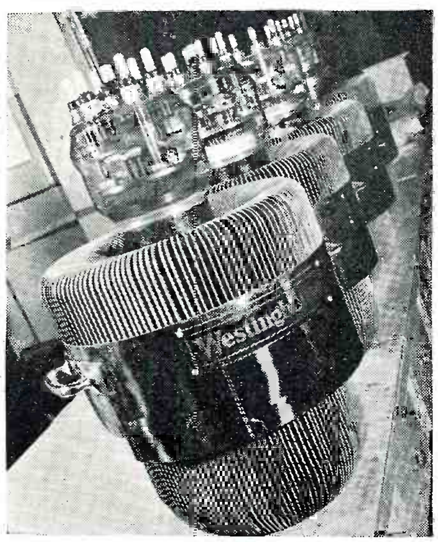
TUBES FOR THE FIGHTING FRONT

AT the outbreak of war the tube manufacturers were the first ones to be called upon to convert their entire civilian production toward the military effort. It was an outstanding accomplishment. Every effort was immediately diverted to fulfill this one aim—"Tubes For The Fighting Front." Many of the tubes that were in production were continued and some are still being used by the armed forces today. However, within the last year new and complicated radionic equipment has been designed with the result that new tubes had to be designed. These tubes today are entirely different from those in the past. New machines had to be built, new techniques followed. Regardless of the intricacies involved, the call for tubes from our various war fronts for tanks, cars, aircraft, communications networks, etc., is being answered!

Operator giving radio transmission tubes the final "noise test."



Bank of transmitting broadcast tubes representing a total of 100,000 watts.



Completing the "mount" or inner structure of a 25-watt transmitting tube.

Switch-Type Audio Oscillator

by RUFUS P. TURNER

This instrument covers a selected group of audio frequencies that are most commonly used for various types of measurement.

FROM time to time, we have described various audio oscillators on these pages. Some have been of the single-frequency type, such as 400 or 1000-cycle modulating oscillators; others have been of the variable-frequency type. The latter type have employed some sort of dial control of frequency setting, permitting a continuously variable control of frequency. Records show, however, that certain

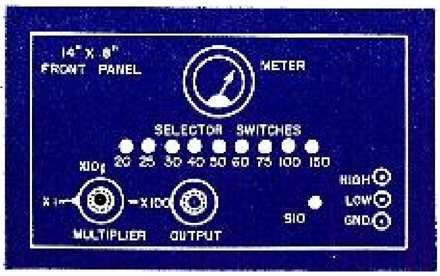


Fig. 1. Front panel view of the completed Oscillator.

frequencies throughout the a. f. spectrum are invariably used by P. A. men and military and civilian technicians, and that many of the other dial frequencies are seldom used.

For greater speed in making frequency runs or selecting spot audio frequencies, there is need therefore, for a rapid frequency selector mechanism in multi-frequency oscillators. The unit described in this article features such a mechanism. A single flip of the finger is the only motion necessary to change from one frequency to another. And no "retrace" errors (such as are occasioned by inability to set a dial exactly to a previous reading) are encountered.

This oscillator started out to be a pushbutton-operated instrument; but, due to the present shortage of multiple pushbutton switch assemblies, the design was modified to include instead a battery of standard toggle switches. However, the reader who possesses a nine-section pushbutton unit may readily substitute it for the switches, observing the same hookup shown in the circuit diagram. Greater ease of operation may then be obtained by means of the smooth-acting, light-touch buttons which are released automatically as neighboring ones are depressed. An ingenious experimenter might even construct his own pushbutton assembly, as the author had planned to do before an insistent time requirement dictated to do otherwise.

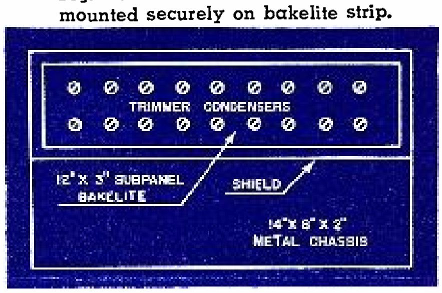
By means of an oscillator of the type shown herein, it is possible for the P. A. serviceman to select at will any one of the common test frequencies in determining the characteristics of an amplifier; for the designer or experimenter to select frequencies and their harmonics when testing filter networks, checking selective amplifiers systems, checking reactances or impedances, etc.; or for the communications operator to select any desirable modulating frequency within the spot-range of the instrument for transmitter modulation. The instrument is recommended for use in all related technical operations in the armed radio services. *It is suited ideally for making "light pattern" test discs by recordists.—Ed.*

General Theory

The basic circuit of the instrument will be recognized as that of the resistance-capacitance-controlled oscillator. This type of hookup was adopted in preference to the beat-frequency oscillator, since it requires no periodic setting to zero or to a reference frequency and since switching of the frequency-control sections has virtually no effect upon frequency. The R-C circuit proper is a modified Wien bridge in which the frequency is inversely proportional to resistance and capacitance values, rather than to the square root of these values as is the case in L-C circuits.

The circuit itself is not entirely new to radio experimenters, having been described on several other occasions. The introduction of the frequency-switching system is entirely new, however, to this particular circuit arrangement. At least one manufactured version of pushbutton oscillator employs the R-C scheme, but in a manner different from the one shown in Figure 4, and with greater complexity.

Fig. 2. Trimmer condensers are mounted securely on bakelite strip.



Sine-wave characteristics in the output a.f. voltage are obtained by regulating the gain in the amplifiers of the instrument automatically in such a way that the amplifiers always operate at the class-A level for low distortion.

This automatic operation may be explained in the following manner: The entire system (Figure 4) may be regarded as a three-stage audio amplifier of good frequency characteristics. Feedback voltages are transmitted from the grid circuit of the last 6V6-GT tube over the line to the resistor R4. This voltage is divided at this point, a portion passing into the frequency-determining network (comprised by a switched-in condenser pair along C1-to-C9 and a switched-in resistor pair along R1-to-R3) and the rest passing through the lamps L1 and L2 in the first tube (6SJ7) cathode circuit. The voltage through the R-C network sets up regeneration neces-

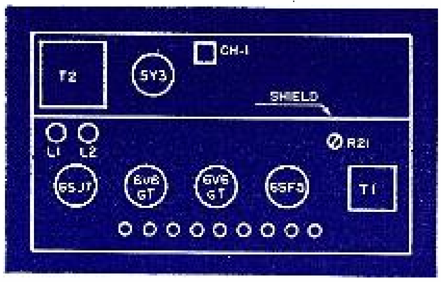


Fig. 3. Showing where principal components are mounted.

sary for oscillation; that through the lamps sets up a degenerative voltage necessary to maintain the strength of oscillations constant.

By keeping the capacitances of the network condensers on each side of the 6SJ7 grid line equal and by keeping the multiplier resistors on each side of the selector switch S12 equal, the oscillation freq. becomes equal to

$$f = \frac{1}{6.28\,RC}$$

The two lamps in the 6SJ7 cathode circuit act as an automatic degeneration resistor by virtue of the positive voltage-resistance characteristic of the tungsten filaments used in them: As the strength of oscillation increases and the 6SJ7 plate current increases along with it, the total cathode current increases. However, increased current through these lamps increases

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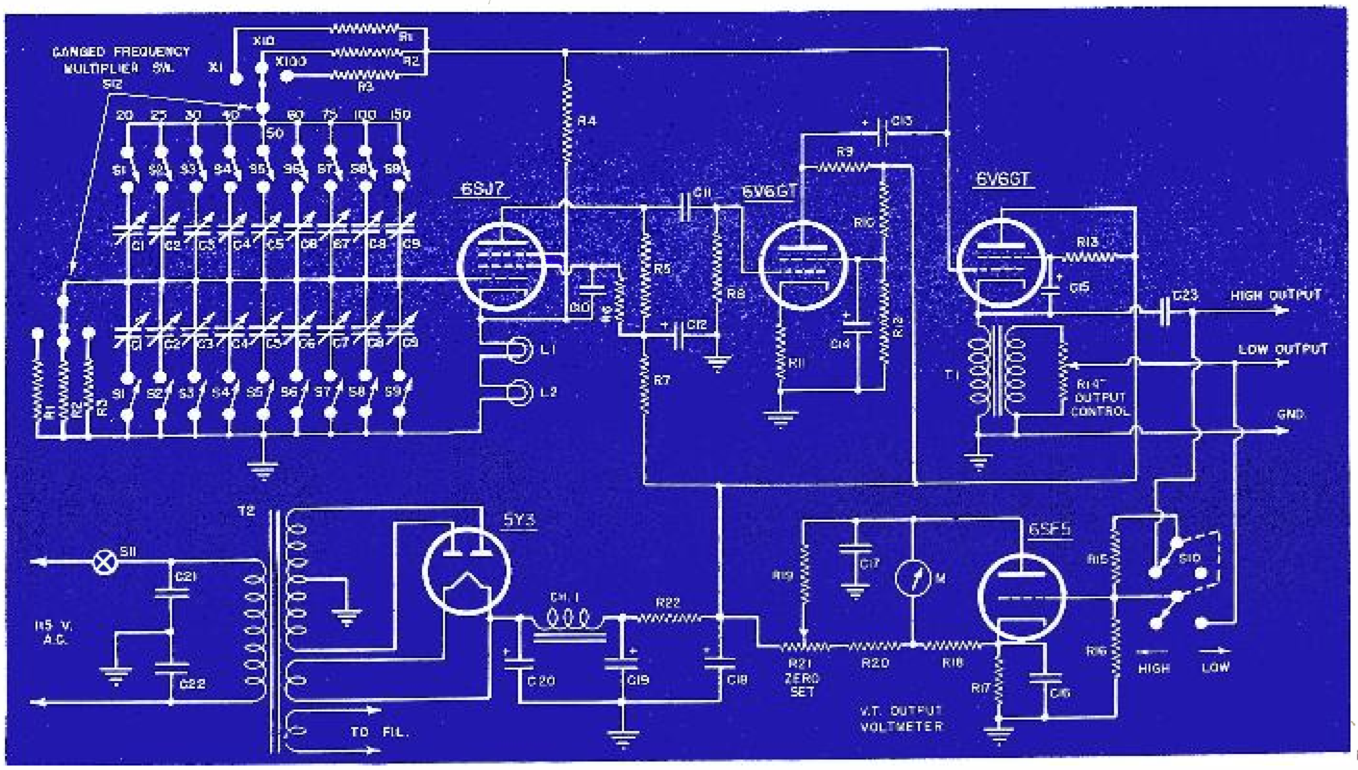


Fig. 4. Most parts for constructing this Oscillator are still available.

C_1—350-600 μμfd. mica trimmer, Meissner 22-7030
C_2, C_3—210-390 μμfd. mica trimmer, Meissner 22-7029
C_4, C_5, C_6, C_7—80-225 μμfd. mica trimmer, Meissner 22-7028
C_8, C_9—25-100 μμfd. mica trimmer, Meissner 22-7002
Two each of the above condensers are required.
C_{10}, C_{11}, C_{23}—1 μfd. 400 volt tubular, Aerovox 484
C_{12}, C_{13}, C_{14}, C_{15}—8 μfd. 450 volt tubular electrolytic, Aerovox PRSV
C_{16}, C_{21}, C_{22}—0.1 μfd. 200 volt tubular, Aerovox 284
C_{17}—0.1 μfd. 400 volt tubular, Aerovox 484
C_{18}, C_{19}—16 μfd. 450 volt tubular electrolytic, Aerovox PRSV
C_{20}—8 μfd. 450 volt tubular electrolytic, Aerovox PRSV

R_1—20 megohms, ½ w., Aerovox 1097 (2 needed)
R_2—2 megohms, ½ w., Aerovox 1097 (2 needed)
R_3—20,000 ohms ½ w., Aerovox 1097 (2 needed)
R_4—2500 ohms, 1 w., Aerovox 1098
R_5—100,000 ohms, ½ w., Aerovox 1097
R_6—500,000 ohms, ½ w., Aerovox 1097
R_7—100,000 ohms, ½ w., Aerovox 1097
R_8—500,000 ohms, ½ w., Aerovox 1097
R_9—10,000 ohms, 10 w., Aerovox 931
R_{10}—50,000 ohms, 1 w., Aerovox 1098
R_{11}—200 ohms, 10 w., Aerovox 931
R_{12}—40,000 ohms, 1 w., Aerovox 931
R_{13}—25,000 ohms, 10 w., Aerovox 931
R_{14}—1000 ohm wirewound potentiometer, ***I.R.C.*** *W-1000*
R_{15}—4 megohms, ½ w., Aerovox 1097
R_{16}—1 megohm, ½ w., Aerovox 1097
R_{17}—1400 ohms, ½ w. (1000 and 400 ohms in series), Aerovox 1097

R_{18}—240,000 ohms, ½ w. (200,000 and 40,000 ohms in series), Aerovox 1097
R_{19}—20,000 ohms, ½ w. Aerovox 1097
R_{20}—7,000 ohms, ½ w.. Aerovox 1097
R_{21}—3,000-ohm wirewound potentiometer, ***I.R.C.*** *W-3000*
R_{22}—500 ohms, 10 w., Aerovox 931
Ch_1—15 henry, 65 ma. midget type filter choke
L_1, L_2—6 w., 120 volt Mazda tungsten filament lamps
M—0-1 d.c. milliammeter (2-inch type), Triplett 221
S_1 to S_9—D.P.S.T. toggle or pushbutton switches
S_{10}—D.P.D.T. toggle switch
S_{11}—S.P.S.T. toggle switch
S_{12}—2-pole, 3-contact rotary selector switch
T_1—Universal output transformer, Utah No. 8775
T_2—Power transformer (350-0-350 v., 50 ma.; 5 v., 2A, 6.3 v., 2A), Utah Z-650

their resistance, reducing the gain of the stage. Thus, automatic gain control is obtained through this degenerative effect and the entire amplifier is held down to the level required for sine-wave output. The value of R4 has so been chosen that there is always the proper ratio of regeneration to degeneration to insure this type of operation.

In the 6V6-GT stages, degenerative operation of the current type is secured by un-bypassed cathodes to enable operation of these amplifiers with minimum distortion. The output amplifier, which serves principally as an isolator stage, introduces no gain whatsoever. And it will be observed that output is taken from this stage in the cathode-follower manner. These steps to minimize distortion have not entailed an unsatisfactory reduction in output voltage, however, since that obtainable at the high-impedance output terminals is of the order of 20 volts.

The entire instrument is self contained with its individual power supply. The output voltmeter is made an integral unit of the oscillator in order that a continuous indication may be had of the audio voltage delivered to any system under test or being driven. This last useful feature reduces the number of instruments necessary for making complete tests.

Electrical and Mechanical Features

The fundamental switched frequencies developed by the oscillator are 20, 25, 30, 40, 50, 60, 75, 100, and 150 cycles per second. These are the frequencies delivered when the two-section multiplier switch S12 is in the X1 position. When this switch is in X10 position; one cipher is added mentally to each of the above frequencies and the output becomes 200, 250, 300, 400, 500, 600, 750, 1000, and 1500 cycles per second. With the multiplier switch in the X100 position, two ciphers are added mentally and the output becomes 2000, 2500, 3000, 4000, 5000, 6000, 7500, 10,000, and 15,000 cycles per second. Thus, the twenty-seven commonly used frequencies from 20 to 15k.c. per second are made available.

In changing frequency, the resistance component of the frequency-determining R-C network is left fixed and the capacitive component is changed in value by switching operations. The small adjustable mica trimmer condensers C1-C9 form the switched-in capacitive legs of this network. Observe that a pair of identical condensers is switched-in for each frequency. Double-pole, single-throw toggle or pushbutton switches accomplish this switching of condenser pairs in a single operation.

The approximate settings of the condenser pairs for the nine fundamental frequencies are as follows: 20 cycles—C1—400 μμfd.; 25 cycles—C2—320 μμfd.; 30 cycles—C3—270 μμfd.; 40 cycles—C4—200 μμfd.; 50 cycles—C5—160 μμfd.; 60 cycles—C6—132 μμfd.; 75 cycles—C7—103 μμfd.; 100 cycles—C8—79 μμfd.; and 150 cycles—C9—56 μμfd.

A distinct advantage in making these condenser legs variable in capacitance is that the nine frequencies may be set "on the nose" during the calibration process and corrections may be made from time to time to compensate for aging of the circuit components.

(Continued on page 70)

WHAT'S NEW IN RADIO

New products for military and civilian use.

NEW MICROPHONE SWITCH AND CORD ASSEMBLY

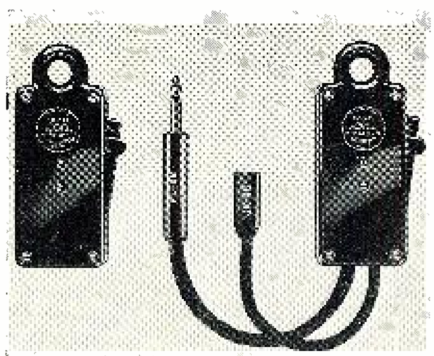
Universal Microphone Co., Inglewood, Cal., has announced to government prime and sub-contractors that early deliveries can be made on its new CD-318 and CD-508 microphone cord assemblies comprising SW-141 switch, the PL-68 plug and JK-48 jack, assembled or as separate parts.

The new SW-141 switch, for which Universal is completely tooled for mass production, uses high impact phenolic case. The Army Signal Corps Laboratory has approved the material and design of this, as well as that of the cordage, which carries specifications CO-219 and CO-122A.

Though primarily used in aircraft and parachute operations, the microphone cord assemblies can also be adapted for use by tanks and other mobile field units.

Under ordinary conditions, SW-141 operates as a press-to-talk switch, though it also has a locking button for continuous operation. Cordage is rubber covered and no extra molded rubber parts are required. The laminated phenolic construction of the switch stack, and the use of non-critical materials, ensures quick delivery. The switch dimensions overall are 4$^{15}/_{32}$ in. long, 1¾ in. wide and ¾ in. thick.

Makers of microphones and accessories since 1928, *Universal Microphone Co.,* is currently on 100% war

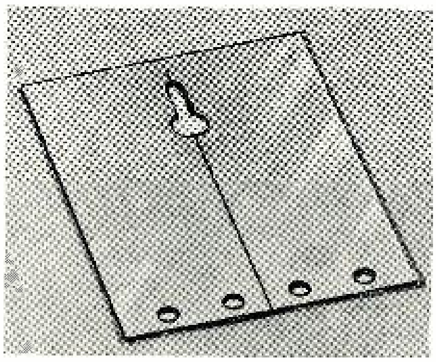


production with 24 hour assembly lines and immediate deliveries on bulk priority orders. Reply to the *Universal Microphone Co.,* Inglewood, Cal.

PLASTIC PARTS FINER THAN HUMAN HAIR

Countless miracles have been performed with plastics we all know, but *Printloid Inc.,* of 93 Mercer St., N. Y. C., have performed one that puts a heavy strain on the imagination . . . a hairline indicator made entirely of plastics with an index line finer than human hair. Not only that, but it is superior in many other ways to the standard indicator material that has been used ever since optical instruments have been made fine enough to require special precision.

Printloid's hairline indicator consists of a fine line engraved on a small



sheet of Vinylite plastic, ink filled. It can be made in widths as narrow as 1/1000th of an inch or heavier and held accurately to the required dimensions. Where the human hair would have to be delicately stretched and clamped into position with a high percentage of breakage and failure under the operating conditions, the plastic hairline indicator is a sheet of plastic 40/1000th of an inch thick which is mounted with screws into place.

Printloid engineers will be glad to provide suggestions to optical engineers and others as to how these plastic hairline indicators may be adapted to their particular needs. Address all correspondence to the *Printloid Inc.,* 93 Mercer St., N. Y. C.

IMPROVED THROAT MICROPHONE

An improved THROAT MICROPHONE is now offered by the *Miles Reproducer Company, Inc.,* of 812 Broadway, New York City, for use in Aircraft, Submarines, Military Tanks and Defense Plants and in all other places which are very noisy.

The *Miles* Throat Microphone is placed around the neck over the larynx (or voice box). Words spoken by the wearer are picked up and may be amplified and transmitted through a public address system.

The advantages of this method are that no matter how much noise there may be in a plant none of the noise will be transmitted through the *Miles* Throat Microphone and the speaker need only use an ordinary tone of voice thereby doing away with the necessity of shouting or straining the voice. The mildest spoken person can be heard just as easily and distinctly as the fellow who can bellow like a bull.

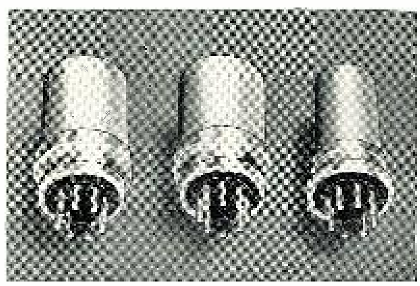
The *Miles* Throat Microphone can be used with any standard amplifier designed to use a crystal or other high impedance microphone. The *Miles* Throat Microphone is constructed on the inductor-dynamic principle, is rugged and compact and weighs only 2 oz. It is leather covered and equipped with an adjustable neck strap. A code system may be developed whereby tapping with the fingers may be used instead of spoken words.

Because of its unusual clarity and brilliance of tone, this Throat microphone is ideal for use for military purposes. Manufactured by the *Miles Reproducer Co., Inc.,* 812 Broadway, New York, N. Y.

IMPROVED "PLUG-IN" TYPE DRY ELECTROLYTIC CONDENSERS

The *Sprague Specialties Company* of North Adams, Mass., has naturally had to develop many parts strictly under cover. At the same time, it has made great strides in the effective and economical use of new materials and methods. With all this there has been a continuous development of various *Sprague* items which were coming rapidly to the fore when war broke out. Some of these are sufficiently standard in kind and application so that we may discuss them here.

In this category is the *Sprague* "Plug-In" type of Dry Electrolytic Condenser which is pictured here. It is recommended for the elimination of low frequency ripple (2—100 cycles). This modern type of electric condenser can be sealed as well as any condenser. It can be easily mounted or removed. It is regarded as so reliable, able to take abuse and deliver long life, that the manufacturer considers it entirely



practical to solder or weld it into units.

Its basic qualities of small size and light weight are further enhanced by the fact that they perform uniformly up to the very last volt on the rating,

(*Continued on page* 81)

Spot Radio News

IN DEFENSE AND INDUSTRY

Presenting latest information on the Radio situation.

by **LEWIS WINNER**
Radio News Washington Correspondent

THAT REGULATION CONTROLLING THE PRICE ceilings on radios and phonographs assembled by retailers and distributors, is at long last to become official. Some months ago, we pointed out that since many dealers and distributors had become "back-of-the-store-manufacturers," assembling phono motors, pickups and other accessories into cabinets with a variety of chassis and selling them at fancy prices, without regard to ceilings, Washington was soon to crack down and hard. They now have and it's going to be an odd situation to face. For, a definite price ceiling will have to be placed on every complete unit sold in this store-assembled fashion. That means that a detailed price schedule will have to be followed by every assembler, such schedule requiring the approval of the OPA. It will be recalled that the original OPA regulation required every manufacturer to provide the wholesale and retail prices of all radios and phonographs.

The service man who repairs or remodels a receiver to the exact requirements of the customer, or who makes changes necessary to reestablish the operation of a receiver, need not post his prices with the OPA, as long as he maintains a ceiling level on all parts used and on his time. He cannot, for instance, charge $3.00 an hour now, if in March, 1942, he only charged $2.00. Nor can he charge $1.50 for a volume control, for which the price in March, 1942, was 90c. If, of course, the service man proceeds to produce a quantity of custom-built units, that is, units of the same design and appearance, he will then have to post a ceiling price with the OPA. For then he has become a manufacturer.

It seems as if the OPA rulings are also raising havoc on another front too . . . the dealer parts-sale front. Some dealers and service men, too, have been making it a habit to refuse to sell tubes to customers, unless service work is requested at the same time. This is also a violation of the OPA regulations, unless such practices were maintained prior to March, 1942. And it is well known that few, if any stores or service men, employed such tactics, prior to March, 1942. OPA officials have been lenient with such violators up to now, believing that most of the violations were not intentional. However, they now point out that if the violations continue, stringent action will have to be taken.

Repair price maintenance has also been a source of troubles in many cities, according to the OPA. In fact, said one official, a suit against a dealer has already been instituted by a customer in Pittsburgh, who claims to have been overcharged on a service call. It seems as if the store's ceiling price for service in the store was $1.00 and he had been charged $2.00, which he claims was the price for outside service. The dealer says that he didn't have a ceiling price for the particular repair work that had to be done on the receiver, and thus had no schedule to follow. While it is quite clear to see the problem the dealer faced in billing the customer, one cannot blame the customer for his complaint, for he simply followed the alleged advertised price. It is apparent that after this ruling goes into effect such conditions will not arise as prices will be fixed and both the dealer and the customer will know the exact cost.

A detailed explanation of the method of pricing for labor and material would have avoided this incident. No one denies that the details involved in submitting price listings of either operations on receiver repairs or material, are not exactly pleasant. But since this is the only way of curbing runaway prices . . . and as we know it works on both sides of the fence . . . the dealer and service man will find it profitable to watch price schedules.

SUPER HIGH, ULTRA HIGH AND VERY HIGH will hereafter be found in wavelength channel terminology. For the radio spectrum has been arranged into seven bands ranging from very low to super high as the result of a decision of the FCC to adopt the standard frequency designations used by the United Nations combined Chiefs of Staff. These new titles were first proposed by the British at the International Radio Consultation Committee conference in Bucharest in 1937. They have since proven very useful in European radio activities, and since the war, they have been used by the Allied Combined Chiefs of Staff.

In the schedule of frequencies, 10 to 30 kc. is designated as very low; 30 to 300 kc. as low; 300 to 3,000 kc. as medium; 3,000 to 30,000 kc. as high; 30,000 to 300,000 kc. as very high; 300,000 to 3,000,000 kc. as ultra high, and 3,000,000 to 30,000,000 kc. as super high.

The range of 30,000 meters to .01 meter has been selected since at the present state of the art it is the useful radio spectrum. According to the FCC, there is no technical significance to the allocation, insofar as the licensing policies over here are concerned. However, it will facilitate various waveband discussion and selection among the United Nations.

In view of this new allocation scheme, part of the aeronautical band falls into the low frequency classifica-

G.E. engineer testing new two-way FM police radio equipment.

Motorola engineers working on special research production line.

tion, instead of the medium frequency channel as we had defined it. In our medium band the frequency began at 200 kc., whereas in the new allocation, it starts at 300 kc.

We'll probably have to look for better adjectives when the centimeter and millimeter wavelengths come into use later, or perhaps, they will simply say . . . super, super-super!

A SHARPLY WORDED AMENDMENT TO THE COMMUNICATIONS ACT of 1934 has been prepared by the fathers of the Communications Act, Senator White, and Senator Wheeler. The bill, which has been referred to the Interstate Commerce Committee, provides for changes in the organization of the FCC, and in its procedure. The bill seeks to assure the equality of right and opportunity among those who utilize radio for public discussion and to further provide against censorship. The bill also stipulates that the Commission shall not concern itself with the business phase of broadcasting or the source of material.

In explaining the purposes of the presentation of the bill, Senator White said that the measure should not be regarded as a general revision of the Communications Act, but one authorizing changes in the organization of the Federal Communications Commission. The White-Wheeler bill, known officially as S.814, will cause plenty of discussion on the floor of the houses when it is presented. The consensus is that the bill will probably pass, but not without a tirade of debate.

VARIABLE CONDENSER MAKERS, who have been working at a fever pace, find that even that pace must be accelerated. They have therefore issued a call for more subcontractors. Such subcontractors should possess cylinder grinding and worm grinding machine tools as well as close tolerance screw machines. There are a wide variety of condenser parts that such subcontractors can produce, according to the prime manufacturers. While it is true that most of those with such facilities are extremely busy now, surveys show that there are small shops scattered throughout the country who could easily handle this type of work. Some of these shops are machining pieces that could easily be pigeon-holed for the duration. And in many shops the schedules could easily be extended.

The condenser manufacturers hope that their plea will be answered and quickly!

CARGO PLANES ARE HITTING THE SPOTLIGHT, as we predicted they would, several months ago. These huge planes, on which are a full complement of radio equipment and operating staff, are rapidly becoming the backbone of our transportation system. Said Major General Ralph Royce, hero of a bomber raid on Japanese bases in the Philippines, recently . . . "we are now operating what will become before long the greatest aerial transportation system the world has ever seen . . . a system of flying boxcars around the world. . . . A German submarine can't torpedo a flying boxcar, and although the plane can carry only a fraction as much as a ship, it can make many, many trips."

The importance of radio on these "flying boxcars" needs little explanation. So vital do the operators of these planes consider radio that special radio flight officers are employed to man the equipment. Since the equipment is of special design and since the traffic procedure is so unusual, these operators require special training. Many are studying for this new, exciting work, and the airlines are urging more and more to study and prepare. They are enthusiastic about the possibilities of cargo planes, believing that this form of transportation will probably become one of the chief methods of shipping.

THE WIRES or the Women in Radio and Electrical Service of the Signal Corps are rapidly proving themselves to be quite adept in many phases of communications work. As the enlisted reserve, these women are trained in Signal Corps specialties at Signal Corps schools. Upon completion of the course, they are assigned as members of the Women's Army Auxiliary Corps or WAAC.

The women will replace men in non-tactical units. Approximately 8,000 have already been taught as radio operators, technicians and repair women. They were, before the inauguration of the WIRES or WAAC, members of the regular Signal Corps training program. While all those who had taken this course, might not fit into the military picture, because extraneous problems, most will, according to the Signal Corps. These reservists, says the Signal Corps, will become an important element in communications assignments.

THE INTENSELY VALUABLE PROPERTIES OF CARRIER RADIO are again in the limelight. New systems developed for use by our boys in camps, now afford reception over any radio set on regular broadcast frequencies. It is now only necessary to plug in a receiver, tune to a specific frequency in the broadcast frequency spectrum, and listen in. This is in contrast to the earlier systems that used low frequencies such as 30 kc. and required special receivers.

The present installations now consist of a master amplifier located in a special studio on the grounds. This amplifier is coupled to an automatic turntable, a microphone and a pair of headphones. The microphone and the turntable are arranged so that fades between selections, programs or announcements can be made. A leased line couples the output of the amplifier to a master oscillator transmitter, which may have an output of from 2 to 20 watts.

The problem of feeding r.f. through a set of transformers on the power line has been solved for most types of lines. To do this, special filter systems have been developed for two and three-phase lines.

Incidentally, a similar system of carrier radio has been used most successfully by the New England colleges affiliated with the Intercollegiate Broadcasting System. Students in their dormitories listen in to special studio programs, lectures, or special announcements.

The system affords a means of contacting large groups simultaneously, who, however, need not be crowded together in an auditorium, but spread out among the various bunks and dormitories of the camp. The system provides that friendly effect, too, since many of the programs are built up around those in the camp.

The methods developed as a result of this system, prove that carrier or wired radio has tremendous possibilities . . . possibilities that will make this form of transmission an important link in the communications systems, once again.

THE RECENT SUCCESSFUL TESTS OF THE HELICOPTER have prompted interesting developments in radio too. Since in this aircraft, many unusual design features have been included, such as the overhead propeller and crane-like tail, ordinary communication equipment cannot be used. For these peculiar design features make it impossible, for instance, to use the standard type of loop or the customary trailing antenna. At the present time, no standard type of radio receiver or transmitter has been developed for this plane. Some models have been made that have overcome the aforementioned antenna problem to a great extent. However, engineers say that it is possible to devise equipment that will actually be superior to the standard type because of the peculiar construction of this aircraft. They say, for instance, that it is possible to use either the tail or the overhead propeller shaft effectively as an antenna. They also say that because of the vertical rising properties of the plane, compass bearing methods can be simplified.

Although the plane is now being used for military purposes only, officials predict that it will become an important civilian instrument of travel and transportation at the conclusion of the war.

General Electric "doughnut" antenna installed at FM station W47NY.

THEY NOW HAVE 1-A'S IN LONDON, too. This new priority rating has been given to replacement parts as well as new parts being made for complete receivers now in the process of manufacture. This priority places these parts on the same level as the normal Services requirements, but of course not as high as the requirements of the special Government and Service projects. This means that many scarce parts will now become available to retailers and service organizations. It also means that close to 100,000 receivers now awaiting certain parts can be completed. These receivers being made, were authorized many months ago to fill a sadly depleted supply in England. It will be recalled that receiver manufacture had been suspended a long while ago. This, coupled with the unavailability of replacement parts, made it impossible for many English homes to maintain any definite listening schedule. With the new 1-A ruling, a majority of homes should soon be able to have working receivers again.

These 100,000 sets will not be of the utility 2-tube type. There had been rumors that such a receiver would be made. But since there are still 100,000 sets to make, there is little likelihood that these utility receivers will be made, at least now.

One of the prime reasons for the 1-A order was the extreme shortage of electrolytic condensers. Countless repairs had been held up because it was impossible to get the condensers. It is hoped that this new 1-A ruling will alleviate this situation. Other items on the scarce list were line cords and "B" batteries.

The battery shortage was caused by the North African campaign. At a press conference at the Board of Trade, Hugh Dalton, president of the Board, explained why the present shortage had arisen. He revealed that the industry had found it impossible to maintain normal supplies and at the same time, meet the abnormal demands of the military. The troops had had to be equipped on very short notice with large quantities of batteries. Definite steps now, however, are being taken to overcome this condition. It was impossible of course, he said, to suddenly increase output, but the situation is well in hand and increased production now scheduled will provide at least most of the normal demand.

As a step towards assuring production for the 1-A products, composite resistors have been standardized in England. Instead of the 800 different values, there will now be 255 types. The method will follow to some extent that used over here. That is, values most commonly used and laying between maximum and minimum averages will be adopted. For instance, a 100-ohm resistor having a tolerance of plus or minus 20%, could well be used for circuits requiring a resistor of from 80 to 120 ohms. Therefore the 100-ohm resistor would be applied to these instances. Of course, there are many cases where the tolerance must be as close as plus or minus 5%. Where such resistances are required, it will be necessary to go to the proper authority for manufacturing approval. A chart is being prepared showing all of the standard values that will be available. Incidentally, the familiar color-coding method is also being used for these resistors. Wire-wound resistors will not be affected by this ruling.

It is encouraging to see that radio has been given so much consideration in England, notwithstanding the countless other pressing problems that face the country. But, say Englishmen, radio is a need. We must have radio at any cost, they say!

QUARTZ CRYSTALS, those essential little mineral slabs, will hereafter have ceiling prices on them. And their applications will also come under official jurisdiction. The major purpose of the price ceiling regulation is to assure stabilization of the supply of this important mineral from the principal source, Brazil. The specific application ruling will also provide stabilization, for it restricts the production of quartz crystals to essential uses. Specifically, the ruling known as conservation order M-146, says . . . "on and after March 8th, no person shall fabricate quartz crystals or blanks except in the manufacture of radio oscillators and filters and optical parts to be used in the replacement of parts which are defective, cracked or broken, provided the equipment or instruments requiring such parts are implements of war or are needed solely in activities directly connected with defense, public health, welfare or security." The manufacture, of course, of crystals for essential military needs is still being permitted. This ruling affects the replacement phase of manufacture only.

Before the outbreak of war in 1939, exportation of quartz from Brazil amounted to approximately 1½ million pounds. The principal quantity buyers were Japan, the United Kingdom, and Germany, followed in a remote way by the United States. Today, the leading buyer of crystals is the United States, which not only buys for itself, but those of the Allies.

OVER TWO HUNDRED THOUSAND RECEIVERS were made in Canada in 1942, according to statistics just released by the Dominion Bureau. Although this is about a 33⅓% reduction as against 1941, this production is impressive nevertheless. For the conditions in 1942 were far from favorable. Incidentally, in 1942 there were more sets in production than ever before . . . over 3,000,000. This is about 15% more than in 1941. Since in Canada there are wide areas of land without electric current, battery models and portables form an important factor in Canada. For instance, close to 33⅓% of the total receivers made were battery receivers. A very small percentage or only approximately 14,000 of the receivers made were combination units. This is very close to the production figure of 1941. It appears as if Canadians are not overly enthusiastic about combination phonograph radio units, a condition caused somewhat by delivery and production problems.

Domestic production in Canada today is, of course, diminishing and by the end of the year will probably be at a standstill. Radio will zoom in Canada after the war, as everywhere else!

ONE OF THE MOST INTERESTING RECORDING EXHIBITS recently went on display in New York City at the Museum of Science and Industry. Sponsored by station WOR, the exhibit displays all of the various types of records made since the inception of recording, as well as all of the various types of recording machines and transcription devices made. The queer cylindrical-horn type units of the early days are a strange comparison to our modern streamline developments, but oddly enough their performance is not so queer. Although the fidelity and volume were not too perfect, they were quite effective considering the crudeness of the equipment used. We will probably call our equipment of today extremely crude too, when it is compared with what we will see in the not too distant future, perhaps even after the war.

The exhibit is now open to the public, and should not be missed by anyone.

New two-way FM emergency radio equipment manufactured for the WPB radio reserve pool.

THE PLAN ORIGINATED BY THE NATIONAL COMMITTEE ON PHYSICISTS for occupational deferment has been most successful. Thus far, Selective Service Boards have endorsed 600 requests made by this committee. This plan, which is the only one of its kind in existence, may be soon applied to the radio engineering profession. Basically, it provides for the Selective Service authorization of the appointment of a National Committee to review affidavits for occupational classification. The plan provides for the setting up of a committee to determine the status of the registrant. If, in the opinion of the committee, the individual possesses the requisite training, qualifications or skill, a stamped endorsement of this fact is filed with the original form and supplied to the local Draft Board. This committee also has the prerogative of appealing the local board's decision.

The plan is sound and being respected as such, is gaining many friends in Government circles. The necessity for placing radio engineers in this plan is acknowledged and undoubtedly prompt action will result.

AT THE FIRST WESTERN CONFERENCE OF THE PLASTICS INDUSTRY, held at the Ambassador Hotel in Los Angeles, 16 speakers presented data that proved quite conclusively that plastics is rapidly becoming the No. 1 material of the day. Its uses in every field, particularly radio, are so extensive that the possibilities seem limitless.

John Delmonte, technical director of the plastics industries technical institute, in discussing the future of plastics, said that he looks forward to the day when every metal firm will have a plastics department. Brig. Gen. Stephen H. Sherrill, Commanding General of the Western Signal Corps school, at Camp Kohler, who was the main guest speaker, stated that of the five million dollars worth of equipment the Signal Corps buys daily, a great deal comes from the plastics industry. He emphasized that plastics was a mighty important Signal Corps material, particularly in the global war being inducted today.

THE SHORTAGE OF COMMUNICATION EQUIPMENT for training purposes and operational uses has again become acute in the Signal Corps. Accordingly they are requesting amateurs to sell many types of equipment. Specifically, the equipment required consists of transmitters (Hallicrafter and Collins) ranging in power from 25 to 450 watts and covering various short-wave bands. Receivers are also required. The types needed include those of Hallicrafter, National, RME, Hammarlund and Howard. Audio frequency and radio frequency signal generators and oscil-

for *Permanent* resistance today and tomorrow...

Many factors contribute to the permanent performance of Ohmite Units-factors of design and construction that enable them to meet every condition of service ... to withstand shock, vibration, heat and humidity ... and keep going. These characteristics make Ohmite Rheostats, Resistors, Chokes and Tap Switches especially well fit for today's critical wartime needs. What's more ... Ohmite leadership in developing an extensive range of types and sizes has made it possible to serve innumerable applications. All this, of course, makes them readily applicable for the new peacetime products of tomorrow. Ohmite Engineers are glad to assist on any problem for today ... or tomorrow.

BE RIGHT WITH OHMITE
RHEOSTATS · RESISTORS · TAP SWITCHES

Send for Handy Ohmite Ohm's Law Calculator. *Thousands of these Ohmite Calculators are in practical use today. Figures ohms, watts, volts, amperes—quickly, easily. Solves any Ohm's Law problem with one setting of the slide. All values are direct reading. Send only 10c in coin to cover handling and mailing. (Also available in quantities.)*

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4884 FLOURNOY STREET, CHICAGO, U. S. A.

loscopes, Weston a.c. and d.c. voltmeters, ammeters, and milliameters and other equipment for testing, are also among the units required. The Signal Corps says that they can also use capacitors, resistors and installation material.

If the equipment is used, but in perfect operating condition or if it can be readily restored to that condition, the Signal Corps will buy it, the price to be determined by a Signal Corps inspector.

Captain James C. Short, of the Philadelphia Signal Corps Procurement District, 5000 Wissahickon Ave., Philadelphia, Pa., is the man to write to, if you have any of this equipment to sell. Send him a brief description of your equipment. The Signal Corps needs this equipment urgently, so don't fail them!

A NEW ARMY-NAVY PREFERRED LIST OF TUBES has been issued by the Office of the Chief Signal Officer and the Chief of the Bureau of Ships. The new lists set up a group of unclassified general purpose tubes selected jointly by these two military divisions. It is mandatory, says the order under which this listing is included, that all unclassified tubes used in the future designs of new equipment under the jurisdiction of the Signal Corps Laboratories or the Radio and Sound Branch of the Bureau of Ships, be chosen from this new list. The exceptions to this rule are . . . equipment basically new in electrical design, with no similar prototypes; equipment having a similar prototype but completely redesigned as to its electrical characteristics, and new test equipment for operational field use.

The new list includes receiving and transmitting tubes. In the receiving list we find . . . (diodes)—1A3, 6H6, 9006, 12H6; (diode triodes)—1LH4, 6SQ7, 6SR7, 12SQ7, 12SR7; (triodes)—1G4GT, 2C22, 2C26, 6C4, 6J5, 1201, 9002, 12J5GT; (Twin Triodes)—3A5, 1291, 6J6, 6SL7GT, 6SN7GT, 12SL7GT, 12SN7GT; (Pentodes)—1T4, 6AG5, 6AK5, 6SG7, 6SK7, 9003, 12SG7, 12SK7, 1L4, 1LN5, 1S5, 6AC7, 6AG7, 6SH7, 6SJ7, 9001, 12SH7, 12SJ7; (Rectifiers)—5U4G, 5Y3GT, 6X5GT, 1005; (Converters)—1LC6, 1R5, 6SA7, 12SA7; (Power)—3A4, 3Q4, 3Q5GT, 1299, 6B4G, 6G6G, 6L6G, 6N7GT, 6V6GT, 6Y6G, 12A6; (Indicators)—991, 6E5, 1629. Transmitting tubes are . . . (Triodes)—304TH, 801A, 811, 826, 833A, 838, 1626, 8005, 8025; (Tetrodes)—807, 813, 814, 1625; (Twin Tetrodes)—815, 829, 832; (Pentodes)—2E22, 803, 837; (Rectifiers)—2X2, 3B24, 5R4GY, 73R, 371A, 705A, 836, 1616, 8020, 4B25, 83, 866A, 872A. Miscellaneous tubes include . . . (Grid Cont. Rectifiers)—394A, 884, 2050, C1B, C5B; (Voltage Reg.)—VR-90-30, VR-105-30, VR-150-30; (Phototubes)—918, 927; (Cathode-Ray)—2AP1, 3BP1, 5CP1, 9EP1.

THE DEVELOPMENT OF FREE-MACHINING grades of Invar, the 36% nickel alloy, will now be of tremendous help to the variable condenser manufacturers. This unique material has been used effectively for applications where it is necessary to overcome the natural tendency of metals to expand when heated. Thus by providing a rate of thermal expansion approximately 1/10 that of carbon steel, at temperatures up to 400 degrees, this alloy has solved many problems. This is particularly true in the variable condenser types used either in aircraft or undersea craft. For here the rate of change of temperature is so great, that expansion and contraction of metals must be somehow controlled.

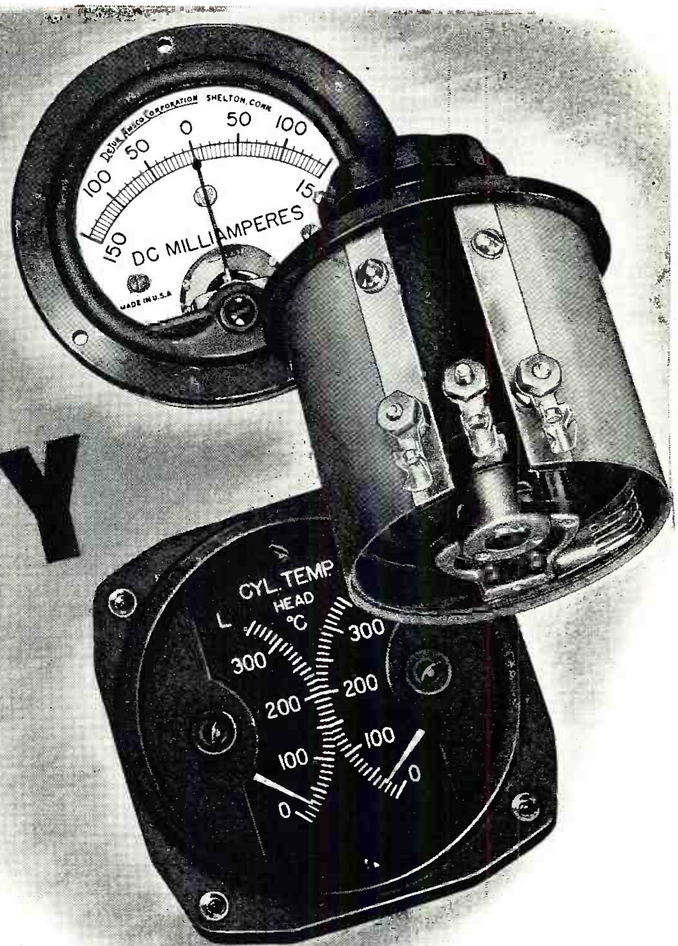
The use of this metal started many years ago. Manufacturers were stymied for quite a while before they were able to machine this tough alloy. The development of specially surfaced tools, hooded to prevent flying chips, solved the problem to some extent, although the time element was far from satisfactory. For many extra hours had to be spent in improving by hand some of the machining. As time went on, some of these machining problems were solved. The development of this new alloy should eliminate most of the production difficulties, and permit its wide use not only in condensers, but in other radio components, in which spring, tension and position is so vital.

REHEARSALS OF ENEMY ACTION COMMUNICATIONS procedure by police are being held in many cities and towns throughout the Nation. Typical incidents of war, with all of the realism possible, are being duplicated in these trials. Some towns have even had surprise tests, cooperating with the facilities of the State patrol units, to gauge the problems that might be expected under sudden enemy action. The rapidity with which the countless emergency problems have been overcome in these tests, has been applauded by all who have seen them. America is ready for any problem, they say. We agree!

PRODUCTION NEWS THAT HAS MADE many manufacturers quite happy was recently released by Washington. The news concerns the ceramic . . . steatite . . . that long has been a bottleneck in the production of military radio equipment. Now, however, according to the Industry Advisory Committee on Ceramic Capacitors and Steatite, producers are able to accept orders for delivery in from four to eight weeks. This is quite a contrast to the backlog problem of last summer, when deliveries were some eight months behind. Improved mining deliveries, processing equipment and production methods have helped to provide this enlightening picture.

NOW THE RADIOS IN THE JEEPS can do a better job than ever before. For new portable generators have been included in the cars to provide extra and longer lasting power. The new extra generator, driven by the

Excellent examples of QUALITY



How may quality be recognized? The determining factors are materials, construction and performance . . . plus the ingredients that come from experience and research.

DeJur Aircraft, Electrical Instruments, Potentiometers and Rheostats are backed by more than twenty-five years experience and laboratory research. They are designed and manufactured to conform with the highest standards of war requirements . . . their worth has been demonstrated on both the battle and home fronts.

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DeJUR-AMSCO CORPORATION

Manufacturers of DeJur Meters, Potentiometers, Rheostats and Other Precision, Quality Electrical Instruments

SHELTON, CONNECTICUT

Every Week . . . Everybody . . . 10% in War Bonds and Stamps four-cylinder engine of the car, is mounted on a special bracket between the front seats. The cars now also have a loudspeaker and remote control panel, similar to the type used in standard motor cars. These improved radio jeeps have done much towards accelerating combat efficiency.

These jeeps always were little packets of traveling dyna'mite. Now, they're traveling dynamite, plus!

PERSONALS . . .

Henry Kasner, a true pioneer of broadcasting, passed away, after a short illness. For thirty years Mr. Kasner had been with RCA and its predecessor, the American Marconi Company. He helped to build the first RCA broadcast station in New York City, WJY . . . The IRE has gained an outstanding member on its board of directors, **W. C. White,** the famed General Electric scientist who was at one time an associate of **Dr. Irving Langmuir,** associate director of the General Electric laboratories. Mr. White is now in charge of the electronic laboratory . . . **Frank McIntosh** has been appointed as assistant to the director of the WPB radio division, in charge of foreign and domestic broadcasting . . . **Dr. Paul R. Heyl,** former physicist with the Bureau of Standards, is now with P. R. Mallory as a consultant. A series of four lectures on the future of electronics is now being given by him for the engineering sales and production personnel of Mallory, and those from broadcasting stations, colleges, training schools of the armed forces, etc., who may care to attend . . . . . . **John Kelly Johnson,** for many years in charge of the Hazeltine laboratories in Chicago, is now with the Office of Procurement in the Navy.

ANNOUNCEMENT:

In order to better indicate the nature of their business activities, the firm name of Wedemeyer Radio Co. has been changed to *Wedemeyer Electronic Supply Co.*

Fred E. Garner Company, of Chicago, announces the opening of Plant No. 2 at 1100 West Washington Street, Chicago. This new plant will be devoted to manufacturing Frequency Meters, Test Equipment, Radio Telephones, Direction Finders, Silent and Sound Picture Projectors, and other Radionic Devices.

The company will occupy three entire floors. The factory will be equipped with the latest production devices and a complete installation of Convers-O-Call intercommunicating units. An unusual type flexible production line has been devised for this new factory which makes possible faster production of various types of precision equipment.

The engineering staff will be located at the new plant at 1100 West Washington Street—the general offices will remain at 43 E. Ohio Street, Chicago. *FRED E. GARNER COMPANY,* Engineers and Manufacturers of Radionic and Optical Equipment.

—30—

Radio-Telephones for MP's

(*Continued from page* 17)

"That does it," roared the sergeant. "Will report to headquarters immediately!" He hung up the phone (which he had known at the time of its installation, "wouldn't possibly work in a jeep"), and wheeled his car around.

"Police radio on a G.I. post," he snorted.

They straightened the sergeant out at headquarters. The khaki-clad policemen had been victims of the atmospheric conditions known as "heaviside layer" and had been following calls for MP's at Westover Field, Mass., and Morrison Field, Fla.

During the last few weeks, however, *Scott Field's* new two-way radio communications system between the provost marshal headquarters and cars patrolling the field has proven it could work and work very well.

Operating on 30 watts of radiated power with a frequency above 31 megacycles, the post's frequency modulated sets are extremely mobile. Only the telephonic mike of the main transmitter is visible in headquarters. The nine tube receiver and 12 tube transmitter are racked under a desk. The mobile units, located in staff and reconnaissance cars, possess 10 tube receivers and seven tube transmitters installed under the dashboard.

A 22 foot tower of the latest type with coaxial feeders is located atop the MP headquarters. The post Signal detachment and the Sub-depot Signal section are responsible for the upkeep of the equipment and perform the maintenance work.

Scott Field MP's have found ready use for two-way radio, just as have police departments of large cities. Patrol cars call into headquarters at scheduled periods, giving locations and pertinent information. Each car monitors headquarters at all times and if they must leave their car, officers call the control station giving the telephone number at which they can be reached in case of a call. When they resume patrolling, they report by radio that they are again "in service" and subject to radio messages and calls. A code system of numbers is issued, of course.

Capt. A. H. Schmitz, Post Signal officer, and in charge of the installation and maintenance of the set-up at *Scott Field,* is familiar with police radio for he was in charge of the installation of similar equipment at Fargo, N. D. Provost marshal is Capt. A. F. Brandstatter, former All-American football star at Michigan State, and recently a member of the Detroit police dept.

Scott Field exists to train thousands of young Air Force soldiers as radio operators on bombers. It was only natural that the post should become one of the first to adopt wireless as a means of coordinating the work of its military police.

—30—

Gas Discharge Devices

(Continued from page 25)

the graph, or if the electrode spacing is held constant and the pressure is varied, the voltage drop will also vary as shown in the graph. It can be seen that there is a pressure for any given electrode spacing at which the voltage drop is a minimum and on either side of this pressure the voltage drop rises. The same is true of electrode spacings with constant pressure. The minimum that exists for electrode spacings with constant pressure is important in designing gas tubes because close spacings can be used between plate and grid to prevent a breakdown from occurring between these two electrodes and while still allowing a breakdown to occur between the plate and the cathode.

The cathode material is important in the discharge because it is the source of the initiating and maintaining electrons. The easier the electrode gives up its electrons, the lower the cathode drop. Positive ion bombardment accounts for most of the electrons liberated from the cathode after the discharge is initiated, but before

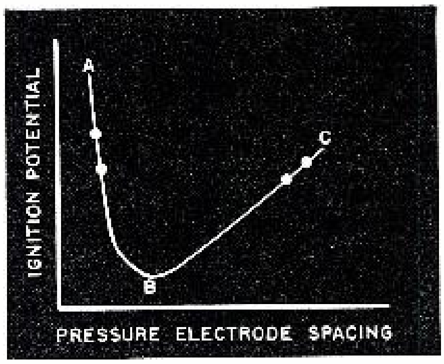

Fig. 7.

the discharge starts the emission of electrons from the cathode under the influence of light provides the initiating electrons as was said before. The emission of electrons when a surface is irradiated with light will be discussed in the next article of this series on photoelectric phenomena.

If the initial electrons could be eliminated, the discharge would not start until the potential was very high because these initial electrons are needed to form the initial positive ions which bombard the cathode to produce emission. But if the potential of the anode becomes high enough, the electrostatic field at the cathode would pull electrons from the cathode. This is called field emission and does not play a very important rôle in gas discharges except perhaps in certain ignition devices used in arc tubes since even if the discharge tube is enclosed in a light tight box, the discharge will still take place but will be very erratic in starting. This is due to the cosmic radiation and the radiation from the radioactive material from the earth producing ions and electrons in the gas which serve to initiate the discharge.

This can be demonstrated by building the relaxation oscillator shown in Fig. 8 using an ordinary neon bulb with the limiting resistance removed from the base, and enclosing the entire apparatus in a light tight box. The oscillations will be very erratic and will not be at all the constant oscillations seen when the apparatus is in the light. The oscillations are seen as flashes in the neon bulb provided the frequency of oscillation is slow enough.

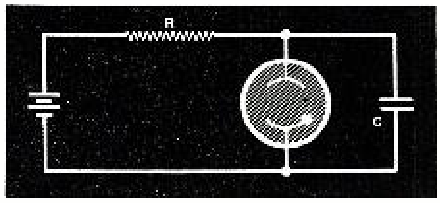

Fig. 8. Relaxation oscillator.

The application of glow discharge tubes is as follows: (1) as voltage regulators, (2) as oscillators, (3) for the production of modulated light and light for display purposes such as the neon sign, (4) as rectifiers, (5) as current and power control devices, (6) as amplifiers, and (7) for the protection of meters and other apparatus against surges. Voltage regulation devices have already been discussed. A circuit for a gas-filled regulator is shown in Fig. 9. A glow tube such as a neon or argon bulb can be used to generate oscillations. A circuit for this is shown in Fig. 8. The condenser C is charged by the battery through the resistance R. As soon as the potential on the condenser reaches the value of the ignition voltage of the neon bulb, the neon bulb becomes conducting, and the condenser discharges through the bulb until the condenser voltage falls to the extinction value of the neon bulb and the discharge goes out. Then the cycle is repeated. The type of oscillations produced by such a circuit is shown in Fig. 10. An oscillator working on the above principle is called a relaxation oscillator. Details for the use of this type of oscillator can be found in any book on electron tubes.[2]

A circuit is shown in Fig. 11 for the production of modulated light by the use of a glow tube. Although an ordinary neon bulb could be used, the light from it is very weak, so special glow tubes are designed to give the maximum amount of light. This use

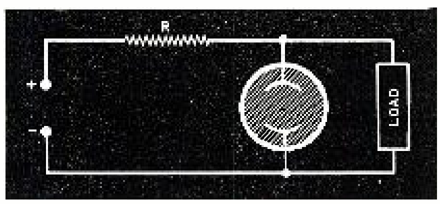

Fig. 9. Voltage regulator.

of glow tubes was important in the early development of television and is still important in the sound recording of motion picture films. The reason it is necessary to use a tube such as a glow discharge tube for the produc-

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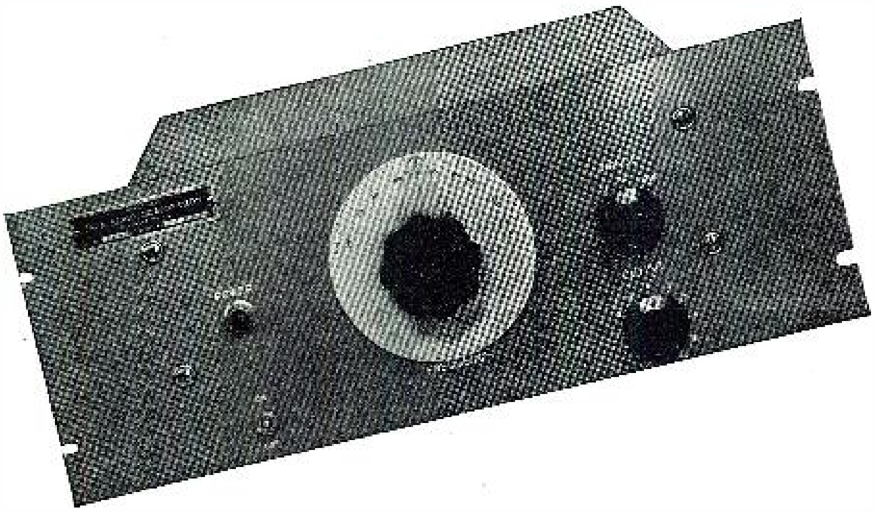

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FADA RADIO AND ELECTRIC COMPANY, INC.
LONG ISLAND CITY, N.Y.

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tion of modulated light is that the tube must be able to change the intensity of the light it produces at the same rate at which the current through the tube changes. An ordinary light bulb, for instance, would not be able to follow such changes at audio frequencies because the ordinary light bulb depends upon the heating effects of the current to produce the light, and there is considerable time lag in the change of current and the change of light output.

Glow tubes can be used as rectifier and current and power control devices, but they are little used for such applications because of their low current carrying capacity and their high operating voltage and in the case of the rectifiers, their backlash. The rectification by glow tubes is of interest as an application of the principles of the dependence of current-voltage characteristic upon the area of the cathode. The circuit for a full wave rectifier is shown in Fig. 12. As can be seen it has two small electrodes and one large electrode. This will mean that the current carrying capacity for a given voltage will be greater when the large electrode is the cathode because the normal glow region of the characteristic curve will be large. When the smaller electrode is the

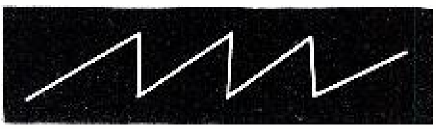

Fig. 10. Relaxation osc. wave form.

cathode there will be less current flowing for a given voltage than before because there is practically no region of normal glow discharge on the characteristic curve.

The curve A of Fig. 4 is the current-voltage curve when the small electrodes are the cathode, and curve B is the curve when the large electrode is the cathode. Such a tube with two small electrodes and a large electrode will then act as a full wave rectifier when connected in the circuit shown in Fig. 12. This type of rectifier has the advantage that it requires no heated cathode. If a glow tube is connected across the terminals of a meter in a circuit in which there is likely to develop a large surge and the voltage across the glow tube is adjusted by means of external resistances so that the glow tube ignites when the surge comes along, thereby shorting the meter. It should not however ignite until a voltage surge equal to the maximum meter deflection is reached.

An example is shown in Fig. 13 for an ammeter with a neon bulb with no limiting resistance in the base and a small resistance R in the circuit as shown to develop the ignition voltage across the bulb when the current in the meter exceeds the safe value but will extinguish when or a little before the full scale meter deflection is reached.

The arc discharge is the most important of the two types of gas discharges because the arc is a high current-low voltage drop phenomenon and most of the present day devices require these characteristics rather than the low current-high voltage drop characteristics of a glow discharge.

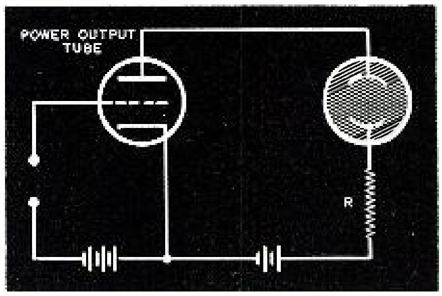

Fig. 11. Glow tube for modulated light.

The voltage drop in an arc is less by a factor of 10 or more than the voltage drop in a glow discharge which means that the voltage drop across the tube is of the order of tens of volts instead of hundreds of volts. This is probably due to the fact that the large amount of back bombardment of the cathode by positive ions increases the cathode temperature and thereby increasing the emission. If this rise in temperature could be prevented, the glow discharge could be followed beyond point D of Fig. 2.

A glow will change itself into an arc unless the current flowing in the circuit is limited by an external resistance to some value to the left of point D in Fig. 2. This is the reason for the external resistance found in the base of neon bulbs used on 110 volt lines. The arc can be used in much the same way as the glow discharge is used and the mechanisms involved are much the same as involved in a glow discharge except the emission from the cathode is many times higher due to the large positive ion bombardment and the cathode dark space and the voltage drop becomes very small. The arc can be used as a relaxation oscillator, as a rectifier, as a control device for current and power and as an inverter to convert d.c. into a.c.

An arc can be started without going through the region of high voltage drop of the glow discharge provided

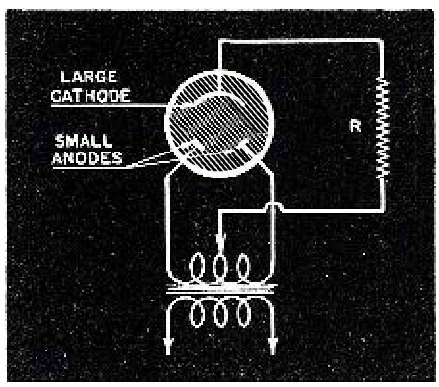

Fig. 12. Full wave glow rectifier.

some means is supplied for initiating the arc. A hot cathode giving a large thermionic emission will cause an arc to be formed at a lower voltage than for a cold cathode. Another method is

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WANTED FOR CASH—Factory-sealed 50L6GT and 35Z5GT tubes; Rider chanalyst; porta-power packs "U," "G," or "L" models; Speedex key (any model) automatic. Cripps' Radio Service, Dunsmuir, Cal.

WILL BUY—Radio tubes, parts and small sets in any quantities. Vance Lind, St. Paul, Nebraska.

TUBES TO SWAP—Will exchange the following tubes: 26, 27, 71A, 80, 12A8GT, 45, 12K7GT, 12Q7GT, 35L6GT for any of these types: 6V6, HY60, 6N7, 6L6, and 5T4. H. Schloblocher, 2987 Salmon St., Philadelphia, Pa.

COMPLETE RADIO LAB FOR SALE—Consists of Supreme 502-S tube tester and 50,000 o-v multimeter; Hallicrafter Sky Buddy receiver; 80-160 meter 'phone or c-w transmitter minus key and mike; 30 tubes (some salvaged); 45 condensers (8 filters); electric clock; universal test prod kit; 1 convenience board; 1 test panel, tools, work bench, wattmeter, used battery radio, and many books and misc. articles. $275 cash takes the lot. Write for further details. Wm. T. Neat, P.O. Box 26, Winchester, Illinois.

WANTED—Stancor model 133 master de luxe pack for auto radio demonstrator; also Solar CE condenser analyzer and Solar QCA condenser tester. Will sell RCA station allocator for $20, or exchange for any of above eqpt. Paul Copito, 637 W. 21 St., Erie, Pa.

MANUALS TO SWAP OR SELL—Rider's Vols. 8, 9, 10, and 11. First two have been used, but are in excellent condition. Need a secondary frequency standard such as Hallicrafters, Telrod, or Meissner. Donald W. Slattery, Chadron, Neb.

TUBES WANTED AT ONCE—Need types 12S27GT; 12SK7GT; 12SQ7GT; 35L6GT; 35Z5GT; 3524GT; 50L6GT. Write giving quantity and price. Rogers Radio Shop, 2402 Madison Ave., Granite City, Ill.

ACORN TUBES TO TRADE—RCA types 954, 955, 956 to trade for test eqpt., cameras, or photographic eqpt. Household Repair Service, 6 Market St., Pittston, Pa.

WILL TRADE OR SELL — Two Jensen 12" speakers, 2" voice coil, 800 ohm field, 2000 ohm output trans. (original packing). Also 3 Wright DeCoster H.D. 10" speakers, 15 lb. field coils, 1 with AC trans. and rect. unit (cones damaged). Also 2 Jewell Pattern 135 2¼" meters, 0-100 mils. and 0-8, 0-160 DC volts, perfect. Also University and Racon Reflex trumpets and units; Supreme Model 555 diagnomoscope de luxe; Philco 077 and C-B model OC all-wave signal generators AC operated. Need signal tracer, Chanalyst, v-t voltmeter, 0-1 mil. meter. Make offer for part or all. Grey's Radio & Sound Systems, Inc., Bridgewater, Conn.

NEEDED BADLY—a good condenser analyzer, Sprague, C-D, Aerovox, or Jackson for cash. State make, model, condition, and price. Jack's Radio Service, Lindenhurst, L.I., N. Y.

WANTED—32 volt radio; 1¼ porta-power pack 110 to 1½ volts; and Superior dynarometer. Ge. Payad, 202 E. Main, Staunton, Ill.

INSTRUMENTS, ETC. TO SELL OR TRADE — Philco Signal Generator 048; Elkon 4 and 6 volt trickle charger; Valley battery charger, 2 to 24 volts; Victor radio-phono model 57 chassis with speaker, mike, and record unit. Will exchange for modern tube tester, set analyzer, volt-ohm meter, or Rider Manuals, Vols. 8 to 13. Theodore Lohr, 140—28—247th St., Rosedale, L. I., N. Y.

TEST EQUIPMENT WANTED—Urgently need following which must be in new or extra good condition: Rider chanalyst or Hickok traceometer; RCA-Rider signalyst (Sr. or Jr.); or other good vacuum tube voltmeter. State price and exact condition. York Electric Co., 420 Lincoln Ave., York, Nebraska.

WANTED AT ONCE—0-1 ma. meter (must be in good condition); old power transformer core with cross section of 3 sq. inch core; also Rider's Manuals Vols. 9 to 12. Will pay cash. Jim's Radio Shop, Mankato, Kans.

WILL BUY—0-1 ma. meters. Will pay high price for Triplett models 221, 321, 227A, 327A; Weston model 301; Beede models 3 and 15; Simpson model (0—1) 2" and 3". Geo. Bell, Jr., RD 1, Niles, Ohio.

MICROMETER TO TRADE—Will trade a Brown & Sharpe No. 47 1/100 mm. 1 to 2 micrometer for Rider's Manuals III or later. Micrometer is practically new. Will consider a tube tester, if not too old. Clifford D. Lessig, Frenchtown High School, Frenchtown, N. J.

WANTED FOR CASH — Oscilloscope and "bug" key. State model, condition, and price. Home & Auto Radio Service, 315 51st, Brooklyn, N. Y.

DYNAROMETER WANTED—Need Superior dynarometer; also 35L6GT, 35Z5GT, and 50L6GT radio tubes. Dearth Radio Service, Augusta, Ohio.

CHANNEL ANALYZER FOR SALE—Have Superior channel analyzer in A-1 condition for sale—or will trade for a 2" Supreme oscilloscope in good condition. Ted Hamilton, Whatcheer, Iowa.

TUBE TESTER TO TRADE—Will trade model 066 Philco tube tester in A-1 condition for signal tracer. Martins Radio Repair Shop, Route 3, New London, Ohio.

WANTED FOR CASH—Set tester or volt ohm millimeter. State price and condition. Calvin E. Underwood, Shuford Rural P.O., Hickory, N. C.

MICROPHONE TO SELL OR TRADE—Carrier model 300, 200 ohm mike brand new. Want to buy professional model dual speed recording motor and turntable; also magnetic pick-up and arm and model GH University speakers. Must be good. Harold C. Hills, 584 Pleasant St., Worcester, Mass.

OSCILLATOR, TUBE TESTER, ETC., TO SELL—Will sell or trade RCA Model 9595 oscillator; RCA Model 56B tube tester; and several amplifiers. What have you. Maynard Bros., Inc., Box 362, Gainesville, Georgia.

WHEATSTONE BRIDGE WANTED—Will pay cash for bridge such as L & N portable testing set No. 3075E or equivalent. All letters answered. W. B. Bailey, 806 N. Broad St., Griffith, Ind.

WANTED — 100 closed circuit jacks (prefer Junior type); 100 good phone plugs; 100 20 to 30 ohm wire wound resistors, 1 watt or more (old filament center tap type will do); 10 copper oxide or any dry disc rectifiers, or packs using same, or battery boosters, etc. (output from 6 to 15 volts—any size up to 10 amps.); 10 good Triplett (or other) meters 0- to as high as 250 m.a. d.c.; 10 good D-C voltmeters 0 up to 10 volts; 2 of any type small receiving or transmitting tubes; also any General Radio equipment. Look in your junk box and help a good cause! Give condition, etc. in first letter. Will answer if interesting. Richmond Radio Club, W3WS, 1227 Windsor Ave., Richmond, Va.

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

to supply an auxiliary electrode close to and in some cases actually touching the cathode which serves to initiate the arc and as soon as the arc is initiated it will transfer itself to the main electrode.

A grid can be used to control the ignition of an arc or a glow discharge but as soon as the discharge is started the grid will have no more control over the discharge. A grid in a gas-filled tube will affect the field at the cathode in the same way as it affects the field at the cathode of a high vacuum tube. As long as the grid is not too negative a discharge will not take place between the cathode and the grid and if the grid is placed close to the plate so that it will be in region AB of Fig. 7, no discharge will take place between the grid and the plate. But as soon as the plate potential becomes high enough to cause the field at the cathode to become great enough to start to discharge, the discharge will take place between the cathode and the plate because they are advantageously placed to one another for a discharge to occur.

After the discharge is started, the negative grid attracts positive ions to it and forms a positively charged sheath around the grid wire which prevents the remainder of the discharge from feeling the effect of the grid. As the grid potential is increased, the size of the sheath increases but very slowly. The only way in which the discharge could be stopped by the grid would be for the positive ion sheath on adjacent grid wires to meet. The potential on the grid in order for this to happen would have to be extremely large so the only way the discharge can be effectively controlled is by changing the plate potential. The tube can be extinguished by lowering the plate potential until it equals the extinguishing voltage. After the discharge has stopped the grid loses its positive ion sheath and is capable of controlling the ignition of the discharge as before. All of the ions present in the gas discharge must be allowed sufficient time to combine with electrons before the plate voltage is raised. Otherwise any ions present

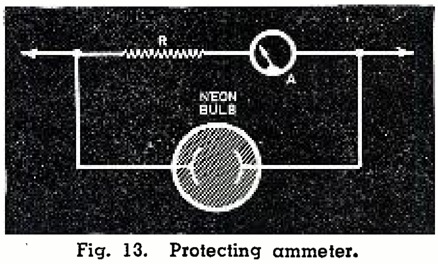

Fig. 13. Protecting ammeter.

will ignite the discharge again at a voltage lower than the ignition potential. The time necessary for all ions to be removed is called the deionization time and determines the minimum length of time that must elapse before the tube is ready to be used again.

The most familiar arc tube to the average experimenter is the mercury vapor rectifier. These tubes are capable of carrying much more current at each point in the a.c. cycle than if the tube were a high vacuum tube. This is an advantage in rectification since it is often desirable for them to handle considerable power efficiently. It would be a more expensive process to build a high vacuum tube to handle the same power that can be handled by an ordinary mercury filled rectifier. A hot cathode, usually oxide coated, is used to initiate the arc and to carry the current in the first part of the a.c. cycle before the arc is ignited.

A type of rectifier which is capable of handling large power, in fact, some are built to handle thousands of amperes, is the mercury pool rectifier.

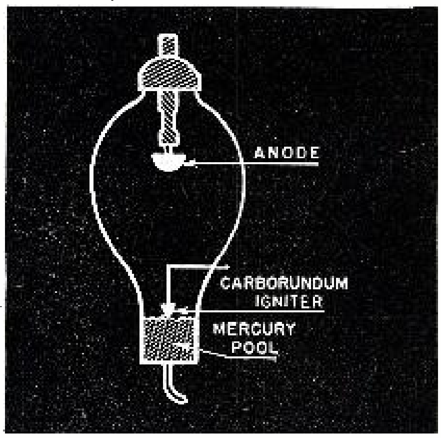

Fig. 14. Ignitron constructure.

Their unilateral conduction depends upon the cathode being a mercury pool which has a much lower ignition potential than the anode which is made of some metal. Also they are usually provided with some sort of initiating mechanism at the cathode in order to ignite the arc at the very first part of the a.c. cycle instead of waiting until the potential across the rectifier was large enough to ignite the discharge from the mercury pool. When the solid metal anode is the "cathode" the discharge is not able to take place because the peak voltage for which the tube is designed is such that the ignition potential of an arc from the metal plate is never reached. Fig. 6 shows three types of ignition mechanisms for arc rectifiers. Fig. 6C uses a carborundum rod dipped into the mercury which when a current is applied through it to the mercury pool causes the arc to ignite. Tubes using the carborundum igniters are called ignitrons. They are a very convenient small rectifier capable of handling from a few amps to several hundred amps. The construction of a glass ignitron is shown in Fig. 14. Ignitrons are much used as rectifiers in arc welders.

The thyratron is an arc tube which is grid controlled. The structure of a typical thyratron is shown in Fig. 5. The grid instead of being wires is here a simple plate of metal with a hole through it fixed in a metal cylinder. This type of grid operates well in a gas discharge since the charged particles which carry the current can turn corners in the tube very easily since they go only an extremely short distance before colliding with a gas mole-

cule. This causes all of the charged particles to have a random motion just as the gas molecules have a random motion. The movement of the charges of the different electrodes can be thought of as a drifting of a charged gas in the direction of the electrodes. Thus, the electrodes do not have to be placed in the direct path from the cathode to the plate.

The cathode in these tubes, as can be seen, faces towards the sides of the tubes and is completely surrounded by a heat shield to make the cathode heating more efficient and since the thyratron uses a hot oxide cathode it will also serve to prevent the positive ions from striking the cathode surface with too much energy which causes the surface to degenerate. The plate is placed at the top of the cathode. This would not be a good design for an ordinary high vacuum tube since the electrons tend to leave the cathode surface perpendicular to it. The plate being on the end of the cathode would cause a great increase in space charge around the cathode.

The thyratron can be used as a switch to control high current devices by applying a grid potential sufficient to keep the tube from igniting at its operating potential. When it is desired to switch on the current in the circuit a positive pulse is applied to the grid of the thyratron causing the tube to ignite. When it is desired to shut off the circuit the voltage on the plate of the thyratron is lowered until the extinction value is reached. The thyratron can be used as a relaxation oscillator in the same way that the glow tube was used. This is probably the most familiar use of the thyratron to the average experimenter since it is the circuit used to provide the linear sweep of the cathode ray oscillograph. The various uses of the arc discharge devices are too numerous to be discussed in this article. The various circuits and the various modifications of the discharge devices can be found in any book on electron tubes.[2]

(To be continued)

1. *"Electron Control Methods," Radio News, Feb.* 1943.
2. *"The Theory and Application of Electron Tubes," H. J. Reich, McGraw-Hill Book Company.*

Intrusion Alarms

(Continued from page 16)

hit for the beam with his own flashlight. The scheme illustrated in Figure 10 aims to make the system more foolproof by covering as much area as possible at a point on entry, making it difficult, if not impossible to evade the light beam. Here, the doorway or window is criss-crossed by the single light beam which is reflected successively by a number of mirrors. Lamp-house, mirrors, and photocell may be concealed by recessing each of these units into the woodwork of the door or window frame and covering them with thick glass windows.

Another alternative consists in obtaining special photocells which have very high sensitivity and are thus capable of operating under action of a light beam too faint to be discerned readily. Or special photocells with increased response in the ultra-violet or infra-red regions might be employed.

Capacity-Operated Relay

Especially useful because of its foolproof qualities and the possibility of its complete concealment, is the capacity-operated intrusion alarm. With this system in operation, there are no light beams or other visible media with which the clever mind of the intruder may reckon. The mere presence of his body sets off the alarm.

A typical capacity-operated relay is shown in Figure 9, as one of the numerous circuits now in operation. This arrangement is a hypersensitive oscillator of the blocked-grid type. Relay action is obtained whenever a nearby conductive body moves close to the sensitive plate labeled "antenna" in Figure 9. This antenna may be a metallic plate of any size. It might consist of a square of metal screen or metal gauze hidden under a rug. Or it might be a grid of wires concealed within the woodwork of a door or window frame. Likewise, the antenna might actually be a piece of secret machinery which is to be guarded.

A simple triode, such as a 6C5, 6J5, or even a 117-volt type with screen and plate tied together is employed *without* grid leak. No rectifier tube is required, the instrument operating directly from the power line. The coupled coils L1 and L2 are ordinary t.r.f. broadcast coils. And the condensers connected in parallel with them are set so that the circuit is just on the verge of oscillation. Any small additional capacitance, such as that introduced by a body approaching the sensitive plate antenna, will be sufficient to spill the circuit over into oscillation and close the plate-circuit relay.

Success of the circuit is due to absence of a grid leak. On each positive half-cycle of excitation, the grid collects electrons; and since there is no grid resistor path for these electrons, the negative charge they produce on the grid soon reaches a value sufficient to cut off the plate current.

Like the photocell pickup station described earlier, a number of capacity-relay pickup stations may be installed at strategic points about a building and their impulses may be piped to a central watch room either over direct wires or by means of wired radio.

Capacity-operated relays may be adjusted for such sensitivity that they will operate alarms positively when an approaching body is several feet distant.

Light-Pressure Switches

There are on the market a series of light-pressure switches which are immensely useful for certain types of theft alarm. These devices, known as *mu switches,* operate on as light movement as 0.0015 to 0.002 inch and very few ounces pressure. They will close

high-amperage d.c. circuits directly without the intermediary of a relay and may thus be employed to actuate an alarm device directly. An example is the tiny mu switch which handles 17 amperes at 125 volts!

Mu switches are provided with either a tiny protruding pin, protruding shaft, or flat blade for actuating the internal mechanism. And they are available in both normally-open and normally-closed arrangements.

There are many possible methods of applying mu switches to a burglar alarm. A noteworthy application is in the guarding against removal of such articles as instruments from a table, books from a shelf, pictures from gallery walls, etc. In this application, the switch may be concealed in the table or in the wall with only the tiny protruding actuating pin or blade extending from the surface. It is wired in a d.c. alarm circuit. With contacts normally closed, a light book or other article resting against the pin or blade will open the alarm circuit. When the object is removed by an unauthorized person, however, the pressure is relieved and the alarm circuit is closed to summon guards.

—30—

QRD? de Gy

(Continued from page 30)

bile is sent via any other coastal station it usually isn't delivered until after the ship docks, due to censorship delay, congestion of land line facilities, etc. . . . I also advise the Port Director, Naval Transportation Service, of the particulars of all msgs I receive so he thus knows of the arrival of all ships as soon as they contact me. . . . Yes, I'm proud that WLO is still serving the public.

"It hasn't been easy to meet all the problems that our entry into the war brought on. Message revenue dropped considerably. During the entire month of March a year ago I earned only $14.17 on messages handled. But now that more ships are entering the port, message revenue has risen considerably. There is much to what Clare Boothe (Luce) wrote: 'There are no hopeless situations; only men who have grown hopeless about them.' We all enjoy a feeling of importance, and I am pleased that I am apparently making a valuable contribution to the nation's war effort." And we are mighty proud that men like Underwood come under the banner of RADIOPS who are doing their best to beat the Axis.

HIALEAH, FLORIDA, where the flamingoes used to flap, is now the happy hunting grounds of our Caribbean Correspondent who advises us that life has been anything but quiet and serene these last few semesters. Matter of a fact, they have been quite hectic, to say the least. Sez he, "Believe you me, this war certainly has wrought many changes in our lives. Unifruitco's 'Gran Flota Blanca' is now scattered—no longer 'great' or 'white.' The Navy took over all our ships and we fell heir to the smelliest, lowliest rust-pot banana hookers. We've suffered a number of losses in ships and many of our side-kicks and close friends. It seems almost like a bad, bad dream.

"When we turned over to the Navy our *SS. Jamaica* (KDCY) in Galveston, I was sent north for my vacation and whilst relaxing the office called my home in Philadelphia for me to dash down to Baltimore to sail on the *SS. Comayagua* whose Hollander radiop had acquired cold feet. Well, we dodged subs down past Hatteras and thru the Windward Passage and made Puerto Barrios, Guatemala, okay. We then sailed for Manzanillo, Cuba, for a load of sugar. When two days out and about 15 miles south of Grand Cayman Island, at 1100 exactly, the 'crash came.' It felt like we had been hit by a freight train. At the time, ironically, I was sitting in the shack copying NSS's 'Submarine Warnings.'

"The first fish hit dead on our starboard side exploding the starboard boiler, killing all hands down below. The radio shack was situated almost over this boiler, and so, steam and fuel oil blew right up thru the shack. My place was a shambles. I could hardly see for steam and fuel oil in my eyes. And I was thrown about 20 feet by the blow. In the shack the steel deck had buckled, motor-generator (main) was ripped from its bed, main xmtr wrecked, transmitting tubes exploded by concussion, all antennas (main, emergency and doublet) all came down and pulled out deck insulators. Two of the mates and I were slopping around in the oil attempting to rig up some sort of antenna when the skipper came along and ordered us into THE boat. So 36 of us piled into one boat and pulled astern of our ship just as the still unseen sub put another torpedo into her. . . . We rowed to Grand Cayman where the folks there treated us royally. We had a helluva trip from there to Kingston, Jamaica, aboard a schooner. Then from Kingston we were sent via Pan-American Clipper to Miami and by train back to NYC. Quite an experience!

"After this we made another rustpot trip down to Honduras for bananas and were chased by two subs one night. We were saved by one of those heavy tropical rain squalls. And the following night we ran smackdab upon a sub taking stores from a small schooner near Dry Tortugas. And as we entered the Mississippi at SW Pass we witnessed a large oil tanker going up in flames. . . . Quite a time, eh, what? But it's nothing to what we're going to have to do to win this darn old war." And that's the spirit of radiops carrying on for those who are carrying on. Three cheers.

IT'S wonderful how a lot of armchair strategists can do a lot of predicting on how, what and where about this local shindig. Good, bad or

indifferent their prognostications go a long way towards making up the minds of the general public. Washington doesn't seem to mind these gents as much as John Q. Public because they seem to always be doing the surprise, or opposite thing which the Arm-chair generals and staffs are predicting. It would be nice to hear someone say, "I told you so," but we mustn't be in the right circles as we haven't heard this crack passed as yet. What we believe is let those with the knowledge, education and experience fight this war and we'll all save ourselves a lot of headaches, while keeping our beans clear to help the nation in their war effort. So cheerio and with 73 . . . ge . . . GY.

Practical Radio

(Continued from page 32)

tal capacitance is represented by C_T in Fig. 4B. This shunting action reduces the voltage applied to the input of the second tube and thereby decreases the response of the amplifier at these high frequencies. For ordinary values of R_L, C, R_g and C_T, the resistance-coupled audio amplifier operates up to 10,000 cycles without much drop in voltage amplification. The manuals of tube manufacturers give all necessary practical design data for such amplifiers.

It is evident that for a given tube (and therefore for given values of r_p and C_T) this shunting effect of C_T at the high frequencies can be reduced by employing lower values of R_L and R_g, but this results in less amplified gain at all frequencies. However, this is the price that must often be paid for good frequency response over a wide band. The actual values used will be discussed again later.

Action at Intermediate Frequency

At intermediate values of frequency, the equivalent circuit of the amplifier is as shown in Fig. 4C. The frequency is so low that the reactance of the comparatively small capacitances C_g and C_p are very high, and their shunting effect across R_g, etc., is negligible. These capacitances may therefore be omitted from consideration in the circuit. Also, the capacitance of C is large enough so that the voltage drop across it at these frequencies is negligible, so it may also be omitted from consideration.

If the voltage gain for this condition of operation is to be calculated, the equivalent resistance of R_L and R_g in *parallel* should be used for the term R_L in the gain formula. The gain thus computed will represent the *maximum* voltage gain the amplifier can have at any frequency. At the very low frequencies it will be *lower* than this because of the increasing impedance of capacitance C; the gain is zero at zero frequency (d.c.), because the reactance of C becomes infinite at zero frequency. At the higher frequencies, C_T the interelectrode capacitances of the tubes and of the circuit wiring add together and by-pass the plate-cathode resistance, causing a decrease in amplification. Fig. 5 illustrates this decrease in gain at the upper and lower ends of the response characteristic of a typical resistance-coupled audio amplifier.

It is not at all difficult to design and construct resistance-coupled amplifiers which give uniform amplification over the entire useful audio frequency range. One disadvantage of resistance coupling is that it does not provide as much amplification per stage when used with triodes as does the transformer-coupled amplifier. When used with screen-grid or pentode type voltage amplifier tubes however, more amplification per stage is obtained (at a much less cost) than with transformer coupling. Another disadvantage of resistance coupling is that higher B-supply voltages are required, to make up for the larger voltage drop which occurs in the plate load resistors due to the direct plate current flowing through them. This is a very important consideration in d.c. line-operated receivers, and battery-powered receivers (especially portable types), in which all B-voltages must be supplied by bulky, expensive batteries that add to the weight and size of the receiver. It is not important in a.c. line-operated receivers because the additional B voltage required may be easily obtained by proper design of the power transformer.

Selection of Components

The coupling condenser C must be of good quality and have very low electrical leakage through its insulation and through the dielectric material between its plates. Any leakage present will permit direct current to flow through the grid leak R_g and thereby tend to bias the grid of the second tube *positively,* thereby upsetting its action as a Class A amplifier, and producing distortion. Good mica-dielectric condensers are usually employed for C. The capacitance value is usually of the order of 0.004 to 0.01 μfd., depending on the other constants of the amplifier, tube types used, frequency-response desired, etc.

The matter of selection of the correct relative circuit constants for a resistance-coupled amplifier are of great importance, because, as we shall see, conflicting requirements appear.

When considering the reduction of gain occurring at *high* frequencies, it can be shown that at the high frequency f_1 at which the reactance of stray capacitance C_T is equal to the combined resistance of the plate resistance r_p of the tube in parallel with the load resistance R_L that is, when

$$\frac{1}{2\pi f_1 C_T} = \frac{R_L r_p}{R_L + r_p}$$

only approximately 70.7 per cent of the full voltage output will be impressed across the grid of the second tube. Any reduction in reactance (due to increase in capacitance) or increase in R_L or r_p leads to greater propor-

tionate loss of high-frequency signal. If the frequency for which the equation is given above is satisfied lies at about 10,000 cycles or over, all will be well for the audio-frequency range.

When considering the reduction of gain occurring at *low* frequencies, it can be shown that because E_g and E_c are 90 degrees out of phase, at the low frequency f_2 at which the reactance of condenser C is equal to grid leak resistance R_g (that is, when $\frac{1}{2\pi f_2 C} = R_g$), only approximately 70.7 per cent of the full voltage output will be impressed across the grid of the second tube. Of course, a reduction in the value of R_g or in the capacity of C further increases the proportionate loss of low-frequency signal. A frequently used combination is $C = 0.01$ μfd., $R_g = 0.5$ megohms. With this, a signal of frequency about 32 cycles is reduced to 70.7 per cent of its full voltage. Doubling the value of either C or R_g will reduce this frequency to 16 cycles, but it is doubtful whether the resulting improvement in bass reproduction would be noticeable with the average loudspeaker.

Transient signal voltages must also be considered when selecting the values of C and R_g for an amplifier. If C and R_g are too large, their "time-constant" may be great enough to cause trouble. A sudden unusually strong peak of signal voltage applied to the amplifier may overbalance the negative bias voltage applied to the second tube and cause its grid to go momentarily *positive,* thus charging the coupling condenser *negative* on the side toward the grid. This charge may be sufficient in magnitude to send the grid potential of this tube below the cutoff point (plate current flow stopped) as soon as the transient has passed, and the amplifier will then be inoperative until the charge has leaked off. This phenomenon is known as "blocking." Since the time required to discharge the condenser is proportional to the product $R_g \times C$, and the low-frequency response is a function of the value of the ratio $1/R_g \times C$, the requirements for good low-frequency response and of satisfactory transient response are conflicting, and compromises must be made in the selection of these two circuit constants.

In practice, the value of C is usually chosen so that its impedance at the lowest frequency to be encountered is at least less than 10 per cent of the resistance of R_g.

Pentodes in R-C Amplifiers

The basic action of a resistance-coupled amplifier employing pentode or screen-grid tubes for the greater amplification obtainable is similar to that described above for triodes. Fig. 6 shows the basic circuit diagram for a suppressor-grid pentode amplifier. A source of positive voltage for the screen grid is provided. The grid-input capacitance C_g discussed previously is greatly reduced in the pentode because of the shielding action of the suppressor grid and the screen grid, so its objectionable effects are also less.

Since the plate resistance of a typical suppressor-grid voltage-amplifier pentode is very high (often 1,000,000 ohms or over), a high value of plate load resistance R_L must be used with such tubes, otherwise most of the signal voltage μE_g generated will be lost inside the tube and very little will be available across the load resistor to be applied to the grid circuit of the next tube. However, since the direct current for the plate must flow through the load resistor, if its resistance is too high a large voltage drop produced across it necessitates the use of a plate supply source of very high voltage, which is objectionable. Hence a compromise is usually effected in practice by using somewhat lower values of plate load resistor than the requirements for maximum voltage amplification would dictate.

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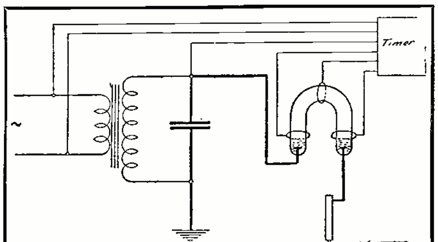
Wartime Radionics

(*Continued from page* 23)

cathode and diode plate. The control grid of the tube is disconnected from the secondary of the first I.F. transformer, but appears to receive some energy from that of the second I.F. transformer through the potentiometer and fixed condenser which is connected between the two fixed resistors that lead from the control grid to ground.

When the switch is thrown to the SW (short wave) position, the output of the first IF transformer feeds directly to the control grid through a fixed condenser, and the output of the pentode section is fed its plate voltage through the primary of the second IF transformer, instead of directly, as when broadcast frequencies are received. Thus the a.c. component of



Pat. No. 2,308,860.

the plate current is fed to the diode portion of the tube through the secondary of the second IF transformer.

In either case, the plate of the pentode section feeds the audio stages of the receiver. And, to be completely frank, your reviewer is not quite convinced of the merits of this particular circuit, although the company which has acquired the patent is one which has an enviable reputation in the Antipodes. Perhaps the reason for this lack of conviction may be an incomplete understanding of what the circuit is intended to achieve—this sci-

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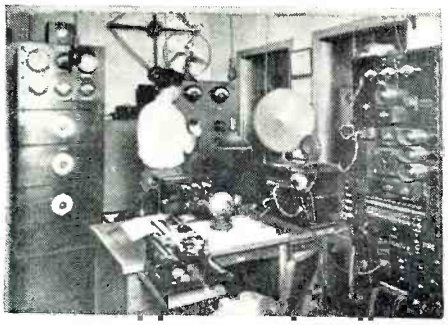
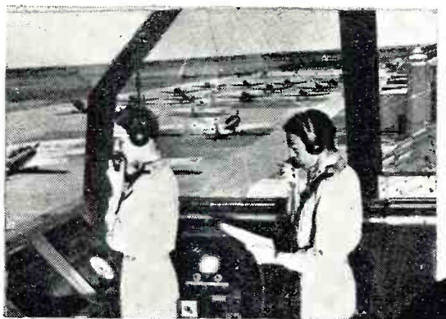
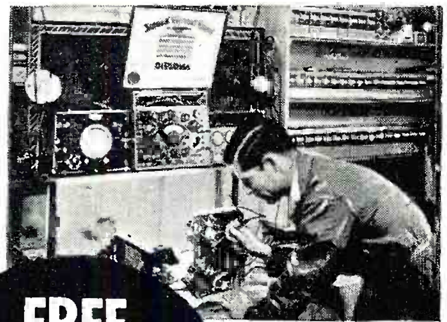

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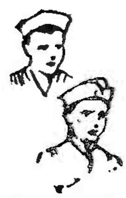

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entific double-talk of Patentees again! Just the other day, this topic (one of this department's pet peeves) was being discussed with a patent examiner who is on temporary leave of absence from the Office. The examiner smiled and said, "Language was devised to conceal thought. Patents have to be disclosed in that way; if they weren't, anybody could understand them!"

Easily understandable is a new British invention, covered by U.S. Patent 2,308,863, of a variable impedance. It has been assigned to RCA by the inventor, H. J. Craymer. This device—which might be used as a variable inductance tuner in receiving or transmitting circuits—consists of a series of open rings. These are mounted side by side, on a common axis; alternate rings are stationary, with rotatable rings between, much like the stator and rotor of a variable condenser. But, unlike the condenser, each ring is connected to the adjacent ring by means of a sliding contact. When correctly aligned, the rings form, in effect, a helical coil, but as one or more are rotated, the coil is shortened.

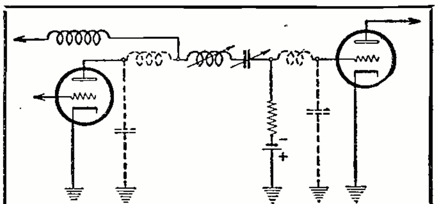
This variable impedance will recall two inventions of yester-year: a variable resistance and a variable inductance. The former consisted of a length of resistance wire, part of which was wound on a threaded cylinder made of dielectric material, the other part being wound on a threaded metal cylinder. The wire could be wound from either cylinder onto the other by means of the knob and shaft with which each was provided. Obviously, when wound onto the metal, the resistance was decreased, for turns of wire were shorted out; when on the dielectric, the turns were insulated from each other and the resistance consequently increased.

The variable inductance was a refinement of the variometer, which in itself was a form of variable inductance. Known as the "phusiformer," it consisted of a set of fixed and movable "pies," each of which comprised two "D" shaped windings on paper or fiber forms. When the current flow was in the same direction in the two sets of windings, inductance was at a maximum, but as the rotor was turned, the direction of current in the movable pies was changed in relation to that in the fixed pies, thus decreasing inductance. Tuned-radio-frequency receivers containing phusiformers did not use any capacitors in the tuning circuits, and much was said at the time about the greatly increased efficiency of completely inductive tuning. Yet the vogue of these devices was relatively brief, and by 1925 or thereabouts they had vanished from the market.

Without knowing considerably more about the circuits in which Mr. Craymer's device will be employed than the patent discloses, it is hard to predict its value to the industry. It would appear to fill a need for a simple variable impedance, but the fact that sliding contacts are employed between a fairly large number of elements leads one to wonder how well contact will be maintained, and whether or not the device will be subject to the ills which so often affect connections of this type.

Two rather unusual devices are also patented this month. One of these is an electronic drill for piercing rock, concrete, etc.; the other, a psychogalvanometer, which might be called a form of lie-detector.

The former, invented by M. S. Clark and disclosed in patent No. 2,308,860, causes a high frequency, high voltage arc to be directed at the point to be drilled. In this circuit, a transformer fed with alternating current has its secondary shunted by a high voltage condenser; one terminal of the secondary is grounded, while the other is connected to one end of a mercury vapor discharge tube, the other end of which connects to a rock drilling arc electrode. The tube has external grids (or "triggering elements" like those on the earlier forms of argon tubes used in photographic stroboscopic flash units), through which a timing device controls the frequency of the arc. Its effect, as this reviewer sees it, would be much like causing miniature lightning



Pat. No. 2,310,455.

bolts to strike not merely once but repeatedly in the same place, each time shattering away a bit more of the material which it is desired to cut.

The psychogalvanometer of L. G. Raesler (Patent No. 2,308,933) incorporates an ultra-high gain vacuum tube voltmeter with a pair of electrodes suitable for connection to the human body. The circuit is direct-coupled somewhat like the Loftin-White circuit of about 1928, with the plate of one stage feeding directly through a battery to the grid of the next stage. However, the grid and plate in the input stage are coupled together. The input from a pair of electrodes connected to the body of the person whose psychogalvanic responses are being tested are thus fed into the input grid and the grid of the second stage at the same time the output of the first stage is fed into the second stage. Note that the first tube, though a triode, is connected like a diode; its purpose is chiefly to maintain a measurable current through the body of the subject, and a meter is provided for checking this current. A switching system permits either two or three of the following direct-current amplifiers to be used; the potentiometer serves to balance the circuit. In the output stage there are both a meter for instantaneous indication of current changes, and a recording meter for making a permanent record thereof. Connection to the subject is through

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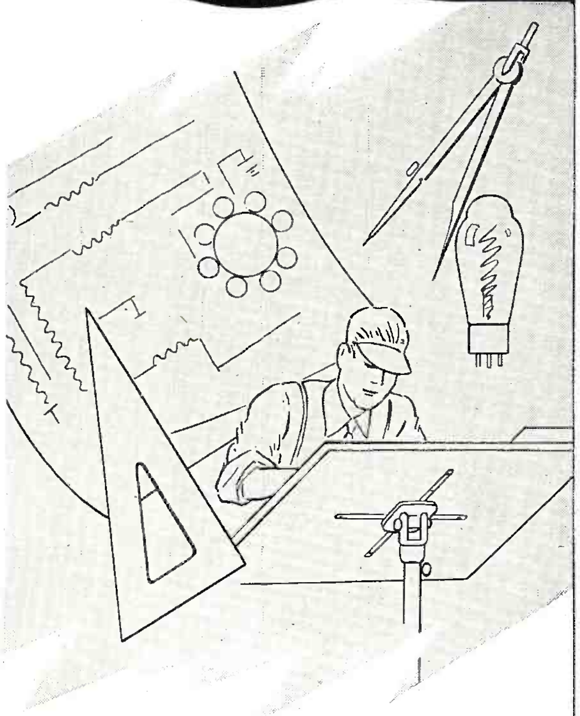

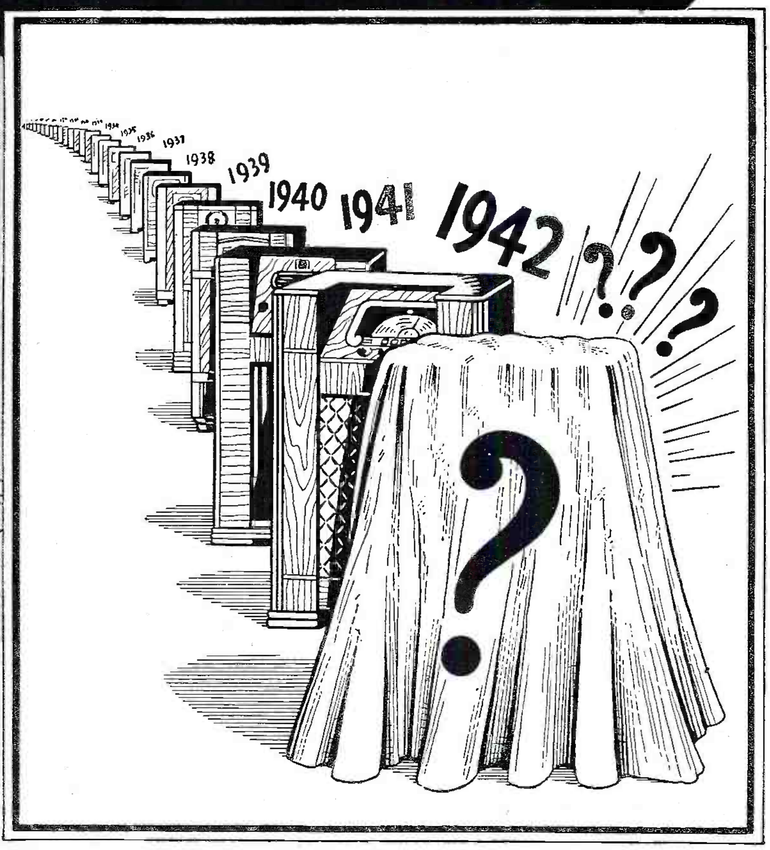

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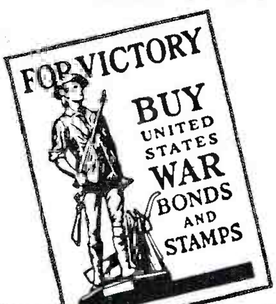

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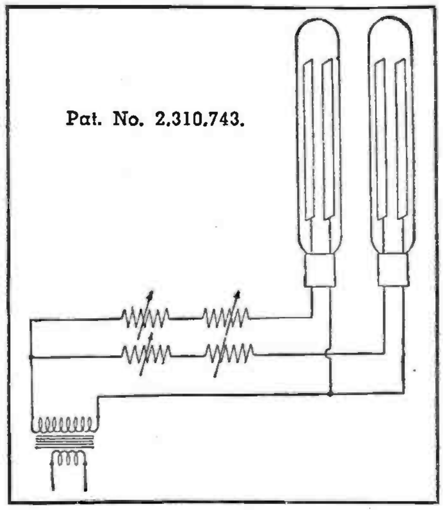
a pair of electrodes coated with a highly conductive substance capable of permeating the surface of the skin; a strong salt solution might serve this purpose.

Getting back to the Alien Property Custodian again, he has taken over control of Patent 2,310,455, covering an ultra short wave amplifier circuit invented by J. Muller, of Germany. It utilizes a pair of triodes with a tuned inductance linking the plate of the first stage with the grid of the second. Capacity shunting this inductance is derived solely from the inter-element capacity of the tubes and that of the connecting leads. The plate of the first stage is fed through an ultra-high frequency choke.

This use of tube capacity for a useful purpose is rather reminiscent of some of the early regenerative circuits, in which inter-element capacity was used to regenerate radio frequency



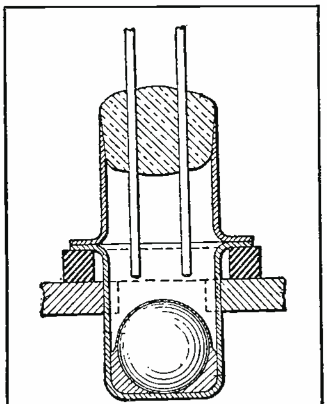
energy from the plate circuit of a detector tube back into the grid circuit. In fact, certain patents on regeneration were dodged by means of circuits which had certain similarities to this one. However, it has heretofore been generally considered desirable to reduce inter-element capacity when dealing with ultra-high frequencies; this circuit appears to make such precautions less necessary.

From radio to blackout lighting may be a rather large step, but the patent which E. B. Moss, of England, has assigned to S. Smith & Sons, Ltd., under Patent No. 2,310,743, is extremely interesting.

For use on the instrument panels of vehicles, it makes use of fluorescent materials and ultra-violet light. The instruments are coated with fluorescent paint, just as many common clocks and watches have hands and numerals treated with phosphorescent paint. The difference is that phosphorescent materials have a persistent glow, while fluorescent substances cease to emit light when they are no longer excited by ultra-violet or other means. In this circuit, each light has a control in series with its current supply, so that all instruments can be caused to glow with equal intensity;

there is also a means of varying the ultra-violet emission of all lamps simultaneously to control the brilliance of the entire layout.

An electro-magnetically operated mercury switch—though mercury is a non-magnetic material—has been assigned to Bell Telephone Laboratories under Patent No. 2,309,953 by its inventor, H. C. Harrison. The switch is not a tilting device, as might have been expected, but embodies a closed chamber containing a ball made of magnetic metal; this ball rests in a pool of mercury. A solenoid coil surrounds a portion of the chamber, and when energized draws the ball upward, causing it to make contact with one or more electrodes. The mercury itself may act as one electrode, the ball serving as a moveable connection between it and the upper electrode. Although the patent claims that "the forces of capillary action" serve "to attract mercury from said pool to cover the remaining surface of said ball with a coating of the liquid" and the drawing shows the mercury doing so, this reviewer wonders whether such action would take place unless the mercury tended to amalgamate with the material of which the ball is composed, for non-wetting liquids such as mercury show capillary action which is virtually the reverse of that manifested by such wetting liquids as water.



Pat. No. 2,309,953.

Lack of space this month prevented much discussion of the interesting material contained in the I.R.E. *Proceedings,* which included considerable discussion of television, some data on engine-driven power plants for broadcasting stations (particularly that used in WIBW of Topeka, Kan.), a description of a frequency-modulated resistance-capacitance oscillator, and one of coupled resonant circuits for transmitters. Of especial interest was a comparison of voltage-feedback and current-feedback amplifiers, by E. H. Schulz of the Illinois Institute of Technology. Among the statements made in the article are that current-feedback decreases the effect of load impedance on load current, and that voltage-feedback decreases the effect of load impedance on output voltage while increasing the damping of the loud speaker and improving speaker response. —30—

Every Minute Counts

(*Continued from page* 20)

department, than Mr. Mack 'phoned me. (Company Officials also go to classes.)

"Ed," he said, "they have a new jig in Department 91. I believe it's an ideal set-up for one of your quick-test arrangements. Get Don and see what you can do with it."

I laughed. "We just saw it, and the deal is already 'in work.'"

"Fine!" from Mr. Mack.

But that wasn't all. About an hour later, Mr. Algraf, the Assistant Superintendent came around. "Don," he said, "up in 91 they've got . . ."

"Wait," Don interrupted. "Don't tell me . . . let me guess. They've got a new jig and you want to us to give it the works?"

"Right!" Mr. Algraf agreed, and he didn't show the least bit of surprise. "On the beam" himself, he takes it for granted that the rest of us are also on our toes . . . unless we prove to be otherwise. . . .

"It's in the bag," Don said. And it was. Two weeks later we delivered the completed jig to Department 91, and it's there now, saving exactly 67.6 minutes' time on every bomber we make.

You'll recognize it in the photo. There's a close-up of the special multi-point switch, held by "Bud" Clark, the old-time serviceman who built it and who is our chief "jig-builder." A flashlight bulb proves continuity of each circuit, and one inspector handles the test instead of two. All wires are numbered, and should any circuit fail to light the bulb, the faulty wire is indicated by number, directly on the face of the switch.

"Bud," is also in another photo, shown holding a circuit-checker which he built with the help of "Jo" Hoover, another ex-serviceman, and which is our masterpiece to date when it comes to time-saving and thoroughness in testing. This circuit-checker tests continuity of 72 circuits in one of our Radio mounting-rack assemblies, as well as shorts between circuits or grounds in any circuit. A seventeen-wafer rotary switch does the job with a single turn, after all cables are plugged in and the time required for the entire operation is five minutes.

Before this checker was designed and built, it took two operators 45 minutes to check continuity alone, and there was no check for shorts or grounds. Two operators, 45 minutes, is equal to 90 minutes time, against 5 minutes with the new checker, and we have a time saving of 85 minutes.

In these times, when every minute counts, especially in aircraft manufacturing, you can easily understand why 85 minutes time saving per ship, "ain't hay."

Now, let's take a look at our Master Radio-unit Test Bench, in the photo. Paul White, who holds a commercial radio-phone ticket (formerly ex-ham), is plugging a transmitter into one of three racks mounted on the bench in front of the sloping sub-panel which holds an oversize output-meter. The three types of radio units used on our ships are merely pushed into these racks where they literally "plug themselves in," plugs being permanently set at rear of racks.

This connecting operation takes only a *few seconds.*

Units are then turned on, and the bank of meters, directly above, read voltage and current in all circuits at the same time of both transmitters and receivers. Ex-Army Radio operator John Strain, on the right in the same photo, is adjusting a novel test instrument, which he built from our design, and which incorporates three crystal oscillators. This oscillator is used to check receiver sensitivity and gain as well as to provide a means of accurate calibration for receiver dial settings.

These crystal oscillators furnish a satisfactorily constant input signal, and gain is read directly on the output meter. This eliminates guesswork, and local interference, of course, does not affect this check. On Aircraft Radio, it doesn't do to say, "Well, I guess this receiver is okay . . . it *sounds* all right." It's necessary to know as accurately as possible that Radio Units *are* all right.

Transmitters are set to specified frequency, after checking dial calibration, and then loaded to a special Dummy Antenna, another of our developments, which has the same characteristics as the actual ship's antenna. Percentage modulation is observed on the oscillograph, mounted at the left on the panel, and if everything is on the "up and up," the units get our "Tested OK" stamp.

Now, let's follow this Radio job through to the final stage, and see just what happens. The Installation men (licensed operators) install the units in the ship. The transmitters, having already been loaded on the bench to approximate frequency, need only to be touched up a bit. (Credit another time saving of 1.0 hour to our Dummy Antenna.) The operator calls our ground station for a final check, and they are ready for the next job.

Interphone amplifiers and their power supplies as well as range switches, are checked on an auxiliary bench, the units being plugged into permanently mounted bases for quick accurate testing. In the photo, my hand is caught in the act of plugging an interphone amplifier into the testing jigs. Repair and adjustments on all radio units are made on the two benches. Our vacuum-tube voltmeter on the master bench next to the oscillograph is used in trouble-shooting for speedy radio frequency gain checks.

Because radiomen have to be elec-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tricians before they *are* radiomen, our boys are perfectly at home in our electrical test and repair section. Here, tests and repairs are made on many different types of radio and electrical parts, small motors and lighting devices.

One might think that the large "V" on the tester in the group photo is either for "Victory," or "Vultee," or both, but actually it's an ideal arrangement for testing all diameter light bulbs having single contact, and any length fuse or resistor.

One leg of the "V" is insulated from the other, which has an extension running part way up on the inside of the "V." Bulbs are placed in the lower part of the "V" and if okay, an indicating light comes on. Fuses are checked by placing the fuse across the "V" and resistors in the same manner, except that an ohmmeter, plugged into the tip-jacks reads the resistance.

Aircraft Instruments are also tested and in practically all cases repaired in our department. You may wonder why these are assigned to a Radio and Electrical Department. Here's why. In the first place this is technical work, and in the second place, about 50% of the aircraft instruments are basically and mechanically the same as ours.

We radiomen, at Vultee, know the importance of the slogan, "Get 'em Into the Blue," and we are proud that we are having a hand in helping to turn out better bombers . . . *faster!*

—30—

RAF Radiomen

(*Continued from page* 21)

whom the lives of many air crews and ground personnel may depend, and see how he has progressed since he went to the recruiting office to reply to the message *"The R.A.F. Needs YOU."*

The break from the comfort of home life to the hard-living ways of the Service was nobly endured, and killed for all time the myth that heroes live in movies only; training over the first few weeks aimed at producing a first-class man, fit in body, eagle eyed and mentally alert, who would thus be enabled to concentrate without undue fatigue on all the intricacies of radio from Faraday's electricity to Watson-Watts' Cathode Ray Tubes.

After the early weeks at the recruits' training center, the trainee starts his *ab initio* theory training at one of the many fine technical colleges operating under the control of the civilian educational authorities. In fact, his first eight months will be spent with civilian instructors, in a life that almost amounts to an extra period at a technical school, where he is taught the fundamentals of radio.

Enter Aircraftsman Ham

At this stage he is no longer Mr. D.X. Ham, but 1234567 Aircraftsman 2nd Class Ham, D.X., A.C.H. u/t R/WM (under training Radio or Wireless Mechanic); but he is still "Ham" to his classmates, and to his civilian instructor, who is perhaps a graduate of some famous university.

His first twenty-four weeks are spent on the *ab initio* course, during which he is instructed in the basic principles of electricity and radio, and is given practical workshop training. In an initial friendly lecture from his Commanding Officer he learns that it isn't going to be all hard work and no play. During the 24 weeks he will be granted limited vacation privileges, covering one 48-hour pass and later seven days' leave.

"Organized games" are part of the weekly syllabus, and include football, tennis, swimming and cricket. Six hours a week are devoted to physical training, under the immediate supervision of professional physical culture instructors, whose methods embrace the most modern and scientific exercises. Exercise in this form aids in developing the trainee physically.

Unravelling the Mysteries

The trainee soon finds the technical language of the classroom intriguing, fascinating and interesting, as the instructors unravel the mysteries of Radio Communications, ranging from Marconi's experiments to that Nazi-baffling subject, radio location. The desire of trainees to handle low and high powered radio equipment, with its galaxy of meters and tubes, equals that of the many aspirants to moviestar fame, but like them, the road to success demands hours of diligent application to fundamentals before making the grade when the time of the "passing out" examination comes.

The examination questions are many and varied, and the minimum pass standard is set at 50%.

During each of the 24 weeks of the course, with the exception of one week's leave, training extends over 44 hours and is made up of 32 hours technical and 12 hours non-technical instruction.

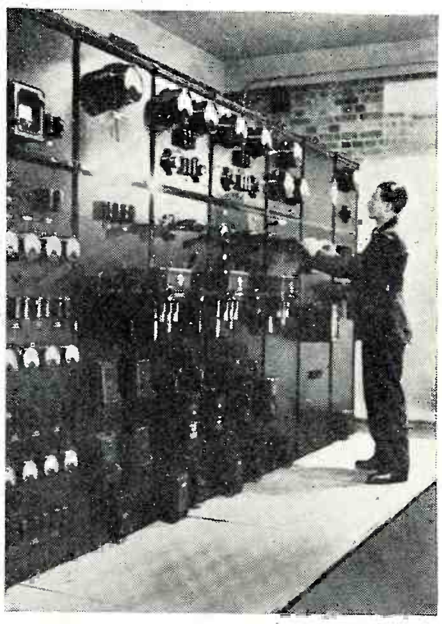
Lectures and practical work in the laboratory combine to cover the following subjects: principles of electricity and magnetism, accumulators, electric measuring instruments, electric motors and generators, elementary a.c. theory, tuned circuits and simple valve and cathode-ray tube theory. At the end of this stage comes seven days' leave.

Builds "Breadboard Model"

The trainee returns to such subjects as amplifiers, oscillators, simple MO/PA transmitter, modulation, reception of c. w. detection, autodyne and heterodyne principles, and power supplies. All this is not just theory, for at an early stage A.C.2 Ham builds a four-valve receiver known as a "breadboard model," with which he can pick up signals transmitted by his teammates in the laboratory.

Finally comes the inevitable examination, which Ham must pass to avoid relegation to a less important R.A.F. trade. The examination is in four parts, two written papers (one on electricity and one on radio theory), a workshop test at which he has to make some particular radio part, involving exercise of workshop knowledge and tools, and an oral examination to ascertain if he has a really practical grasp of the basic principles of radio theory and workshop practice.

If successful in this examination, he is granted seven days "passing out" leave, which is followed by posting to a Royal Air Force Signals School for the second and more advanced course.



Mechanic operating power generators.

Handling Actual Aircraft Sets

The half-fledged mechanic enters the advanced phase with yet greater enthusiasm, for it covers handling of actual sets as used in aircraft, in the field, and at main stations; from this course he can graduate as Aircraftman 2nd class, 1st class, or, as Leading Aircraftman, depending on whether he obtains 40%, 60% or 80% or more in the final examination. In exceptional cases of marked ability, a recommendation is given for further training, prior to obtaining a commission as an officer in the Technical (Signals) Branch of the R.A.F.

This second course lasts 14 weeks; the first four weeks consist of revision of the theory learned during *ab initio* training. Then in the fifth week Ham gets his first glimpse of a general-purpose transmitter-receiver used in bomber aircraft. This is followed by other sets, and he begins to marvel at the amount of radio equipment—and wiring—in an aircraft.

His first transmitter is a simple matter—an oscillator power amplifier, such as was constructed on the *ab initio* course, but this is only a foretaste of what is to come. For in eight weeks' time he will be handling powerful transmitters requiring careful and accurate adjustment to ensure successful communication over ranges of thousands of miles.

Training is assisted by the use of special instructional movies covering everything from "an electric current" to "Cathode-ray oscilloscope," and the maintenance of servicing instructions peculiar to the specialized equipment, whether airborne or ground installation.

Non-technical training on this part of the course takes up ten hours a week and is devoted to advanced physical training, organized games, drill, first-aid, fire-fighting, anti-gas drill, and for the men, musketry and field training. There are interesting sessions when the trainees "battle" with the local military on exercises, usually involving defense of the Signal School.

The multiplicity of radio equipment, both British and American, on which training is given keeps enthusiasm at a high pitch and insures that the trainee is sufficiently advanced by the eleventh week to go on to one of the most interesting periods of the training, that is, "Air Operations" instructions, where he receives initiation into the complex side of aircraft, radio equipment, power supplies and wiring maintenance. This instruction is of a practical nature and is carried out inside fuselages of operational type aircraft, such as Wellingtons, Hampdens, Spitfires, Beaufighters and Hurricanes.

Operational Conditions Reproduced

The instructors try to reproduce as far as possible the sort of conditions that will be found on an operational squadron, whether operating from a permanent or satellite airfield.

After the "Air Ops" week, the remaining two weeks are devoted mainly to revision, and on the Monday morning of the 14th week Ham takes his final Trade Test Board to qualify for the reward of his labors.

This "Boarding" of a trainee may last anywhere from half to one-and-a-half hours, during which he is questioned by a highly technical and well-experienced Warrant Officer or Flight Sergeant (a member of Central Trade Test Board Establishment) who not only asks questions on the apparatus but also insures that Ham can tune it and carry out effective fault location and repairs under operational conditions. This means that he must really possess both theoretical and practical ability.

After this it is with great pride that the successful trainees sew on the much prized and coveted *"sparks"* badge, the only trade badge issued in the R.A.F.; henceforth Ham is entitled to tell the world that he is a member of the R.A.F. Signals Branch.

So Ham can start on his new life as a radio mechanic at an R.A.F. unit, secure in the knowledge that his thorough training will stand up to any test; for he is a product of the wonderful organization built up within *Britain's Air Force* to enable skilled radio personnel to be rapidly produced by the thousand from the most varied raw material.

—30—

Switch Type Oscillator
(Continued from page 35)

The multiplier-resistor pairs (R1 to R3) must be chosen very carefully with respect to ohmic value if the higher frequencies are to be exact multiples of the fundamental frequencies. It is suggested that the builder select his six resistors very painstakingly from available stock, using a d.c. Wheatstone bridge for measurement. When the *exact* values have been obtained (either by selection of perfect individual values or by connecting several in series to make exact values), the resistors should be dried very thoroughly and dipped in wax to preserve their characteristics. Ceresin wax will be the best material for this purpose; but if it is not obtainable, a half-and-half mixture of paraffin and bees-wax will suffice.

The pushbutton or switch assembly may be located at the most convenient point on the instrument case, since individual adjustment of the frequency-determining condensers will compensate for any stray capacitances which may be introduced on either side of the circuit by long leads, proximity to chassis or nearby parts.

Layout of the instrument is not at all critical, except that reasonable care must be exercised in the placement of the power supply section in order to prevent pickup of hum fields from the power transformer and filter choke or of heat from the rectifier tube. It will be seen that a midget, broadcast-type power transformer is employed. This is the smallest unit which will supply the instrument satisfactorily and, if placed (as shown in Figure 3) in one of the rear corners of the chassis, will occasion no trouble from a.c. fields.

High-impedance output is taken directly from the cathode of the last 6V6-GT tube. Low-impedance output is delivered by the output winding of the cathode-circuit transformer T1 through the output (gain) control potentiometer R14.

The output voltmeter is built directly into the oscillator, being composed of the 6SF5 tube and its circuit. It is a "must" that the output voltmeter in a high-grade audio oscillator be a vacuum-tube voltmeter, since the reading of regular oxide-rectifier a.c. voltmeters is not dependable at the several frequencies in the a.f. range. (We find that one well-known a.c. multimeter has a voltage error of almost 50 percent at 2500 cycles, while being perfect at 60 cycles). The VTVM indication is independent of the frequency of the output voltage.

The VTVM circuit is straightforward, being of a high-impedance input triode arrangement with fixed plate, cathode, and bucking voltages obtained from a voltage divider across the d.c. plate voltage. The plate circuit contains the arms of a resistance bridge which is balanced by means of the control R21 to set the meter initially to zero. With the O-1-milliammeter specified, the normal full-scale deflection of the meter will be approximately 4½ volts, sufficient for the low-impedance output. By means of the input voltage divider, composed of the two resistors R15 and R16, however, this range is changed by means of the range switch S10 to 0-22.5 volts for reading the higher voltage at the high-impedance output terminals. It will be observed that the d.p.d.t. toggle switch S10 automatically switches the meter from low to high-impedance output terminals at the same time that the scale range is shifted from low to high voltage.

The v.t. voltmeter is powered from the self-contained power supply of the oscillator and requires no additional source of potential. It has unusually low zero-drift and may be depended upon to hold its calibration over long periods of time. Its indications of 4.5 and 22.5 volts full-scale are RMS values, although the builder may, if he desires, make his scale peak-reading simply by multiplying the RMS calibrating values by 1.41 when he is preparing his scale.

The writer finds that very little shielding of leads is necessary in an oscillator of this kind. By placing the output transformer as close as physically practicable to the output terminals, it becomes unnecessary even to shield the output leads. Shielding of the active portion of the instrument from the power supply is very important however, as is also the complete boxing-in of the instrument when it has been completed.

In line with the latter remark, it will be observed that a panel-high baffle shield is mounted on top of the chassis to shield the upper portion of the instrument from the power supply (See Figure 3) and also that directly under this shield and below chassis a similar shield (Figure 2) likewise separates oscillator and power supply components. In some duplicates of the instrument, the writer has been advised that it has become necessary to enclose both output transformer and filter choke in box shields. However, this does not seem to be necessary with the components shown in Figure 3.

As shown in Figure 1, the various controls are arranged for greatest convenience and ease of operation, although considerable variation in layout is permissible and the reader is free to follow his own inclinations without running into any important electrical difficulties. The indicating meter occupies the top center of the front panel, with the frequency-selector switches directly beneath. The multiplier switch, output voltage control, and output terminals are arranged from left to right along the bottom of the front panel and beneath the switches. With this arrangement, the frequency-selector switches are above chassis, their leads extended through grommet-lined holes to the selector condensers below chassis, while the lower line of components feed through both panel and chassis for under-chassis connections. Other builders might prefer to keep the entire frequency-selector mechanism under chassis and therefore might prefer to arrange the multiplier switch, output control, and output terminals directly beneath the meter and the selector switches along the lower line. This is entirely permissible.

The v.t. voltmeter zero-set potentiometer is mounted directly to the chassis, as will be seen in Figure 3, its shaft being sawed short and slotted for screw-driver adjustment. A small hole in the top of the oscillator dust-cover permits this control to be adjusted with a long-blade screwdriver inserted through the cabinet. This arrangement is the result of considerable attention to the matter, it having been observed that (1) the zero setting seldom changed, once the instrument has come up to operating temperature, and (2) that the zero set knob on the front of the panel is invariably struck accidentally, throwing the meter indication off during measurements and thereby introducing an annoyingly frequent error.

The tungsten-filament miniature lamps are mounted directly behind the 6SJ7 tube (Figure 3) into screw-type porcelain sockets, the bases of which are mounted below chassis.

The 18 mica trimmer condensers used in the frequency-selector system are mounted on a 12″ x 3″ bakelite or fiber strip (See Figure 2) and slung below chassis under the tube sockets, circuit condensers and resistors, and wiring by means of long metal pillars or threaded rods. These condensers are thus readily accessible for adjustment without having to remove the important shielding dust-cover. The lower power supply shield is seen directly to the rear of the condenser sub-panel.

The chassis is seen to be 14″ x 8″ x 2″ in size, while the front panel is 14″ x 8″. These parts were formed by the writer from ordinary galvanized iron (due to the shortage of critical radio hardware) and later given a coating of black lacquer. The constructor may, if he is able to find a source of standard-size panels and chassis, select the nearest sizes to those just specified, preferably remaining slightly on the larger size rather than smaller than the stated dimensions.

An outstanding electrical feature of this audio oscillator is the fact that it will deliver an almost even voltage through its range with sine-wave form. It is readily applied to any of the uses to which audio test oscillators are commonly put; such as fidelity checking, other types of frequency runs, modulation of r.f. signal generators, network testing, transmitter modulation, test-tone generation, reactance and impedance measurement, gain measurement, and the like.

Calibration

After the instrument is completed, the wiring must be inspected very carefully for errors. It is essential that wiring mistakes be corrected before the power is switched on. This procedure not only eliminates backtracking but protects the components from damage, an important protection in this day of scarcity.

If the wiring is correct, short-circuit the input circuit of the v.t. voltmeter by fastening a jumper from the top of R15 to chassis. Switch on the power and watch the milliammeter. As the tubes come up to operating temperature, the meter will assume a reading somewhere along the scale. After allowing 15 minutes for complete warm-up, remove the jumper, disconnect the lead from the high-Z output terminal-to-cathode (retaining only the connection between this terminal and S10). Calibrating a.c. voltages may now be introduced between the hi-Z terminal and the common terminal. Set the meter to zero by adjusting the potentiometer R21.

Introduce various values of a.c. voltage at these terminals, varying in appropriate steps from 0 to 23 volts by means of a potentiometer or variac, noting the meter deflection for these various values and either making up a calibration curve or chart or marking the identical voltage values on the meter face. For indicating the value of input voltage, a good a.c. voltmeter must be used. The meter switch S10 is in the *high* position for this adjustment. After a number of voltage points have been located, the meter calibration is complete. When the switch S10 is thrown to the *low* position, the v.t. voltmeter will show one-fifth of these values. Now reconnect the lead from the final-tube cathode to the high-Z output terminal.

The frequency calibration may now be undertaken. With all the other switches open, throw the selector switch S1 closed and set the multiplier switch to the X1 position. The instrument is now in the 20-cycle position. A good source of 20-cycle voltage should be connected along with the oscillator (lo-Z output) to a cathode ray oscilloscope in the manner described by the writer in RADIO NEWS for December 1942 (See Figure 4, page 18). The source should preferably be a variable-frequency audio oscillator of good calibration. Now adjust the pair of trimmers labelled C1 until a circle pattern on the oscilloscope indicates "resonance" between the oscillator and source. At this point, the instrument is set to 20 cycles. In making this adjustment, it is preferable that both trimmers be tightened as far as they will go and that both then be loosened *together* in small steps until the resonance indication is obtained.

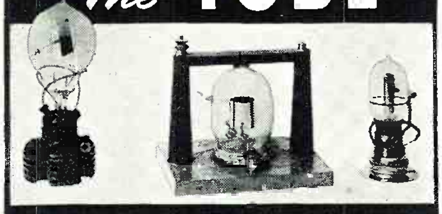
The source is now set to 25 cycles, S1 opened, S2 closed, and the adjustment procedure repeated. The entire procedure is repeated for each fundamental frequency up to the last switch frequency—150 cycles.

After all the fundamental frequencies are set, the multipliers may be checked in the following manner: With all other freqency switches open, close S1 (20 cycles), set the multiplier switch S12 to X10, and "locate" the frequency by tuning with the source oscillator. The frequency indicated by means of the oscilloscope should then be exactly ten times the fundamental frequency — or 200 cycles. If it is higher or lower, R1 must be increased or decreased in accordance (both pairs of resistors being altered by the same amount). Once the multipliers have been adjusted for any particular frequency multiple, all other frequencies will be found to be multiplied exactly. The procedure is repeated for the X100 multiplier, altering the next pair of multiplier resistors if necessary. Some operators prefer to make all calibrations on the highest range (X100), making multiplier alterations there, since any error then appearing on the lower-frequency ranges will be a small percentage of any remaining on the high-frequency range.

When changing from *any* frequency to another, one switch may be opened with one finger while the other is closed at the same instant with another finger, one operation being thus all that is necessary.

—30—

The TUBE COLLECTOR



FROM the mailbag comes a request for clarification of the requirements needed for membership in the club. He asks:

"Have noticed in late issues of Radio News articles about a Tube Collectors Club. Not until I saw the last issue, listing certain tubes wanted, did I get up enough nerve to write, as I hardly consider myself an old-timer or a collector. I started listening around 1921 with crystals, and if I remember correctly, my first tube was a UV200. As the years have rolled by, I have laid aside some of the tubes I have used or picked up with the idea that some day I might make a serious collection. I also have laid aside an RCA2, RCA5, old 5 tube AK and speaker, six volt dynamic Magnavox, some of the first call books, old copies of RN, etc., etc.

"I am most interested in the *Tube Collectors Club,* but don't think I have more than 50 to 75 tubes and you say it takes 200 to make the grade. The thing in my mind is, what do you call a type? It looks to me like you would have to make up a list to be used as a standard. . . . For instance, I always regarded UX199 and CX199 as one type. How about brass base UV201 and bakelite base? How are we to determine if any tube was made before 1933? Is every 201A made by a different manufacturer a different type or how about the 201A with an unusual bulb or how about a blue 24A by Arcturus against a plain one by RCA and so on and so on? Don't forget those spray-shield jobs, what types? If you are including rectifiers, why not include Westinghouse or Tungar types; after all they were used in A eliminators, which was part of some of the old sets. If I remember right, in the Raytheon B rectifier, there are two types of element construction. Is it still one type? Then there are certain unusual tubes like some of the deForest transmitting types with leads on both ends that do not seem to have any identifying marks. If we submit a closeup, will you tell us what we've got?

"These are just a few of the questions that come to mind at this time. . . . A standard list of old types might be included as a sort of application for membership and sent in the mail rather than be printed in RN. . . ."

We think this letter to be of sufficient interest to many readers who have asked similar questions in recent

Special AVIATION COMMUNICATIONS issue of RADIO NEWS, June, 1943

weeks to warrant opinions by other collectors who are faced with the common problem. We would like to hear from as many of them as possible. The letters will greatly influence future changes in membership requirements for participation in the *Tube Collectors Club*. Let's hear from you! Send in your opinions and suggestions.

Every radioman should follow the authentic series on "The Saga of the Vacuum Tube," appearing in RADIO NEWS. It will include complete information on the development of every early tube. The Tube Collectors will then be able to identify those specimens which do not have code numbers and other pertinent data.

A compiled listing of tubes wanted by various collectors appeared in the April issue. Space does not permit a repetition each month. This list is being devised almost daily and will appear from time-to-time in this column.

(To be continued)

For the Record

(Continued from page 4)

Little information was available on radiation in those early days. The twentieth century finds radiation of such significance that Massachusetts Institute of Technology and California Institute of Technology both call their laboratories devoted to research on ultra-high frequency equipment and nuclear physics, the cornerstones of future industry, "Radiation Laboratories."

What are the building blocks of all these new devices? The answer, in the light of what we know today, is radiation, charged particles, vacuum tubes in some form and connecting networks such as wire or hollow tubes.

Let us now evaluate the etymology and semantics of the two words "radionics" and "electronics." Radionics springs from the Latin "to radiate" and the Greek word "ienai" to wander or go. In English the word becomes "ion." The literal translation then is wandering or traveling radiation, which is to the point and descriptive. By this there is no intention to imply a change in the scientific meaning of the term "ion" as "charged particles." There is something, however, to be gained in the term "Radionics" by the second interpretation, namely, the presence of "charged particles." Chemists will feel a bond of kinship if their univalent ion whose charge is the same as the electron is recognized. Also, the noun suffix "ion" signifying act or process, state or condition, adds to the total advantages of scope in meaning from various interpretations. In coining scientific words, the suffix "on" is used to form nouns in physics to denote an ultimate particle as in "proton." It seems logical to deduce that the suffix "on" is contracted from "ion" used to indicate "charged particles." With the first syllable telling something as to behavior or character—broad applications are found in photon, neutron, proton, positron, rumbatron, magnetron and cyclotron. In view of all this, the word "radionics" now takes on greater significance. We have in it radiation, charged particles, the coverage for future developments in radio technique (an act or process using some new ultimate particle).

Radionics' three important points are as follows:

1. The literal translation is descriptive.
2. The scientific connotation has broad and accurate meanings.
3. It also implies "radio techniques" as thought of by not only the layman but scientists and engineers.

"Electronic" comes from a Greek root. Thales discovered in 546 B.C. that when amber was rubbed, it took on new properties. The Greek word for amber is "elektron." The term "electron" as used today was probably first used by C. J. Stoney in 1891. It is easy to see how he arrived at this terminology. By simply changing one letter he had a word whose first syllable indicated amber with historical value but little else, and the "on" suffix necessary to show charged particles. The literal translation then becomes "wandering amber." Is that descriptive? Our words "electricity" and "electrical," etc., all come from this same Greek root "elektron," but until Stoney's time only the first syllable was used. Therefore, it certainly follows that Stoney, conscious of charged particles wanted the "on" ending to carry its full significance.

Suppose the public wants to know the meaning of the word "electronic" and looks it up in the dictionary. What do they find? Nine chances out of ten only the word "electron" defined as "a minute particle of matter charged with the smallest quantity of negative electricity." Now can you blame the man on the street for becoming confused, or to believe that he is being kidded and end up by thinking "Oh, well, it's all radio anyway."

The term electronic has three important points as follows:

1. The literal translation is not descriptive, "wandering amber."
2. The scientific connotation at its best can stand for only this particular charged particle, justified primarily by being a fundamental charge and historical value.
3. There is no implication of "radio techniques" as thought of by the public and this causes a misunderstanding. Their question is "Why do these electrons all of a sudden become so important? They have been with us all the time; therefore, if radio is a branch of electronics, why all this delay in bringing it to light?"

We have a good American word in "radionics." "Electronic" is British in origin. Since we did not adopt the words, petrol, underground, bobby, pub, valve and wireless, but instead are using Americanisms — gasoline, subway, cop, saloon, tube and radio—there doesn't seem to be any really substantial reason for adopting "electronic" as an American all-inclusive term for radio.

Scientists and engineers who have used such care in coining contemporary terms as neutron, magnetron, iconoscope, photo, etc., when they realize the confusion that is now occurring will want to do something about it. Remember, this is the same type of confusion as that between "radio" and "wireless."

We are not in doubt. "Radionics" is descriptive of the scope of this science, and, therefore, RADIO NEWS will use "radionic" in preference to "electronic" wherever it is more descriptive.

There may be exceptions where the term "electronic" is used as a trade name or in a direct quotation from an engineering paper, etc. However, with these possible exceptions, "radionics" will be used in the future by this publication.

RECEIVERS that will see, hear and print were predicted for the post-war era by *James L. Fly,* Chairman of the F. C. C. He said that while such a device may seem to be an impossibility now, present developments appear to make the design of a combination television, facsimile and broadcast receiver entirely feasible. Said Mr. Fly, in explaining the prediction . . . "There will be only one service, and separate television. Standard, F.M., facsimile services and separate receivers will all be washed out. I would conjecture that such an instrument will be based upon the best of the developments we have had to date and those that we get out of the war, and it will be a chain operation carried on by relay. Relay problems are pretty well licked now. We have been in the horse-and-buggy days up to now."

That's quite a strong prediction, but it isn't as fantastic as it may sound!

WHICH reminds us, how are so-called radio servicemen to be classified in the days to come? What with new services and new techniques, it seems that some serious thinking should be done by those keenly interested in making their living in the radio industry from the service standpoint and that they decide now as to which phase or portion of the art will offer the greatest personal appeal.

After this decision is made it would be advisable to obtain as much knowledge of that field as possible. There will be hundreds of new radionic and other gadgets, new television receivers, etc., that must be serviced intelligently by someone. Only by carefully planned study, can the serviceman of tomorrow be recognized!

AS we go to press with this issue, we continue the interesting task of preparing our June issue which we believe will be the most outstanding presentation ever made on the activities of the various branches of Aviation Communications. Among the many specially prepared feature articles will be included factual data by the U.S. Army Air Forces, Navy, Marine Corps, Coast Guard, Civil Aeronautics Administration, and the Civil Air Patrol. In addition, there will be a complete analysis of the part that the radio Industry is playing to supply the aviation services with vital equipment. Never before in our history have we found a closer cooperation between Industry and our Military Branches.

One of the highlights of the June issue will be the appearance of an exact replica of the famous *McElroy* code chart which includes every known code, Arabic, Russian, International Morse, American Morse, Japanese, Spanish, Flag Signals, "Q" Signals, and many others. Printed in color—this chart will be well worth keeping by every reader of this important issue.

73, OR. . . . —30—

Saga of the V.T.

(*Continued from page* 29)

at moderate voltages. Howell states that he had measured vacuous currents in an ordinary carbon incandescent lamp, of more than *25 amperes,* which were sufficient to expand the platinum lead-in wires and shatter the glass.

The effects obtained are shown in Figure 14, which is reproduced from Howell's paper. He also showed that in the presence of the *"blue glow"* the Edison-effect current will flow around corners. In the discussion of this paper, Professor A. E. Kennelly said, "It is interesting to observe that a vacuum tube, in the broadest sense of the word, is capable of supplying . . . continuous currents from alternating currents."

Up to this time, it is to be noted, no one except Edison had shown any technical application of the *Edison-effect.* It is probable that Edison did so primarily for the purpose of obtaining patent protection, although Frank J. Sprague, in a letter to William J. Hammer, dated December 27, 1883,[102] praises the arrangement as an extremely sensitive indicator of small changes in voltage at the operating potential of the lamps.

With these experiments we have reached the end of the pure scientific investigation alone in this field. Inventors, making use of this knowledge, were responsible for the next step in development.

This might naturally be expected with the increase in the pace of living. Man's rapidly increasing demands could not wait for complete knowledge before insisting upon practical applications. Man stated his objective, and electrical experts proceeded to clear the path toward that objective.

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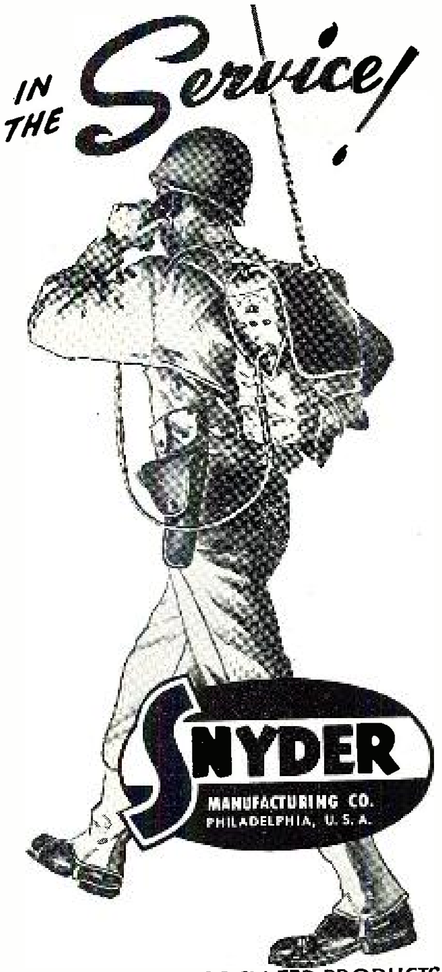
Fig. 7. Drawing of Edison effect lamp. Reproduced from U.S. Pat. No. 307031, issued October 21, 1884.



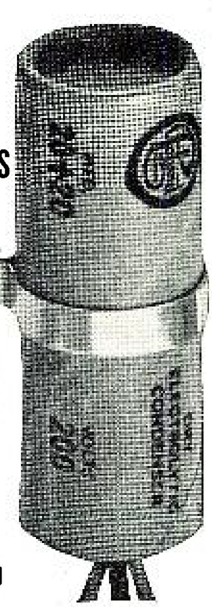


Fig. 8. Edison effect lamp used by Prof. Houston. Reproduced from Trans. A. I. E. E. 1884.

Fig. 9. Tube used by Elster and Geitel in 1887. Reproduced from Annalen der Physik, 1887.

Fig. 10. Tubes used by Elster and Geitel to demonstrate unilateral conductivity. Reproduced from Annalen der Physik, 1889.

Fig. 11. Tube used by Hittorf to demonstrate unilateral conductivity. Reproduced from Annalen der Physik, 1884.

Fig. 12. Tube used by Fleming to demonstrate bi-directional conductivity as unidirectional conductivity. Reproduced from Phil. Mag. 1896.

Fig. 13. Curve showing relation between Edison effect current and lamp voltage. Reproduced from Phil. Mag. 1896.

Fig. 14. Incandescent lamp stems which have been subjected to space currents of 25 amperes. Reproduced from Trans. A. I. E. E. 1897.

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(To be continued)

Electronic Drive

(Continued from page 12)

similar application is that of synchronizing the speed of conveyors with that of a material in a plastic state as it emerges from an extruding machine, and for maintaining a fixed relationship between two or more conveyors which must handle the same material. Numerous applications of this type may be found in the rubber industry.

Electrical Feed-back Arrangement

Where speed regulation is an essential factor, the electrical feed-back arrangement, utilizing a pilot generator with a suitable circuit, makes it possible to hold the speed of a motor very nearly constant over a wide range of loads.

As in the mechanical arrangement, a full-wave rectifier is used, but a saturable reactor instead of a movable core reactor varies the output of the voltage on the motor.

Full Automatic Control (Thy-mo-trol)

Experience with the type of equipment just described has resulted in the development of the Thy-mo-trol system by General Electric. This control in combination with a suitable motor provides a variable-speed drive with features which are not ordinarily found in other conventional drives.

This electronically controlled motor drive was not developed with the idea that it can or will supplant the various other types of mechanical and electrical drives in use today, where such drives have the characteristics and provide all the features needed. The development has been carried on rather to evolve an electronic drive providing features not inherent in conventional drives where close speed regulation, smooth acceleration, precise control of speed, and other similar features are desirable. However, it is believed that this type of drive offers both the user and builder of machinery an equipment ideally suited to his needs.

General Description of Drive

The standard drive of this type consists of an anode transformer, a control and rectifier panel, a push-button station or other control accessory, and a d.c. driving motor.

In some instances, a smoothing reactor may also be required, depending upon the size and characteristics of the motor being used.

Anode Transformer

The anode transformer is used in order to make use of motors of standard voltage. By designing a special motor, it would be possible to eliminate this item entirely in most cases, but it is felt that the use of a motor of standard design has some definite advantages to the user.

The transformer is of conventional design and may be either of the insulating or of the autotransformer type. It is generally supplied as a separate item to keep to a minimum the size, weight and cost of the rectifier cabinet in which it might otherwise be located.

Control and Rectifier Panel

Fig. 2 (right) shows a conventional type of control panel. It consists of a suitable base on which is assembled the control and power tubes, a line contactor, a thermal overload relay, a field-failure relay, a cathode-protective timer and the necessary transformers, and other material required for the electronic circuit. Suitable anode fuses are provided for protection against short circuits.

The panel is hinged in the stationary part of the enclosing cabinet and by loosening suitable screws it can be swung completely open so that the parts and wiring are readily accessible.

The control tubes and other parts associated with them are mounted on an individual sub-panel which can be removed quickly and replaced by another unit with little loss of time.

Accessory Control

The control accessory (Fig. 2—left) is a standard heavy-duty-type push-button station in which are mounted the necessary number of momentary contact units and the speed-adjusting potentiometer. Both the speed-adjusting potentiometer and the momentary control units may be supplied as separate items which the user can mount in any convenient location.

Motor

A shunt-wound d.c. motor is used. In order to make more economical use of the rectifier tubes, 230-volt machines are ordinarily supplied.

Although the motor is of conventional design, its characteristics must be such that it will operate satisfactorily from an unfiltered rectifier supply. This is particularly true when the a.c. power supply is single-phase.

Electrical Characteristics

One of the characteristics of a good drive is that it should be capable of starting its load with a minimum of shock to the machine and under conditions which will permit the motor to commutate satisfactorily. From an engineering point of view, the accelerating scheme employed in this drive is one which does approach this ideal. It is termed constant-current limit acceleration. By means of an adjustment in the panel, it is possible to vary the accelerating current and thus the accelerating torque to a value which will bring the motor up to operating speed in the quickest time consistent with the nature of the load and the commutating ability of the motor.

From the moment the start button is pressed, the motor will assume a maximum value of current as determined by the adjustment. Under these conditions the motor will pull with smooth, uniform torque until the load is up to speed; then the current will drop off to the value needed to maintain the required torque.

Preset Control

For many applications, it is desirable to preset the speed at which the motor is to operate anywhere within the operating range. This type of equipment provides this feature so that the motor will be accelerated smoothly up to the speed called for by the setting of the potentiometer. The motor is always started under full-field conditions regardless of whether the potentiometer is set for operation below base speed by armature voltage control or above base speed in the field weakening range.

Overload Protection

Protection against sustained overload is provided by means of a conventional thermal overload relay.

Stopping

Quick stopping of the motor is provided by means of conventional dynamic braking. When the STOP button is pressed, the power is disconnected and a resistor is connected across the armature.

Regeneration or Pump-back

The standard equipment does not provide for regeneration or pump-back, so that when the speed-adjusting potentiometer is quickly turned from a high setting to a lower one, the motor will coast down to the new setting at a rate which will be determined largely by the friction of the load. This means that it is not suitable for use with overhauling loads.

Another factor is that when motor speed is being reduced with field applied, the motor acts as a generator and generates an excessively high voltage. In the Thy-mo-trol system, a "voltage-snubbing" circuit automatically keeps the voltage down to a safe value.

Where quick slow-down is required, a modification can be furnished which provides a form of automatic dynamic braking to slow down the motor. Except in special instances, this feature has not been found essential. A typical application where it may be necessary is in the case of a turret lathe where the operating speeds must be stepped up or down rapidly so as to synchronize with the speed of the turret and to maintain maximum production.

Speed-range

The speed-range obtainable with equipment of this type is largely a function of the size and type of motor employed. The range, theoretically, is something from a value approaching zero up to the maximum for which the motor is designed to operate by field weakening. The practical limits are largely determined by the heating and stability of the motor. From tests which have been made it appears that the motors can be operated over a range of up to 20 to 1 below base speed by armature control on an intermittent basis without exceeding a dangerous temperature rise, and as high by field control as the motor is designed to operate. Much, however, depends upon the nature of the load to be handled, the duty cycle, etc.

Effects of A-C Voltage Variation

The system will operate successfully on line-voltage variations of as much as 10 per cent of rated voltage, but to obtain maximum tube life the variation should not exceed plus or minus 5 per cent.

For a plus or minus 5 per cent line-voltage variation, tests have indicated that when operating over a range of from 5 per cent of base speed up to 2 to 1 by field control, the speed will not vary more than plus or minus 1 per cent.

Tube Failure

One very important consideration with any electronic equipment is the question of what will happen if one or more of the tubes should fail. In this system, the circuits have been so designed that the equipment is entirely safe regardless of which tube or combination of tubes may fail. The equipment will either shut down instantly or will continue to operate, deprived of the function of the tube which fails.

All of the inductive circuits in the system which might be injured due to excessive voltage are protected by Thyrite units which keep the voltage rise down to safe limits.

Principle of Operation

The operation of the equipment can best be understood by considering individually the part which makes up the power circuit and that which constitutes the control circuit.

From the diagram shown in Fig. 3 it can be seen that a pair of tubes (Tube 1 and Tube 2) constitutes a full-wave rectifier which converts to direct current the alternating current supplied by the anode transformer. The direct current is then fed through the armature of the motor. Likewise, Tube 3 and Tube 4 make up a full-wave rectifier, which supplies direct current to the shunt field of the motor. By varying the outputs of these two rectifiers, it is possible to control the operation of the motor. Its speed can be varied from zero, by armature-voltage control, up to maximum for which the particular motor is designed to operate by field weakening.

Electronic Control Circuits

The means by which the output of the power rectifiers is varied is a group of radio-type control tubes, whose basic circuit is shown in Fig. 4. Acting as amplifiers of current and voltage signals received from the motor circuit, these tubes supply the necessary direct current to the saturating winding of the saturable-core reactor in the resistance-reactance bridge which is used to vary the output voltage of the power rectifiers by the phase-shift method previously described. By varying the current in the saturating winding, the power tubes are turned on or off as required to give the desired motor performance.

To provide for the current-limit acceleration of the motor, a current transformer, T5, is used. This has two primary windings connected in the anode circuit of the two power tubes supplying current to the motor armature. The design is such that an a.c. voltage is produced in the secondary, proportional to the current flowing through the thyratron tubes. The a.c. voltage is rectified and connected into the circuit in such a way that when it reaches a value as determined by the

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setting of a potentiometer, it will have the effect of turning off the armature tubes, thus reducing the voltage on the armature and maintaining the current at a fixed maximum value.

If the control had been set to operate the motor in the field-weakening range, the current-limit control acting through a suitable tube will maintain full field until the armature current starts to reduce. Thus, during acceleration under these conditions the motor will always accelerate from zero to base speed with full field. At this point, the field will be weakened gradually until the motor reaches the preset field weakened speed. Then the armature current will drop to the value necessary to drive the load.

The adjustment of the speed is controlled by two adjustable potentiometers—one controls armature voltage, the other controls field voltage. The potentiometers are operated from a single shaft and are arranged so that approximately half of the rotation of the adjusting knob will vary the armature voltage from approximately zero to maximum. Then the other potentiometer becomes effective, and further turning will tend to reduce the field voltage so that the motor speed can be increased to the value desired, up to the maximum for which the particular motor is designed to operate by field weakening.

To maintain accurately the preset speed, it is necessary to hold armature counter-emf constant. This can be done by increasing the armature terminal voltage by an amount equal to the IR drop of the armature circuit. In this system, this is accomplished through the use of the same current transformer that controls the current limit. The circuit functions in such a manner that as armature current increases, the thyratrons in the armature circuit are turned on, thus increasing the armature voltage. If the load increases, the circuit operates to increase the armature voltage proportionally, which thus acts to maintain the speed at its preset level. An adjustable potentiometer used in the circuit makes it possible to maintain essentially constant speed from no load to full load for any given speed setting, or to provide a drooping speed characteristic where desirable.

When the START button is pressed, the motor will be accelerated rapidly and smoothly by current limit as described above until it reaches a speed corresponding to the setting of the speed-adjusting potentiometer. The motor will then maintain this speed closely, irrespective of variations in load, within the limits of the IR-drop-compensation feature. When the STOP button is pressed, the anode contactor will be dropped out and a resistor will be connected across the armature to bring the motor to a quick stop as full field is applied.

The substitution of a magnetic-reversing switch for the anode contactor makes it possible to reverse quickly the direction of rotation by current-limit regeneration of the motor.

RADIONIC OR ELECTRONIC?
See page 4

When the motor is operating at speeds below basic, during which it has full-field voltage and reduced-armature voltage, it will provide constant torque. The horsepower output will decrease in proportion to the decrease in speed. When operating at speeds above basic, during which it has full-armature voltage and reduced field voltage, the motor will provide constant horsepower and reduced torque output. This is illustrated by Fig. 5 which shows the torque and horsepower curves for the full operating range. Fig. 5 also illustrates how the speed is increased by armature voltage as the speed adjusting potentiometer is turned from zero to midposition, and how the motor operates by field weakening from midposition to the point where the knob is turned to the extreme clockwise position.

Typical Applications

Many interesting applications of the Thy-mo-trol drive have been made—most of them to machine tools because of the present limitations in size. Among the types of machines to which drives have been successfully applied are grinders, milling machines, toolroom lathes, turret lathes, and thread mills. In addition, they have been supplied for automatic welding machines and for various special equipments for testing magnetos, airplane propeller governors, and instrument tachometers. Fig. 6 shows a standard Thy-mo-trol panel applied to a milling machine.

A particularly interesting application has been made for driving the headstock on grinders. The wide speed range obtainable and the constant torque characteristics provided at low speed make it possible to provide the right speed for every type of grind. In several instances the new control has made possible a simplification in the headstock itself through the elimination of gears and pulleys formerly required.

Another important factor in this application is that the equipment can be mounted on the grinder without fear of introducing any undesirable vibration such as might be produced with high-speed rotating apparatus. The machine can be made entirely self-contained, and it can be moved at will without worry as to the availability of a d.c. power supply.

For reversing table drives, the use of two independent speed-adjusting potentiometers makes it possible to provide full-range, independently adjustable speed for both directions of travel. A simple relay for selection between the potentiometer and a standard double-throw limit switch are all the additional material needed.

Built-in Control

The electronic control can be supplied in a form suitable for building into a machine in the same manner as conventional control equipment. An interesting application of this type is shown in Fig. 7 (cover removed) which shows a panel of this type built into a form and thread milling machine. In this instance, the electronic equipment is combined on a single panel with standard magnetic switches used for starting the coolant pumps, etc. The features provided by the Thy-mo-trol system used on the work spindles have helped to increase production materially by increasing the amount of work that can be done between grinds, lengthening the life of the cutter, and by eliminating the necessity for changing gears and sheaves to obtain the necessary range of speed.

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RADIO Engineering, broadcasting, aviation and police radio, servicing, marine and Morse telegraphy taught thoroughly. All expenses low. Catalog free. Dodge Institute, Elm St., Valparaiso, Ind.

RADIO REPAIR

EVERY Radio Store and Radio Service Man will want to display the one and only, one of its kind—Hawkins Radio Servicing Card. It builds goodwill, by telling the customer how many reasons there can be for each kind of trouble. Details free. Hawkins Specialties, 537 S. Dearborn, Chicago.

METERS and Testing equipment repaired. Center Radio, 111 Center, Clifton, N. J.

RADIO EQUIPMENT

WANTED: Oscilloscopes, Volt-ohm-milliammeters, Vacuum-tube Voltmeters—RCA, Hickok, Supreme, Precision, or equivalent makes. Hallicrafters SX28, SX25 Receivers, Super Pro's and HRO's. Also 0-1 milliammeters and 0-5, 0-10, 0-25 AC or DC ammeters, 3-inch size. Idle test units and meters are needed for the War effort. Help train thousands of radio personnel by selling your equipment now. Send equipment for liberal appraisals to Allied Radio Corporation, Dept. 1X-D-3, 833 West Jackson Boulevard, Chicago.

WANTED MISCELLANEOUS

SONG Poems wanted to be set to music. Send poem for immediate consideration. Five Star Music Masters, 420 Beacon Bldg., Boston, Mass.

Index to Advertisers

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.

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Book Review

(*Continued from page* 30)

to discuss the subject in terms the average reader can understand—without regard to previous training in physics or mathematics. These factors make the book attractive for the reader who plans to enter the communication branches of the armed forces.

It follows a unique "spiral" form of organization that takes the reader successfully over each of the basic principles. The authors take nothing for granted. For example, they do not go into the subject of electrons until they give the reader a clear-cut picture of which an electron is. Scores of easy-to-follow illustrations are employed throughout the book to help the reader grasp quickly the various phases of the subject.

The authors have drawn on their unusually broad experience in radio to make this book one of the simplest, yet complete and authoritative, available on this essential method of communication.

"AIR NAVIGATION FOR BEGINNERS," by Scott G. Lamb, B.S., M.S. Published by *The Norman W. Henley Publishing Co.*, 17 W. 45th St., New York City. 99 pp. plus index. Price $1.50.

This book has been written to provide an introduction to air navigation for many thousands of young men and women who are eager to learn something about model planes and kindred subjects concerned with aviation. It is unquestionably true that many of our younger readers will, at a later date, include aviation as part of their peacetime endeavor along with radio. While not a radio textbook, it does offer considerable help to students, particularly those about to enter the army air forces.

—30—

What's New

(*Continued from page* 36)

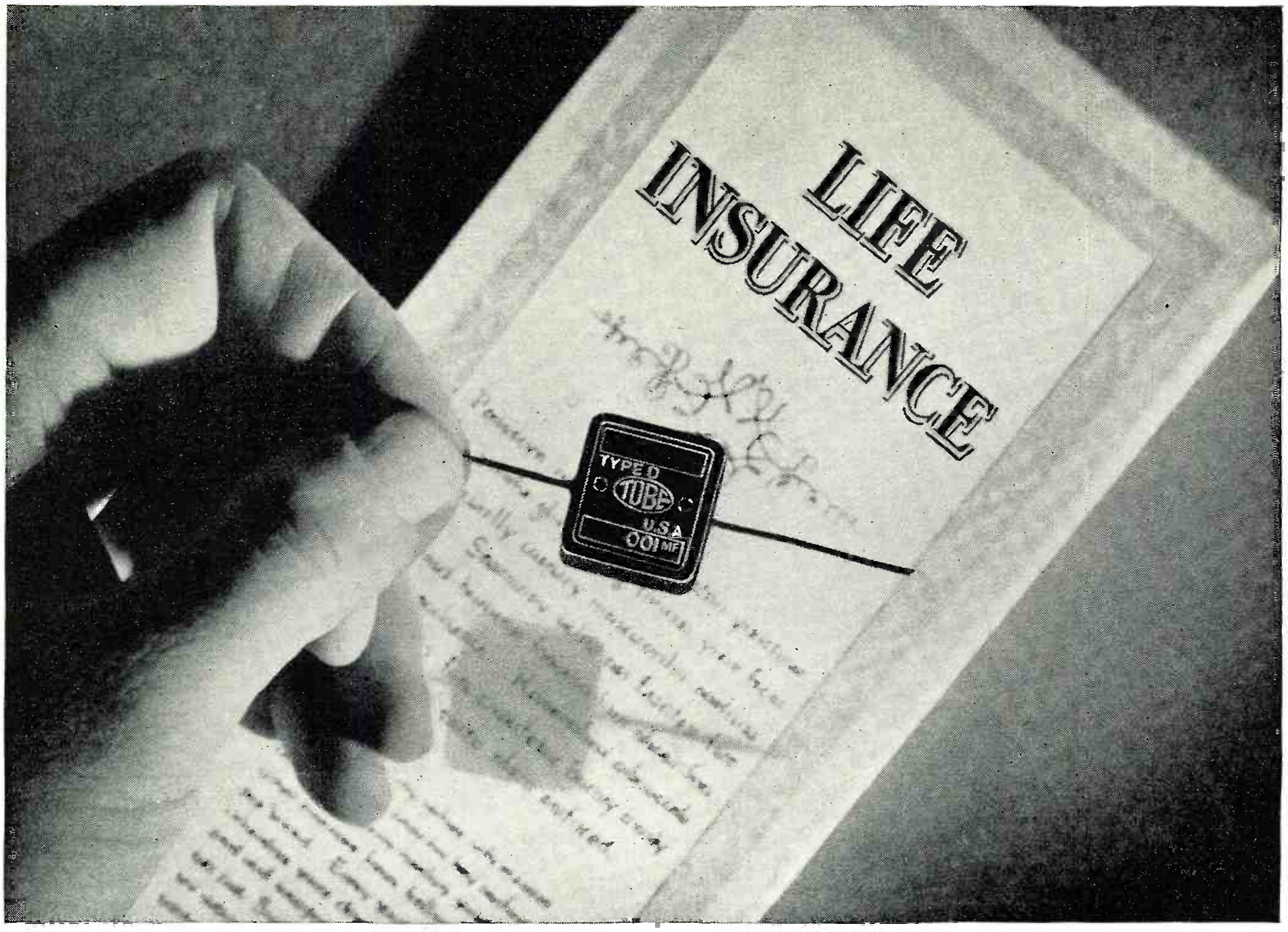
and will take repeated surges even higher. Underloads likewise are no problem.

Special emphasis is placed on the ability of these "Plug-In" type dry electrolytic condensers to operate efficiently under the most adverse temperature and climatic conditions, whether at extremely high or at normal levels.

The use of these dry electrolytics is becoming widespread. Specifying authorities are all using them in at least some of their equipment. Many who have hitherto been skeptical of electrolytics have of late necessarily relied implicitly on them with satisfactory results, both in general application and in highly specialized installations.

Address all information to the *Sprague Specialties Co.*, North Adams, Mass.

—30—



OFFERING LONG LIFE INSURANCE!

To make a capacitor with long life expectancy, every step of manufacture from winding to impregnating must be meticulously supervised—rigid inspection must be standard procedure—electrical ratings must lean far to the conservative side.

By following these principles, Tobe offers you capacitors that are, in a sense, protected by our special form of "long life insurance." The soundness of this procedure is being proved every day by the virtually complete *absence* of "returns", i.e. condensers that *didn't* live.

Type DP Molded Paper Capacitor illustrated above is the first oil-impregnated condenser to be found physically and electrically interchangeable with the majority of mica capacitors used in the by-pass and coupling circuits of radio and radar equipment. We cannot fill new orders immediately, but early requests for samples will be given priority.

SPECIFICATIONS—TYPE DP CAPACITOR

CAPACITANCE	.001 to .01 mfd.
WORKING VOLTAGE	600 volts DC—flash test 1800 volts DC
SHUNT RESISTANCE	At 185° F.— 1000 megohms or greater At 72° F.—50000 megohms or greater
WORKING TEMPERATURE RANGE	Minus 50° F. to plus 185° F.
OPERATING FREQUENCY RANGE	Upper limit 40 megacycles Q at one megacycle—25 or better
POWER FACTOR	At 1000 cycles—.005 to .006

These capacitors meet Army and Navy requirements for immersion seal.

TOBE DEUTSCHMANN CORP. · TOBE · CANTON · MASSACHUSETTS

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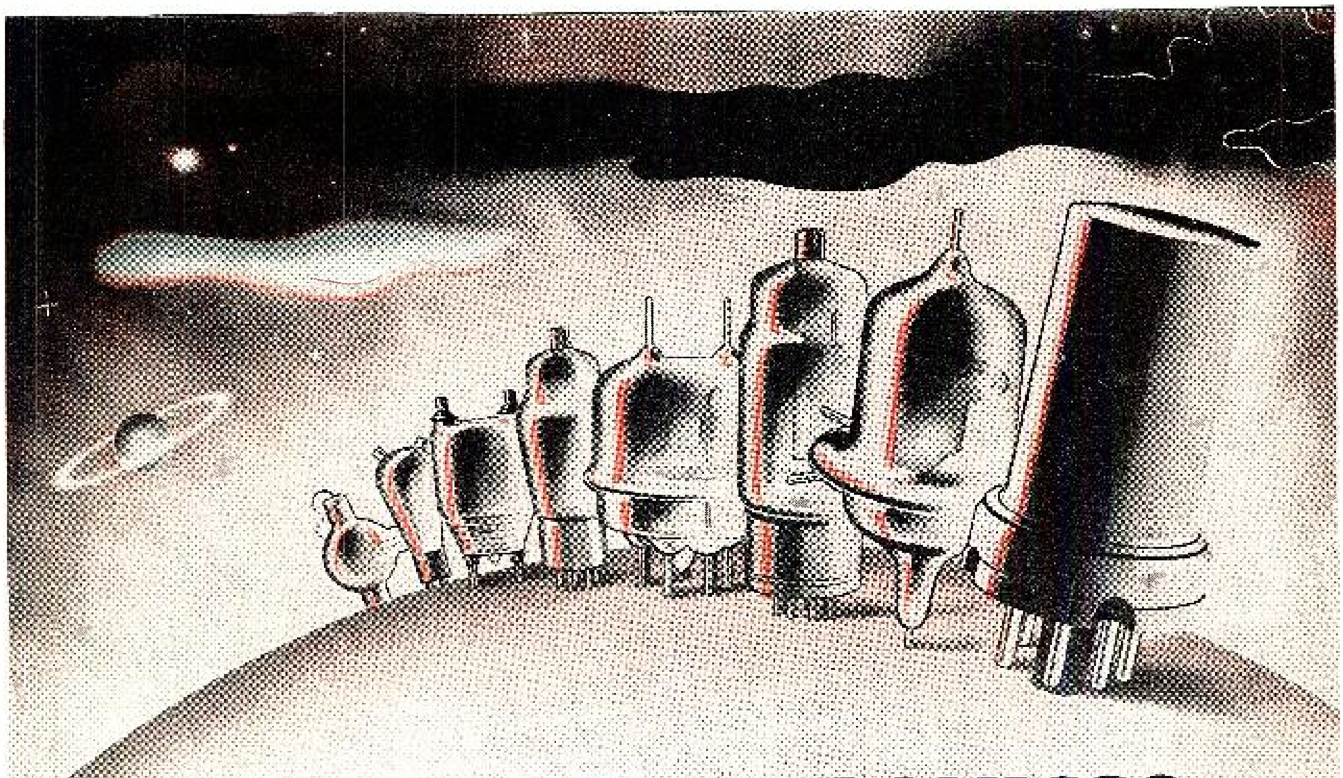
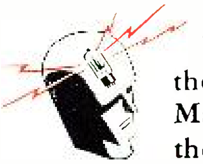


WHAT IS ELECTRONICS?

. . . and what does it mean to the radio serviceman and tube equipment distributor?



You've been hearing a lot about the "Electronics Industry" lately. Maybe you've been puzzled about the aura of mystery surrounding it. Perhaps you've even done a little wondering as to where such a development leaves you, and why.

Actually, "Electronics" is neither altogether new nor mysterious. Just as "wireless" grew into Radio with all of its ramifications in the fields of communications, and entertainment, so is Radio now expanding into "Electronics."

"Electronics," then, is simply a term for the newer applications of the basic radio-electronic circuit utilizing the well-known Radio Tube and its derivations.

Thus, in considering the latter, it is well to remember that the "Magic Brain" of any Electronic device is a tube—and that the fountain-head of modern tube development is RCA. Remember, too, that development of a new tube, or a new application for an old one, stands as a new opportunity for the men to whom *no* tube or the circuit designed for its operation is altogether new. *This means you.*

The whole history of Radio has been one of rapid growth. New developments have constantly created new business and markets—and the best of these have fallen naturally to those who have specialized in the basic principles behind them all. Certainly they should continue to do so now.

Thus, to the RCA Tube and Equipment Distributor and Serviceman, "Electronics" means that Radio again stands on the threshold of another of its beginnings—one which may prove to them to hold the greatest possibilities of all!

RCA RADIO-ELECTRONIC TUBES

RCA Victor Division, **RADIO CORPORATION OF AMERICA,** Camden, N. J.

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