RADIO NEWS

DECEMBER
1943
25c
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DECEMBER, 1943

RADIO NEWS

Reg. U. S. Pat Off.

Vol. 30, No. 6

CONTENTS

FEATURES

DEPARTMENTS

COVER PHOTO—RUDY ARNOLD

Air Forces Bombardier shown in the nose section of an American B-25 medium bomber, talking to the pilot by means of the aircraft's intercommunications system. Once the objective is neared the Bombardier will take over, and direct the plane towards the target.

Editorial Offices: 540 N. Michigan Ave., Chicago 11, Ill.
Member of the Audit Bureau of Circulations

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FOR THE *Record*

BY THE EDITOR

A RECENT INVESTIGATION showed that the larger suppliers of radio and electronic equipment for the military have fallen very short in meeting their production commitments. It seems that the larger companies, in particular, find themselves turning out only about 40% of their contracted material on schedule.

We are told that a great deal of this bottle-neck could be eliminated if the production chiefs and foremen were called in for a general meeting at the time contracts were awarded and to let them state whether or not, in their opinions, commitments made by the front office could be carried out. There have been recent cases in the East where the production departments were not aware of certain contract schedules until the complete arrangements had been made. The ability of the production chiefs to estimate production apparently has been underestimated. They have worked hard to keep an endless flow of material coming off their assembly lines. They are perfectly aware of the capabilities of their employees. They know exactly how much material can be produced and can estimate very accurately whether or not they are capable of increasing the manufacture of the various items required.

It seems that the answer to this problem is to have complete understanding between the front office and the production chiefs.

THOUSANDS OF PIECES OF RADIO COMMUNICATIONS EQUIPMENT will be left on foreign shores at the end of the present war. It seems that now is the time to lay proper groundwork so that none of this equipment is returned to the United States proper for the consumption of American purchasers. With countries like China, Brazil, Russia and many others in need of improved communications, it seems to us that here would be a golden opportunity to dispose of such equipment by sending it to those countries where it could be used to

(*Continued on page* 106)


DOING A BIG JOB IN RADIONICS
Like the men in the infantry, ARHCO electronic components aren't showpieces. There isn't much glamour in a plug or a jack—nevertheless, they're doing a mighty big job in helping communications equipment stand up under the gruelling conditions of warfare.
ARHCO produces thousands of such parts . . . has been doing so for more than twenty years. Noted for their dependability, rated high in the field, our components travel with the Armed Forces and civilian services throughout the world. After the war, they'll play an equally important role not only in radionics, but also in diversified industrial applications. Inquiries are invited.
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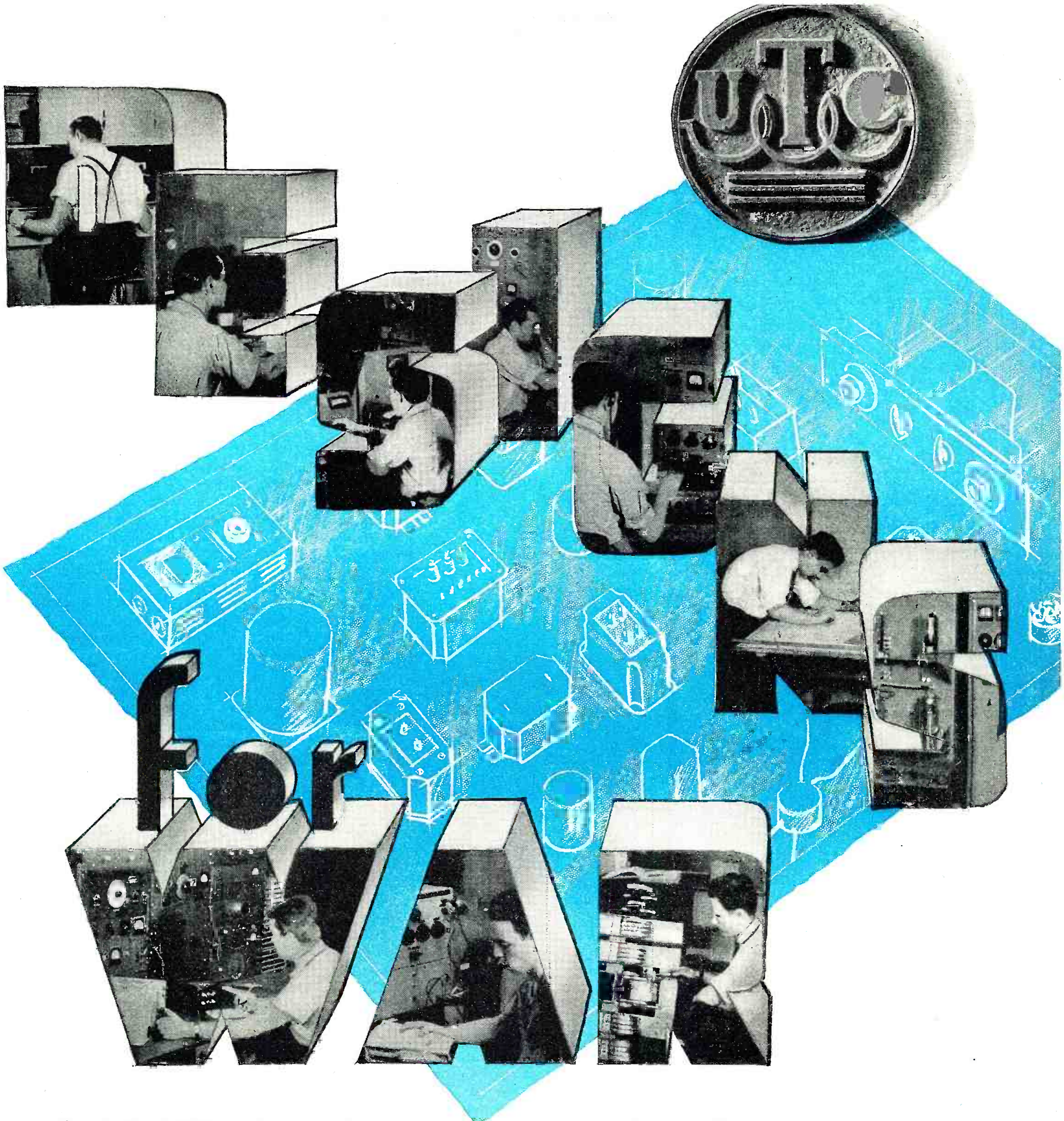

The bulk of UTC production today is on special units designed to specific customers' requirements. Over 5,000 new war designs were developed this past year. These designs ran from open type units to hermetically sealed items capable of many cycles of high and low temperature and extreme submersion tests. They included units from 1/3 ounce in weight to 10,000 lbs. in weight and from infinitesimal voltages to 250,000 volts. It is impossible to describe all these thousands of special designs as they become available. Our staff of application engineers will be more than pleased to discuss your problem as related to special components.

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Spot Radio News

IN DEFENSE AND INDUSTRY

by **LEWIS WINNER**
RADIO NEWS Washington Correspondent

Presenting latest information on the Radio Industry.

THAT FCC INVESTIGATION WHICH SETTLED DOWN to a bit of nestling during the first weeks of House assembly, suddenly awoke, and with a fury. In a series of events that had everyone breathless, Representative E. E. Cox resigned as chairman of the Select Committee conducting the investigation, Rep. Clarence D. Lea was appointed chairman of the committee and Senator Burton K. Wheeler, chairman of the Senate Interstate Commerce Committee introduced a resolution calling for a study of radio and wire communications on an international basis. The resolution was proposed on behalf of Senator Wheeler and Senators White and McFarland. Hearings on the White-Wheeler bill (S. 814) which would revamp the Communications Act, have also begun.

In resigning, Rep. Cox made an impassioned speech, declaring that the chairmanship had compelled him to maintain a judicial attitude "which can no longer be done in the face of insults and slander being hurled at me from day to day" . . . "As long as I am connected with the investigation," he said, "it is obvious that the effort will be made to divert public attention from the real issue, alleged maladministration of the affairs of the Federal Communications Commission, to a personal controversy."

Rep. Lea who was appointed chairman by Speaker Sam Rayburn has been chairman of the Interstate and Foreign Commerce Committee since the 75th Congress (1937). Last year he presided over hearings on the Sanders bill, covering revamping of the Communications Act. Thus, he has had a background of experience which should serve him well in his new post. Radio legislation, incidentally, originates in the House Committee guided by Rep. Lea.

Radio activity appears to be destined to undergo some interesting legislative changes, before the year is out!

THE USE OF TELEVISION to flash photos of missing persons has been revived, and in an effective and useful manner by the police of New York City. Employing the facilities of the DuMont television station W2XWV, the police have been transmitting photographs of from six to eight missing persons every Sunday night. The televised photographs are viewed in eighty-five police precinct stations on television sets previously provided for civilian defense purposes. In addition, there are some 4500 television receivers within a fifty-mile radius of the station that pick up the photos.

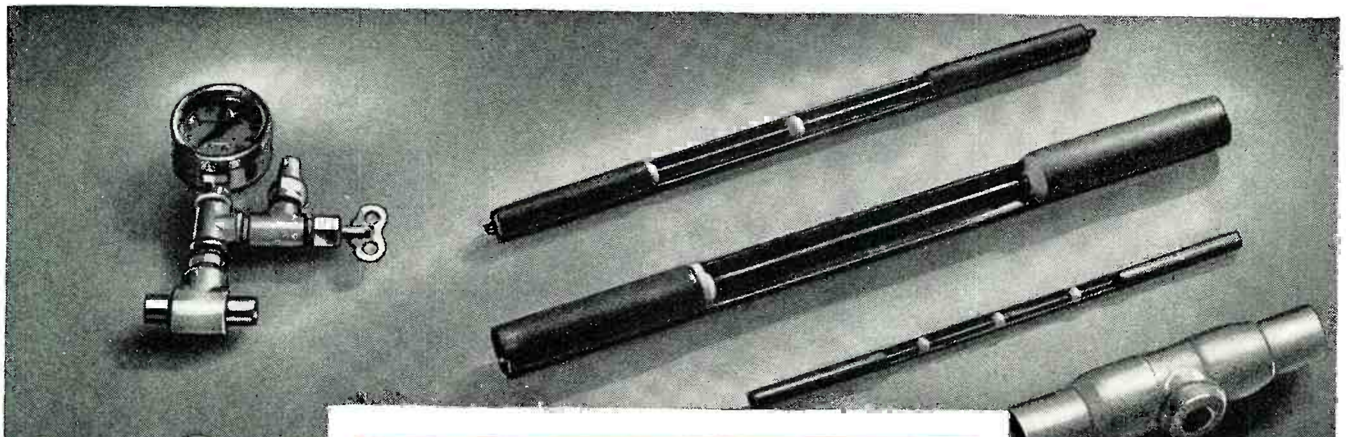
During the initial broadcast, the personal appeal was employed with the appearance of a mother whose son had disappeared. After she pleaded for his return, his photo was transmitted and a complete description was broadcast.

The use of television facilities in such vital applications as these *missing person* broadcasts, demonstrates the unusual possibilities of this art.

Wounded service men in Army and Navy hospitals are also reaping the benefits of television. For during the latter part of October, NBC began televising the rodeo for the benefit of the wounded boys in the hospitals on Staten Island, Queens, Brooklyn and Harriman, all in the New York area. The telecasts were arranged in cooperation with the Army and Navy medical authorities. Receivers were loaned to the hospitals by NBC officials. So that the boys in hospitals in Philadelphia and Schenectady, New York areas can *look-in,* the programs are being rebroadcast. Upon the conclusion of the rodeo transmissions, track meets, basketball, hockey games and other sports events will be telecast.

Television is very much alive in Europe, not only in wartime applications, but in postwar planning programs. Speaking in Glasgow before the Radio Industries Club of Scotland, Edward E. Rosen, chairman of Ultra Electric, pointed out that television offers untold possibilities. He said that with proper application of manpower and materials, television could be completely national, ready to serve nine million homes. In 1939, he said, just before war began, television started to loom on the horizon and mass production had begun. We can regain that lead when peace comes, he concluded.

Even the correspondence schools of England are busy calling for students of television. One particular school ran substantial advertising in a trade



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JOHNSON coaxial transmission line is widely used for efficiently transferring electrical energy from transmitter to antenna or for interconnecting transmitter stages. Both inner and outer conducters are of copper insulated from each other with Alsimag number 196 beads.

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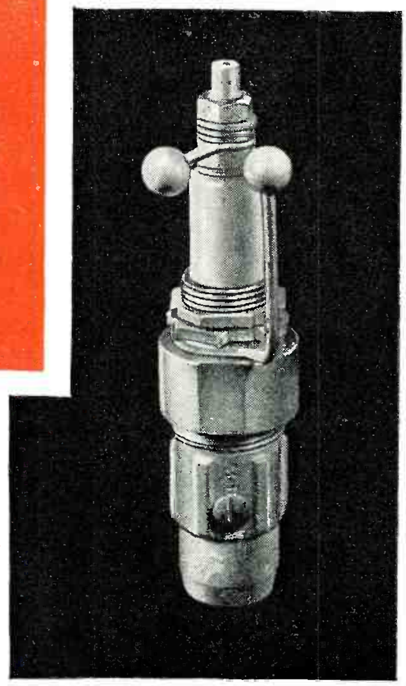

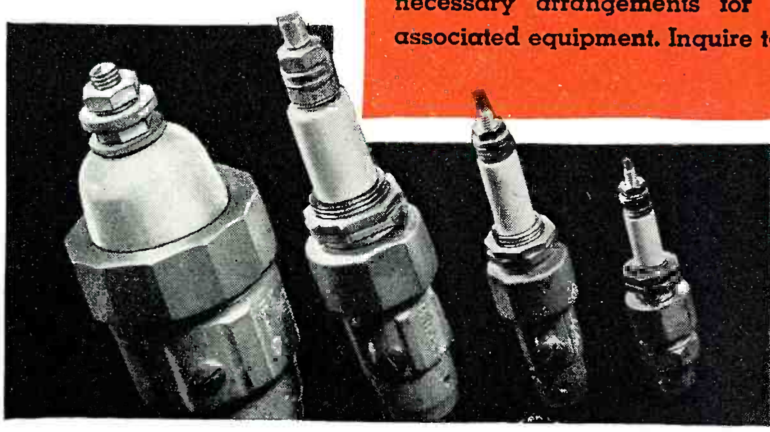

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JOHNSON
a famous name in Radio

E. F. JOHNSON COMPANY • WASECA • MINNESOTA journal referring to the opportunities of television after the war for the *trained man.*

In Hollywood, at the recent Society of Motion Pictures Conference, the subject of television was a major topic of discussion. Officials of motion pictures companies, who have taken a vigorous interest, stated that special technical and studio departments are already being set up to plan and produce television programs.

We seem to be scheduled to have television on a practical plane in the postwar era.

FILM-RECORDED PROGRAMS of symphonies and musical productions for broadcast applications may become a practice of sponsors and stations soon. By recording a program on a film in a manner similar to that used by the motion picture studios, wherein only choice orchestral, speech and voice renditions are retained, a perfect "take" can be secured, according to motion picture sound engineers who are studying the project. Prints of the film delivered to stations would be used. Line troubles, amplifier eccentricities and orchestral and artist rendition problems that frequently prevail the night of broadcast would all be avoided by the "perfect-take film" method. The cost of film for a one-hour show say the sound specialists is about ten dollars. In addition, the films can be processed over night, with the necessary corrections.

Playback equipment would be of special design, but not necessarily as large as a motion picture installation, for optical transfer apparatus is only needed.

Motion picture engineers believe that film technique will become a vital factor in recording, particularly in the postwar period.

ON COLUMBUS DAY approval of the sale of the Blue network was formally granted by the FCC. Thus, for the first time, the Nation has four individually controlled national networks. To accelerate approval of this sale, the FCC decreed that regulation 3.107 prohibiting multiple ownership of networks serving substantially the same area, becomes effective six months from now. This regulation, adopted May 2, 1941, had been suspended indefinitely to make possible the orderly sale of the network without a deadline, which would have depressed the network valuation.

In granting permission for the sale, FCC said that the transfer . . . "will mean a much fuller measure of competition between the networks for stations and between stations for networks than has hitherto been possible. In addition the transfer should aid in the fuller use of the radio as a mechanism of free speech. The mechanism of free speech can operate only when the controls of public access to the means of dissemination of news and issues are in as many responsible ownerships as possible and each exercises its own independent judgment."

During formal transfer ceremonies at Radio City in New York, Edward J. Noble presented a check for $7,000,000 to David Sarnoff, president of RCA. The total purchase price was $8,000,000. In return, Mr. Noble received a certificate for 1000 shares, the entire stock of the Blue Network Company. Mark Woods continues as president of the Blue, and Edgar Kobak continues as executive vice president. The new operating company will be known as the American Broadcasting System of which Mr. Noble is president and sole owner. The Blue title will be retained. Mr. Noble is chairman of the board of the Blue.

Thus for the first time in radio history an entire network has been sold and delivered. Oddly enough the Blue system will have a new transmitter installation soon for their key station WJZ. As announced in this column several months ago, WJZ is being moved to Lodi, New Jersey from Bound Brook. Ground breaking ceremonies recently took place. Shortly after the first of the year, the new installation should be on the air. An interesting fact about this change in locations is that during the move WJZ remains on the air, with no loss of time. An auxiliary transmitter is being used now.

MICE AND FLIES HAD A FIELD day recently at two broadcast stations. At WWVA in Wheeling, Virginia, a field mouse who was chilly decided to nestle in the warmth of a plate coil of the transmitter, where some 1400 volts flow. The result . . . the mouse found himself lying across the coil, and the station found itself off the air. A half-dozen mousetraps and some cheese, supplied by chief engineer Ed Kem ended that problem. At WNBC, Hartford, it was a fly that kept the station off the air. This fellow decided to pay a visit to the plates of a variable condenser where some 8000 volts are involved. The result . . . a short circuit that kept WNBC off the air for 19 seconds. The discovery was made by transmitter supervisor Harry Wrasko.

SO KEEN HAS BEEN THE INTEREST in freedom of speech by radio because of . . . the recent resignation of Cecil Brown from CBS, prompted by a dispute with station officials as to what constitutes news analysis, the FCC inquiry into the policies of Edward J. Noble when he begins operation of the Blue network, and other flares between stations and commentators, that Congress has taken a decided interest. A joint resolution (H.J.Res.—) proposing a constitutional amendment prohibiting "abridging the freedom of speech by radio or wire communication," was introduced by Rep. Martin J. Kennedy of New York. This proposal would

become an amendment if it was passed by two-thirds vote of both houses of Congress and by 36 of the 48 State Legislatures. Such passage would make it the 22d amendment to the Constitution.

Says the resolution. . . . "Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Constitution of the United States is hereby amended by adding the following article: Amendment 22—Section 1.—Congress shall make no law abridging the freedom of speech by radio or wire communication. Section 2.—The provisions of any law, license or contract in violation of Section 1 hereof are hereby declared inoperative."

Looks as if Congress means business!

RADIO RECEIVED ITS MEDAL OF HONOR during the recent two-day military analysis conference in Washington. Military leaders praised the outstanding work of radio in all theaters of warfare. Discussing *Supply By Air,* Colonel Emmet O'Donnell, Air Corps, Advisory Council, Headquarters Army Air Forces, pointed out that the secret of our fighter success in the Assam fields in India lay in an air-warning reporting system in which radio played a major role.

"Jap raids from their Burmese bases were made so costly in view of this installation, that the raids are practically non-existent now," said Colonel O'Donnell.

In describing the warning system, he said that it had been necessary to rely on a visual system of air warning. A number of air-warning teams, equipped with radio, were subsequently set up. Upon observing the approach of the Japs, radio notification permitted our fighters to get off in time for interception. These warning teams, each composed of ten men, are supplied by air, as it requires two or three weeks with the aid of porters to reach some of them. It is obvious, therefore, how helpful radio was in this instance.

The extent of radio equipment used in warfare today was shown in a symposium on production. Appearing in behalf of the Signal Corps, Brigadier General John R. Gardner, Assistant Chief, Procurement and Distribution Service, Office of the Chief Signal Officer, said that since September 1941, the Signal Corps has ordered $7,000,000,000 of radio, telephone, wire and other communications equipment.

"In 1943, deliveries of Signal equipment must total $3,250,000,000, or about two and one-half times the 1942 production," he said. "And in 1944, we must produce $4,500,000,000 of material or one-third more than in 1943. From now on," he emphasized, "monthly production must exceed 12 times that of the entire prewar radio industry. In 1944," explained General Gardner, "the volume of all Air Forces Signal equipment will be approximately two-thirds greater than in 1943. The next year and a quarter," said the General, "will be strenuous for ourselves and our 5,000 contractors."

A report that bristled with startling information on our radio activities was delivered by Major General Leroy Lutes, Director of Operations, Headquarters Army Service Forces. In his report, titled *Logistics,* General Lutes said that any large scale amphibious operations depend heavily upon communications.

"Our signal supply men were simply blitzed this past spring with requisitions from General Eisenhower for the attack on Sicily," he explained. "For other reasons," continued the General, "this flood of requisitions, was beyond all previous estimates, even for an over-water operation. For," said he, "as the Tunisian campaign developed, our troops had to carry the communications system in Africa farther to the East than originally planned. In addition, the very excellence of the United States equipment had brought urgent requisitions on General Eisenhower from our British and French allies for radios, mine detectors, and so on. Consequently," said the General, "when General Eisenhower began requisitioning more signal supplies in April and May, the quantities needed were beyond what the Army Supply Program had estimated. We furnished radio sets just prior to the Sicilian attack," he said. And we postponed the fulfillment of some demands for training requirements in this country, although we did not pull back any sets already in the hands of troops," he explained. It was necessary to round up a number of the 17,000 pound, truck-and-trailer-mounted radios, which is the basic equipment for infantry and motorized divisions," said the General.

The General also pointed out that the same kind of expediting of equipment was necessary to ship a quantity of the little 5½-pound handy-talkies and several hundred larger sets, 100 of which were lent to the Navy for the combined operations.

In commenting on the reports presented before the conference, Neville Miller, president of the National Association of Broadcasters, said that although the radio industry does not build munitions and weapons, it does deal with a vital ingredient in total warfare.

"I am sure," he said, "that radio stations will redouble their efforts to inform and stimulate this nation until the last shot is fired and the last wounded American boy comes painfully, but safely home."

THE HALLICRAFTERS COMPANY, announces receipt of the second white star for their Army-Navy "E" flag, which is equivalent to winning the production award for the

third time. The Hallicrafters received the award for increased production of the high-powered mobile radio stations for the Signal Corps, widely used in African, Alaskan, Italian and South Pacific theaters of war.

In awarding the second white star, Robert P. Patterson, Under Secretary of War, said:

Pearl Buss, of Hallicrafters Company, placing white star on their Army-Navy "E" Pennant.

"I am pleased to inform you that you have won for the third time the Army-Navy Production Award for high achievement in the production of radio war materials. In maintaining the fine record which first brought you distinction, you have set an inspiring example for your fellow Americans on the production front. This second renewal adds a second White Star to your Army-Navy Production Award flag, and stands as a symbol of your great and continuing contribution to the cause of freedom."

ALTHOUGH THE TREND IN STATION OPERATION has customarily been to request increased power, war problems have prompted reverse action. For instance, a station in the state of Washington found itself with insufficient manpower. Thus, they requested a reduction of power from 1,000 to 250 watts. The FCC, aware of the difficulties, thus granted authorization for this reduction in power. There are many other stations in remote sections of the country that are also planning a similar reduction in power, although the FCC frowns on such a general move. The FCC feels that the small areas must be served, even more than the larger sections where any one of several stations could serve because of their vast prime coverage characteristics. Only when the manpower and material condition is truly severe will power reduction be granted, according to the FCC authorities.

THERE HAVE BEEN MANY AMENDMENTS to the Communications Act of 1934. Accordingly, the FCC has recently published a revised copy of the Communications Act with all amendments and an index. The revisions include orders adopted up to March 6th. Copies of this revised edition are available from the Superintendent of Documents, Government Printing Office, Washington, D. C. The price for the publication is 15 cents. All those concerned with the operations of this Act should certainly have a copy of this revised edition.

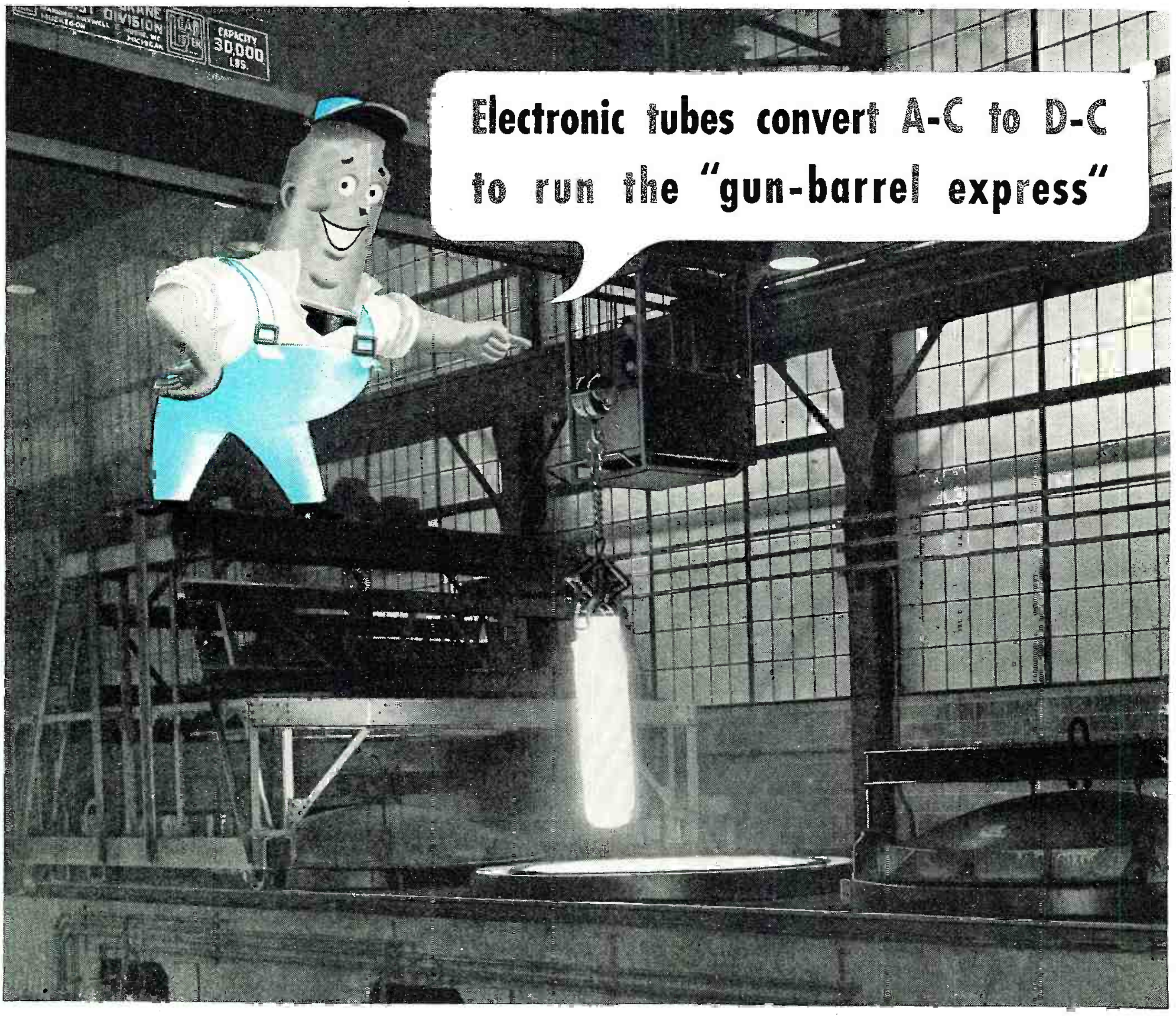
RADIO PLAYED A MIGHTY IMPORTANT ROLE in the construction of the telegraph and telephone system along the length of the Alaska Military Highway. This communication system, which is the second longest in the world and extends over more than 2,000 miles, has taken nearly a year to build. In ordinary times such construction would involve a decade of operations. To expedite construction, radio stations were installed at strategic points. These stations served as emergency communications for highway and telephone line construction crews. The stations also provided a link between the Army Corps of Engineers, which built the highway, and the Signal Corps command in the United States. Many of these stations were installed in special huts, known as Nissen huts, for protection from sub-zero weather. During actual operation of the communication system, four emergency portable radio stations will be installed as emergency standbys. These will be used should the telephone system fail due to heavy snow storms or other quirks of the elements.

The link between the United States and Alaska, which is just about being completed now, is truly a miracle of construction. The civilian and military personnel, who were engaged in this dangerous mission, should be applauded loudly for their outstanding achievement.

MEMBERSHIP ACCEPTANCE IN THE BRITISH INSTITUTION of Radio Engineers involves not only approval of a governing board, but passing of a comprehensive examination. That the examination is of a most thorough nature is quite evident from a study of the examiners' report, a report that reveals that too many of the candidates forgot some of their fundamentals. For instance, in the radio technology portion of the examination, the average percentage of marks was 56.4, which the examiners called fairly good. In the radio engineering section of the examination, the examiners said that the candidates revealed a weak knowledge of the general aspects of radio work. Some concentration on the design side, involving ability to employ mathematical aids in solving the problems involved are necessary, they explained. Comments of the examiners on the radio transmission, reception, measurements and television sections of the test, were quite caustic. Discussing the radio transmission portion, the examiners said that in general the results of these papers were poor. Too many candidates did not prepare seriously enough for the reception section, said the examiners. No can-

(*Continued on page* 98)

No. 7 OF A SERIES EXPLAINING THE USES OF ELECTRONIC TUBES IN INDUSTRY



The General Electric sealed ignitron is used instead of rotating machinery

THIS traveling crane, 100 feet long, is suspended from the sides of a war plant turning out gun-barrels for destroyers. Its power supply offers an excellent example of electronic tube application.

Direct current is essential for precision crane operation. Here, rectifiers using the G-E steel-jacketed ignitron (available in ratings from 20 amp to 200 amp) provide D-C at about the same installed cost as rotating machinery, but at lower operating costs.

This electronic tube has no moving parts. It requires no special foundation. It is quiet in operation. Overall efficiency is high, and practically constant over the entire load range.

The steel-jacketed ignitron is only one of a complete line of G-E electronic tubes now working for industry in a thousand different jobs.

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

FREE BOOKLET ON ELECTRONIC TUBES

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

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

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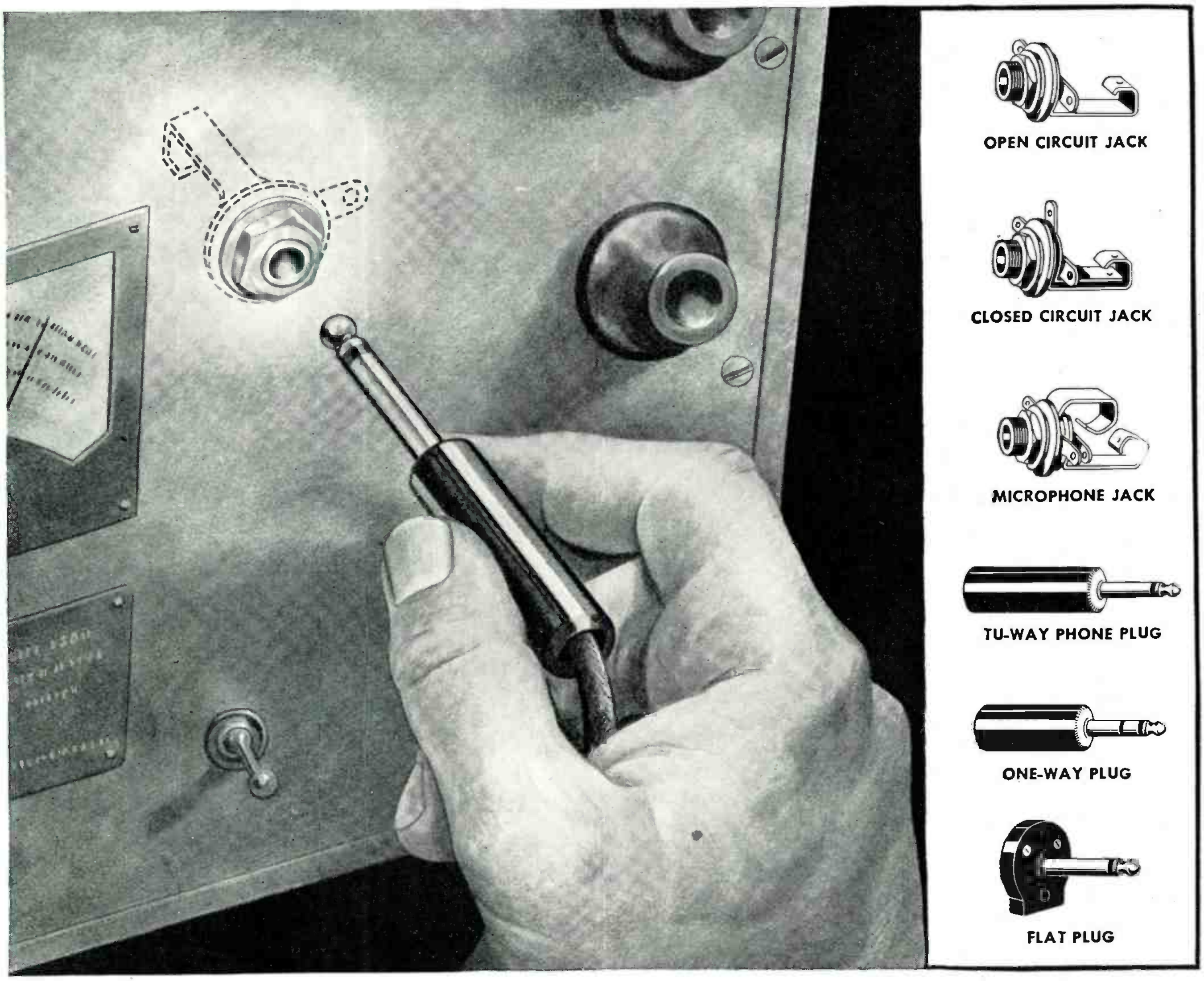

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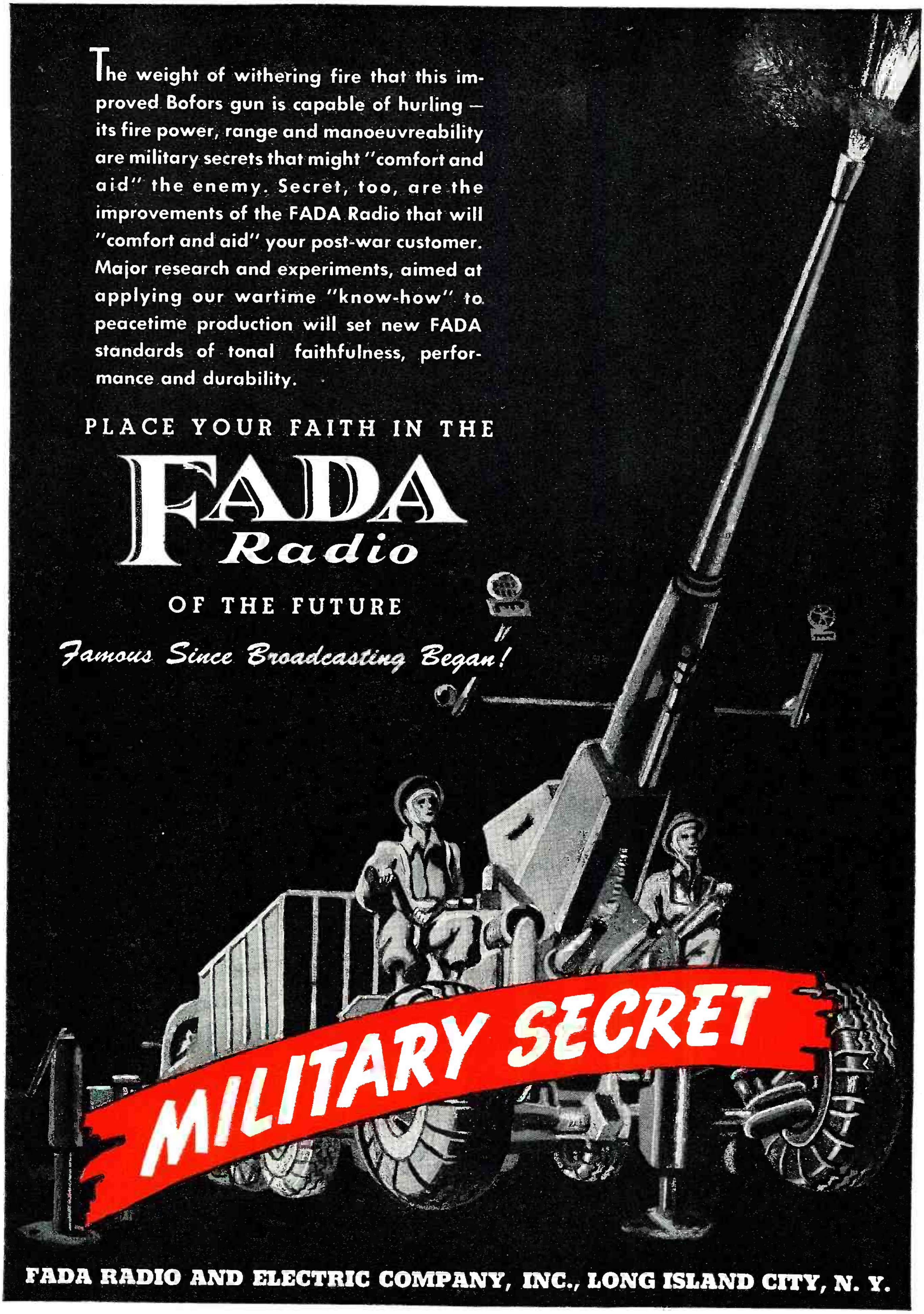
The weight of withering fire that this improved Bofors gun is capable of hurling — its fire power, range and manoeuvreability are military secrets that might "comfort and aid" the enemy. Secret, too, are the improvements of the FADA Radio that will "comfort and aid" your post-war customer. Major research and experiments, aimed at applying our wartime "know-how" to peacetime production will set new FADA standards of tonal faithfulness, performance and durability.
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OF THE FUTURE
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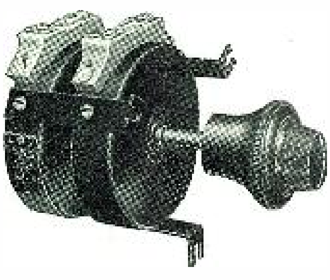
in four inches!



Concentric arrangement for back of board mounting

The new Ward Leonard 4-inch Pressed Steel Rheostat offers the happy combination of a small sturdy power rheostat with a large number of steps and ample current carrying capacity. Like all Ward Leonard Pressed Steel Rheostats this model may be arranged for front of board, rear of board and multiple assembly mounting. Other types and sizes also available. Send for descriptive bulletins.

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CHINA

ELECTRONICS—POSTWAR INDUSTRY

Cathode bombardment—being studied during an investigation of fluorescent minerals.

By

A. C. MONTIETH

Westinghouse Electric & Mfg. Co.

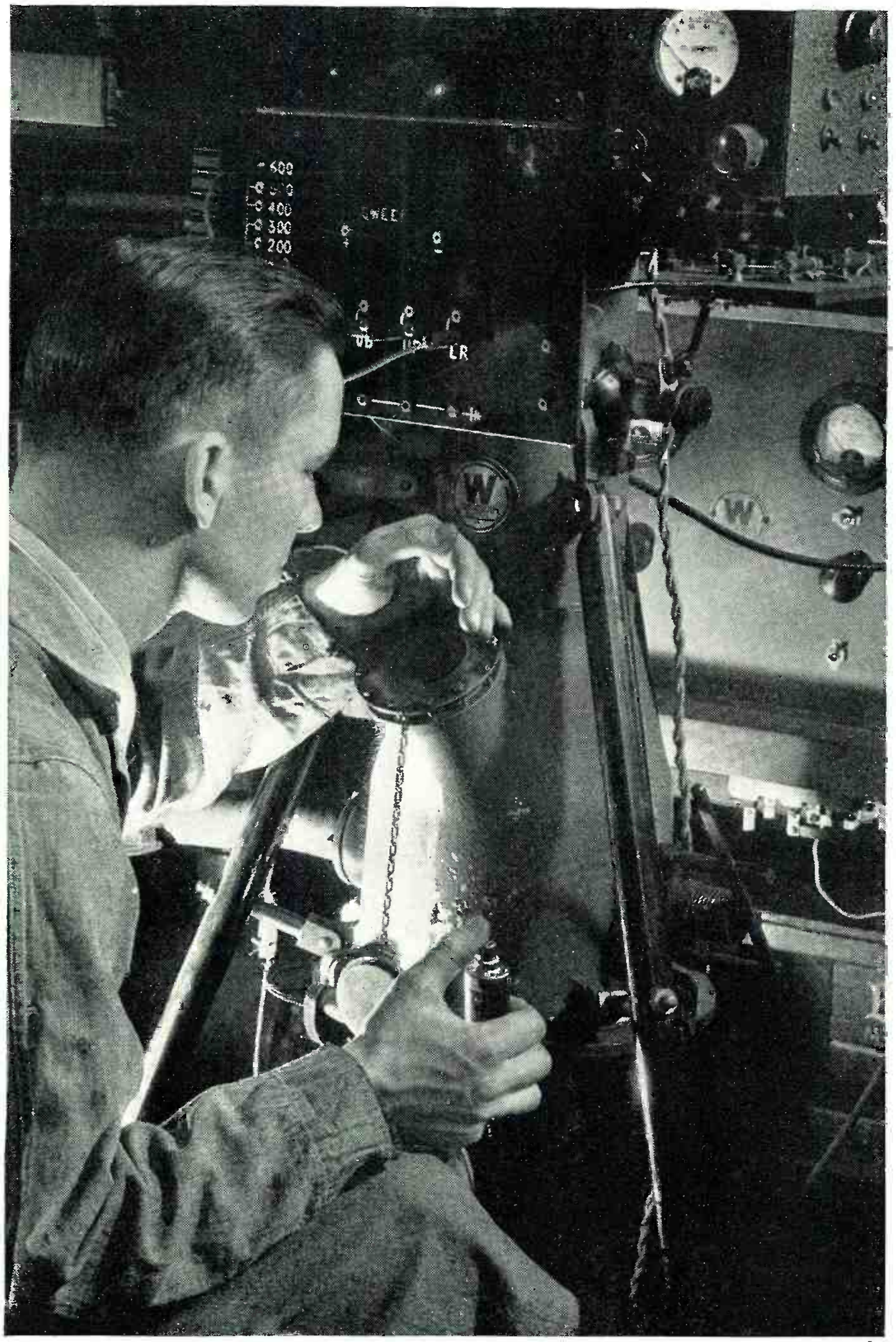
A review of many recent electronic developments and their application to postwar industries.

PROPERLY applied, electronics can be one of the biggest postwar possibilities in industry.

But as with all such scientific developments, the "pay-off" from potential markets follows in the footsteps of expert engineering application of the new technique. So, despite the lure of fascinating gadgetry, only uses that pay-their-own-way will live long enough to show a profit. The strength and earning power of electronics in industry will be in performing a useful task that is impossible without it, or doing a job better or cheaper than other methods will do it. With these thoughts in mind and an eye to the future, it is interesting to see what industry is already doing with electronics, what lies ahead, and what effect may be expected on the businesses of the world. How electronics has helped some of the metal industries is a timely and significant story.

The production of aluminum and magnesium of which we have heard so much, requires every bit as much as the ore from the earth, large quantities of electric current. This power must be in the form of direct current and not as alternating current, in which form it is now almost usually initially manufactured. To effect the change from alternating current to direct current requires some rectifying device. This can be and indeed was until only a few years ago, rotating machines, called motor-generator sets, which do not come under the heading of electronics. Or it can be done by mercury-arc rectifiers, without moving parts and in which the rectification takes place by electronic means.

At the beginning of 1940, all industries such as electro-chemical, trans-



Research engineer studying the path of an artificial lightning stroke through lightning arresters under investigation. The lightning generator develops 60-kilovolt surges which are measured by the cathode-ray oscillograph into which the research engineer is peering.

portation, central station, steels, etc., had 500,000 kw. rectifiers in operation or on order covering a period of 15 years. In three years' time, five times this or 2,500,000 kw. of rectifiers have been purchased in this country and two times or 1,000,000 kw. have been purchased in Canada. All of this equipment will be in operation within the next two or three months.

Most of this new electronic-rectifier equipment is of the Ignitron type. In this type of rectifier the losses are approximately half of the former types with an outstanding improvement in reliability which is the principal reason for its use in such large numbers instead of the motor-generator or non-electric rectifier. The use of the Ignitron in the aluminum and magnesium programs saved the installation of a 60,000 kw. station worth 80-100 dollars per kw. because of improved efficiency or lower losses.

There has been a total of approximately $120,000,000 worth of business done in this field in the last five years.

Looking to the future in this type of business we can see that the trend is going to swing from electro-chemical industries to general industrial customers. Also, where rectifiers for 60,000-ampere aluminum and magnesium producing units have been sold, future business will be in smaller units of a thousand amperes or so, or smaller rectifiers for a wide variety of industries. Ignitron rectifier equipment is now available for the complete range of d-c power requirements of all applications from 45 kw. up to the large electro-chemical type of installations with over 200,000 kw. installed in one plant. The standard equipment is designed for the practical range of factory voltages ranging from 125 to 900 volts. The idea of factory-built and assembled apparatus has been extended to this type of equipment, units being available requiring practically no installation work. In the Ignitron rectifier we have electronics at work on a big scale.

Some industrial companies that require large quantities of direct current have been hesitant to apply rectifiers, preferring to continue the installation of motor-generator sets. We see very definite evidence that this hesitancy is fast disappearing. 14,000 kw. of Ignitron-type rectifiers are being installed at the present time in a western steel plant to supply power for driving auxiliary machines in the steel mill. Also, an Ignitron rectifier is supplying the power to the main-roll motors in another western steel mill.

The general idea of using rectifiers has been extended to applications where frequency conversion from the more common 60 cycle power to the less common 25 cycle power is necessary in industry. The principles developed from this type of application will be very useful in making an engineering decision on how best to handle some of the problems in the much discussed direct-current transmission of electric power. Studies indicate that long-distance transmission of power from large hydro-electric developments offers opportunity for direct-current transmission. Its future progress is still dependent upon the development of economical and practical tubes for converting the more general alternating current to direct current for transmission from the hydro-electric site over the line to the receiving end where it is reconverted to alternating current.

Developments for other war needs are contributing to electronic tube improvements that will, no doubt, be applicable for this purpose but in the final analysis the decision regarding the use of direct-current transmission must be based largely on economic considerations. High-voltage cable circuits may be the first to utilize direct-current transmission. There is still, therefore, development work before a large installation of direct-current transmission can be made but the electrical manufacturers are now working on equipments that are solving some of the problems involved.

Another market for this type of equipment that was just beginning to develop prior to the war is the use of rectifiers in metropolitan areas where the old Edison or direct-current system of power distribution in big cities, such as New York, is being replaced by the low-voltage alternating-current network system. The rectifier equipment will be used in this field where there is so much expensive equipment in an office building that it is economical for the power company to supply a limited amount of direct current for this equipment. The rectifier is ideally suited for this application because it can be made push button operated, makes almost no noise, and has no moving parts.

Good acceptance for the rectifying equipment in mining service has been seen and its use will be more extensive in this industry.

Broadly speaking, the rectifier is going to be a real competitor of rotating conversion devices wherever direct current is needed in industry. The rectifier is now a very reliable device and has the advantage of no rotating parts which minimizes maintenance.

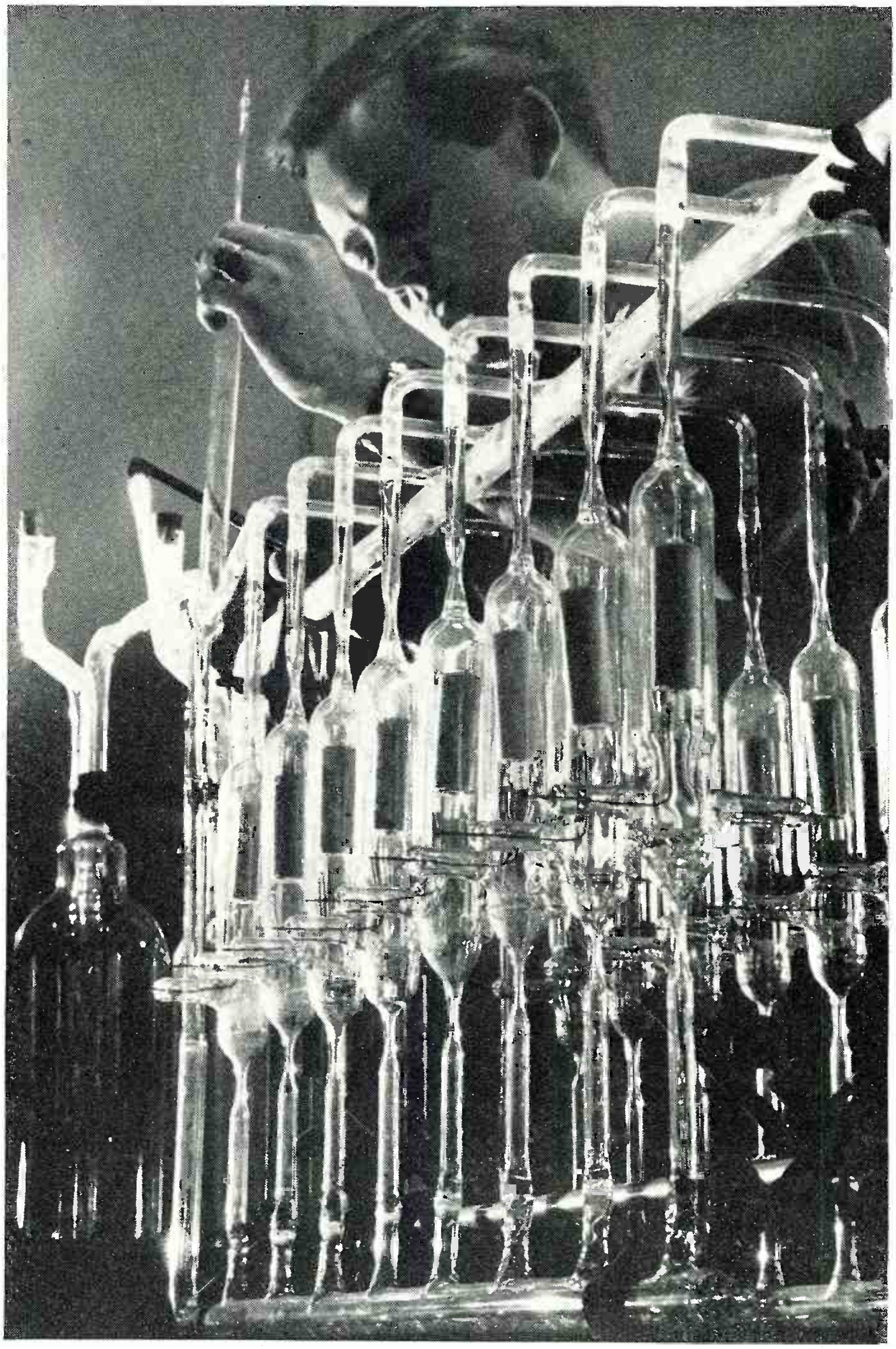
Carrier-Current

Many years before WPB was ever dreamed of, electric power engineers dreamed up a way to make transmission wires do the double job of carrying information as well as electric power, thereby saving the copper in a separate pair of telephone wires. This scheme is called carrier-current and has become quite popular in the power-transmission field because of the large savings that can be made in system capacity through its use.

The operation of protective relays with information provided by carrier-current in combination with high-speed circuit breakers makes it possible to remove short circuits from systems in times as short as 1/20 of a second. This not only releases system capacity but eliminates burning of the equipment and undesirable system disturbances. To get some idea of what 1/20 of a second means, hold a coin ½-inch from the desk and drop it. Let us consider an example of a saving of system investment through the use of carrier-current relaying. A certain project required the transmission of a large block of alternating-current power for a distance of approximately 250 miles. The high-tension transmission lines, two of which were installed, each cost approximately $6,000,000. These two lines equipped with ordinary mechanical type relays, had a certain current-carrying capacity. Through the installation of carrier-current relaying the capacity of these lines was increased approximately 50 per cent.

In other words, the equivalent of a third line was obtained through the use of carrier-current relaying. A saving of $6,000,000 in investment was made as a result of a small additional investment of $50,000 in carrier-current and associated apparatus.

In this discussion carrier-current in connection with relaying has been used as an example but we should not overlook the fact that carrier-current has far greater possibilities in a power system than for relaying alone. We find its use expanding into power-system control, telephone communications, long distance transmission of metering and telling information and the like. On account of the possible savings in critical materials, WPB is considering releasing for purchase a number of carrier-current projects.



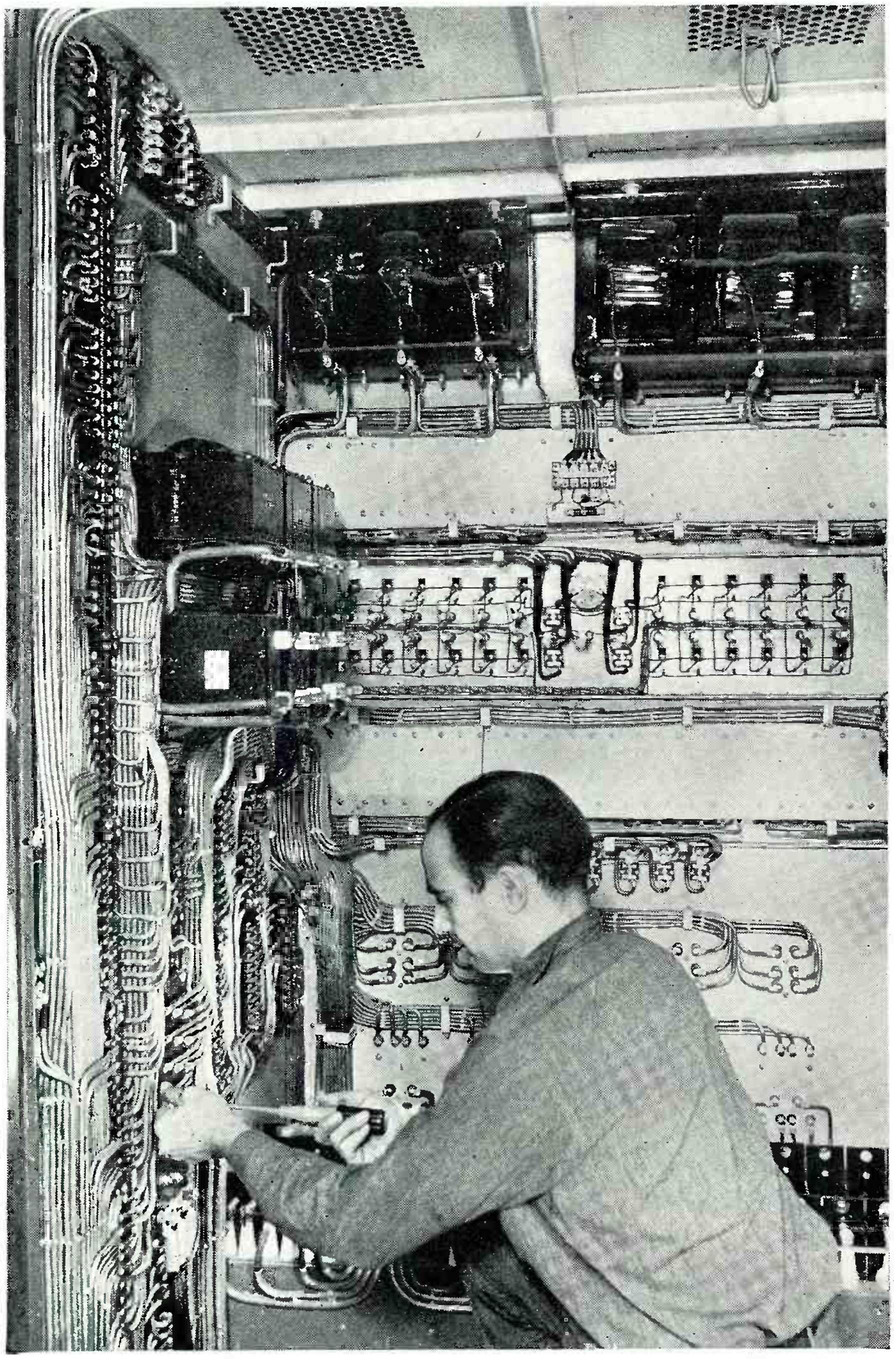
This research development determines what type of paper serves best as insulating layers in electrical condensers, devices for storing electric chargers or filtering radio currents. To prepare for this test, a glass blower worked for two weeks sealing 16 condensers in glass vacuum tubes strong enough to withstand temperature extremes, ranging from 300 degrees below zero (Fahrenheit) to 250 degrees above.

In terms of other branches of the field of electronics, carrier-current is relatively a small item. On the other hand, it probably will be a steady type of business. In the past five years there has been approximately $3,500,000 of business done in this field.

Precipitron

Another application of electronics is that of the dust and pollen removal from ventilating air. This is accomplished by an electronic device known as an electrostatic dust precipitator and called the Precipitron.

The use of electricity in the smoke precipitation problem is not new. The Cotrell process has been in use for some years. The Precipitron, however, allows a more compact design so that it is economically and physically possible to use the device in ventilating ducts, in buildings, industrial plants, homes, and the like. In the early stages of this development a market analysis indicated a promising possible field for a home-size air cleaning unit. It is of interest that, as



Accuracy and good workmanship are essential in electronic devices. This is increasingly important as electronic devices grow in size and power in industry.

matters have turned out on account of the war, very few home units have been built.

Instead, the Precipitron has been extensively used in the cleaning of air in the large, expensive and important motor rooms in steel mills. It has also been extensively used to clean the air in precision aircraft manufacture, as well as in film-processing rooms and the like. Its applications are expanding. We find great interest in its use for taking oil mist out of the air in machine shops. This is not only of importance in connection with the efficiency of lighting but also in the maintenance of shops. The Precipitron on a trial installation collected four gallons of oil in 24 hours from one machine. Although this is possibly an extreme case, neverthless it indicates the amount of oil that could have been deposited on the walls, windows and fixtures which not only means an oil saving but a simpler housecleaning job in the shop.

Let us look at the smoke precipitation problem for a moment. To solve the tough problem of smoke abatement from industrial and power plants, Westinghouse, in cooperation with Prat-Daniel Company, has been working on a way to combine the electrical Precipitron. This scheme shows promise where large volumes of solid material have to be handled, the mechanical precipitator getting the heavy particles and the electrical precipitator taking off the lighter particles.

The Precipitron is, relatively speaking, a newcomer in the electronic field. It was conceived some 10 years ago but has had extensive commercial use only in the last three or four years. Approximately $5,000,000 of business has been done in this time, most of which has been in industrial plants. The use of this device in industrial plants is bound to expand when restrictive orders on critical materials are raised.

There are several yet untapped uses for it in other industries, and to each when applied, it will bring the many benefits that accrue from operating in absolutely clean air. Only a bare beginning has been made in cotton mills which is still a very promising field for the device and there is no question that the home market will rapidly develop for this device after the war.

Control

A large number of applications of electronic devices have been made in the field of electric machine and industrial process control. When we talk about control we mean all types of devices, such as voltage regulators, speed and process controllers, welding timers, motor controllers, and the like.

In the production of planes, ships and all mechanical type devices, production has increased manyfold through the use of electric welding. Electric welding has played a leading part in the war program. The Ignitron has also been one of the keys to resistance-type electric welding as it lends itself admirably to a very precise type of control for the higher currents that must be handled in modern welding practice. A large variety of timers for accurately controlling the welding cycle have been built and electronics has made possible much of the fine control that has been used in this welding field. In the past five years there has been a total market of approximately $8,000,000 for the electronic welding-control equipment.

Another fine example of how electronics is contributing to the speeding of production is on machine tools where the speeds of motors are accurately adjusted over a wide range. An electronic device called the Mot-O-Trol is another form of electronic device that converts alternating current to direct current directly at the machine itself, thereby overcoming many inherent difficulties of former schemes. It is possible to obtain flexible control of speed over a 20 to 1 range with this new electronic device. Although the equipment itself is in some cases more costly than the equipment for former methods of control, nevertheless, when the production schedules are taken into account, it is a very economical type of application. The application of this device is in its infancy. It will find greater and greater use where wide-speed range with good regulation is desired in the

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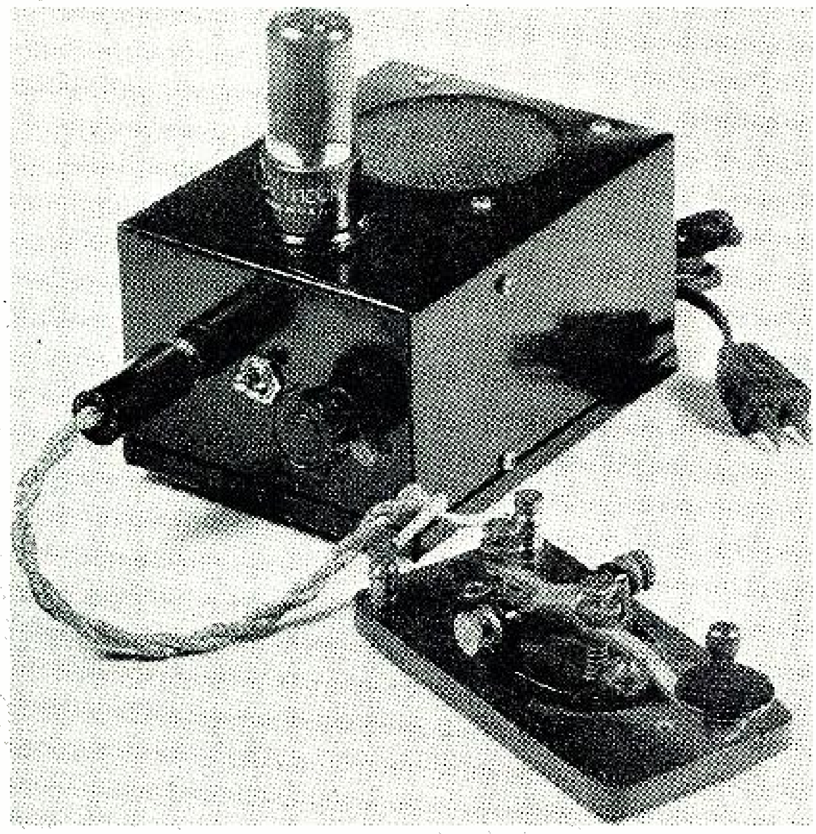

The completed unit, showing the position of the speaker and external components.

CODE PRACTICE OSCILLATOR

by R. C. ZAUN
Eng., Thordarson Electric Mfg. Co.

A professional type code practice oscillator designed especially for the student at home or in the classroom.

HERE is an easily constructed code oscillator which has proven its worth after several years of constant service. Such a unit is in special demand, both by beginners just learning the code and experienced operators desiring to keep their code proficiency up to par.

This oscillator is completely enclosed in a compact metal case which houses the oscillator components and its associated power supply. The only function necessary to place it in operation is the plugging in of the line cord and key. The speaker is mounted horizontally in the cabinet so that it has a non-directional effect and affords ample volume for good coverage in a large size room. A maximum power output of approximately .75 watts is available, which is more than sufficient to provide distinct code signals. The 117N7GT tube is mounted on top of the case rather than inside so as to provide for maximum dissipation of heat and also easy access for tube replacement. The following controls appear from left to right on the front apron of the cabinet: A closed circuit jack for convenient plugging in of the signal key, on-off line switch, and the knob which controls the oscillator's volume.

This unit is designed for either 110 volt a-c or d-c operation. No power transformer is required as the 117N7-GT tube used in this circuit has its 117 volt heater and rectifier connected directly across the line. The 117N7GT contains a pentode and a diode section, which performs the dual function of an oscillator and half-wave rectifier. The power supply uses a conventional half-wave rectifier and condenser input plus one section of choke and condenser filtering.

Inspection of the schematic drawing will reveal that the oscillator circuit is the familiar tuned-plate feedback type. The push-pull plate-to-voice-coil output transformer in reality performs two functions. The primary winding comprises the oscillator grid and plate components, whereas the secondary, being closely coupled to this primary winding, transfers the signal power to the 3½" permanent magnet speaker. The condenser, C_4, is used to tune the plate circuit of the oscillator. This, to a large extent, determines the frequency of oscillation which is approximately 1,600 cycles.

It is sometimes desirous to change the pitch of the audio note to suit the operator's ear. This can be accomplished by one of several methods. A simple way to make the frequency of oscillation variable over a fairly wide range would be to replace the grid leak

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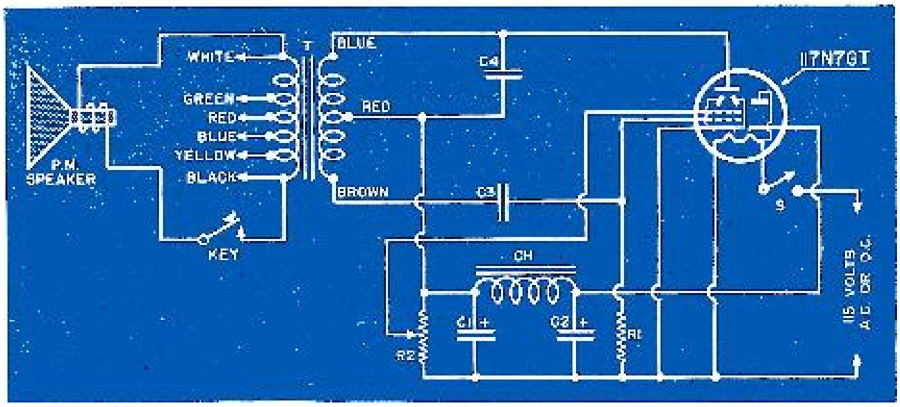
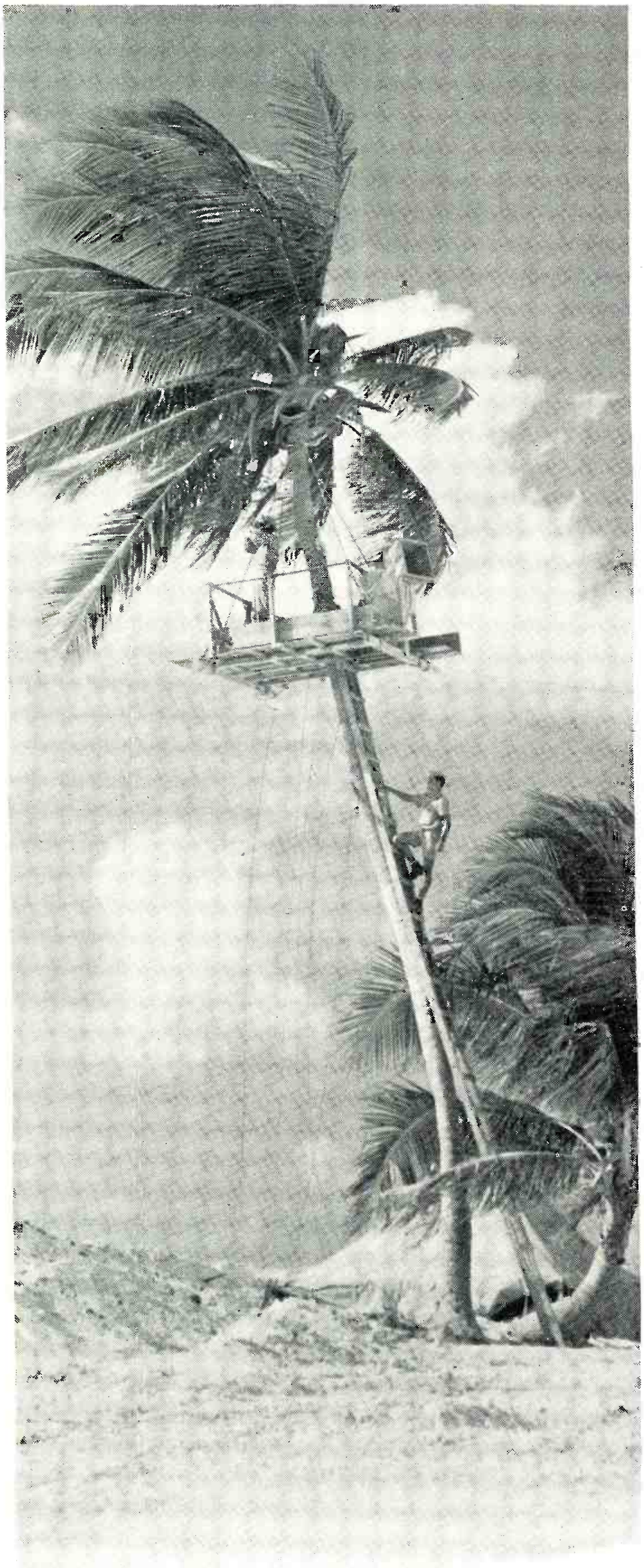
Schematic diagram of the single-tube code oscillator.



C_1, C_2—8-8 µfd., 250 w.v. elect. cond.—Aerovox PBS-250
C_3—.0001 µfd., mica cond.—Cornell-Dubilier #5W
C_4—.1 µfd., 400 volt paper cond.—Cornell-Dubilier #DT-4W1
R_1—2 megohm, ½ watt carbon resistor—Centralab
R_2—10,000 ohm potentiometer—Mallory #M10MP
T—Push-Pull Output Transformer — Thordarson T-14S85
CH—Filter Choke—Thordarson T-13C27

Communications in Pictures

RADIO has proven to be a potent weapon of war. Wireless-equipped advance posts direct artillery fire on enemy targets. PT boats on the prowl, having a two-way communications system, locate the prey for the heavy battle units to pounce on. "Caissons go rolling along" in comparative safety for they are never completely out of touch with Headquarters. Conquered territory becomes a part of a vast Allied Communications system through which official orders become known to the populace, while Military Governments can at the same time keep in touch with other Allied headquarters. Lonely outposts are all only as far apart from each other as the nearest radio set.



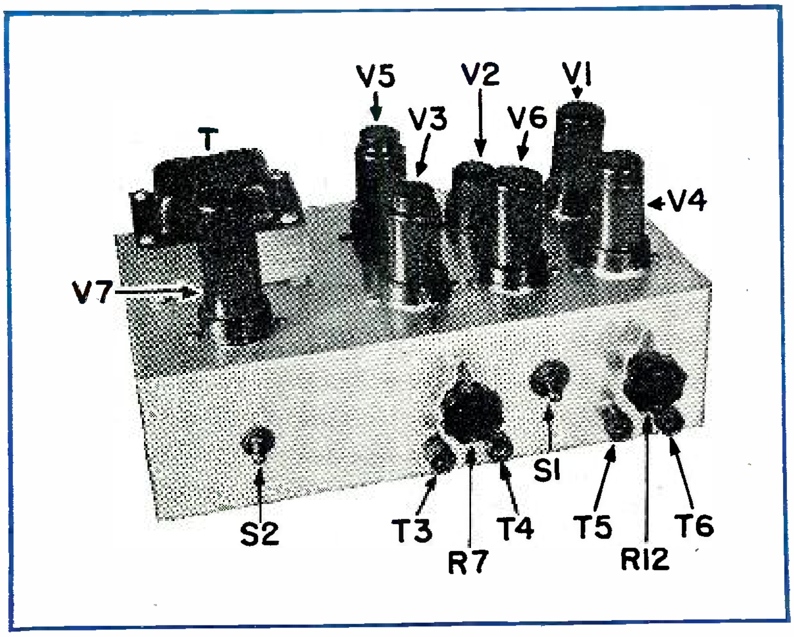
This lonely little island in the Southwest Pacific is one of the many far-flung spots linked with the outside world by the Air Transport Command. In this camouflaged structure Yanks maintain constant guard to watch for enemy planes and ships.

Crouched beneath his excellent camouflage screen of tobacco, Cpl. C. L. Ball spots enemy aircraft on the Italian front. Note heavily constructed communications unit.

Officers of an Allied tank division studying a terrain map at one of our many battle fronts. Note heavily armored radio-equipped tank. Communications antenna can be seen mounted and tied to the rear of the tank.

Navy men on a radio-equipped PT boat are on the alert and ready for anything that may come their way while hunting the Japanese somewhere in the South Pacific. The boat has been decorated with the Clover and Pipe insignia.

ELECTRONIC SWITCH



Chassis layout of the Electronic Switch. T1, T2, T7, and T8 mount outside the right-hand end of the chassis.

by

RUFUS P. TURNER

Consulting Engineer, RADIO NEWS

Constructional details on an Electronic Switch. By means of this device, two signal voltages may be observed on a single oscilloscope.

☆

IN MODERN radionic circuits, it is common to find several alternating or pulsating voltage or current components which are related in one way or another. In the vacuum tube amplifier, for example, alternating plate and grid voltages are encountered. Anode current pulses

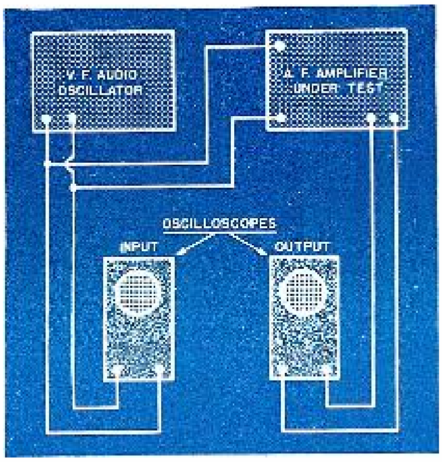


Fig. 1. The old method of observing two signal voltages simultaneously.

in thyratron circuits are related in phase to grid voltage alternations. In the synchronized sweep oscillator, saw-tooth-shaped output voltage pulses are phased with synchronizing grid voltage alternations. In a clipper circuit, the input voltage is of sinusoidal waveform, while the output voltage pulses may be square in shape. In an audio amplifier, being tested with a square-wave generator, the input signal pulses are of square waveform, while the output signal wave is more or less square, depending upon the amount of distortion introduced by the amplifier.

When studying any phenomena typified by the above examples with the oscilloscope, it is customary to examine each component separately. The vertical plates of the oscilloscope are switched successively from one circuit position to another. This method has the disadvantage that one signal pattern is lost, and must be remembered as closely as possible, while the other is being observed. The use of two identical oscilloscopes for the simultaneous observation of two signal components is helpful, though not economical.

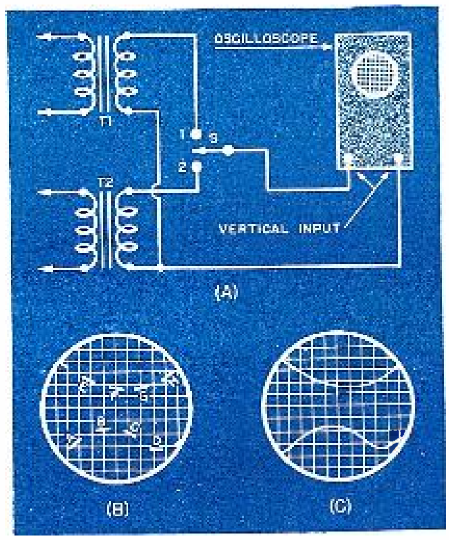
A familiar example is illustrated in Fig. 1. Here an audio-amplifier is being tested, by means of an audio-frequency oscillator, for distortion and gain. The task is to establish the ratio of output to input voltage and to determine the extent of waveform distortion introduced by the amplifier.

In order to make these observations, two oscilloscopes are employed—one actuated by the amplifier signal input voltage, the other by the output voltage. At a given oscillator frequency—the input oscilloscope is adjusted to show a stationary pattern of one or more input-signal cycles, and the output oscilloscope is adjusted in the same manner.

Due to amplifier action, the amplitude of the output pattern will exceed that of the input pattern by the ratio of the overall gain within the amplifier. The gain may thus be determined by measuring the height of the pattern on each screen. It is assumed, of course, that the oscilloscope gain controls are similarly set, in order that pattern amplitudes may tell a true story.

Distortion is checked by direct comparison of the shape of one pattern with that of the other. At best this is a difficult operation when small distortion percentages are involved, and it is further complicated in this case by the use of two screens.

Fig. 2. The new and most accurate method, using one oscilloscope to observe two voltages simultaneously.



Obviously, any such observation of two or more patterns would be facilitated if all could be viewed simultaneously on a single screen. Even if wave traces did not overlap or coincide, but appeared one above the other on the screen, a normal angle of vision would render all visible at the same time and accuracy of observation would be greatly enhanced.

The *electronic switch* affords this very type of operation. The various signal-voltage sources are connected to the "switch" and the latter, in turn, to the vertical plates of the oscilloscope. The electronic switch, described in this article, employs a simple circuit which requires no more parts than a small resistance-coupled amplifier. Aside from the transformer and choke in the self-contained power supply and two volume controls, the circuit employs only tubes, resistors, and capacitors. It is inexpensive and easy to build, while demanding no essential equipment which cannot normally be found in a spare-parts box.

Principle of Operation

In order to understand the operation of the electronic switch, it is advisable first to consider a simple electrical analogy. The comparison is given in Fig. 2.

Two signal voltages are available, being supplied by transformers T_1 and T_2 respectively. The vertical plates of the oscilloscope are connected rapidly to first one signal voltage and then the others, by switch S which we conceive to be moved between points 1 and 2 at high speed. As a result, *double tracing* takes place on the oscilloscope screen, as shown in Fig. 2B.

When S is first at 1, voltage 1 is of such magnitude as to give the small trace A (Fig. 2B). The length of the trace is governed by the length of time during which the switch is closed, and its slope by the growth of the voltage cycle. Shortly after trace A is completed, however, S moves to 2 and catches voltage 2 at a portion of its cycle to produce trace E. As switch S swings from one position to the other, a number of separate traces are made, as indicated by A-B-C-D and E-F-G in Fig. 2B. The switch movement must be sufficiently rapid to give, through persistence of vision, the illusion of a continuous trace. If the switching is slow, the trace will consist of many disconnected lines or dots, as in Fig. 2B. If, instead, switching is very rapid, a pair of continuous-line traces will result, as in Fig. 2C.

Mechanical switching, while serving as a good analogy, is subject to numerous vagaries, and has been superseded by circuits in which the switching is accomplished electronically. Fig. 3 shows such a circuit.

Triodes V_3 and V_4 are biased somewhat higher than cutoff. A sine-wave voltage applied to terminals T_1 and T_2, is amplified by triode V_1, and is converted into a square-wave voltage by the double-diode clipper tube, V_2.

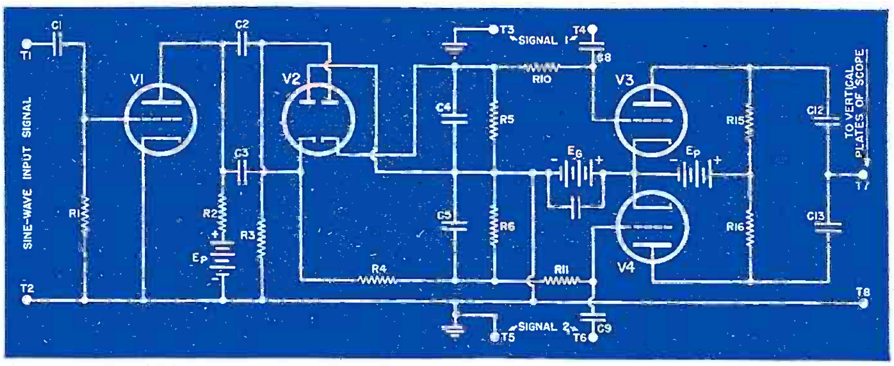


Fig. 3. Basic circuit used in the construction of the Electronic Switch.

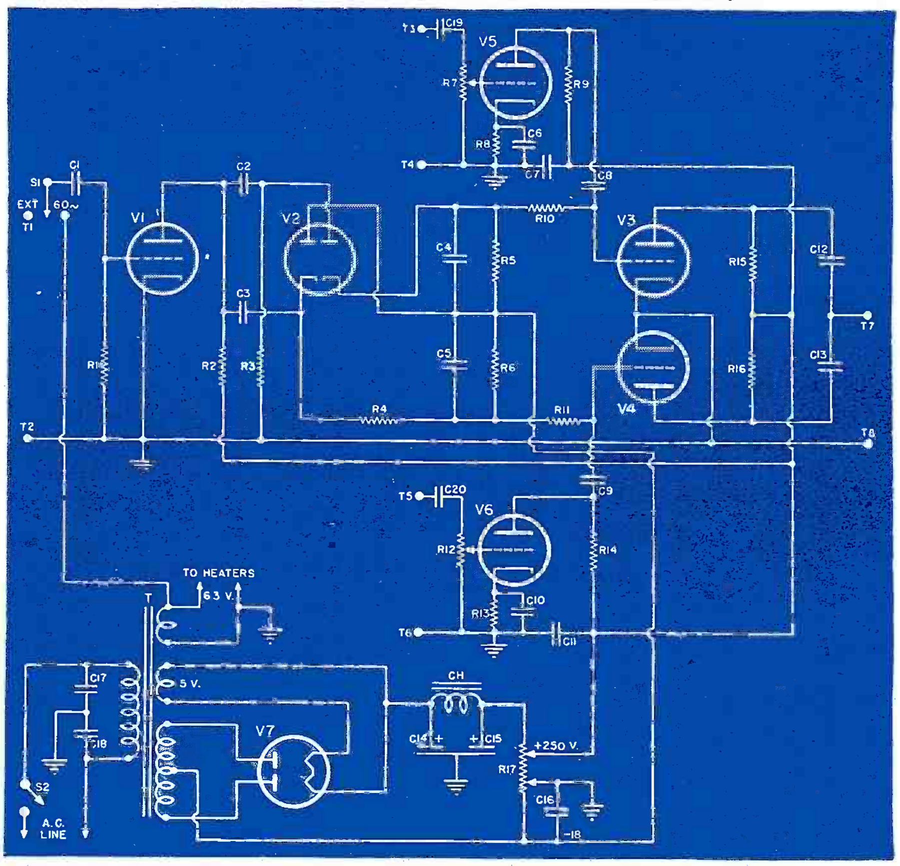
Positive half-cycles of these square waves appear across resistor R_5 and negative half-cycles across R_6. These half-cycles of square-wave voltage make the grid circuits of V_3 and V_4 alternately conductive, so that if separate signals are applied to terminals T_3-T_4 and T_5-T_6, these signal voltages will be delivered alternately by V_3 and V_4 to the vertical plates of an oscilloscope connected to terminals T_7 and T_8. Signals 1 and 2, thus, are switched alternately to the oscilloscope at a per-second rate equal to the frequency of the sine-wave voltage applied to terminals T_1 and T_2.

Complete Circuit

In order to complete the electronic switch circuit for best practical application; it is necessary only to add (1) a power supply, (2) single-stage amplifiers for the two signals, and (3) a single-pole double-throw toggle switch to throw the sine-wave input

(*Continued on page* 70)

Fig. 4. Circuit diagram of the completed unit showing the addition of a power supply and two separate input stages.



C_1, C_2, C_3, C_8, C_9, C_{12}, C_{13}, C_{19}, C_{20}—.01 µfd., mica cond.—Aerovox.
C_4, C_5, C_6, C_7, C_{10}, C_{11}, C_{17}, C_{18}—.1 µfd., 400-volt tub. cond.—Aerovox.
C_{14}, C_{15},—Dual 8 µfd., 400 w.v. tub. elect.—Aerovox PRS.
C_{16}—8 µfd., 50 w.v. tub. elect. Aerovox PRS.
CH—10 henry, 75 ma. filter choke—U.T.C. R-18.
R_1—.5 megohm ½ watt resistor—Aerovox 1097.
R_2, R_3, R_4, R_{10}, R_{11}, R_{15}, R_{16}—200,000 ohm, 1 watt resistor—Aerovox 1098.
R_5, R_6—20,000 ohm, 1 watt resistor—Aerovox 1098.
R_7, R_{12}—.5 megohm potentiometer, I.R.C. Type CS.
R_8, R_{13}—1500 ohm, 1 watt resistor—Aerovox 1098.
R_9, R_{14}—50,000 ohm, 1 watt resistor—Aerovox 1098.
R_{17}—50,000 ohm, 75 watt (with slider)—Aerovox Type 956.
S_1—s.p.d.t. toggle switch—Arrow.
S_2—s.p.s.t—toggle switch—Arrow.
T—Power Transformer: 350-0-350 v., 70 ma; 5 v., 3A.; 6.3 v., 2.5A.—U. T. C. R-2.
V_1, V_5, V_6—6J5 tubes.
V_2—6H6 tube.
V_3, V_4—6C5 tubes.
V_7—5W4 or 80 tube.

THE SAGA OF THE VACUUM TUBE

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

Part 9. The evolution of the vacuum tube from its original conception to its application as a practical commercial device.

THE evolution of the practical high-vacuum tube from the low - vacuum de Forest Audion provides an interesting example of the painstaking development work required to make of an invention a commercially practicable device. The manifold problems encountered in such development work are almost incapable of solution in any reasonable time by any one individual. It is only in the industrial laboratory, where each problem is attacked by a specialist in the particular field, that the desired result will be attained.

In this and succeeding articles an attempt will be made to follow this evolution as it took place in the Engineering Department of the Western Electric Company and later the Bell Telephone Laboratories. The chief stress will be laid on the mechanical or physical evolution to assist in the identification of the various early types of the tubes that materialized. This is necessary because for many years Western Electric vacuum tubes were designed and manufactured almost exclusively for telephone and Government use, and did not reach the public through the ordinary channels of commerce. Hence, they will not be as familiar to tube collectors as are vacuum tubes made by other manufacturers for general use and for sale to the public, after the advent of broadcast radio had created the demand.

By the year 1912 land-line telephony had made considerable progress in the field of long distance circuits, but there was need of a telephone repeater more suitable than any at that time in use. The useful length of telephone circuits could at that time be extended either by loading or by the use of repeaters, but in general both could not be used on the same circuit at the same time. The characteristics of the mechanical repeaters which had been developed were such that satisfactory operation in tandem was not practicable. It was realized that the solution to the problem must be sought in some form of inertialess repeater, and early in 1911 work was started on the development of a mercury vapor device of the general type covered by the Peter Cooper-Hewitt patents.

This task was undertaken by Dr. Harold D. Arnold, who had studied the infant science of electronics under Dr. R. A. Millikan at the Ryerson Laboratory of the University of Chicago. By the summer of 1912 Dr. Arnold had succeeded in producing an amplifying device which gave promise of becoming a useful telephone repeater. This was known as the "mercury arc" repeater and an experimental form of the device, which was used to a limited extent, is shown in Figure 61. An experimental installation of these repeaters is shown in Figure 62. The development of this device was never carried to the point of commercial practicability because of the appearance on the scene of another device which showed more promise.

In October 1912 John Stone Stone,

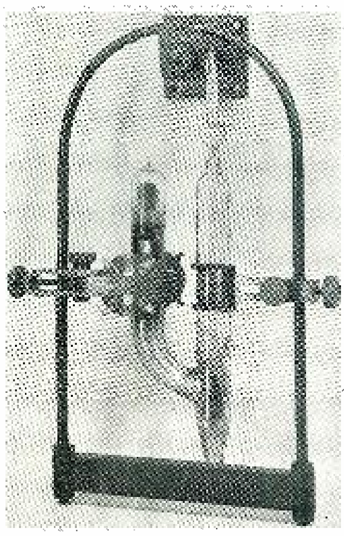


Fig. 61.

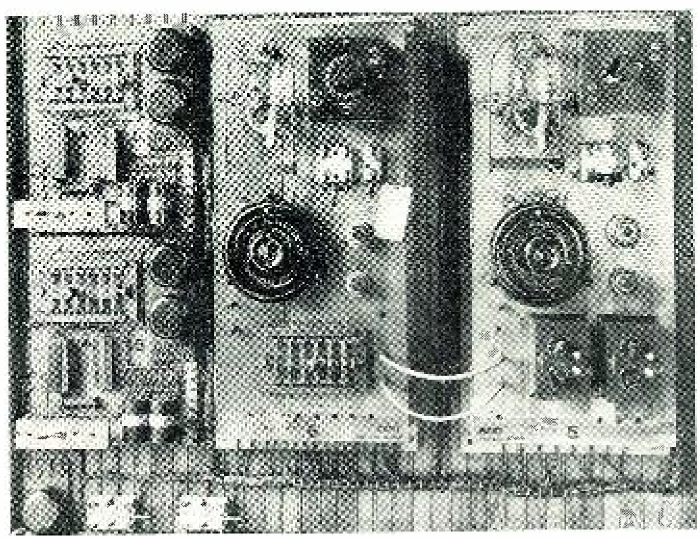


Fig. 62.

acting for Lee de Forest, got in touch with J. J. Carty of the American Telephone and Telegraph Company with a view to demonstrating the de Forest Audion for use as a telephone repeater. A meeting was arranged and on October 30, 1912 de Forest and Stone came to the Engineering Department of the Western Electric Company, ready to demonstrate the device. The demonstration showed that under the conditions of operation employed by de Forest, that is, operation with the grid condenser of its radio detector days, the Audion would function as an audio-frequency amplifier, but only at such low levels as not to build up on the grid a blocking voltage. The demonstration was repeated on the following day with the same results, and de Forest left the apparatus for further tests and experiments by the telephone engineers. There were two forms of Audion used in these demonstrations. One form was that previously shown in Figure 44, the other is shown in Figure 63.

On the next day, November 1, 1912, Dr. Arnold saw the Audion and recognized its possibilities, even though the device and its operating circuit as disclosed by de Forest was incapable of fulfilling the requirements. Arnold recognized the defects and told how they might be remedied. But the accomplishment of the remedies and the development of the comparatively crude Audion into a reliable telephone repeater was a long and arduous process.

A satisfactory telephone repeater must meet many requirements other than the primary one, that of producing amplification. It must be capable of handling the energy levels existing at repeater points on telephone lines, must amplify all frequencies present without discrimination, have long useful life, operate under essentially the same conditions, and produce the same results throughout its useful life. It must be such that it can be manufactured in quantities, and that the individual devices so manufactured be commercially interchangeable.

The device, in general, should be such that, once installed, it will function satisfactorily without any other attention then routine inspection. At the end of its useful life, it must be possible to remove the unit and replace it with another commercially similar unit, and have the circuit ready for operation without changes in the auxiliary apparatus and with only minor readjustments.

The Audion, as demonstrated by de Forest, fell far short of these requirements. It amplified very weak speech currents and amplified them accurately. When the input level was raised to that normally encountered in telephone practice the quality was greatly impaired and the amplification considerably reduced. Under these conditions blue haze sometimes occurred. If the plate battery voltage

(*Continued on page* 56)

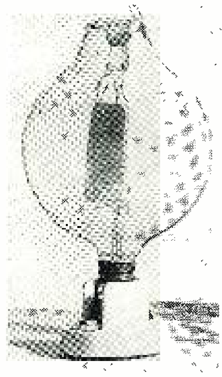


Fig. 63.

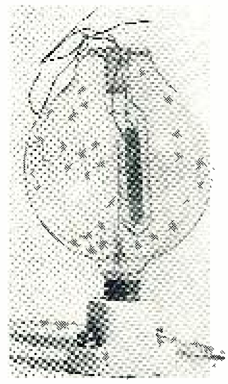


Fig. 64.

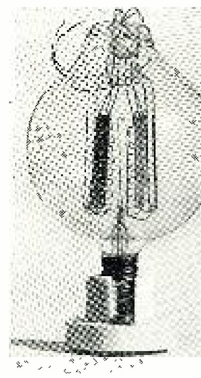


Fig. 65.

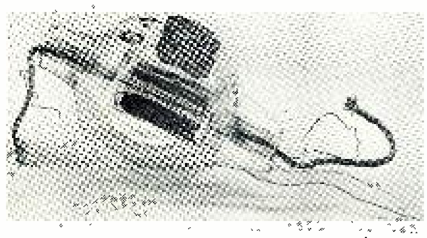


Fig. 66.

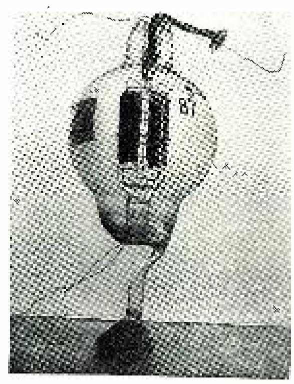


Fig. 67.

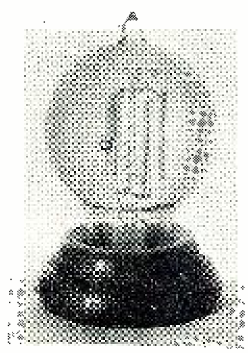


Fig. 68.

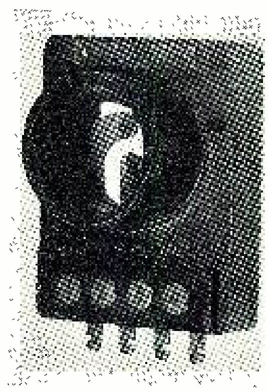


Fig. 69.

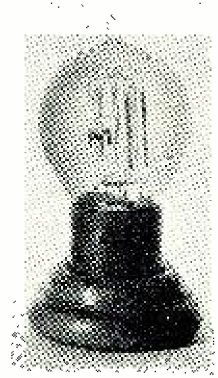


Fig. 70.

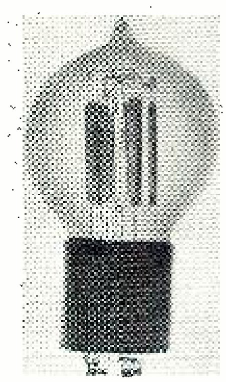


Fig. 71.

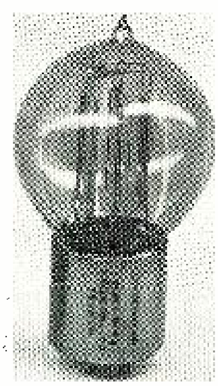


Fig. 72.

Sine and Square Wave A-F Oscillator

by McMURDO SILVER
Vice President, Grenby Mfg. Co.

Presaging the design of the future, this new instrument combines two heretofore separate units to yield sine or square-wave output.

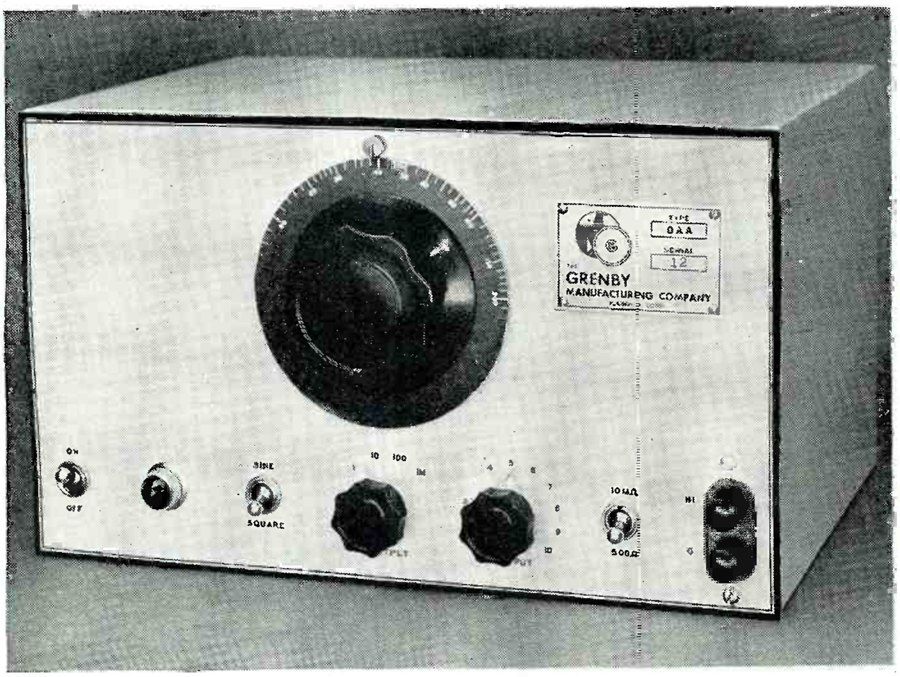
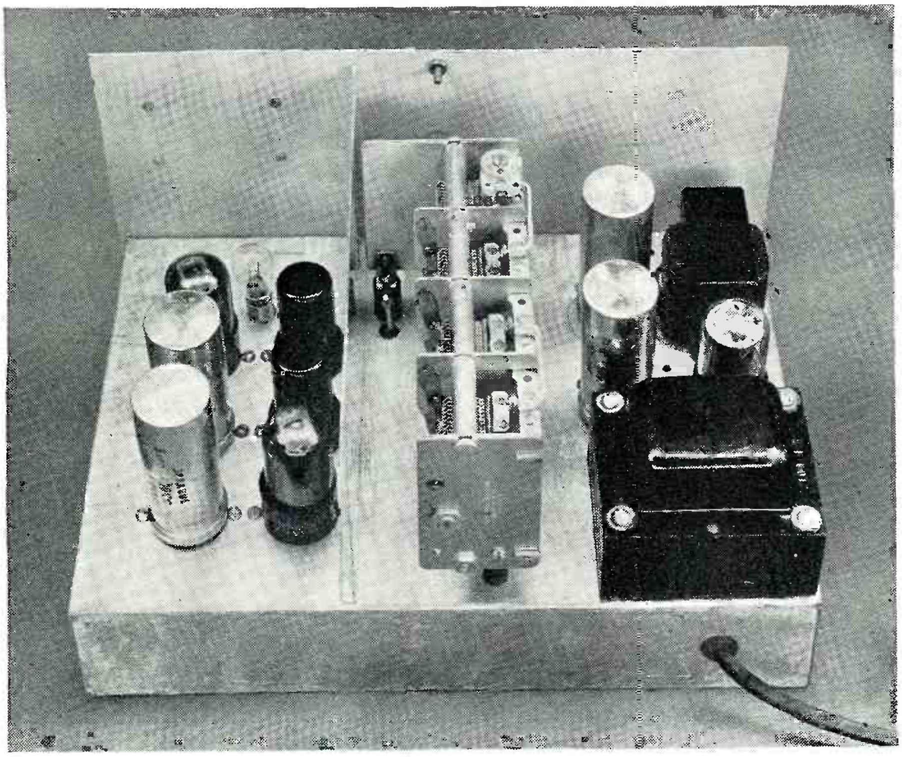


Fig. 1. (Top) Sine and square-wave output, 20 to 200,000 cycles—all in a single laboratory instrument. Fig. 2. (Bottom) Interior view showing logical, progressive circuit arrangement, and replaceable plug-in electrolytic capacitors.



IT APPEARS to be a sound philosophical concept that man first conceives the idea of a potentially useful instrument, then by empiric processes and investigations develops progressively simpler and better means of accomplishing the desired result. Without carrying this thought to an extreme conclusion, it is safe to say that the course of the majority of scientific inventions has been from a cumbersome beginning to, in their final form, a close approach to final utilitarian simplicity. If the end device has become more complex than its original form, it is usually not because of lack of simplification, but rather because simplification has been so effectively accomplished that various new or added functions may be combined with the first.

The instrument, herein described, satisfies the above premises, since it represents a simplification of two heretofore separate and relatively complex devices. It has the ability to rapidly determine characteristics of audio-frequency apparatus, a procedure previously requiring much time. As such, it is believed, it may be regarded as representing one of the newer techniques which have been developed under the pressure of war to permit a greater speed and precision in the production and maintenance of communication equipment.

Basically this new instrument is a combination of the, now justly popular, Wein Bridge resistance-capacity tuned audio-frequency oscillator followed by a two-stage audio-frequency amplifier, and the usually separate and almost equally complex square-wave generator.

The engineer, accustomed to using the conventionally bulky combination of these two instruments, may find it hard, for the moment, to recognize both in the extreme simplicity of the instrument pictured in Figs. 1, 2, and 4—and diagramed in Fig. 3. It is just this dissimilarity between conventional equipment and this instrument which makes it different. The use of both sine and square waves will be a tremendous advantage to the design engineer and service man.

Fig. 1 illustrates the instrument in its 12″ long by 7″ high by 8″ deep "telephone-grey" enameled steel cabinet which is military in character, because it is rendered corrosion resistant by the application of zincchromate primer before spraying with thin baked on "telephone-grey" lacquer. It has a dull gloss instead of crackle which makes it easier to wash and clean, because dust and dirt do not remain in the irregularities so prevalent in the crackle finish. The various controls from left to right, are: main power on-off switch; pilot lamp bezel to indicate power on or off; two-position toggle switch to shift from sine to square wave output; four-position range multiplier switch, which, with the large central dial, allows selection of any one of four frequency ranges of 20-200, 200-2,000, 2,000-20,000 and 20,000-200,000 cycles. To the right of the frequency dial, and in line with the lower controls, are: continuously variable sine-wave output voltage control; switch to select either nominal 10,000 ohm or 500 ohm output impedances; the two output binding posts, the lower one "ground," the top one "high" or "hot." The cord and plug is at the rear for connection to a source of 110-120 volt, 50-60 cycle alternating current, from which approximately 40 watts are required to power the instrument.

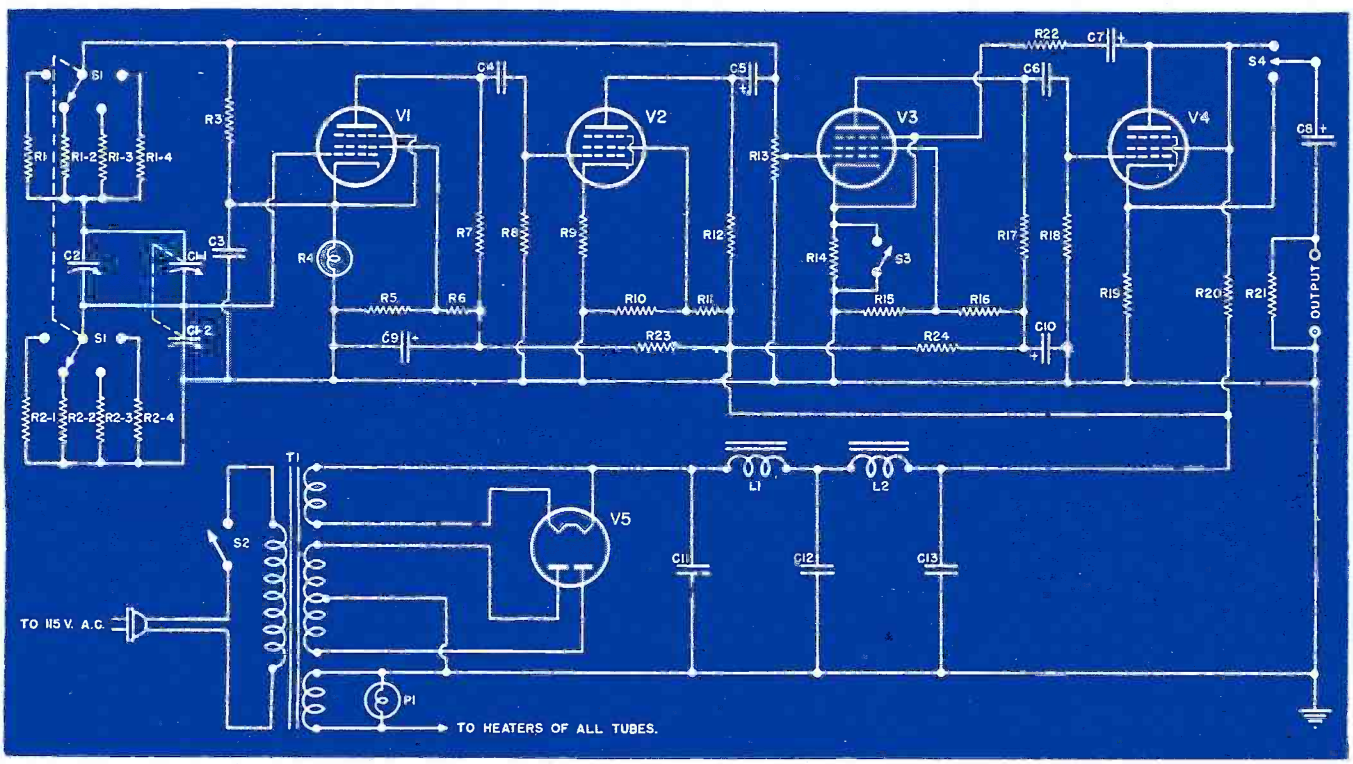
Fig. 2 illustrates the internal construction. At the right, front to rear, are one of the two power supply filter chokes, the 5Y3GT full-wave power supply rectifier tube V_5 and the power transformer. The two cans just to the lef[redacted]lti-section, p[redacted]apacitors; the three [redacted]its are in one can, and the [redacted] individual 6SJ7 plate circuit filter capacitors in the second.

The use of the more costly plug-in construction of electrolytic capacitators is justifiable for the following two reasons: First, they are hermetically sealed, thus insuring a longer life than that of the conventional "broadcast" types, and also they are of a better quality due to the requirements of military standards. Second, the plug-in feature permits immediate replacement in event of failure, an advantage, since electrolytics deteriorate with age. Due to such a combination of factors—high quality and instant replaceability—the most confirmed purist cannot help but recognize their merit.

At the center of Fig. 2 is the "two-gang" tuning capacitor, physically a large-size, amply-spaced, four-gang unit. Each section provides 440 μμfd. capacity, and is connected with front two sections and rear two sections in parallel. This combination yields a two-gang capacitor of 880 μμfd. per section such as is required to give each dial range a frequency coverage of 10-1, plus essential overlap at the end of each range. To the left of the partition, located at the left of the gang condenser to minimize electrostatic interaction, are the actual oscillator circuit components. At the front is the 3-watt, 110-volt incandescent lamp R_4, which operates to keep the output of the oscillator constant in voltage vs. frequency to within 1½ db. from 20 through 200,000 cycles. Immediately to its rear, left to right, are the 6K6GT second oscillator tube V_2 and the 6SJ7 first oscillator tube V_1. Behind them are the 40-μfd., 450-volt oscillator output coupling capacitor C_5, and the 6SJ7 first audio-frequency amplifier and square-wave shaper tube. At the rear is the 40-μfd. output coupling capacitor C_8 and the 16-μfd., 350-volt inverse-feedback capacitor C_7, both in a one plug-in unit. The assembly and arrangement is logically sequential-circuit-wise, and open for easy servicing, as is the chassis or "engine-room," of Fig. 4.

Possibly the most noticeable thing about Fig. 4, at least to readers principally accustomed to broadcast receivers, is the typically military-commercial arrangement and interconnection of component parts. Capacitors are of a military type—hermetically-sealed, oil-impregnated, or molded mica types. Resistors are molded in approved military types, color-coded for identification, and arranged in definite physical order in each successive instrument for easy

Fig. 3. Simplicity, true keynote of this instrument, is well exemplified in its circuit diagram.



R_1, R_{2-1}—10 megohm, 1 w. res. ± .25%
R_{1-2}, R_{2-2}—1 megohm, 1 w. res. ± .25%
R_{1-3}, R_{2-3}—100,000 ohm, 1 w. res. ± .25%
R_{1-4}, R_{2-4}—10,000 ohm, 1 w. res. ± .25
R_3—3,500 ohm, 1 w. res. ± 5%
R_4—G. E. 3 w. 110 volt lamp
R_5—35,000 ohm, 1 w. res.
R_6—75,000 ohm, 1 w. res.
R_7, R_{16}, R_{17}—50,000 ohm, 1 w. res.
R_8, R_{18}—500,000 ohm, 1 w. res.
R_9–R_{19}—500 ohm, 2 w. res.
R_{10}—50,000 ohm, 2 w. res.
R_{11}—10,000 ohm, 2 w. res.
R_{12}—10,000 ohm, 10 w. res.
R_{13}—25,000 ohm, Potentiometer
R_{14}—5,000 ohm. 1 w. res.
R_{15}—25,000 ohm, 1 w. res.
R_{20}, R_{21}—25,000 ohm, 2 w. res.
R_{22}—3,000 ohm, 1 w. res.
R_{23}—10,000 ohm, 1 w. res.
R_{24}—4,000 ohm, 1 w. res.
C_{1-1}, C_{1-2}—880 μμfd. per section variable condenser
C_2—7–50 μμfd. trimmer
C_3—50 μμfd. mica cond.
C_4, C_6—.1 μfd., 400 v. oil cond.
C_5—40 μfd., 450 v. elect.
C_7—16 μfd., 350 v. elect.
C_8—40 μfd., 350 v. elect.
C_9, C_{10}—Dual 20 μfd., 450 v. elect.
C_{11}, C_{12}, C_{13}—Single unit; 10 μfd. 525 v., and two 15 μfd. 450 v. respectively; elect.
V_1, V_3—6SJ7 tube
V_2, V_4—6K6GT tube
V_5—5Y3GT tube
P_1—6 volt pilot lamp
L_1, L_2—10 henry, 85 ma. filter choke
T_1—Power transformer 115 v. pri.; 5 v., 2A.; 6.3 v., 2A.; 700 v., 85 ma. ct.

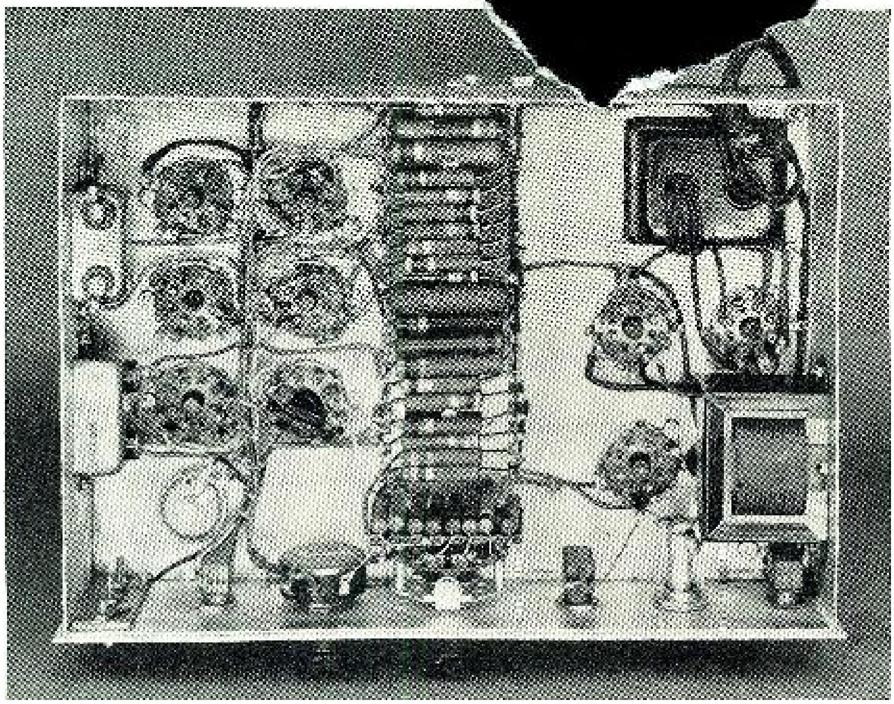


Fig. 4. Rigidly mounted component parts: screws, nuts, and lock washers in lieu of rivets: cabled and color-coded wiring, makes this type of construction easy to analyze and service, and dependable in the extreme.

identification in service. All components are mounted with machine screws, nuts, and the essential lock-washer to prevent loosening under vibration—no rivets, whatever, are employed to mount component parts. Following military practice which, except in "pick-up" purchases of commercial equipment for emergency war-time service, will have no part of the broadcast industry's custom of hanging resistors and capacitors by their leads in mid-air—an invariable source of trouble under vibration—all such components are mounted upon resistor boards, in such manner, that their fastening leads hold each part tightly against the supporting board so that leads may not vibrate, with resultant frequency shift, or break as a result of that self-same vibration. The single exception is the 50 μμfd., molded mica, phase-correcting capacitor upon the first oscillator tube socket—mounted by the less than ½" of unsupported lead length permissible even in air-borne equipment The eight frequency determining resistors, R_1 through R_{2-4}, are mounted upon their own phenolic resistor board which is a part of the range multiplier switch. All other resistors are mounted upon the single long resistor board immediately behind the range multiplier switch. Resistor ratings are sufficiently conservative so that heating, with consequent impaired performance, is no problem. All wiring is of a special type stranded copper wire, which is insulated by a fabric lacing twine impregnated with butyrate, and it is color-coded to permit not only easy circuit tracing, but to permit correct initial wiring, since the wiring cable is made up in advance, laced on its layout board, and then dropped into place for the soldering of its wire ends to terminals. This constitutes all wiring with the exception of a few "hot" individual leads. Despite the fact that power transformer and filter reactors appear to be of conventional "open" construction depending upon vacuum impregnation with wax or varnish for humidity resistance, appearances are deceiving, for they employ, within the limits of an old form of construction, a new type of coil impregnation which renders their humidity resistance closely equal to military approved types of potted and poured units—a new invention the details of which may not be revealed as yet.

The circuit diagram of Fig. 3 tells most of the electrical design story. Vacuum tube V_1, a 6SJ7 and V_2, a 6K6GT, form a two-stage resistance coupled amplifier, the output of which is coupled back to its input through the Wein Bridge composed of R_1, R_2, R_3 and R_4. The frequency determining bridge arms are made up of R_1, in series with C_{1-1} and R_2 shunted by C_{1-2}, the gang capacitors. C_2 is the only "trimmer" adjustment, compensating C_{1-1} for the greater circuit stray capacities which of necessity shunt C_{1-2} in any practicable mechanical design. C_2 balances the bridge for constant output amplitude and low harmonic distortion.

Two-gang switch S_1 selects equal values of R_1 and R_2 for the different frequency ranges, there being four pairs of resistors making up R_1 and R_2 beginning with a 10 megohm pair for the low-frequency range and progressively diminishing by a factor of 10 for each pair to the 10,000 ohm pair used for the 20,000 through 200,000 cycle range. Each pair is selected to within ½%, which, with gang capacitor accuracy of ½%, assures overall dial calibration accuracy of 1%. R_3 is the feed-back resistor, and upon correct selection of its value depends, as does the match of C_1, C_2 and R_1, R_2, the freedom from harmonic distortion which may be obtained—averaging less than 1% from this type of oscillator. R_4 is a 3-watt, 110-volt lamp, used because of its negative resistance characteristic. In operation it never heats to the point of glowing visibly, but its filament in a vacuum does vary in resistance with the magnitude of applied voltage in a most beneficial manner, while its relative warmth tends to swamp out external temperature variations. This lamp, in conjunction with correct proportioning of other circuit constants, operates to maintain oscillator output voltage constant in reference to frequency.

Vacuum tubes V_3, a 6SJ7 and V_4, a triode-connected 6K6GT, form a two stage amplifier to isolate the oscillator proper from the load the oscillator may be used to drive, and which may vary from resistive through capacitative to inductive—a variation no calibrated oscillator should ever be asked to feed directly, if its calibration is expected to remain fixed—and fixed, it remains in this type of circuit by virtue of careful selection of component values, quality, balance, and usage. The output control, allowing variation of output voltage from 0 to 30 volts across the 10,000-ohm output terminals (½ watt maximum) and from 0 to 1.5 volts at 500 ohms output (25 milliwatts maximum), is the grid circuit potentiometer of V_3, variable resister R_{13}, following the oscillator proper and preceding its amplifier. Variation in output impedance is provided by switch S_4, which switches the output isolating capacitor C_8, in series with the "high" output terminal, either to the plate of V_4

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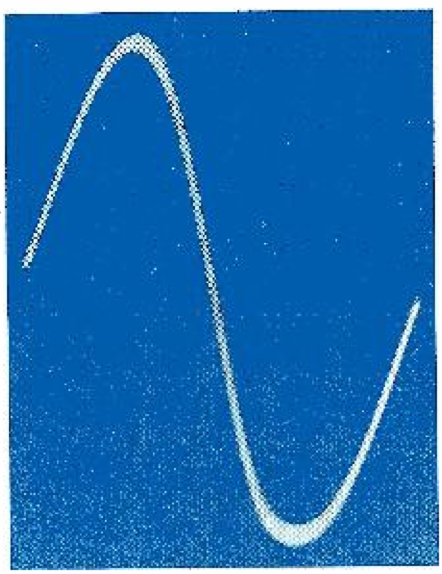
Fig. 5. Sine-wave output obtainable, as pictured at 200 cycles-per-second.



THEORY AND APPLICATION OF U.H.F

by MILTON S. KIVER

Part 1, covering basic theory of ultra-high-frequencies. The series will include fundamental and advanced theory of UHF applications.

WITH the advent of many new detecting devices using ultra-high frequency waves, the war has brought us face to face with an almost entirely new field of radio. What might have taken years to accomplish, has been brought about in literally months. The ultra-high frequencies have finally come into their own.

It must not be thought, however, that these devices and all their associated apparatus are entirely new. Nothing could be farther from the truth. They are based on radio as we know it today with modifications applicable to the higher frequencies. It is with these modifications and ultra-high frequency generators that this article is concerned.

Let us review what happens when an ordinary receiving (or transmitting) tube is used in an oscillator and the frequency is increased. It will first be found by application of the usual frequency formula $f = \frac{1}{2\pi\sqrt{LC}}$ that either L or C or both must be decreased. In the final limit, *L* will consist of merely the tube leads and *C* will be the interelectrode capacitances. This has been depicted in Fig. 1A, where an ordinary Colpitts oscillator is shown and then the modified circuit for the ultra-high frequencies, Fig. 1B. The components of the frequency formula are also shown. With the above changes, frequencies up to 10 megacycles can be reached.

Fig. 1A shows the circuit diagram for an original Colpitts oscillator, the frequency of which can be determined by the following formula:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Fig. 1B is a result of reducing the Colpitts oscillator circuit so that it will operate at the ultra-high frequencies. The frequency may be determined from the following formula:

$$f = \frac{1}{2\pi\sqrt{C_T L_T}}$$

where:

$$C_T = C_{GP} + \frac{C_{CP} \cdot C_{CG}}{C_{CP} + C_{CG}}$$

$L_T = L_G + L_P$

L_P = Inductance of the plate leads

L_G = Inductance of the grid leads

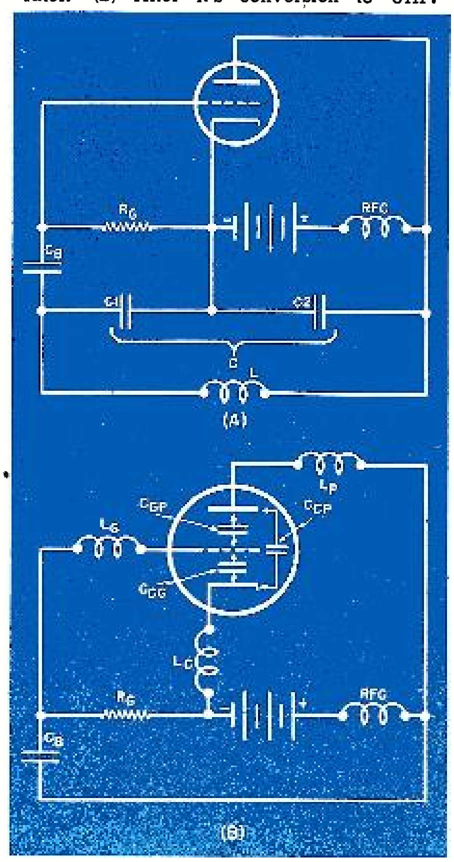
L_C = Inductance of the filament or cathode leads

C_{GP}, C_{CG}, and C_{CP} = Various interelectrode capacitances

In order to further the reduction on wavelength, designers turned to the tube itself. Dimensions were reduced until the tube had shrunk to the "acorn" and "doorknob" sizes. (See Figure 2 where the tubes 8025, 826, 9001, 9002, and 956 are shown.) Leads connected to the electrodes were brought directly out of the tube through the glass envelope, and onto these were connected the tuning elements. Isolantite and polystyrene insulators were used throughout to further minimize losses due to dielectric leakage.

While the tube design was being radically altered, so were the tuning elements. As mentioned above, in the limit the tube leads and capacitances

Fig. 1. Converting a Colpitts oscillator to UHF application. (A) Colpitts oscillator. (B) After its conversion to UHF.



were used for the tuned circuit. However, the Q of such a circuit is very low and therefore, not much power can be developed. Concentric lines and Lecher wire systems, on the other hand had the three desirable properties of a tuned circuit and so came into widespread use. The three requirements are:

1. A high Q or, what is the same thing, low ohmic, eddy-current, and dielectric losses.
2. Ability to resonate accurately with the oscillator so as to build up large values of currents and voltages.
3. And lastly, the least possible radiation of energy.

In the Lecher wire systems shown in Fig. 3A, which consists of a pair of parallel wires, resonance is accomplished by means of a shorting bar which can be easily moved along until the resonant point is found. The shorting bar changes the length of the system and hence the resonant frequency. It will be shown in a later article on transmission lines that large values of standing waves can be formed in this way. Lecher wire systems are usually a quarter wavelength or some odd multiple thereof.

The loss due to radiation of the concentric resonant line shown in Fig. 3B is appreciably less than in the open wire arrangement of the Lecher wire system. The Q of the concentric line is very high, as much as 15,000 or more, and in order to make the concentric line flexible, a moveable shorting stub is used and the effective length adjusted to a quarter wavelength or some odd multiple thereof. Furthermore, when the concentric line is tuned so that there is a standing wave with a current node (a zero value) at the open end of the line, the high-frequency current is confined to the inside of the lines. Direct voltages can then be applied directly to the concentric lines without having the high-frequency currents flowing in the supply lines. Another advantage obtained by this confining of the electric fields inside the concentric lines is the absence of body capacitance effect on tuning. It is only when the length required becomes unwieldy that other means are sought.

In Fig. 4A is the circuit diagram of an ultra-high frequency oscillator using a Lecher wire transmission line for the tuned circuit. This is the fa-

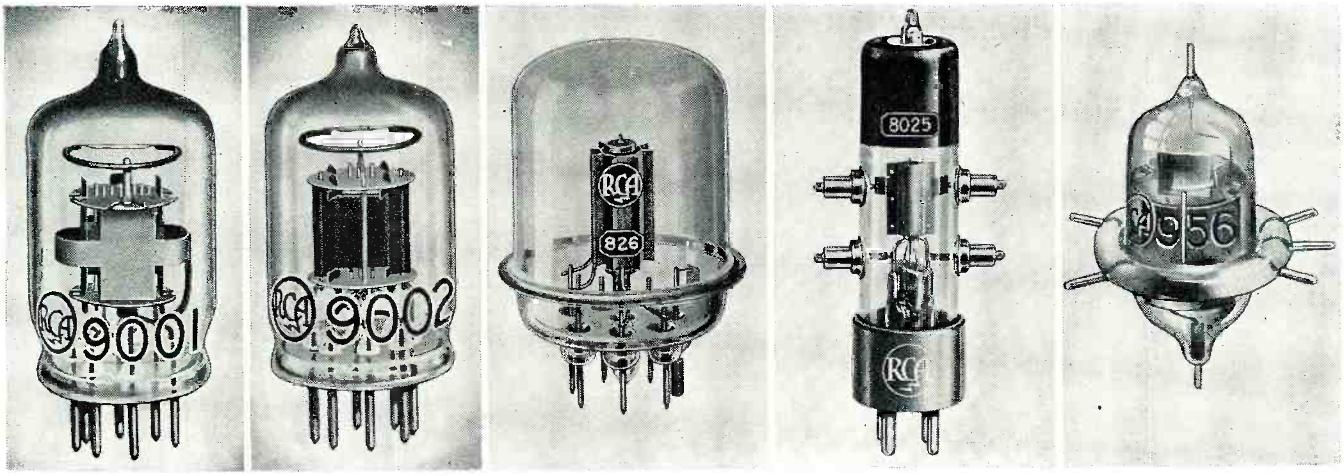


Fig. 2. Number of different tubes that have been designed specifically for ultra-high-frequency applications

miliar ultraudion oscillator shown in Fig. 4B in its usual form for the low frequencies. In adjusting this high frequency oscillator the plate and grid leads are tapped onto the quarter-wave tuning line as close to the shorted end as possible in order that, for a given voltage from the tube, the open-end voltage may be as large as possible. To transfer energy from this

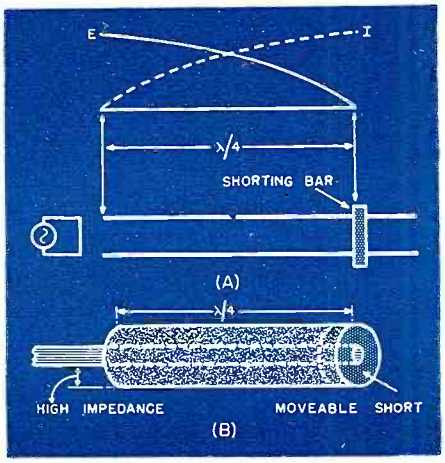


Fig. 3. (A) Lecher wire system showing possible current and voltage distribution on wire. There are many such distributions possible. (B) Concentric resonant line.

oscillator to an antenna or amplifier, a small loop of wire is placed near the line to pick up the required energy. Generally, the tap adjustment is made with the load coupled to the line. A peculiarity to be noted in Fig. 4A is the presence of coils and condensers in the filament leads. The effective or electrical length of this circuit is one-half wavelength, thus preventing the loss of energy through the filament supply lines. Instead of the coils and condensers, we might also have used concentric line stubs and tuned them to the required wavelength.

For a push-pull arrangement, Fig. 5 might be suggested. Here again, we have a quarter-wave transmission tuner and shorting bar for our resonant circuits, the plate and grid each having one. To tune this oscillator the grid resonant circuit is first set, and then the shorting bar in the plate quarter-wave system is slowly moved until a point of resonance is found. The output is taken off from a point of high voltage (called a voltage antinode) by means of a pair of condensers. All leads in these high-frequency oscillators should be as short as possible.

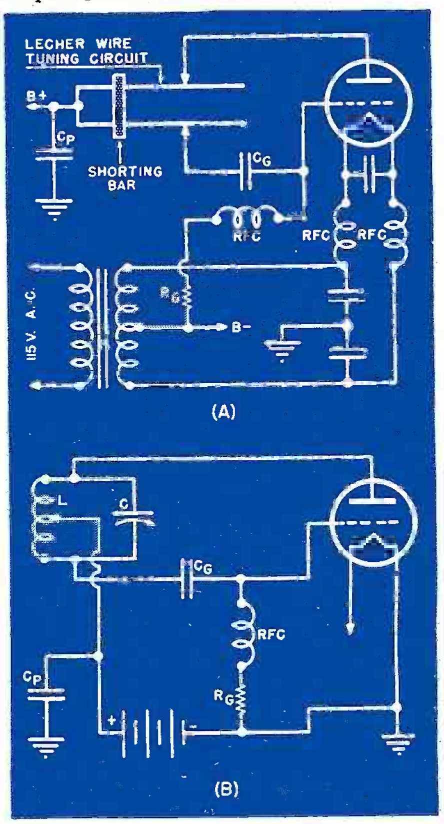
One of the shortest wavelengths reached by these oscillators (about 17 centimeters) utilizes the 368A tube. A circuit diagram of such an oscillator is shown in Fig. 6. Due to the double-ended construction of this tube, it is possible to place it at the center of a half-wave concentric line system with closed ends. Because the lumped interelectrode capacitance may be assumed to be divided between the two quarter-wave halves of the concentric line system, the frequency of oscillation is higher than in the single-ended case, where all the capacitance is associated with one quarter-wave circuit. Also, since only half the charging current flows through each set of leads, there is a decrease in the amount of power lost.

While the above modifications succeed in raising the frequency that can be generated, a limit is still reached somewhere in the neighborhood of 600 megacycles. This represents the usable limit—but models for experimental purposes have gone beyond this. The reason for this limit is something which in ordinary tubes is completely disregarded, namely, the time of flight of an electron between the cathode and the plate, called transit time.

At the low frequencies, the time it takes an electron to travel the interelectrode distance is considered as instantaneous, because this time represents a small portion of the time it takes to complete one cycle of the alternating wave. As the frequency, however, is raised, the time needed for one complete cycle becomes less and less and soon the electron transit time becomes comparable to the period of the alternating wave. When this happens, there is a phase shift between the plate current with respect to the grid voltage, and the effective grid conductance of the tube increases, thereby lowering the Q of the input tuned circuit and the efficiency of the tube.

In order to help visualize the entire process, let us first revise or rather extend some of our ideas of electron flow. Ordinarily, we do not think of current flowing in either the plate or grid circuit until the electrons from the cathode hit these elements. Actually, however, this is the point that completes a cycle begun when the electron first leaves the cathode. The charge of the electron is negative, and at the moment it leaves the cathode the conditions shown in Fig. 7A prevail. Here it can be seen that by leaving the cathode the electron has left an equal and opposite (or positive)

Fig. 4. Ultraudion oscillator. (A) At ordinary frequencies and (B) when used at UHF.



charge on the cathode. At the same time a very small positive charge is induced on the plate due to the fact that since the cathode electron is now slightly closer to the plate, one electron on the plate has been repelled a small distance from the anode surface. As the cathode electron gets closer and closer to the plate, the positive charge of this anode will correspondingly increase, and the electron that was originally at the plate will be further and further repelled from the anode toward the cathode through the wire. When the cathode electron finally reaches the plate, it neutralizes the positive charge there and likewise, the anode electronic effect by this time has reached the cathode and has neutralized the positive charge there. The circuit is now in equilibrium and the current flow has ceased. (See Fig. 7C.) Multiply this electron by the billions that actually flow and we have our large plate currents in motion.

The above idea is not new, but has seldom been mentioned because at low frequencies results obtained agree with our ordinary concepts of electron flow in tubes. With increase of frequency, however, the transit time effects as far as the grid is concerned requires that this more general idea be used. Now we shall see how the grid is affected.

When an electron approaches the grid, there is induced in it a small charge with the result that a small current is obtained due to the displacement of the charges in the grid caused by the oncoming electron. If the frequency is low, this induced current caused by the approaching electron will be equal and opposite to the induced current when the electron passes the grid and goes to the plate. The two currents will thus cancel. As the frequency is raised, however, there will exist differences between the phases of the various induced currents and complete cancellation will not occur. Hence, it is the in-phase component of this induced grid current which is responsible for grid losses. All energy that causes these currents must be absorbed from the inter-space electrons, thus leaving less energy available for the plate circuit.

Another way of saying the same thing is to deal in terms of conductances, which is the reciprocal of resistance. A high resistance means a small conductance and vice-versa. Ordinarily the conductance shunted across the grid is zero which indicates infinite resistance. As the frequency is raised, the conductance of the grid increases as the square of the frequency according to the formula:

$$G_g = Kg_m f^2 T^2$$

G_g = is the input conductance.

K = is a constant of the tube.

g_m = is the mutual conductance of the tube.

f = is the frequency under consideration.

T = is the time of electron transit from one point in the tube to another.

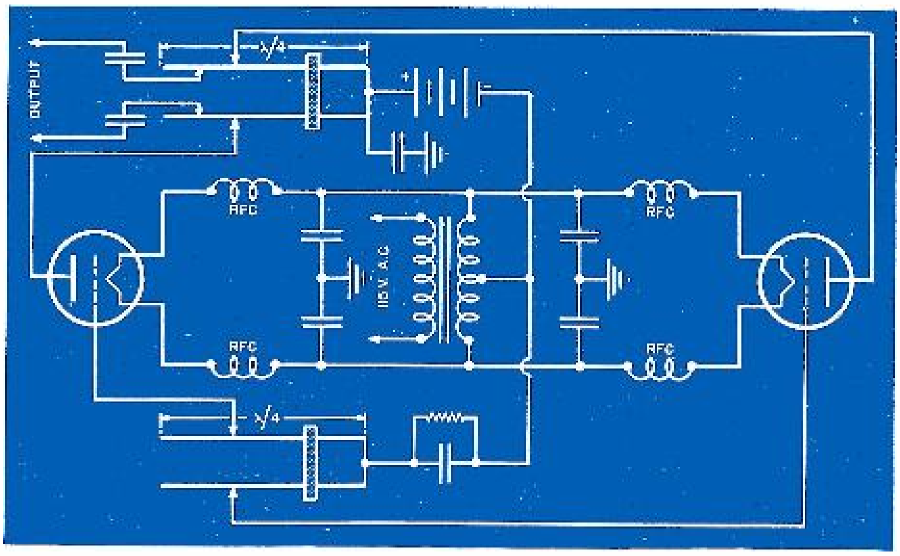


Fig. 5. A push-pull ultra-high-frequency oscillator circuit.

Inspection of the above equation reveals that the conductance rapidly assumes great importance as the frequency is raised.

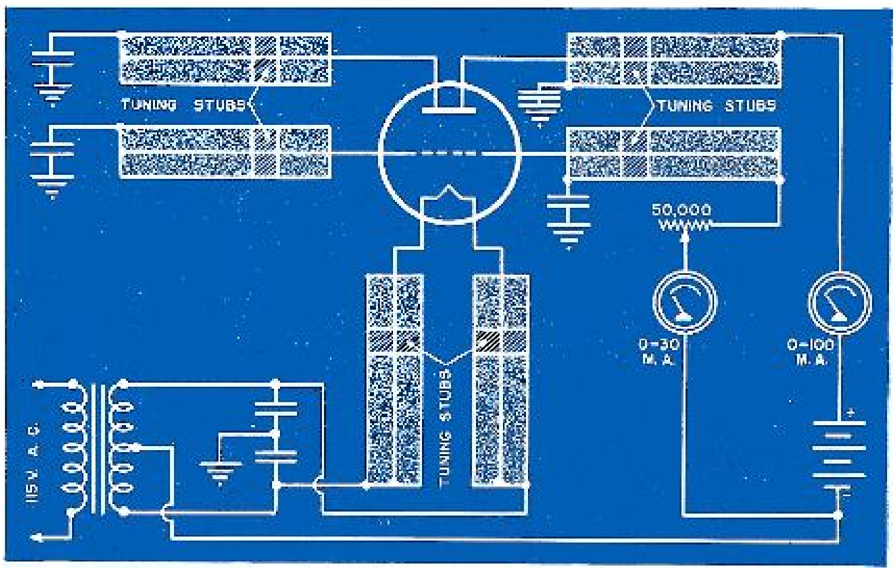
Since the conductance of the grid usually shunts the tuned circuit, an increase of this parameter will increase the energy dissipation. One way to overcome the effect of transit time is to increase the voltages on the electrodes, thus speeding the electron up and allowing it to remain less time in the interelectrode spaces. But this increase of operating voltages will necessarily increase the heat dissipated at the anode and so has its limitations. Another way that has been used to counteract transit time is to move the electrodes closer together, but the closer the electrodes are to each other, the less is the allowable heat that can be lost at the plate without physical injury to the grid structure. Thus, we have reached an impasse and other ways must be found that will allow large amounts of power to be efficiently generated at the very high frequencies.

One of the first attempts to get away from using the triode in its conventional form was brought about by Barkhausen and Kurz in 1920. They discovered that by placing a large positive voltage on the grid and either a zero or slightly negative voltage on the plate that oscillations of a high frequency were produced. Over a short range of grid and plate voltages, it was found that the frequency of oscillation was independent of the Lecher wire system attached to the tube and was dependent only on the transit time of the electrons within the tube. Wavelengths generated by Barkhausen and Kurz varied from 43 to 200 centimeters and were found related to the grid potential by the formula: $\lambda^2 E_g = K$, where K is a constant of the circuit.

In 1922, Gill and Morrell, working with an oscillator similar to the B-K oscillator, found that for the range from 200 to 500 centimeters the gen-

(*Continued on page* 92)

Fig. 6. The 368A type tube used for very-high frequencies.



AUDIO-FREQUENCY METER

by GUY DEXTER

A laboratory instrument incorporating many new refinements in an audio-frequency meter, while retaining single adjustment control.

AN important application of the Wien bridge circuit is the simple audio-frequency meter shown in Figure 1. By means of this setup, frequencies between 20 and 15,000 cycles-per-second may readily be identified. Operation of the circuit is based upon the fact that the bridge may be balanced for only one frequency at a time; and at null, an unknown input frequency may be determined from the corresponding resistance and capacitance values.

The nature of the Wien bridge circuit is such that, if R_3 is made twice R_1, C_1 equal to C_2, and R_4 equal to R_5, the frequency at which the bridge is adjusted to null may be determined from:

$$f = \frac{10^6}{6.28\ RC}\ \text{c.p.s.} \quad \ldots \quad (1)$$

where R is the resistance in ohms of R_4 or R_5 at null, and C is the capacitance in μfds. of C_1 or C_2.

Since R_4 and R_5 will be equal at all settings, their control shafts may be ganged and operated from a single dial graduated in cycles-per-second according to Equation (1). It may be shown that by making the capacitance value of C_1 and C_2 .0159 μfd., a dual 500,000-ohm rheostat in the R_4-R_5 position will permit coverage of the entire range from 20 to 15,000 cycles-per-second.

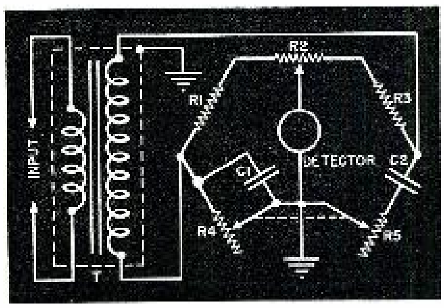


Fig. 1. Wien bridge audio-frequency meter.

It is necessary to incorporate into the circuit a small potentiometer, R_2, for resistance balance. This component is generally of the order of 100 ohms and does not alter the R_4-R_5 setting, serving only to give a sharper null. Since the input circuit of the bridge will not have a common ground with the generator and detector, the shielded transformer, T, is recommended for stable operation.

Sensitivity and accuracy of the audio-frequency meter will be increased by employing a vacuum-tube voltmeter, with high-impedance input, as the bridge detector in Figure 1. Sensitivity is increased, likewise, by an increase of the input voltage level.

Chief disadvantages of the simple Wien bridge-type audio-frequency meter are the necessity for a shielded input transformer and resistance balance, its lack of a common ground with the generator, and its relatively low input impedance.

The parallel-T network (Fig. 2) offers several advantages over the Wien bridge, while retaining the simple balance condition of Equation (1). In this network, symmetry of the two separate T sections is preserved. The two sections consist of R_1-R_2-C_3 and C_1-C_2-R_3. The common ground is at point G. By making C_1 equal to C_2 and to one-half the value of C_3, and R_1 equal to R_2 and twice the value of R_3, the resistance balance is always satisfied and for the reactive balance:

$$f = \frac{10^6}{6.28\ R_1\ C_1}\ \text{c.p.s.} \quad \ldots \quad (2)$$

Where R_1 is in ohms and C_1 in μfds.

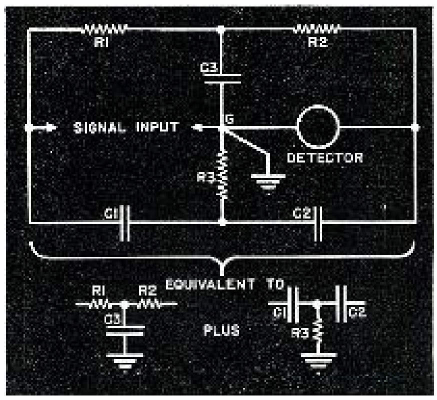


Fig. 2. Parallel-T network type a-f meter.

$$\text{since,} \quad (6.28F)^2 = \frac{C_1 + C_2}{R_1 R_2 C_1 C_2 C_3}$$

It is seen from Equation (2) that the parallel-T network may be employed to determine unknown frequencies in the audio range. From the foregoing discussion, it is also evident that three network components must be varied simultaneously. These will be R_1, R_2, and R_3 or C_1, C_2 and C_3. But since variable capacitors

Resistance settings of the three resistors in Fig. 4, corresponding to frequency.

TABLE I

C_1 & C_2 = 0.0159 μfd.			C_3 = 0.0318 μfd.		
f (c.p.s.)	R_1 & R_2	R_3	f (c.p.s.)	R_1 & R_2	R_3
20	500,000	250,000	950	10,550	5275
30	334,000	167,000	1000	10,020	5010
40	250,200	125,100	1500	6,670	3335
50	201,000	100,500	2000	5,010	2505
60	167,000	83,500	2500	4,010	2005
70	142,900	71,450	3000	3,340	1670
80	125,500	62,750	3500	2,862	1431
90	111,500	55,750	4000	2,502	1251
100	100,200	50,100	4500	2,224	1112
150	66,700	33,350	5000	2,002	1001
200	50,100	25,050	5500	1,823	911.5
250	40,100	20,050	6000	1,670	835
300	33,400	16,700	6500	1,540	770
350	28,624	14,312	7000	1,431	715.5
400	25,050	12,525	7500	1,336	668
450	22,250	11,125	8000	1,252	626
500	20,030	10,015	8500	1,180	590
550	18,230	9,115	9000	1,113	556.5
600	16,700	8,350	9500	1,055	527.5
650	15,400	7,700	10000	1,002	501
700	14,310	7,155	10500	960	480
750	13,360	6,680	11000	911	455.5
800	12,520	6,260	11500	871	435.5
850	11,800	5,900	12000	834	417
900	11,120	5,560	12500	802	401

are not available in high capacitance values as required for audio-frequency response, the network will be resistance-tuned when operated as an audio-frequency meter.

For continuous coverage of the entire audio-frequency spectrum without range switching, R_1 and R_2 will each have a maximum resistance of 500,000 ohms. The maximum resistance of R_3 will be 250,000 ohms. C_1 and C_2 will each be .0159 μfd's in capacitance; C_3 .0318 μfd's. Resistance settings for all three resistors, corresponding to a number of frequencies, are given in Table 1.

It is difficult, in general, to obtain for the R_1-R_2-R_3 position commercial megohm-type triple-ganged controls which track sufficiently well for application in the parallel-T network. For this reason, numerous experimenters will prefer to use a set of lower resistance values than those given in the preceding paragraph, and to cover the audio-frequency spectrum in several ranges rather than in one dial rotation. With a low maximum resistance, a small frequency range will be covered with any given set of C_1, C_2, and C_3 values. The basic range, however, may be multiplied by simultaneous switching of all three capacitances to a new set of values.

Table II applies to such a range switching arrangement with low-value variable resistors. The basic frequencies (20-200 cycles) in the first column are those obtained with the three capacitance values in the fourth and fifth columns. To multiply these basic frequencies by 10 (transforming range to 200-2000 cycles) or by 100 (transforming to 2000-20,000 cycles), the three capacitances are switched simultaneously to the corresponding values given. A 3-pole, 3-position non-shorting selector switch is required for this range switching.

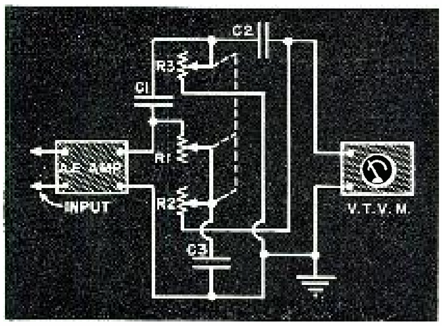


Fig. 3. Basic schematic arrangement of the improved audio-frequency meter.

Improved Circuit

As in the Wien bridge, sensitivity of the parallel-T audio-frequency meter is improved by employment of a vacuum-tube voltmeter as a detector, and the instrument is given high input impedance when an amplifier stage is added. Fig. 3 shows the basic schematic arrangement of the improved audio-frequency meter.

Advantages of the improved meter are (1) high input impedance, (2)

(*Continued on page* 78)

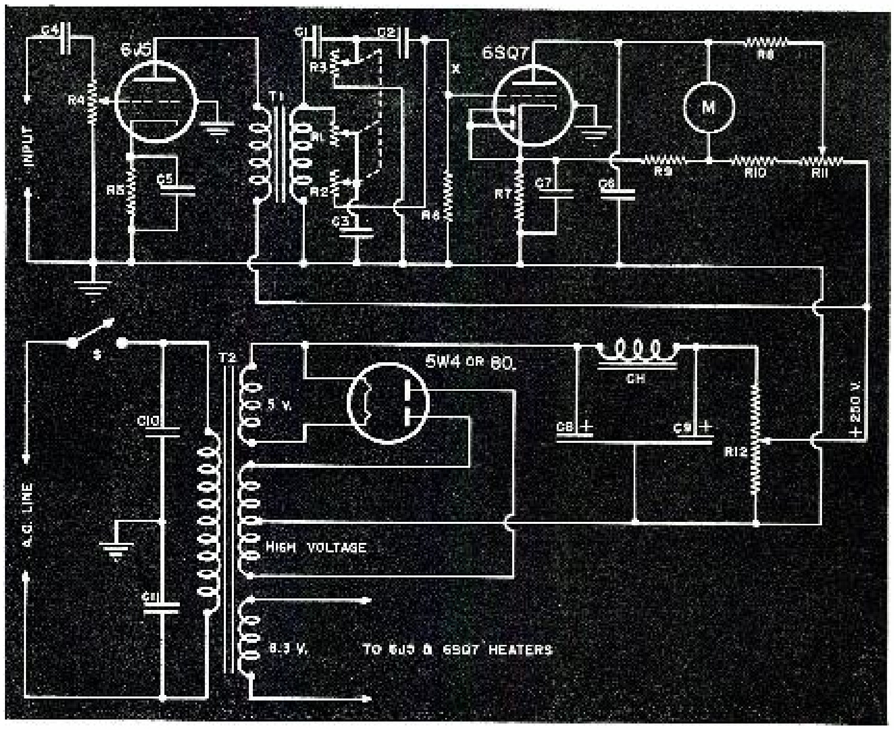


Fig. 4. The complete circuit diagram of the audio-frequency meter.

C_1, C_2, C_3—See Text.
C_4,—.001 μfd., mica cond.—Aerovox 1467.
C_5, C_7—.1 μfd., 200-volt tub.—Aerovox 284.
C_6, C_{10}, C_{11}—.1 μfd., 400-volt tub.—Aerovox 484.
C_8, C_9—Dual 8 μfd., 450 w.v. elect.—Aerovox PRS. 8-8.
CH—10 henry 35 ma., filter choke—U.T.C. R-55.
M—0-500 D.C. Microammeter—Triplett Model 221.
R_1, R_2, R_3—See text.
R_4—1 megohm potentiometer—I.R.C. Type CS.
R_5—1500 ohm, 1 watt resistor—Aerovox 1098.
R_6—1 megohm, 1 watt resistor—Aerovox 1098.
R_7—1400 ohm, 1 watt resistor—Aerovox 1098.
R_8—20,000 ohm, 1 watt resistor—Aerovox 1098.
R_9—240,000 ohm, 1 watt resistor (200,000 and 40,000 in series)—Aerovox 1098.
R_{10}—7000 ohm, 1 watt resistor—Aerovox 1098.
R_{11}—3000 ohm wirewound potentiometer—I.R.C. W-3000.
R_{12}—50,000 ohm, 75 watt bleeder resistor (with slider)—Aerovox 956.
S—s.p.s.t. toggle switch—Arrow.
T_1—Interstage transformer—U.T.C. S-1.
T_2—Power Transformer: 325-0-325 v., 40 ma.; 5 v., 2A.; 6.3 v., 2A—U.T.C.R-1.

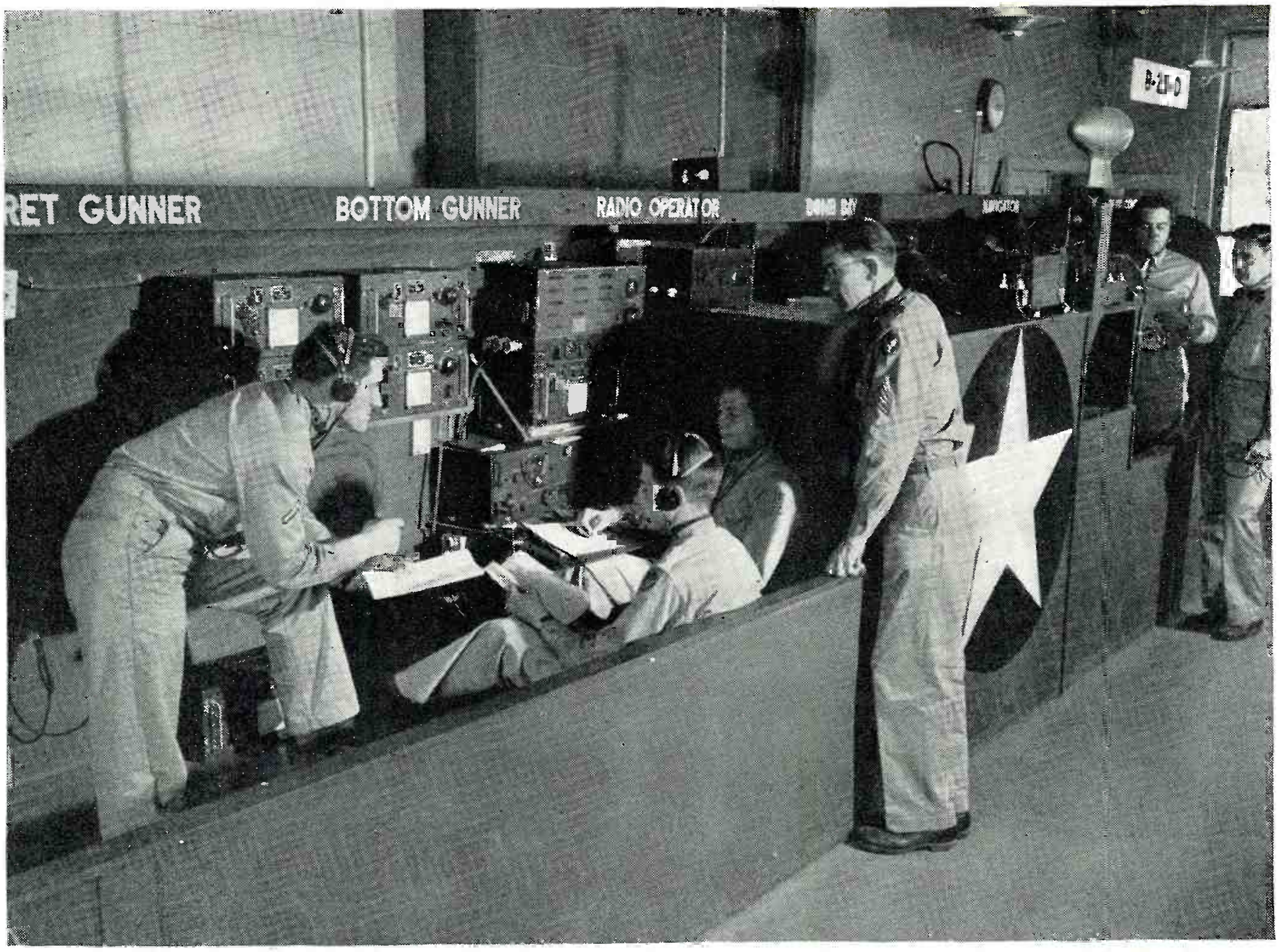
Values given in table may be used to calculate frequency when calibrating instrument.

TABLE II

f	R_1 & R_2	R_3	C_1 & C_2	C_3
20	10,000	5,000	0.796 μfd.	1.592 μfd.
25	8,000	4,000	"	"
30	6,670	3,335	"	"
35	5,730	2,865	"	"
40	5,000	2,500	"	"
45	4,450	2,225	"	"
50	4,000	2,000	"	"
55	3,640	1,820	"	"
60	3,335	1,667.5	"	"
65	3,080	1,540	"	"
70	2,865	1,432.5	"	"
75	2,670	1,335	"	"
80	2,500	1,250	"	"
85	2,355	1,177.5	"	"
90	2,225	1,112.5	"	"
95	2,108	1,054	"	"
100	2,000	1,000	"	"
110	1,820	910	"	"
120	1,667.5	833.75	"	"
130	1,540	770	"	"
140	1,432.5	716.25	"	"
150	1,335	667.5	"	"
160	1,250	625	"	"
170	1,177.5	588.75	"	"
180	1.112.5	556.25	"	"
190	1,054	527	"	"
200	1,000	500	"	"

To multiply frequencies in column 1 by 10,
C_1 & C_2 = 0.0796 μfd.
C_3 = 0.1592 μfd.
(Range: 200-2000 cycles)

To multiply frequencies in column 1 by 100,
C_1 & C_2 = 0.00796 μfd.
C_3 = 0.01592 μfd.
(Range: 2000-20,000 cycles)



A rear view of the bomber shows the various stations of the crew members with the emphasis on the radio equipment. Sgt. Roy Martle, instructor, is shown at right foreground, outside of the fuselage watching future radiomen for America's bombers.

☆ Radio Mock-ups ☆

RADIO mock-ups, sensational devices for training aircraft radiomen, which were revealed recently to be in operation at *Scott Field,* parent radio school of the Army Air Forces Technical Training Command, have made important new strides forward.

Matching America's increasing production of planes and pilots, this AAFTTC school has so perfected the teaching of radio communications that soldier-students may now become familiar with the radio systems of four different bombers, operate them with all the hazards of actual flight involved and never leave the school building in which they're studying.

The latest type of mock-ups are known more accurately as "semi-mock-ups" and are constructed of plywood with one side open to facilitate study and classroom operation. Besides demonstrating operation of the radio equipment, the purpose of the semi-mock-ups is to acquaint men with the precise location of various communications equipment.

Thus, in Aircraft Radio Branch buildings, a student comes face to face with the plywood replicas of a B-17-E or Flying Fortress, B-25-D, medium bomber known as the Mitchell B-24-D, Liberator, and a B-26-D Marauder.

In the mock fuselages, built to scale, the radio equipment is placed as in the actual aircraft. Every detail is complete and correct, except that the bomb bays are slightly smaller than in real planes. Only item lacking is the engine of the airplane which ordinarily supplies the power.

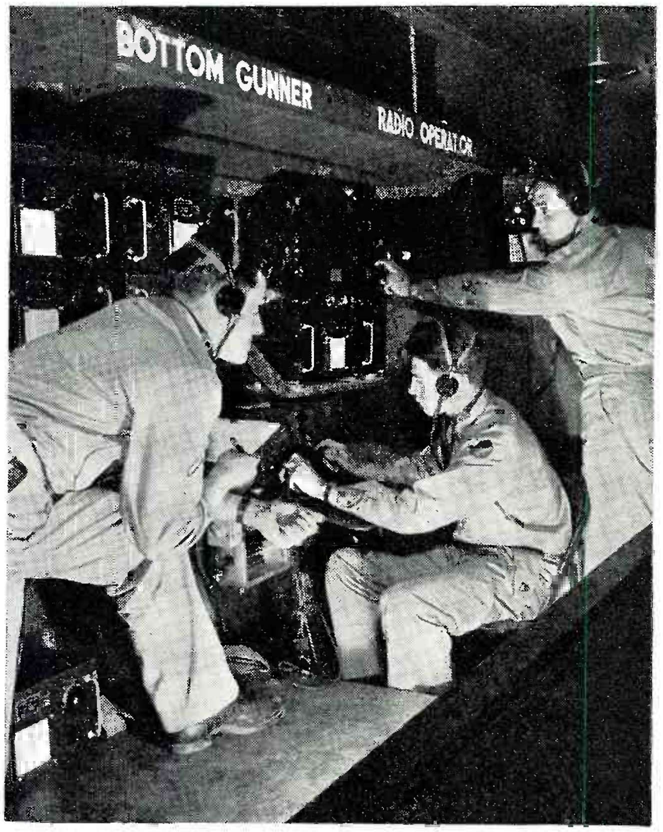
Instead of an engine a three-phase motor generator in the power room is used as a power supply in conjunction with an inverter which converts the direct current into the 400 cycle, 115 volts necessary for parts of the equipment.

Each mock-up consists of various compartments such as in the B-24 where there is space for the pilot radio operator, bomb bay, bottom turret, waist gunner and tail gunner.

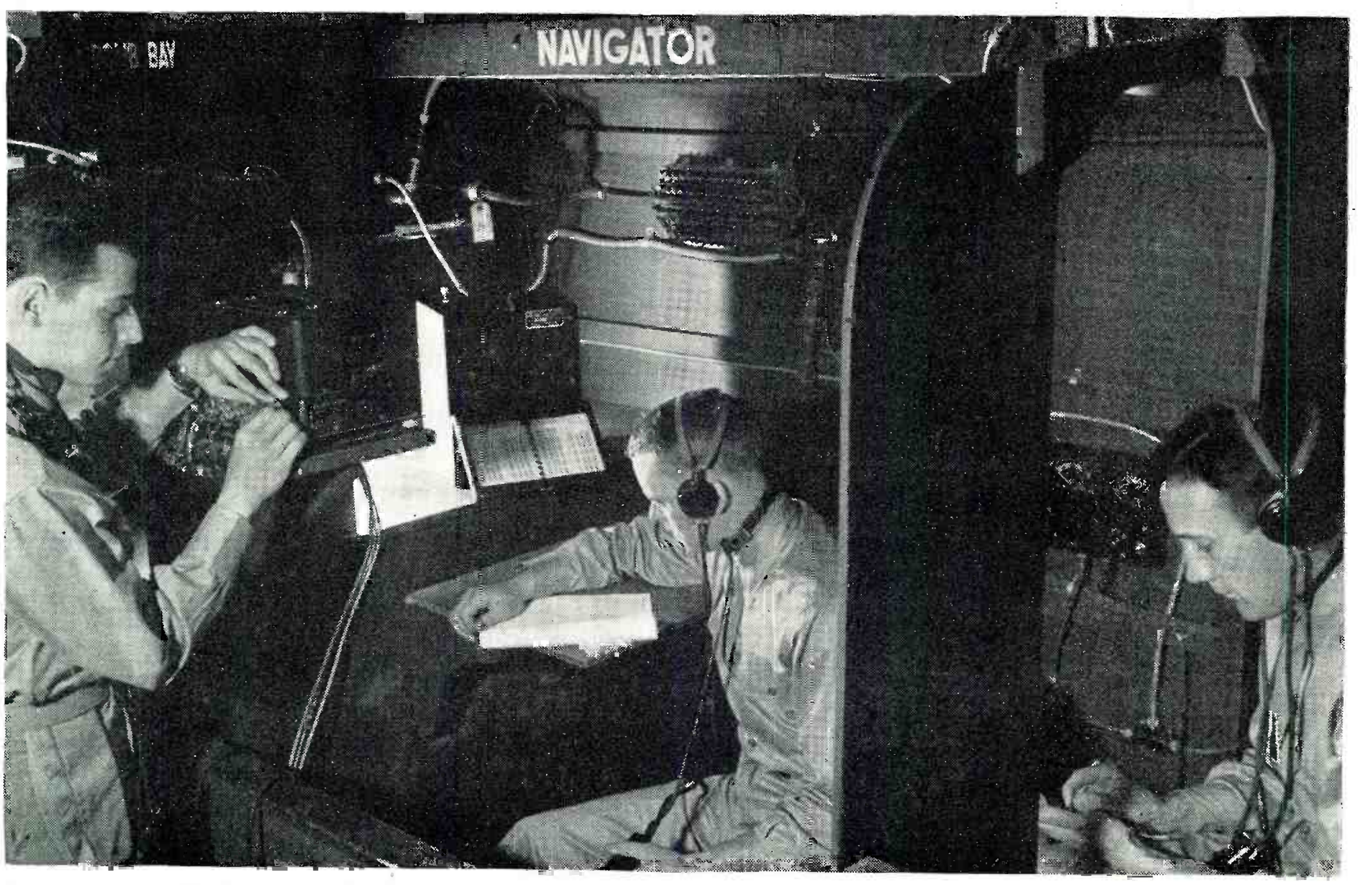
Each compartment has its necessary component parts of communication equipment and, in this manner, the student is able to grasp the actual placement of the communication equipment in various types of planes.

(*Continued on page* 70)

Semi-mockup built according to the exact scale of a B-25-D medium bomber, known as a Mitchell. Student in foreground is acting as pilot on a simulated radio flight.



Radiomen receiving instructions on aircraft radio operation. Simulated flight practice is obtained by each student before he can become a full-fledged operator.



All sections of a bomber are hooked up to the radio system and while student (center) takes the part of a navigator, another at the left makes adjustments of the connections to the power supply unit. In this way AAFTTC students receive practical training in schoolrooms before they ever enter a real plane.

AM VS. FM IN TWO-WAY RADIO

By S. FREEDMAN

The advantages and disadvantages of frequency modulation compared to amplitude modulation as applied to police communications.

THE writer has engineered and supervised the construction of more than fifty 2-way radio systems during the past ten years. These included the Main State Police state-wide and the Cape Cod Police Radio System county-wide. In organizing these systems, new developments were quickly incorporated as they became known and feasible.

During this period, 2-way radio progressed in three stages. The first was the use of the modulated oscillator type of transmitter and super-regenerative receiver employing amplitude modulation. The second was the crystal-controlled oscillator type of transmitter and superheterodyne receiver employing amplitude modulation. The third was the Armstrong system of frequency modulation transmitter and receiver.

All three of these categories gave satisfactory performance so far as enabling police and other public agencies in the emergency service to have 2-way communication with their mobile units. It rendered great public service and led to nationwide adoption of mobile communication.

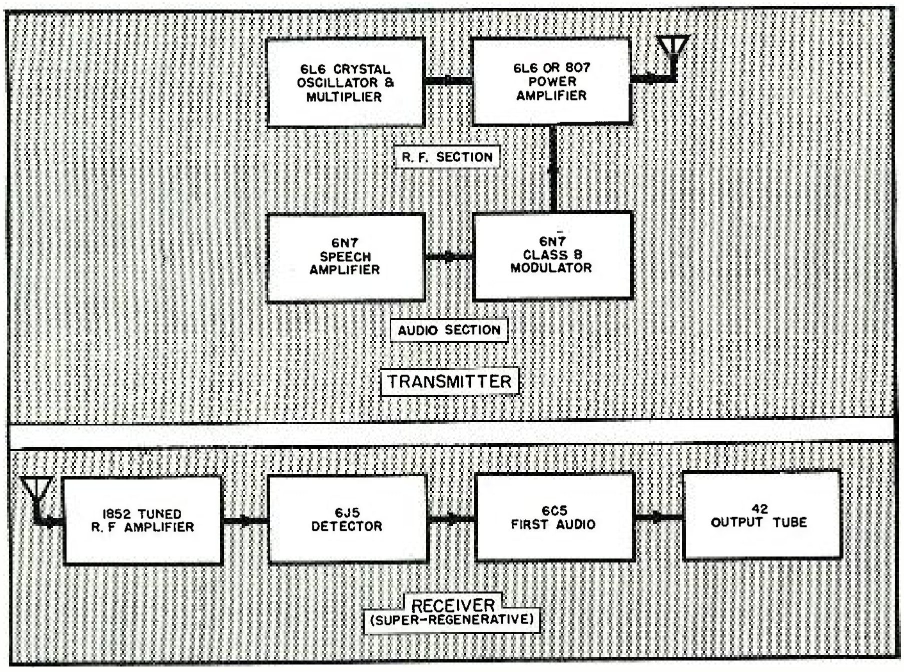
As more systems came on the air and channels began to get crowded, modulated oscillators were found to occupy too much channel space and drifted in frequency. Crystal-controlled transmitters were developed with frequency tolerances not exceeding .01 percent. Up to that time, super-regenerative receivers were almost a necessity because the super-heterodyne was too sharp to use on modulated oscillator signals. The super-regenerative receiver has always been very sensitive, but its quality was poor; it hissed excessively on standby condition, and it would cause a squeal to be heard on other receivers as much as five miles, depending on antenna height over the horizon. For these reasons, the super-regenerative receiver has been constantly replaced by the super-heterodyne, although many are still in operation in rural areas.

Even the crystal-controlled oscillator and super-heterodyne receiver were not the final answer. Ignition and many other forms of interference were making it impossible to utilize the maximum sensitivity of the super-heterodyne receiver. Frequency Modulation used by the Connecticut State Police, came into being with remarkable ability to ignore interference and static of many kinds, permitting receivers to operate at maximum sensitivity and resulting in much greater ranges and improved clarity of reception.

It is the purpose of this article to convey to the readers of this magazine, just what can be had when employing amplitude modulation and when employing frequency modulation. By block diagrams, functional comparisons, and quoting actual tests made with both types of equipment under identical conditions and in identical areas, the writer is endeavoring to compare the two types of communication.

Illustrated in chart form in Fig. 1, are the tube complements of AM. communication equipment, designed

Fig. 1. Typical AM equipment used in police radio cars, showing block diagram of the tube line-up of a transmitter and super-regenerative receiver. If the receiver is of the super-heterodyne type the tube line-up would be as shown in the tables listed below. Tube complements are shown for two different manufacturers.

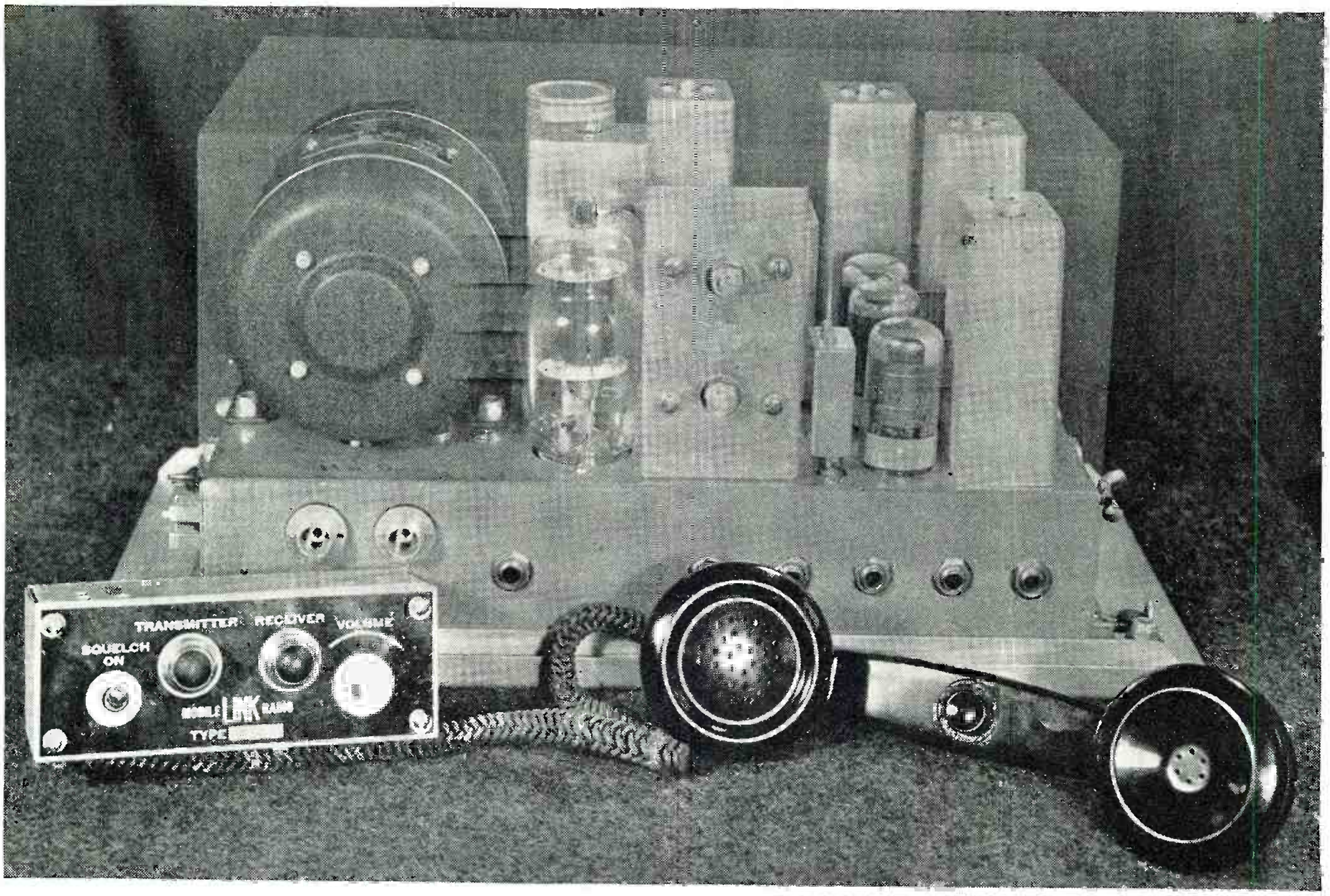


MANUFACTURER A

1852 RF Amplifier
6V6 Oscillator
6K8 First Detector Amplifier
6K8 Second Detector Amplifier
6B8 IF amplifier and AVC
6H6 Third Detector and Noise Limiter
6C8 Squelch Tube and Audio Amplifier
6K6 Audio Output Tube.

MANUFACTURER B

1853 RF Amplifier
6L7 Mixer
6K7 Crystal Oscillator and Multiplier
6K7 First IF Amplifier
6K7 Second IF Amplifier
6Q7 Detector, Squelch, AVC.
6SF5 First Audio
6V6 Audio Output
6H6 Noise Silencer.



The 25 watt FM transmitter installed in mobile units for the South Portland, Maine, Police, Fire, and Public Works Department. This transmitter worked up to 58 miles, car to car with a corresponding receiver.

by two different manufacturers.

Listed in Fig. 4 are the tube line-ups of FM Transmitters for the three leading manufacturers of two-way FM mobile equipment. All operate on the 32nd harmonic of the crystal. For 15 kilocycle swing in each direction, this is equivalent to only one-half a kilocycle drift of the crystal. These transmitters deliver about 25 watts output in operation and require approximately 27 amperes drain from car battery during transmission.

The FM receivers described in Fig. 4 draw from 5 to 6 amperes and are energized from the car storage battery and vibrator plate supply. Equipment employed, had 2 crystals in the receiver. One was cut to the operating frequency less 5000 kilocycles divided by eight. The other crys-

Fig. 2. The limitations of AM and FM in actual practice. These values were taken on an actual range test in the State of Maine, car to car.

FROM	TO	DISTANCE	COVERAGE
Quoddy, Maine	Calais, Maine	25 miles	AM dropped out at 12 miles. FM covered the entire area and 18 miles beyond Calais with an inconsistent area at 12 to 18 mile zone due to terrain.
Eastport, Maine	Calumbia Falls, Maine	58 miles	AM worked 25 miles with bad and frequent blank spots after 10 miles. FM held signal for 49 miles and then worked intermittently 9 miles more.
Wiscasset, Maine	Portland, Maine	53 miles	AM undetermined. FM worked spottily from Wiscasset to Bath but thereafter was consistent for last 40 miles into Portland.

In computing probable operating ranges in advance, the writer has found the following formula surprisingly accurate in New England.

For Amplitude Modulated systems on ultra high frequencies:

$$\sqrt{H_1 + H_2} \bullet 1.4 = \text{range in miles.}$$

For Frequency Modulated systems with deviation ratio of 5.

$$\sqrt{H_1 + H_2} \bullet 1.7 \text{ to } 2.0 = \text{range in miles.}$$

H_1 is height of transmitting antenna.

H_2 is height of receiving antenna.

1.4 is factor that the square root of both heights combined should be multiplied by for Amplitude Modulation.

1.7 to 2.0 (it is not definite but are the average minimums and maximums experienced) for the FM factor.

FIG. 3. FUNCTIONAL COMPARISONS FM vs. AM

	AM	FM
Carrier Frequency.	Remains constant.	Varies with modulation.
Amplitude of RF Carrier.	Shape and amplitude vary with level of modulation.	Remains constant.
Radiated Power.	Power varies with modulation.	Remains constant.
Frequency Deviation.	Remains constant except for sidebands.	Depends on LEVEL of the modulating frequency. NOT dependent on the modulating frequency itself.
Effect of modulating frequency.	Varies width of sidebands.	Merely determines how fast the carrier frequency shifts.
Effect of 2 stations operating simultaneously on same frequency.	Produces intolerable and unintelligible howl. One station must be 30 to 100 times more powerful than other to break through the other.	The louder station predominates particularly, if twice as strong. It may fluctuate between one and the other, but usually both never are heard together. A very small zone may occur where slight flutter or both may be heard together. No squeal or howl at any time.
Effect of static, lightning, ignition or induction interference.	Susceptible to all these.	Only evident when it has a frequency and wave-form that covers conditions of operation. Automobile ignition can be weakly heard if inadequately filtered when carrier is on.
Intelligibility.	Good for local ranges, when able to override all interference.	Good for full horizon and frequently several horizons.
Range.	Maximum about 20% beyond horizon ordinarily.	With squelch on, it is about same as AM or slightly better. With squelch off, the hiss comes in on standby position but signals can be heard twice as far as AM. This is for identical stations and areas.
Equipment Cost.	$200 to $500 per car.	$275 to $425 per car.
Maintenance.	About same as FM.	About same as AM.
Battery Consumption.	Super-regenerative receiver draws 3.6 amperes. Super-heterodyne receiver draws 5 to 6 amperes. AM 10 watt transmitter draws 22 amperes.	FM receiver draws 5 to 6 amperes. FM transmitter draws 26 amperes but delivers 25 watts output.
Number of tubes in a car installation.	Super-regenerative receiver has 4 tubes. Super-heterodyne receiver about 9. Transmitter 4 or 5.	Receiver has 11 or 12 tubes. Transmitter 7 or 8 tubes. FM uses more tubes but they are of inexpensive and easily procurable type with low consumption.
Coverage.	Inconsistent at horizon. Within horizon ranges it is quite consistent.	Consistent at all times and even well beyond the horizon. Better overall coverage.
Frequency band required.	Can operate on 10 kc. band.	Present equipment needs 30 kc band with 10 kc. extra for guard against spill-over into adjacent band. If it had wider band would perform clearer and stronger.
Final detection.	Uses 2nd detector.	Uses discriminator.
Last IF Stages.	Uses 2nd and 3rd IF.	Uses 1st and 2nd limiters. These are IF stages but their amplitudes cannot exceed a selected value equal to the weaker amplitudes in order to have uniform amplitude to the discriminator.

Both AM and FM respond proportionately as well to the usual conditions affecting ranges. These are:
1.—Nature of the terrain.
2.—Nature of the earth along that terrain.
3.—Weather Conditions.
4.—Obstructions to the line of sight.
5.—Dispersion beyond the horizon.
6.—Reflection from the body of an automobile.

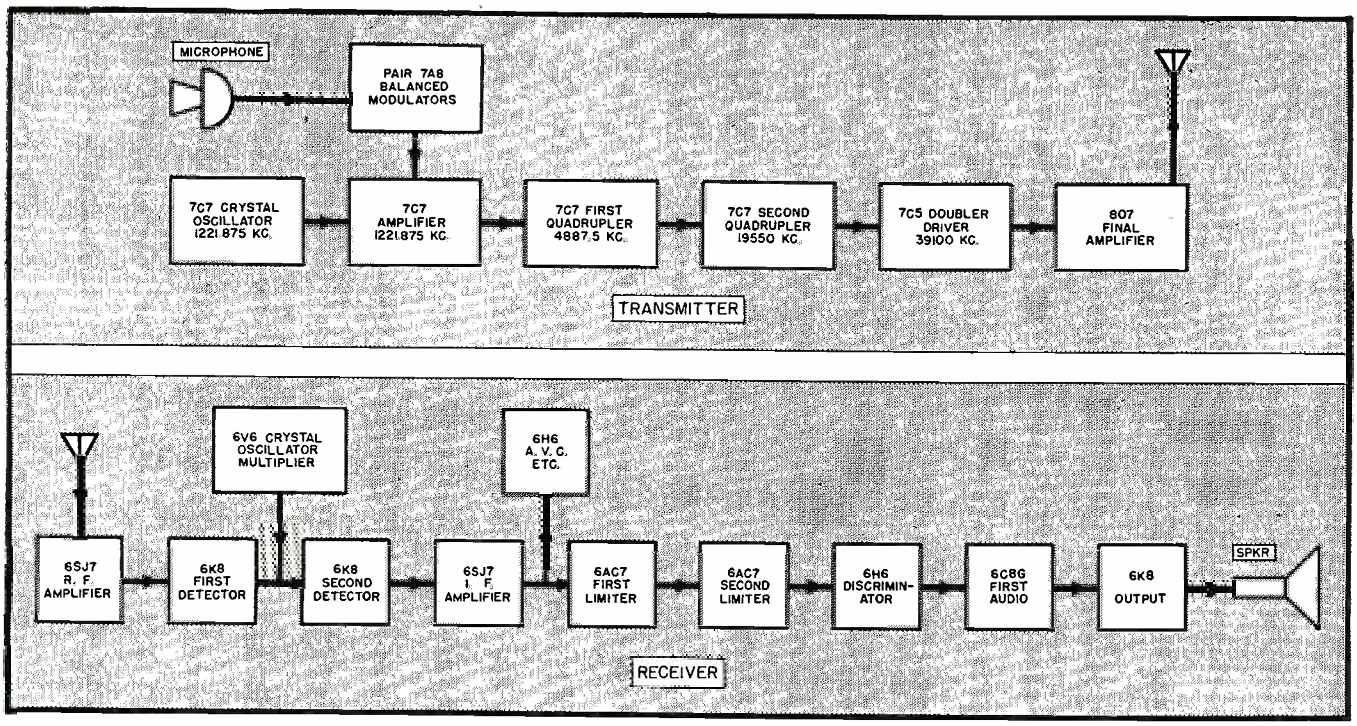


Fig. 4. Typical equipment used in police radio cars. Illustrated in block-diagram form is the system installed at South Portland, Maine, on 39,100 kilocycles. Listed below are the tube complements as used by three different manufacturers.

FM TRANSMITTER TUBE LINEUPS

MANUFACTURER (A)

2-7A8 Balanced Modulators
7C7 Crystal Oscillator
7C7 First Quadrupler
7C7 Second Quadrupler
7C5 Doubler Driver
807 Power Amplifier

MANUFACTURER (B)

2-7A8 Balanced Modulators
7C7 Crystal Oscillator
7C7 First Quadrupler
7C7 Second Quadrupler
6V6 Doubler Driver
807 Power Amplifier

MANUFACTURER (A)

7B7 Modulator
7B7 Oscillator
7B7 First Quadrupler
7B7 Second Quadrupler
6V6 Doubler Driver
807 Power Amplifier

FM RECEIVER TUBE LINEUPS

MANUFACTURER (A)

6AC7 RF Amplifier
6K8 First Detector
6V6 Crystal Osc. Multiplier
6SH7 IF Amplifier
6K8 2nd Det. Crystal Osc.
6SJ7 First Limiter
6AC7 Second Limiter
6H6 Discriminator
6H6 AVC, Squelch Filter
6SL7GT 1st Audio, Squelch
6K6GT Audio Output

MANUFACTURER (B)

6SD7GT RF Amplifier
6SD7GT 1st Mixer
6SD7GT High-frequency osc. multiplier
6SD7GT IF Amplifier
6K8 Low-frequency Osc. and 2nd mixer
6SD7GT Low freq. Amp.
6SD7GT 1st Limiter
6SD7GT 2nd Limiter
6H6 Discriminator
6C8G Squelch, 1st audio
6SD7GT Noise Amplifier
6H6 Squelch
6K6G Power Amplifier

MANUFACTURER (C)

7H7 RF Amplifier
7H7 1st Converter
7C7 High-Frequency IF Amplifier
7C7 2nd Converter
7C7 Oscillator
7C7 Low-frequency IF Amplifier
7C7 1st Limiter
7C7 2nd Limiter
7A6 Discriminator
7C6 Squelch Amp.
7C6 1st Audio Amp.
6V6GT Power Output.

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tal was 5456 kilocycles. This resulted in an IF frequency of 456 kilocycles.

Fig. 3. Shows a comprehensive listing of the advantages and disadvantages of frequency modulation as compared to amplitude modulation. This list, in tabulized form, is an actual comparison made through various field tests.

On frequencies ordinarily used for two way radio, i.e. 30 to 40 megacycle band, rolling terrain will not be a serious obstacle even if interfering with line of sight. Sudden abrupt obstructions, such as a mountain of rock, will stop signals, although not conclusively or always. An inlet of salt water can bring the signal around the corner. A hill covered with heavy moisture, snow or ice can conduct the signal over the mountain. An area of very dry sand and low humidity may stop signals from extending to the visible horizon due to the high rate of attenuation. A steel bridge instead of shielding like on medium frequencies, will have the opposite effect and increase performance. If the fishpole antenna on an automobile is on the back of the car, the greatest ranges (particularly beyond horizon ranges) will be in the direction the car is pointed at. An increase of 50% range is easily possible that way. The car can serve as a reliable direction finder as a result of that phenomena. A car on a railroad track can have an extended range due to the effect of the steel track and its endless length. All these situations cannot be accurately predicted and vary with

(*Continued on page* 90)

Manufacturers' Literature

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

CODE EQUIPMENT

The *McElroy Manufacturing Corporation* has recently published a catalog, No. 643, announcing their many types of code machines. The apparatus described meets the ideal combination of high efficiency, compactness, light weight and smart appearance. The listings of the equipment include high-speed automatic radiotelegraph assemblies, including Wheatstone code tape perforator, automatic transmitter, high-speed recorder, various types of tape pullers, and radio beam keyer.

These items are well illustrated and the descriptive data gives a well-rounded, valuable picture of the instruments. Catalogs are available by addressing the *McElroy Manufacturing Corporation,* 82 Brookline Avenue, Boston, Massachusetts.

TRANSFORMERS

A new transformer catalog has been published by the *Kenyon Transformer Company, Inc.* The complete transformer line includes such features as totally sealed and shielded, one-style case, and universal mounting. The catalog covers such transformers as low impedance source to grid, line to line and line to voice coil, auto transformers, interstage audio, universal driver, drivers, amplifier outputs, output transformers to 500-200 or 15-8-4 ohms, universal output, grid modulation, modulation, plate transformers for standard amateur duty, plate transformers for heavy amateur duty, filter reactors, swinging reactors, plate and filament, power filament, and many others.

The catalog is profusely illustrated and all transformers listed give complete information on their particular characteristics. A copy of the catalog may be had by addressing *Kenyon Transformer Company, Inc.,* 840 Barry Street, New York, New York.

RESISTORS AND RHEOSTATS

With the sole purpose of helping servicemen in their efforts to keep home radio sets working despite parts shortages, *IRC* presents a new booklet entitled "Here's How."

A considerable portion of the booklet is devoted to the presentation of ideas on how to make "duration" volume control repairs to home radio sets when normal replacement units are not readily available. These

(*Continued on page* 84)

A Serviceman's iary

by B. M. PIERCE

A narrative of a typical day in the life of a serviceman, as told by one who knows.

TING-ALING-ALING- The phone jingled, a man hunched over a radio bench, looked at the phone with disgust. He got up slowly, sighing dismally and leisurely took the receiver off the hook. "Good afternoon, Busy Bee Radio Service," he says in a cheerful voice.

"This is Mrs. Smith, you know me, I had a radio in your shop just a few days ago, and you were supposed to have fixed it."

"Yes," says our service man. "Your name does sound faintly familiar. What seems to be the trouble?"

"Well, you charged me $4.50 to fix my set and now it doesn't work as good as it did before I brought it in."

"What seems to be the trouble now?" our hero repeats.

"Well, I was playing it last night, and right in the middle of my favorite program, it just faded right away." The querulous voice intoned, "Now, what are you going to do about it?"

Our Busy Bee Service Man remembers, hastily, the old adage "The Customer is always right." Before he can start to say anything, the voice goes on:

"Now, I'm going down town to do about an hour's shopping and I'll drop by with the set. You can fix it and I'll stop by and pick it up on my way home." Click, goes the receiver.

Our radio man slowly replaces his receiver, wondering how any human being can be lucky enough to find a fading part in an hour. The thought also occurs to him, "Why, did I pick Radio for a profession? Of all the thankless jobs, this is it! Do people expect a garage man to replace a transmission on a car for the simple reason, that two weeks before, a certain garage had replaced a radiator?" He wishes he was a writer, so he could tell the Public, via "Reader's Digest" or what have you, how much they, the Public, expect of a radio repair man. He wearily thinks, "By the way, I've never seen a wealthy radio man. Wonder if I hadn't better give this up and get a job as a garage mechanic."

He just nicely settles himself at the bench and starts peering into the "innards" of another set, when he hears the front door open. He forces a smile and walks briskly out front. He sees a lady coming in, carrying a small set. She hands it to him and says:

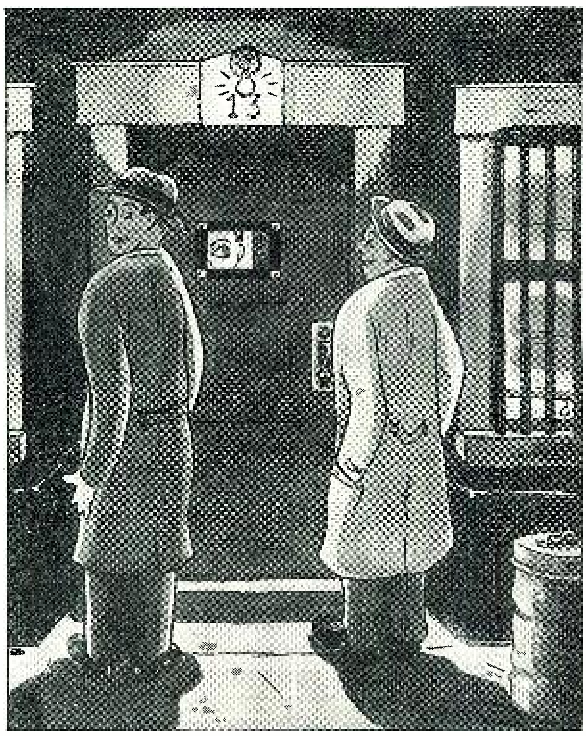
"Will you please look at this set?" There isn't much wrong with it, just a tube or possibly a loose wire. It should just take a minute to fix it. I can't afford to spend much anyway, the set isn't worth it. If it is going to cost too much, I shall simply get a new set."

By this time, our hero is busily engaged plugging in the set, turning knobs, etc. In a minute or two, a loud hum greets his ears and he immediately knows a filter condenser is cutting up. He turns to the lady and says:

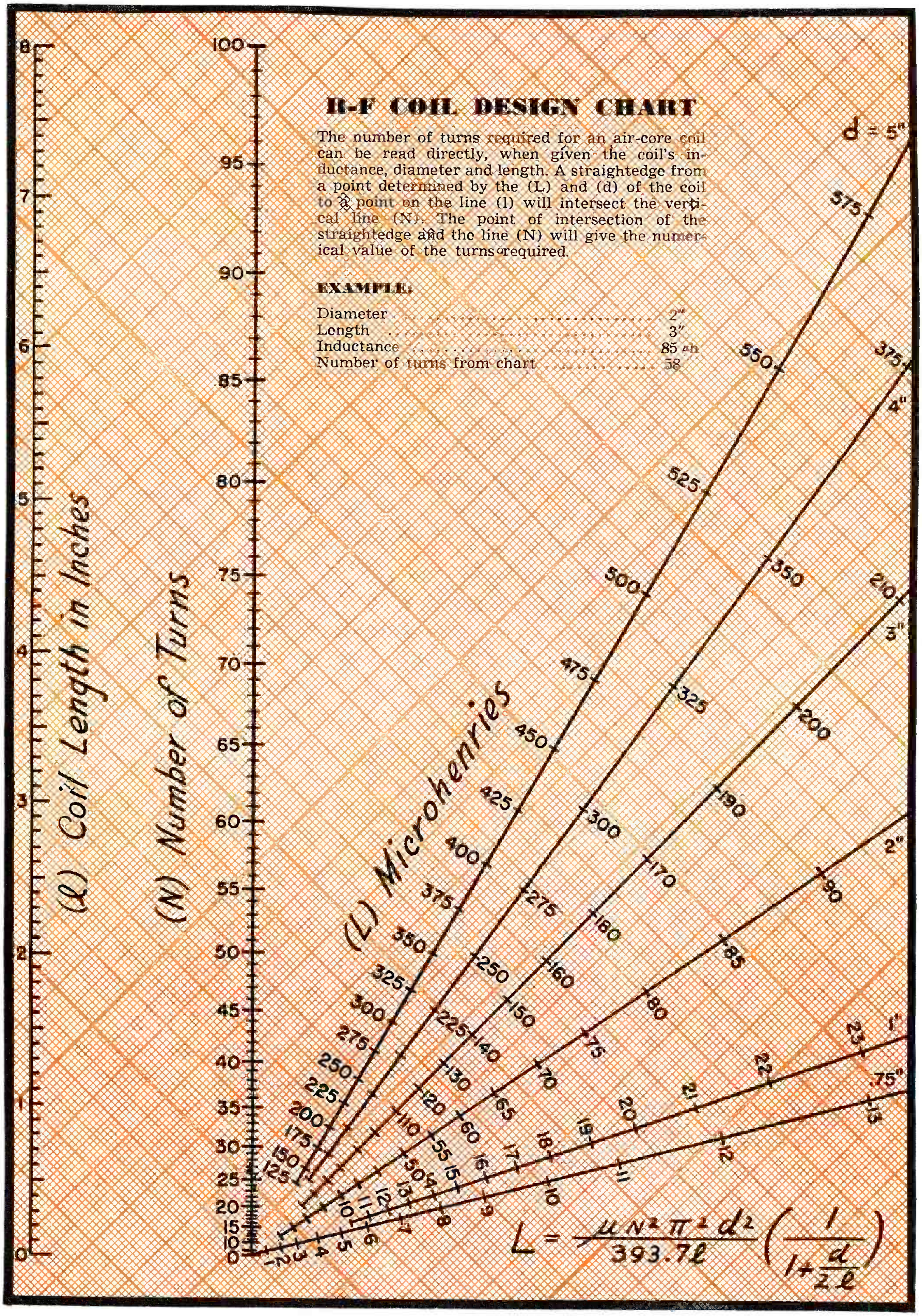
"For one thing, you have a bad filter."

"Bad filter," she retorts. "What's that? It must be a tube. The neighbor next door looked at it and he says it's a tube or a loose wire."

(*Continued on page* 82)



"We'd like some aluminum Discs. It's all right — Joe sent us!"


R-F COIL DESIGN CHART
The number of turns required for an air-core coil can be read directly, when given the coil's inductance, diameter and length. A straightedge from a point determined by the (L) and (d) of the coil to a point on the line (l) will intersect the vertical line (N). The point of intersection of the straightedge and the line (N) will give the numerical value of the turns required.
EXAMPLE:
Diameter 2"
Length 3"
Inductance 85 μh
Number of turns from chart 58
(l) Coil Length in Inches
(N) Number of Turns
(L) Microhenries
d = 5"
4"
3"
2"
1"
.75"
L = μN²π²d² / 393.7l (1 / (1 + d/2l))

TECHNICAL BOOK & BULLETIN REVIEW

"BASIC RADIO PRINCIPLES" by Maurice G. Suffern, Lieutenant, U. S. Army. Published by *McGraw-Hill Book Company, Inc.*, New York and London. 256 pp. plus index. Price $3.00.

This manual designed to aid in the training of radio technicians will be an invaluable book for any person who has a basic knowledge of the principles of electricity and who is preparing for practical radio work. "Basic Radio Principles" represents a definite departure from present texts in this field because it entirely omits all mathematics, formulas, and involved graphs and expresses as simply as possible the basic facts of radio theory. The purpose of the book is to give the student a knowledge of basic radio fundamentals involved in the science of radio transmission and reception; the ability to identify materials used in radio along with their symbols; the ability to interpret diagrams; and an understanding of the principles involved in the operation of radio equipment. With the knowledge gained from this manual the student will be well prepared to enter the radio field, not only in the Civil Service and other civilian occupations requiring this background knowledge, but also in the Armed Forces of the United States.

"HOW TO PASS A WRITTEN EXAMINATION" by Harry C. McKown, formerly Professor of Secondary Education, University of Pittsburgh. Published by *McGraw-Hill Book Company, Inc.*, New York and London. 155 pp. plus index. Price $1.50.

This book was prepared to provide practical help for any student or adult taking written examinations in any subject. It is written in an interesting and informal style and offers more than 150 definite suggestions, nearly all of which are illustrated by actual examination questions, settings, or conditions. It explains the purpose of examinations, how to prepare for them emotionally, physically, and mentally, how to answer both objective and essay type questions, and what to do after examinations have been completed.

"HOW TO USE DIAGRAMS IN RADIO SERVICING," by M. N. Beitman. Published by *Supreme Publications*, Chicago. Price 10c.

This booklet emphasizes the necessity of using circuit diagrams in radio servicing. In order to help the beginner become acquainted with circuit diagrams, a typical seven-tube superheterodyne receiver is analyzed by carefully studying the symbols of common radio parts and correlating them with the practical circuit.

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QTC — Communication Operators

By CARL COLEMAN

MOST of us have been wondering what postwar shipping is to be like and it was good news to hear Rear Admiral Howard L. Vickery of the U.S. Maritime Commission recently say in no uncertain terms that the United States has become a maritime nation and intends to remain one. The Admiral, speaking in London, said that it would be done by cooperation if they (Britain) wanted to but if they didn't want to we were going to remain a maritime nation anyway. He suggested it was much better to do it by cooperation than to start to wrangle, however.

With the vast fleet of shipping available after the war the U.S. Merchant Marine should be the largest and most able to compete with ships of any nation, and as Rear Admiral Vickery stated that if we are to remain a maritime nation, we must be prepared to compete with vessels from all nations, for our prime interest must be in looking out for our own welfare. If we do not do this it is certain that no one else will do it.

CHARLIE REBERGER, formerly of the F.C.C. and also ex-WOR is now holding down the job as chief on a former Savannah Line passenger vessel. Charlie sends word on the following members of the gang. Thanks, and lets hear from more of you boys, both at sea and ashore. Charlie Leipert, old time Marconi Company radio op is now holding down a berth with the F.C.C. in the Los Angeles area. Another old timer back on the job at sea is Charlie Kahn, formerly of Sun Oil Company. Clarence Thevenet, ex-WOR and RMCA has gone back to pounding brass at sea for the duration.

THE American Communications Association, Marine Department, has recently resumed their "msg," publication of marine activities, a very neat and meaty little magazine of ACA news with much of interest, including a very helpful "Technitips" article which will do a great deal toward helping the boys out of some unusual circumstances with a minimum of trouble and wasted time. Members are invited to suggest a new name of the mag; same should be forwarded to the New York office. The winner of the prize name is to be awarded a $25 war bond. The mag has several interesting departments and bang up articles are presented each issue by some very able writers. The last issue had a centerfold two page spread of the citation of Kenneth Maynard, first radioman to be awarded the Merchant Marine Distinguished Service Medal, presentation of which was made last Maritime Day, it was one of seven such awards throughout the country at that time. Kenneth Maynard distinguished himself for heroism under unusual hazards aboard a tanker and was instrumental in saving the lives of the entire crew of his vessel. There cannot be too much said for a fellow who will stick to his post under such conditions and deeds such as this will show the entire world the quality of the radiomen aboard ships of the U.S. Merchant Marine.

Speaking of magazines and such, ROU has a publication "The Commer-

(*Continued on page* 72)

WHAT'S NEW IN RADIO

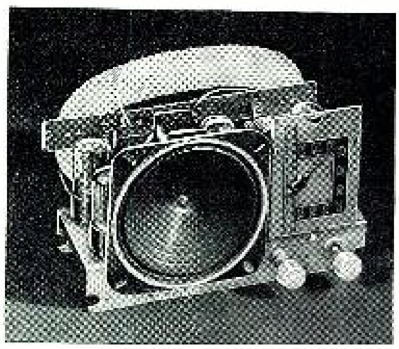
New products for military and civilian use.

RADIO RECEIVER KIT

Allied Radio Corporation offers a modern radio receiver kit especially developed for illustrating theory and practices now being covered in basic or pre-induction radio training. It is now available to all schools and colleges conducting war training programs. This 5-tube kit permits progressive study of basic receiver subjects such as rectification, filtering, detection, RF, IF and AF amplifications, etc.

The kit consists of all necessary parts, wire, hardware, solder, tubes, and speaker for the construction of a 5-tube a.c.-d.c. superhet receiver of advanced up-to-the-minute design. Chassis is completely formed, punched and rust-proofed. The only tools needed for assembly are screwdriver, pliers and soldering iron. Circuit includes many outstanding features such as oscillator biased RF and IF stages, contact-potential biased audio stage, inverse feedback, automatic volume controls, high capacity filtering, self-contained antenna and others.

Write *Allied Radio Corporation*,



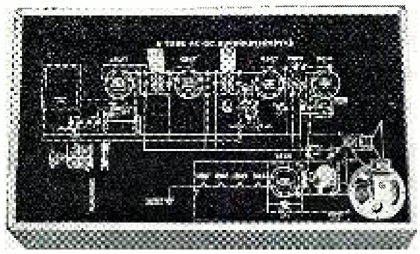
Educational Division, 833 West Jackson Boulevard, Chicago 7, Illinois, for free descriptive material and circuit diagrams.

RADIO DEMONSTRATOR BOARD

This 5 tube a.c.-d.c. superhet demonstrator board is a "must" for radio and physics classroom training programs and for lecture and demonstrating purposes. It is laid out schematically in bread-board style with actual radio parts mounted in position for quick removal and replacement to demonstrate function at each part in the circuit.

Terminals are provided at all tube elements for measurement of voltages and signals. Jumpers are provided to open condenser, resistor and coil circuits and to short out these circuits wherever no damage will result. Schematic diagram is in color according to the R.M.A. code; grid circuits in green, plate circuits in blue, "B" positive circuits in red, and balance of circuits in black. Tubes are included.

This and other training kits are of-



fered by *Lafayette Radio Corporation*, 901 W. Jackson Boulevard, Chicago, 7, Illinois, and 265 Peachtree Street, Atlanta, 3, Georgia.

SILVER MICA CAPACITORS

Centralab's types 830 and 831 are special purpose oil impregnated silver mica capacitors that are particularly useful in high frequency applications. They are a new item and capacities now manufactured range from 65 μμfd. to a maximum of 500 μμfd.

Both types are made of mica discs of the highest grade, individually silvered for maximum stability and stacked to eliminate any "book" effect. The assembly is vacuum impregnated with transil oil. The outside metal ring or cup connects to one plate of the capacitor, the center terminal connects to the other plate by means of a coin silver rivet. Other metal parts are silver-plated brass.

Type 830 has a metal cup holding the mica capacitor and is assembled to a threaded brass mounting stud with a terminal in the center. Stud, terminal and shell are electrically connected.

Type 831 is of "lead-thru" construction. There is a center terminal on each side making contact to each other and to one plate of the capacitor by means of a coin-silver rivet. The other capacitor plate, contacts the outside metal shell or ring.

General specifications of types 830 and 831 are: voltage 1300 volts d.c. test, 500 volts d.c. working. After 100 hours exposure to a relative humidity of 100% at 40° C., power-factor is less than .1% and leakage at 100 volts d.c. not less than 5000 megohms.

All units are color coded in μμfd. by means of colored dots on the metal rim arranged in accordance with the following: 0 Black, 1 Brown, 2 Red, 3 Orange, 4 Yellow, 5 Green, 6 Blue, 7 Violet, 8 Gray, 9 White. Manufactured by the *Centralab Div. of Globe-Union Inc.*, Milwaukee, Wisconsin.

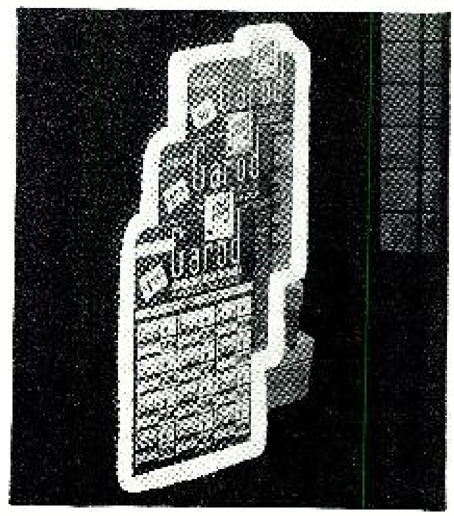
PHONO NEEDLE

The Garod Radio Corporation has announced a new plan to help tide distributors and dealers over, until final victory on the battle front has been achieved, by the introduction of the new Garod Permatone Phono Needles.

The needles are put in attractive, individual, three-color cards, easy to handle and easy to display. Along with them, Garod has prepared striking, self-selling display cards, approximately 10x15 inches. In addition, consumer folders, printed in three colors are also on the list of promotional helps. A quantity of these folders are supplied, free of charge, with a kit of 4 display cards.

These Needles feature an exclusive "filter trap," which has a highly polished, tempered surface. When it rides the groove, shock is absorbed and scratches are reduced to an imperceptible degree. These needles are made to a special formula from rare metal alloys, with a velvet-smooth, non-corrosive tip to help minimize noises.

Designed to fit perfectly into the groove of the record, sidesway is prevented, vibration eliminated, and rec-



ord wear and tear considerably reduced. Garod Permatone Phono Needles are uniformly high in quality, and may be used on any type of phonograph and any make of record. For additional information, write to the *Garod Radio Corporation*, 70 Washington Street, Brooklyn 1, New York.

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⋆ THE 1944 ⋆ SIGNAL CORPS ISSUE

(FEBRUARY 1944)

MANY weeks have been spent in preparing what promises to be the most outstanding issue of any radio publication ever to be presented. Since the appearance of the first *U. S. Army Signal Corps* issue of RADIO NEWS, November 1942, there has been an ever increasing demand for more complete details on this important military branch of the Army.

The present war has demanded that new techniques be employed to give our soldiers the finest system of communications to be found anywhere in the world. New branches have been added to the Signal Corps but little information has been given to the public as to the activities of these various branches.

At this writing, 35 outstanding articles have been scheduled, with hundreds of exclusive photographs both in color and in black and white which depict the many functions of the Signal Corps at war.

Information heretofore unpublished is being prepared, with dozens of special photographs taken at every major fighting front showing the Signal Corps personnel "getting the message through" under every conceivable condition.

Many captured enemy radio transmitters and receivers and other signaling devices will be shown for the first time together with a complete analysis of their performance and characteristics. The American manufacturer will be able to study this material and get an accurate picture of the use of ceramics, metals and other materials used in the assemblies and parts of this captured equipment.

The entire editorial contents will be prepared by the officers of the Signal Corps, all of whom are experts in communications. Included will be articles covering the organization of the Signal Corps itself, procurement, distribution, engineering—crystals, wire and new telephone communications inspection agencies—fixed, mobile, portable and telecommunications equipment; the Signal Corps in Combat—case histories, techniques, etc., in Alaska, on the European Continent and in the Pacific; Army Pictorial Division, Training of Signal Corps Personnel, Meteorology, Lend-lease, Communications, Equipment, Operations, the Civilian's Place in the Signal Corps, Signal Units Survey, Vehicular Equipment. Action shots of Signal Corps men and equipment, and charts, maps, and graphs will illustrate the articles.

Two special pictorial sections of the Signal Corps personnel in action,

(*Continued on page* 84)

Maj. General Harry C. Ingles, Chief Signal Officer of the Army, and Oliver Read, Managing Editor, RADIO NEWS, lay plans for forthcoming Special 1944 U. S. Army Signal Corps Issue.

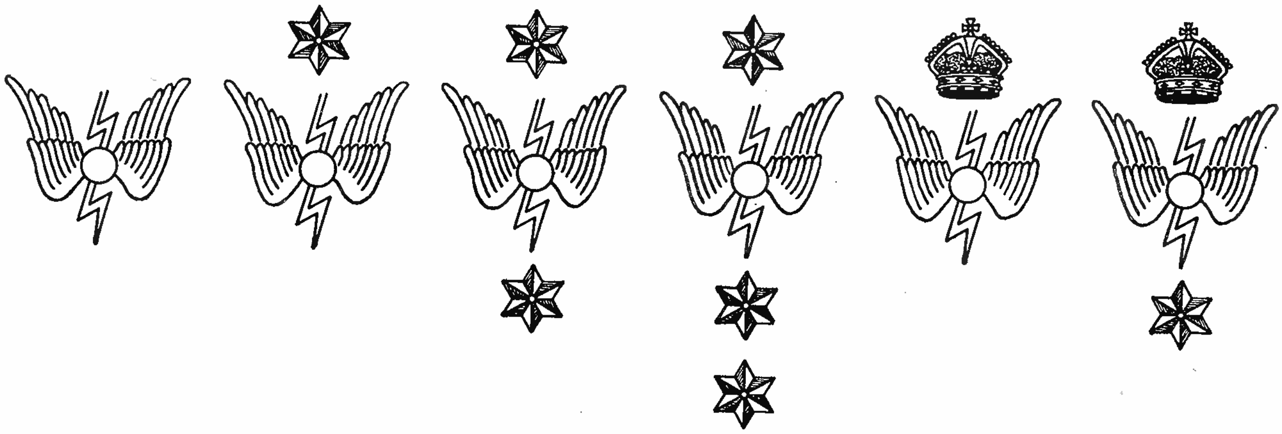
IT WILL be of great interest to members of "The Tube Collector Club" to learn that there has recently been completed for a national museum a complete, authentic set of replicas of the actual experiments carried on by Dr. Lee de Forest from the time he conceived the idea of the Audion and on through the bunsen burner open flame experiments which preceded the introduction of various types of terminals within the glass envelope of an evacuated tube.

This exhibit comprises eighteen separate models terminating with the final success, namely . . . the "first grid," in the *first* tube. Unfortunately, no such thing as the actual "first radio tube" exists today . . . not even any of the many similar or slightly modified hand made specimens that were turned out during the succeeding six or eight months, as these, and all other valuable historical data of de Forest's early experiments, were consumed in a fire on January 10, 1908 which completely destroyed the old thirteen story Parker Building on the corner of Fourth Avenue and Nineteenth Street, New York City, where in the attic, the first workable "three element vacuum tube" was born.

Since the completion of this exhibit which also includes the various patents involved—covering nearly 200 basic claims together with the reasons and logic used with each step—several other museums, clubs and tube companies have requested duplicate exhibits, but all such requests have, so far, been denied as it is desired to retain for posterity, merely the one *exclusive* exhibit. There have also been individual requests received and devised for reproductions of the single, final replica . . . the one containing the likeness of the first "grid . . . wing . . . and carbon filament" mounted on a block similar to the reproduction of Edison's first electric lamp.

In view, however, of the interest shown in *The Tube Collector's Club* of RADIO NEWS . . . the idea of making up a quantity of this single type for exclusive distribution among its members might be reconsidered providing enough interest in the matter is displayed which would justify the making up of a certain number. What the cost of these individual

(*Continued on page* 105)



(a) (b) (c) (d) (e) (f)

Fig. 1

Fig. 1. Badges signifying Naval W/T ratings. Details given in accompanying text.

Fig. 2. Naval Air Arm radio mechanics' badge.

Fig. 3. Distinguishing badge worn by Naval Air Arm Observers, on their left sleeve.

Fig. 4. Telegraphist Air Gunners' Badge.

Fig. 5. (Top) Chief Wren Wireless Telegraphists' badge, worn on the collar of their jackets. (Bottom) Badge worn on the right arm by Petty Officers, Leading Wrens, Wren Wireless Telegraphists and Radio Mechanics.

Fig. 2

Fig. 3

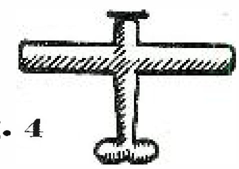


Fig. 4

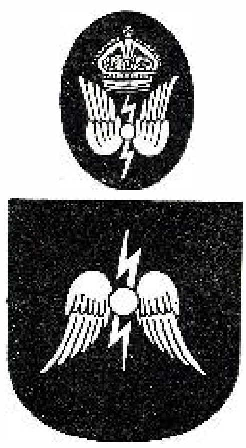


Fig. 5

Britain's Radio Heraldry

by H. W. BARNARD

"Wireless World," London

Badges and insignia, symbolizing the various ratings worn by Britain's radio technicians.

BRITAIN'S radiomen are justly proud of the part they have played in World War II. The speed of communication made possible by modern apparatus in skilled hands is fully attuned to the tempo of mechanized war, as typified by 400-miles-an-hour aircraft, and fast-moving tanks. Above all, the technicians can point to the achievements of radiolocation.

In the dark days of 1940, this radio system of locating enemy aircraft played a decisive part in enabling the Royal Air Force to beat off the mass attacks of the Luftwaffe.

Britain has now passed from the defensive to the offensive, and again radio technique is playing its all-important role. Every Stirling, Lancaster, or Halifax bomber that sallies forth to strike another blow at the heart of Germany is equipped with ten or a dozen radio sets. Moreover, as the offensive on the stronghold of Europe increases, radio plays a vital part in ship, submarine, plane, tank and armored vehicles.

Now that United States radiomen are using their skill side by side with those of Britain, the badges worn by Britain's technicians may interest American readers. The work these men and women do, and the badges indicated by that work in the navy, army and air force are described and illustrated in this article.

In peace as well as in war an essential section of the Royal Navy is the wireless telegraphy branch, for without it a ship has no means of long-distance communication.

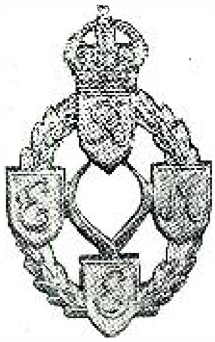
Junior ratings in the W/T branch are Boy Telegraphists, Ordinary Telegraphists and Telegraphists (not trained operators) who wear badge (a) in Fig. 1. This is the basic design for all wireless telegraphist badges.

When proficient in the operation of the W/T gear in general use in His Majesty's ships, ratings are placed in the category of Trained Operator (W/T) and wear badge (b).

A higher standard of technical training is given to Wireless Telegraphists 3rd Class, who may be the senior W/T rating in small ships and therefore must be well versed in the complexities of naval wireless procedure. They wear badge (c).

Wireless Telegraphists 2nd Class

Fig. 6



(a)

(b)

Fig. 7

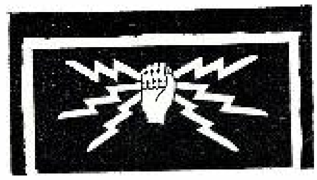
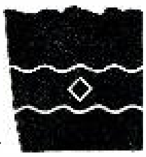
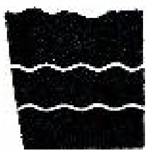


Fig. 8

Fig. 9



(a) First



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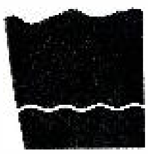
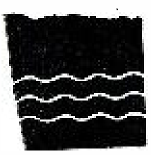
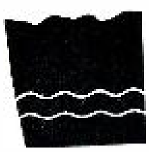


(c) Third

Fig. 10



(a) First



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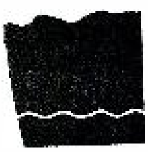

(c) Third

Fig. 11

Fig. 6. The Royal Signals Badge, colloquially known as "Jimmy."

Fig. 8. The R.A.F. "Sparks" badge.

Fig. 10. Bands worn by First, Second, and Third Class Radio Officers in Merchant Navy.

Fig. 7. (A) The insignia of the R.E.M.E. (B) R.E.M.E. wireless badge worn embroidered in red by Radio Mechanics and in white by Wireless Mechanics.

Fig. 9. The Radio Observer's brevet.

Fig. 11. Airways Radio Officers' Insignia.

(ratings below Petty Officer) wear badge (d). They are, in many cases, the senior W/T ratings on destroyers, and other of the smaller ships.

Usually the senior W/T ratings on large destroyers (Tribal Class), cruisers, etc., are Wireless Telegraphists 2nd Class (Chief Petty Officer and Petty Officer Telegraphists) who wear badge (e). There are comparatively few wearers of badge (f), which is that of Wireless Telegraphist 1st Class. They are Chief Petty Officer (C.P.O.) Telegraphists and Petty Officer (P.O.) Telegraphists, who usually serve in Flag Ships and Capital Ships, and Leading Telegraphists of not less than four years' seniority.

All the badges refererred to are embroidered in red for working dress, but in gold for No. 1 dress. They are worn on the right arm with the exception of that for C.P.O. Telegraphist which is worn on the lapels of the jacket.

In all branches of the Navy, leading ratings are distinguished by wearing an anchor on the left sleeve, and Petty Officer ratings by crossed anchors surmounted by a crown in the same position. Chief Petty Officers wear, in addition to the badge of their branch on the lapels of their jackets, three gilt buttons on the cuff of each sleeve.

With the growth of the Air Arm of the Royal Navy, there has been an increase in the ratings required for the maintenance of airborne radio equipment. This work is undertaken by Britain's Naval Air Arm Radio Mechanics, who wear on the right sleeve of thier uniform a badge of the same basic design (Fig. 2) as Wireless Telegraphists in the Navy.

Radio Mechanics serve on aircraft carriers and in Naval stations at home and abroad. In either case they are likely to carry out flight tests in order to be sure the equipment is functioning satisfactorily under operational conditions.

When proficient, ratings in this branch of the Naval Air Arm are advanced to Leading Radio Mechanic and subsequently are eligible for promotion to Acting Petty Officer, Petty Officer and Chief Petty Officer.

The operation of all naval airborne radio equipment, with the exception of that installed in single-seater fighters which, of course, is operated by the pilot, is normally the duty of the Observer or Telegraphist Air-Gunner. Nearly all Observers are now officers who, in common with all Naval Air Arm officers, are distinguished by the letter "A" worn in the curl of the Officer's gold lace on each cuff, while on the left sleeve is worn the Observer's badge as illustrated in Fig. 3. The Telegraphist Air-Gunner wears the seaman's class of uniform and has on his right arm the distinguishing badge shown in Fig. 4.

There has been a growing tendency in the British Forces to replace men by women for non-combatant service in order that men released may be used for more active work. This is seen in the Navy, where members of the Women's Royal Naval Service (W.R.N.S.) are replacing men in shore establishments.

There are two categories in the W.R.N.S. which handle radio apparatus. They are Wireless Telegraphists and Radio Mechanics. The same design of badge (Fig. 5) is worn on the right arm by both of these categories.

W.R.N.S. Wireless Telegraphists are proficient operators and work at Naval shore radio stations in Britain

(Continued on page 54)

Britain's Radio Heraldry

(*Continued from page* 52)

and abroad. In addition to operating the apparatus they occasionally maintain it.

A comparatively new W.R.N.S. category is that of Radio Mechanic. A high standard of technical knowledge is required of Women Radio Mechanics who are employed on the maintenance and repair of radio apparatus installed in planes of the Naval Air Arm.

The task of maintaining the British Army's lines of communication, whether by radio, wire, dispatch rider or visual signaling methods, falls to the Royal Corps of Signals and unit signallers. As there is no distinctive badge for radio personnel of the Corps, the Royal Corps of Signals badge (Fig. 6) is included, with its symbolic figure of communications, Mercury—the Greek messenger of the Gods, standing on a globe. The motto of the Corps, which was formed in 1920, is "Certo Cito" (Sure and Swift).

In 1942 the formation of the Corps of Royal Electrical and Mechanical Engineers (R.E.M.E.) brought together into one corps personnel from various units of Britain's Army who are concerned with the maintenance of electrical and mechanical equipment. This transfer included men and women who repair and maintain telecommunications apparatus. Telecommunications is Britain's official comprehensive term for all radio and line communication apparatus in use in the British Army.

R.E.M.E. personnel who repair and maintain radar apparatus wear on their right arm a red embroidered wireless flash, of the design illustrated in Fig. 7, on a navy blue background. Wearers of this badge are either Armament Artificers (Radio) or Radio Mechanics.

A badge of the same design, but embroidered in white, is worn by Armament Artificers (Wireless) and Wireless Mechanics. These men are responsible for the maintenance and repair of radio and line communication apparatus which varies in size from the small pack sets carried by infantrymen to the complex transmitters and receivers fitted in modern tanks.

Both badges are worn on the right arm; in the case of Warrant Officers on the forearm below the rank badge, by N.C.O.'s Non-Commissioned Officers above the rank chevrons and by other ranks on the upper arm below the formation sign, or other badges.

Members of the Auxiliary Territorial Service (A.T.S.) in Britain are fast replacing men in many of the branches of the Army. This is especially so in radio.

In the Royal Corps of Signals women are being employed in signal offices as operators—wireless and line (colloquially known as "OWLS"). Their operating skill in both telegraphy and telephony is high. These Auxiliaries wear the Corps badge of Royal Signals above their left breast pocket.

Many members of the A.T.S. wear the badge of the Corps of Royal Electrical and Mechanical Engineers above the left breast pocket of their tunics. Some of them have passed the requisite trade tests for Radio Mechanics or Wireless Mechanics and wear the same badge as their male counterparts in the Corps, with whom they are working side by side in repair workshops and on gun-sites.

One of the best known radio badges (Fig. 8) is the "Hand and Lightning" worn by Radio Operators in the Royal Air Force and Women's Auxiliary Air Force.

Radio apparatus on British bombers, which in some planes includes 12 sets, is almost entirely under the control of the wireless operator. Air crew wireless operators are usually Air-Gunners, and therefore, wear the Air Gunner (A.G.) brevet over the left breast pocket in addition to the "Sparks" badge on the right arm. Ground staff at Airfields who operate repair and maintain communication apparatus wear the same badge.

A badge less frequently seen worn by members of the R.A.F. is the Radio Observer's brevet. (Fig. 9.) This is worn above the left breast pocket by commissioned and non-commissioned officers of air crews who handle special gear. Although the R.O. brevet has been superseded

(*Continued on page* 109)

The Model "U" shown above is 12″ in diameter and rated at 1000 watts. The Model "L" is 4″ in diameter and rated at 150 watts. Other models in this series of larger units are 10″, 8″, 6″ and 5″ in diameter and rated at 750, 500, 300 and 225 watts respectively. These rheostats handle tough applications with ease. They provide permanently smooth, close, trouble-free control on big jobs. Made in single or tandem assemblies, in straight or tapered winding, from 25 watts to 1000 watts.

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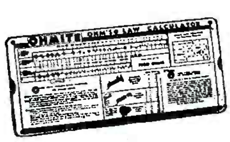

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Saga of Vacuum Tube

(*Continued from page* 31)

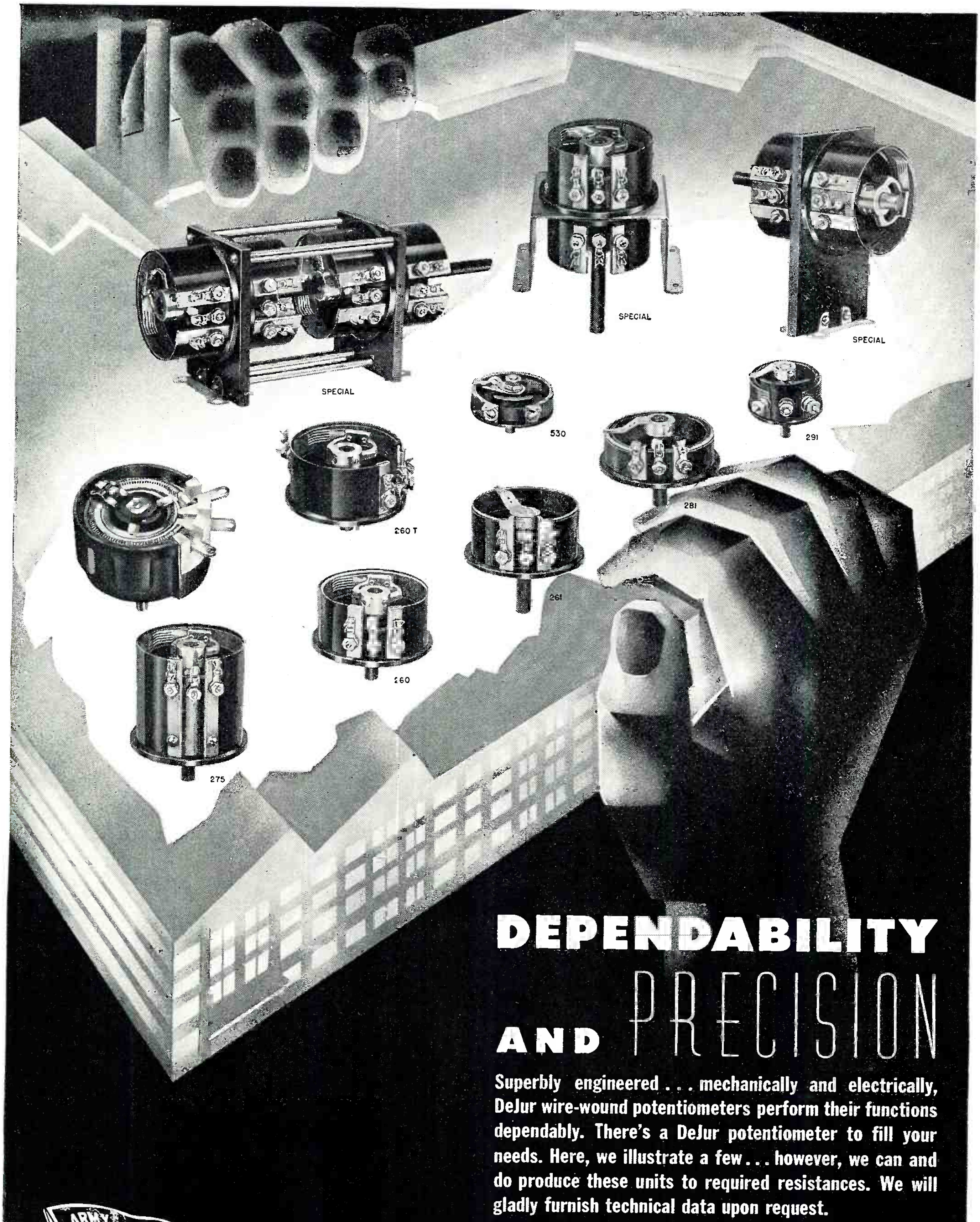
was raised, a condition of permanent blue haze ensued. When blue haze was present not only was the amplification lowered and distortion high, but the device introduced noise.[165] The life of the filament was very short, and frequent readjustment of the filament and plate potentials was required. The structure was flimsy and the bulbs were fragile. Individual bulbs differed greatly in their characteristics.

Yet it would amplify, was remarkably simple in operation, and to one trained in the then science of electronics, gave immediate evidence of real promise. Arnold has testified that when he first saw it he was amazed and realized that he "had overlooked the wonderful possibilities of that third electrode operation, the grid operation in the audion."[166] He recognized that the presence of gas in the bulb, which de Forest had considered essential to its operation, was a liability rather than an asset. He knew that in order to make the operation uniform and reliable the gas should be removed. This would convert the audion from a semi-gaseous thermionic tube into a pure electron discharge device. He also felt that the difficulties presented by the use of the tantalum filament could be overcome by the use of a cathode of the Wehnelt, or oxide-coated, type, a more copious generator of electrons and one which would operate at a comparatively low temperature. This would give an energy-carrying capacity, a stability, and life of operation more in keeping with practical requirements. The mechanical disadvantages could be overcome by a suitable redesign of the element structure.

Arnold, and those in the laboratories who soon joined him in this work, were familiar with the technique of high evacuation. Arnold had been working since he joined the Western Electric Company on the mercury arc repeater, which required careful evacuation even though it operated in the presence of positive ions, and previous to that had been engaged in research work on high vacuum devices at the Ryerson Laboratory under Professor Millikan. Such scientists were also familiar with the literature on the Fleming valve and the Wehnelt cathode.

The first improvement effected was not in the device itself, but in the circuit in which it was used by de Forest. The improvement consisted in removing the series condenser in the grid circuit. This, although necessary for operation of the audion as a wireless detector, was the cause of blocking when the attempt was made to use the audion at telephone operating levels.

The next step was to improve the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mechanical construction of the device. This was done by adding a glass "arbor" to the element assembly to increase its rigidity. Figure 64 shows one of the audions so reinforced. The next change made was to increase the plate area, which was accomplished by the addition of a second grid and plate assembly, thus producing the tube shown in Figure 65.

Up to this point, the changes made were comparatively easy to accomplish. The next steps were not so easy.

Work, meantime, had been begun on a theoretical and experimental investigation of the audion to determine its mode of operation and characteristics. At the same time, the problems involved in obtaining the needed higher vacua and developing a suitable commercial oxide-coated filament or cathode were attacked simultaneously, by Dr. Arnold and his associates. The technique of obtaining high vacua by the use of liquid air and charcoal, which had been developed by Sir James Dewar, could not be used, because there were no facilities available in the vicinity for obtaining the requisite quantities of liquid air and the problems of its transportation had not yet been solved.

Within a month of the time Arnold first saw the Audion, one of his assistants working in accordance with his instructions had succeeded in "cleaning up" or increasing the vacuum by electrical means in one of the audions. This increase in vacuum was sufficiently great so that the tube could be operated as a pure electron discharge device up to a plate potential in excess of 80 volts[167].

In 1912 the Gaede Molecular Pump was placed on the market by a foreign manufacturer. This pump was capable of producing vacua of the order of 0.00001 mm. of mercury, and would remove vapors as well as gases from the space being evacuated. One of these pumps was secured as soon as possible, and by its use tubes were made which could be operated at plate voltages in excess of 200 volts without harmful ionization. That is, they were pure electron-discharge devices.

Development of the oxide-coated filament progressed at such a rate that by the middle of 1913 there had been obtained a preliminary form of such a filament with a laboratory life of 1,000 hours.

In the fall of 1913 the problems of making a satisfactory high vacuum telephone repeater had been solved to such an extent that a field trial of the device could be made. Accordingly, a trial installation was made at Philadelphia on a toll circuit between New York and Washington. The high vacuum tube repeater was actually placed in service on this trial basis on October 18, 1913, and it was probably the first high vacuum tube amplifier to go into service in the annals of electric communications.

The vacuum tubes used in this re-

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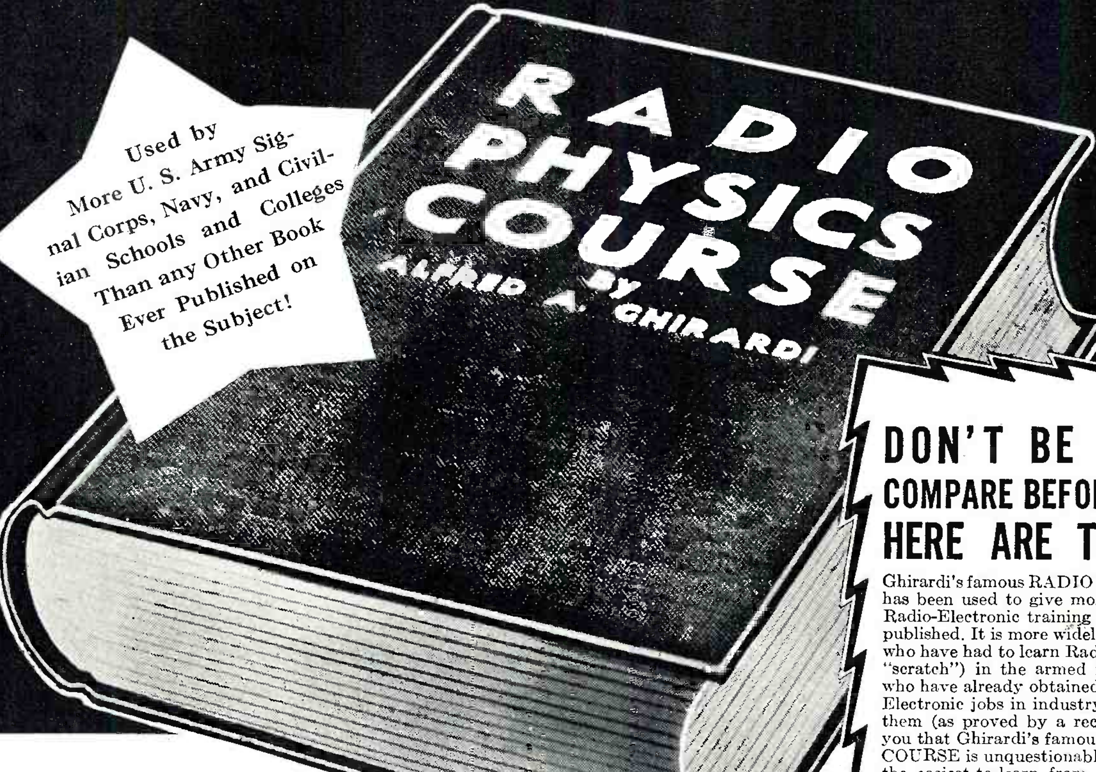

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peater were known as "Type A" and a photograph of one of them which is still preserved in the Bell System Historical Museum is shown in Figure 66. The type "A" was an unbased spherical tube about 2⅜ inches in diameter and was double-ended. The stem and press at one end carried the filament, which was Λ shaped, the apex being supported by a wire extending upward from the press. The filament was platinum coated, in the case of this particular tube, with barium nitrate. It was approximately ⅞ inch high and the lower ends were about ⅜ inch apart. The plate and grid assemblies were supported from the stem and press at the opposite end of the tube to the filament assembly, and were kept rigid by the use of glass arbors, one for each grid-and-plate. The plates were approximately 1⅛ inches high and were of nickel. The grids were made by welding hairpin-shaped loops onto a narrow supporting strip. The grid was approximately ⅝ inch wide by 1¼ inches high. Nine hairpin loops were used, hence the grid had eighteen laterals.

After a short period of use the type "A" tube was superseded by the type "B." This tube was an improvement over the type "A" in several ways. The filament was somewhat larger and was of twisted platinum ribbon. The most noticeable difference was in the grid structure. Each grid was made up of eight horizontal wires, evenly spaced in a vertical direction and welded to two upright supports. This construction became known as the "ladder-type" grid, and was extensively used up to a few years ago by the Western Electric Company.

Early in 1914, it became apparent that the use of unbased tubes was unsatisfactory, and steps were taken to provide a suitable base and mounting socket for these tubes. The first based tubes were known as type "M" tubes (M-mounted), and the socket shown in Figure 69 was a heavy cast brass affair, similar to that previously used for the mechanical repeater.

A photograph of a type "M" tube (set in a display mounting) is shown in Figure 70. The base was a heavy machined brass affair, equipped with four studs on the bottom, and a bayonet locking pin on the side. The four studs pressed against corresponding springs in the socket when the tube was inserted, thus completing the electrical connections required. This arrangement made for facility in replacement of the vacuum tube elements.

Vacuum tube repeaters were utilized for very long distances for the first time when the transcontinental telephone line, New York to San Francisco, was opened on January 15, 1915. At that time the type "M" tubes were used. They operated at a filament current of 1.35 to 1.55 amperes at a voltage of approximately 4. The normal plate voltage was 100 volts, plate current 10 to 15 milliamperes, amplification factor 5, and in-

ternal plate impedance about 5000 ohms. The useful life of about 400 hours was well in excess of that of the de Forest Audion.

Theoretical studies indicated, however, that this life could be considerably improved by an increase in the electron emitting area of the filament, which would permit operation at a lower filament temperature and still give the required thermionic emission. Hence, a new tube, which came to be known as the type "L," was designed and was first produced on a commercial scale in 1915. The type "M" was still made, for replacement purposes.

A photograph of one of the early type "L" tubes is shown in Figure 71. It will be seen that the filament length has been approximately doubled, resulting in doubled emitting area. Other changes in design have also been made. The grid has been changed from 8 to 9 laterals, and the bracing of the plates is different. This tube had a life of about 4,500 hours, which was eleven times that of its predecessor the type "M," and fifty to 100 times that of the Audions originally submitted to the Telephone Company by de Forest.

The first type "L" tubes carried no patent marking. Late in 1915 patent markings began to be applied. The markings were steel-stamped in 1/16 inch high characters on the base shell.

One of the tubes having this patent marking on the base is shown in Figure 72. There was also a serial number on each bulb, applied with a rubber stamp and "diamond ink."

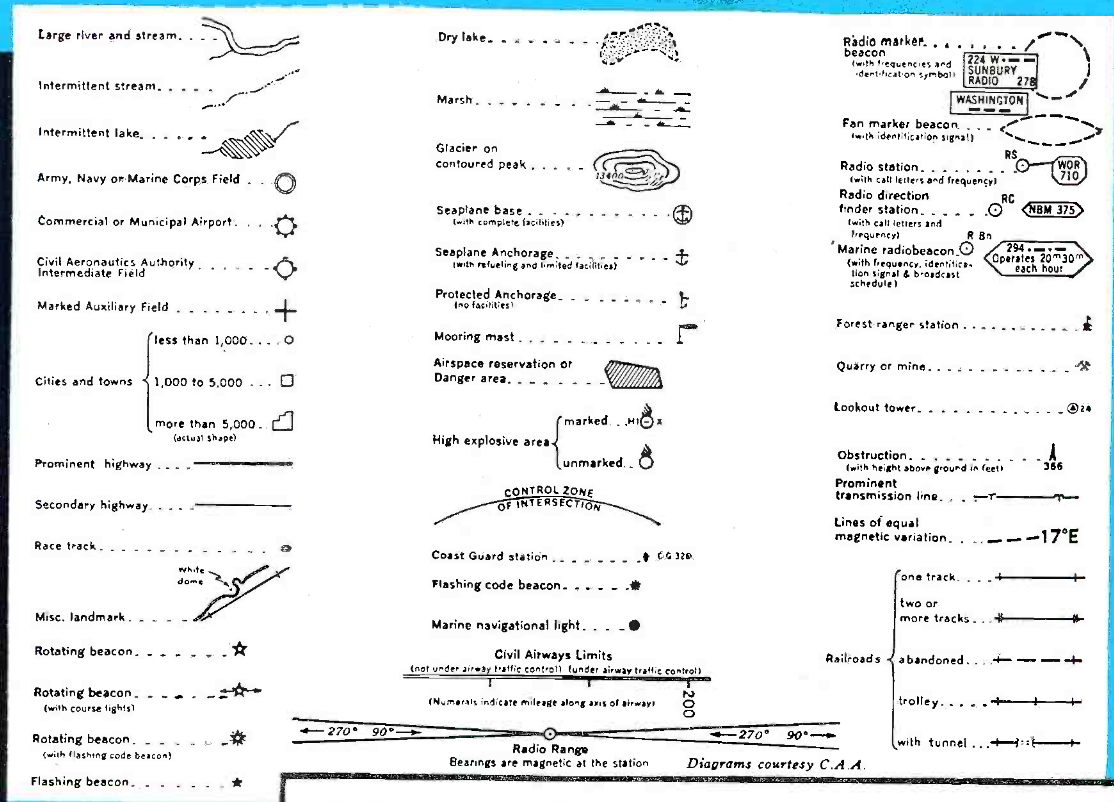
About the middle of 1916 the use of the letter designations was officially abandoned, and code numbers similar to those assigned to identify other types of telephone apparatus were given to repeater tubes. The type "M" became the "101A" and the type "L" the "101B."

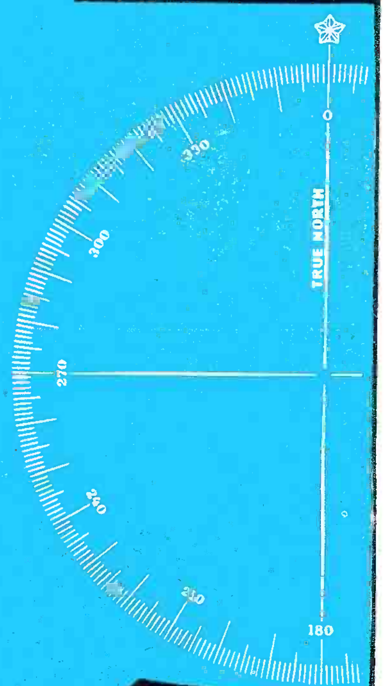
The reader will note that the letter designations were *officially* abandoned. Such official action did not, however, change the mental processes of those who had become familiar with the letter terminology, and today, some thirty years later, we hear even the younger generation of telephone engineers refer to the 101 types as "L tubes."

These tubes were first known as "Telephone Repeater Elements." Later, in 1917, the name was changed to "Repeater Bulb." These names were used rather than "Vacuum Tube" to differentiate the tubes made for telephone repeater use from those made for the U.S. Government and other non-telephonic applications. These latter were officially known as "Vacuum Tubes." This nomenclature was used until about 1922, when the term "Vacuum Tube" was applied to all such devices no matter for what use they were intended.

Captions for Illustrations

Figure 61. Arnold Mercury Arc Telephone Repeater, mounted in swinging bracket. (1914) Photograph





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courtesy *Bell Telephone Laboratories.*

Figure 62. Experimental installation of Arnold Mercury Arc Repeaters on transcontinental telephone line. Photograph courtesy *Bell Telephone Laboratories.*

Figure 63. Large single grid single plate Audion submitted to the American Telephone and Telegraph Company by de Forest for consideration as a telephone repeater element. (1912) Photograph courtesy *Bell Telephone Laboratories.*

Figure 64. First modification of the de Forest Audion by Western Electric Company. A glass arbor has been added to promote rigidity of the element structure (1913).

Figure 65. Second modification of de Forest Audion by Western Electric Company. Double grid and plate assemblies, supported by glass arbors. This tube had lower impedance and passed greater plate current than that shown in Figure 64. Photograph courtesy *Bell Telephone Laboratories.*

Figure 66. Philadelphia Audion No. 64. This is a sample of the first high vacuum tube, designated type "A," made by the Western Electric Company. This particular tube was used as a telephone repeater in commercial service at Philadelphia in October 1913. Bell System Historical Museum Exhibit. Photograph courtesy *Bell Telephone Laboratories.*

Figure 67. Double-ended type "B" high vacuum tube. This is the first type to use the "ladder" grid, characteristic of the early Western Electric tubes. Photograph courtesy *Bell Telephone Laboratories.*

Figure 68. Single ended type "B" tube, set in wooden base for display purposes. Later construction than that shown in Figure 67. Photograph courtesy *Bell System Historical Museum.*

Figure 69. Cast brass socket used by the American Telephone and Telegraph Company for the first based repeater tubes (1914).

Figure 70. Western Electric type "M" tube, the first high vacuum based telephone repeater tube (1914). Later designated as "101A Telephone Repeater Element." Photograph courtesy *Bell Telephone Laboratories.*

Figure 71. Western Electric type "L" repeater tube (1915). This was later designated as the "101B Telephone Repeater Element." Note increased length of filament as compared with type "M." Photograph courtesy *Bell Telephone Laboratories.*

Figure 72. Early Western Electric type "L" or 101B Telephone Repeater Element, showing patent markings applied to base (1915).

References

165. *Transcript of Record—General Electric Company vs. De Forest Radio Company. U. S. Circuit Court of Appeals. 3rd District*—Nos. 3799, 3800, 3801—*March term*—1928. *Testimony of E. H. Colpitts, pp.* 497-500.

166. *See reference* 165. *Testimony of H. D. Arnold, p.* 556.

167. *See reference* 165. *Testimony of H. D. Arnold, pp.* 601-604.

(*to be continued*)

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A-F Oscillator

(*Continued from page* 34)

for nominal 10,000-ohm output, or to the cathode of V_4, which is unbypassed in line with the heavy degeneration provided by C_7, R_{22}, R_{14} and other unbypassed cathode and screen resistors. This type of non-inductive out-

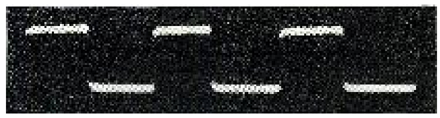

Fig. 6. Square-wave output, viewed at 200 cycles, is close to ideal.

put circuit is preferable to an output transformer, which would be almost impossible to build for such a wide frequency range in any case.

In sine-wave operation, since V_3 is voltage fed through R_{13}, no power is drawn from the oscillator itself, and consequently, neither adjustment of output level by R_{13}, variation in load character, or impedance can operate to seriously disturb either frequency calibration or stability.

In square-wave operation, R_{13} is turned full on, cathode resistor R_{14} of V_3 is short-circuited, and V_3 draws some small power from the oscillator (on the order of a few microwatts). Being substantially constant, this power drain causes a slight shift in oscillator frequency which is so small as to be negligible. Square-wave output is a maximum and not variable—which appears to be a little disadvantageous in amplifier or communication circuit testing in everyday use.

In this instrument, exactly one single-pole-single-throw toggle switch had to be added to get square waves where only sine waves "grew" before—coupled with adroit selection of circuit constants and voltages. What happens is that when the bias V_3 is

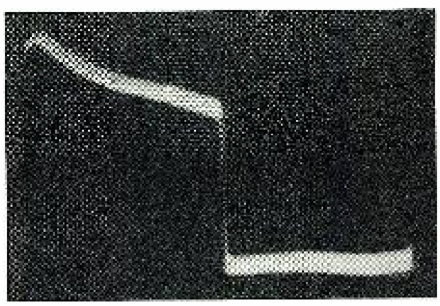

Fig. 7. Effect of 20-cycle square-wave applied to a good push-pull a-f amplifier under test. Decay of upper trace indicates poor low-frequency response, while flatter lower trace shows both amplifier unbalance and better low-frequency performance of one side of the push-pull amplifier.

shifted from negative to zero, V_3 becomes a limiter, or clipper as in conventional FM receivers, and operates, through saturation, to clip of both positive and negative peaks of the applied sine wave. The result is the

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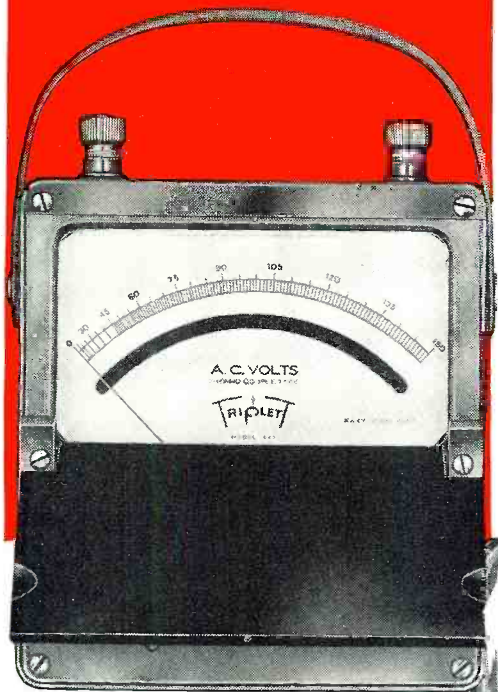

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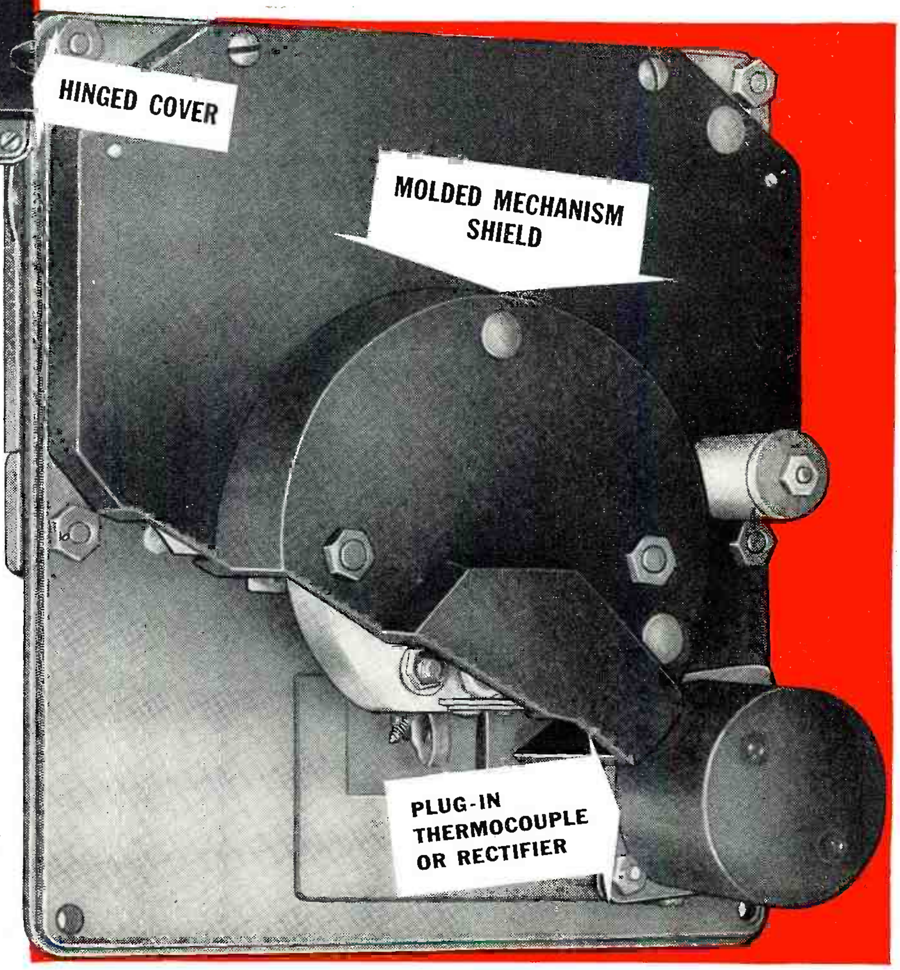

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The molded mechanical shield excludes dust, and allows replacement of plug-in thermocouples or rectifiers without exposing sensitive mechanism of instrument. Also, it protects the movement from possible damage when the case is open.

The Plug-in feature permits pre-calibration of thermocouples or rectifiers. Plug-in units are interchangeable. No recalibration of the instrument is required. In case of burn-out of a thermocouple or a rectifier a new one may be secured and replacement effected without returning instrument to factory.

For additional engineering information on Model 645 and other instruments of the same case style write for 645 data sheet.

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square wave of Fig. 6. Shorting R_{14}, to get square-wave output, automatically eliminates the inverse feedback used to improve sine-wave performance of the amplifier V_3, V_4. This raises the gain of V_4 sufficiently to maintain square-wave output practically identical with sine-wave output voltage, and does no harm, as seen from Fig. 6, which, typical for the range of the instrument, shows close to an ideally square wave at 200 cycles—the slight departure therefrom in the form of low-frequency distortion is due to the oscilloscope used. But that is a story in itself, for the unsuspected things which a square-wave oscillator will show up in otherwise supposedly perfect communication systems will prove amazing—it did in the development of this instrument, in terms of the several quite good oscilloscopes used to test it.

The process of examination of the frequency response with a sine-wave source, while essential to some activities, is slow and cumbersome, involving as it does a succession of gain measurements made throughout the frequency range of the amplifier, or other device, under analysis. Using square waves instead of sine, the process is the exact reverse, fast, easy, and at the same time capable of revealing faults almost completely undeterminable by the usual method. It is not the purpose of this paper to examine this most profitable field for investigation in any detail, but rather to refer the interested reader to Capt. Gilbert Swift's most informative paper in the Feb., 1939 issue of COMMUNICATIONS magazine. Yet, Figs. 6, 7, and 8 are suggestive of the merit of square-wave analysis which, the writer feels, will gain rapidly in popularity and application.

Fig. 5 shows typical sine-wave output of the new oscillator, as observed at 200 cycles. This is a good, distortion-free sine wave, customary flicker on the oscilloscope screen accounting for the slight fuzziness of the photograph. Fig. 6 is the square-wave output, in which all conditions were the same as in Fig. 5 except oscilloscope amplifier gain was reduced to eliminate photographic oscilloscope distortion.

Connecting the oscillator to a good amplifier, and applying 20 cycle square-wave output to it, the pattern of Fig. 7 was observed on the oscilloscope. The downward bend of the upper trace indicates low-frequency attenuation as might be expected. In a single-tube amplifier, the bottom trace would appear practically identically bent, but in the particular push-pull amplifier, under test, significant unbalance between the two sides of the push-pull stage existed at the lowest frequency used, hence the difference in positive and negative traces. Fig. 8 illustrates the slight high frequency attenuation which was revealed when a 20,000 cycle square wave was applied to this same amplifier, rated at 2,000,000 cycles.

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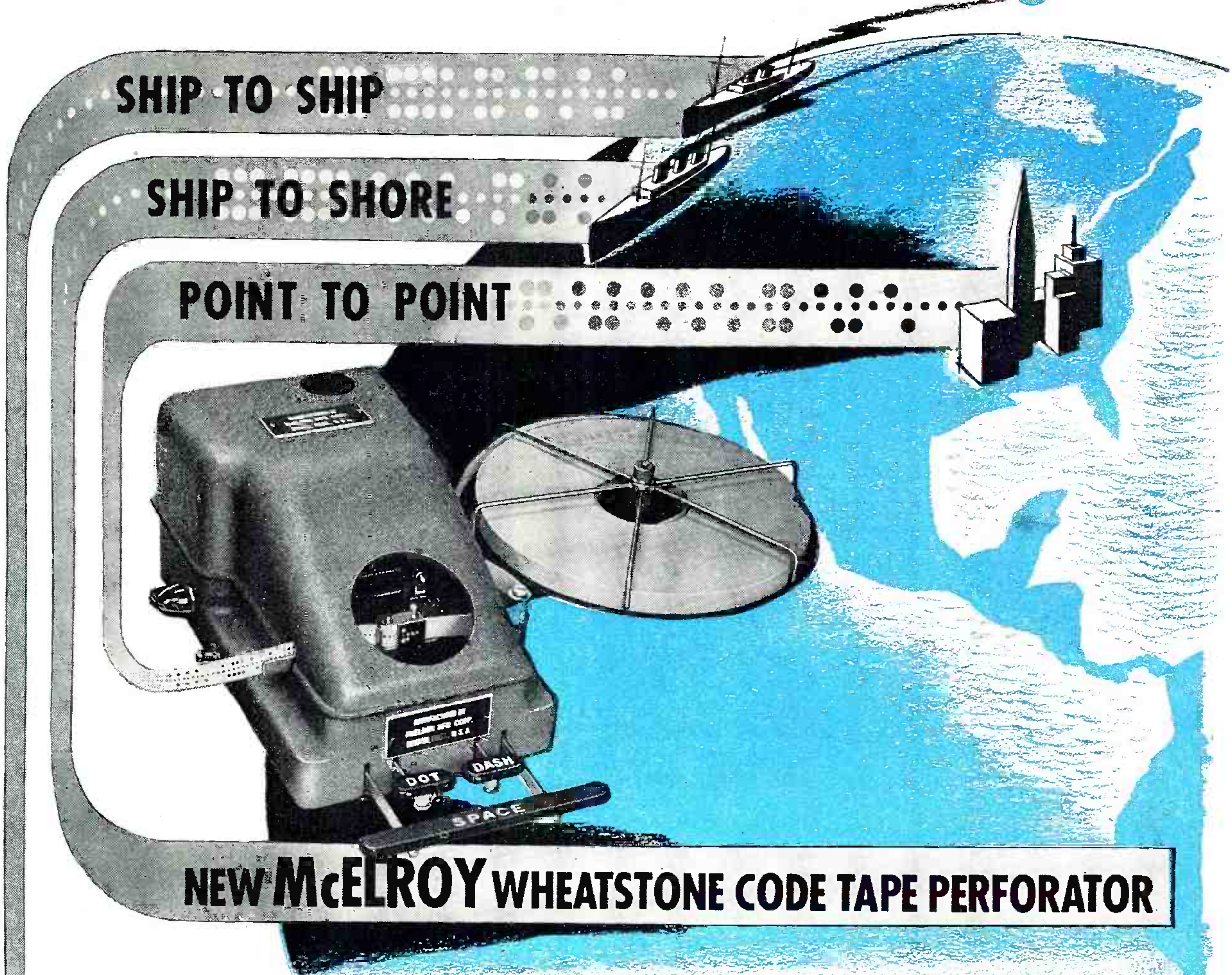

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Aware of the need for an instrument that would provide more efficient marine radiotelegraph communications, Ted McElroy* and his creative engineers have perfected the Model PFR-443 Wheatstone Code Tape Perforator.

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Here are two pictures taken from the oscilloscope screen—the result of two quickly made adjustments—which tell the story of frequency response of the entire amplifier and, through the absence in major degree of other variations which would be super-imposed upon these patterns by a poor am-

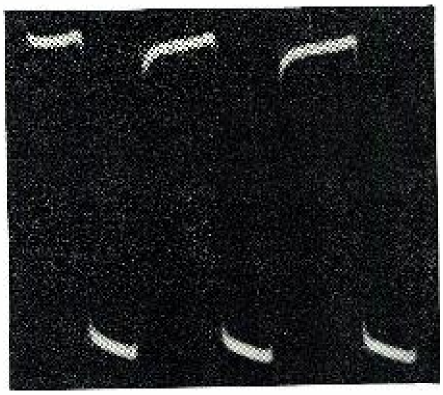

Fig. 8. Effect of 20,000 cycle square wave applied to amplifier designed to pass up to 2,000,000 cycles. Downward bend of beginning of traces evidences high frequency attenuation.

plifier, of its goodness with respect to transients, damping and delaying time.

By the use of an oscilloscope and a square-wave oscillator, using but two frequencies, one near the low-frequency end of the range, the second somewhat higher in frequency, two quickly made observations have told pretty much the whole story of the amplifier under test—more than could have been told by ten or more different individual gain measurements via the sine-wave route. It is a small wonder that square-wave testing of communication equipment is rapidly gaining favor, and will come into wide-spread use in the design of post-war radio equipment—particularly in servicing and maintenance.

—30—

Radio Mock-ups

(*Continued from page* 40)

A soldier is introduced to the semi-mock-ups in Aircraft Installation classes, one of the phases in the Aircraft Radio Branch. His first task is to learn tuning procedure on all equipment, and when he has mastered this, inter-mock-up nets are established and inter-plane communication is carried on. The nets are beneficial because they keep a man keyed to alertness, give him practical experience in receiving and sending and help him to familiarize himself with procedure.

In addition to the many types of operational nets that they must learn, the students must perform periodic inspections on all of the various communications systems and their allied equipment in the semi-mock-ups.

—30—

Electronic Switch

(*Continued from page* 29)

terminals, T_1 and T_2, either to internal 60-cycle source or to terminals for connection to an external sine-wave audio oscillator. The complete circuit is shown in Fig. 4.

The sine-wave signal amplifier tube is V_1. The grid lead of this tube may be switched between terminal T_1 and the "high" side of the 6.3-volt winding of the power transformer. By this arrangement the switching triodes, V_5 and V_6, may be actuated either sixty times per-second or at some faster rate determined by the frequency of an oscillator connected to T_1 and T_2.

V_2 is the 6H6 clipper tube, and V_3 and V_4 the switching tubes. V_5 is the input amplifier for one observed signal; V_6 the input amplifier for the other. Both of these amplifiers are provided with gain controls (R_7 and R_{12}). Each amplifier input is isolated from d.c. by a blocking capacitor.

Signal source No. 1 is connected to terminals T_3 and T_4; signal source No. 2 to terminals T_5 and T_6. T_7 and T_8 are connected respectively to the high and low vertical-input terminals of the oscilloscope.

Construction

Construction of the electronic switch is relatively simple. No elaborate shielding is necessary, it being sufficient to keep a-c wiring well separated from grid-circuit wiring. Gain controls are placed as close as practicable to the tubes with which they are associated, and all wiring, in general, is kept as direct and as short as possible.

In order to prevent deflections by stray a-c fields, leads up to T_7 and T_8 should be enclosed in shield braid, and the line from these terminals to the oscilloscope should, likewise, be sheathed.

The only terminals and controls occupying the front panel are the two gain controls, four signal-input terminals, the sine-wave signal switch, and the line switch. The terminals T1, T2, T7, and T8 are mounted on the right-hand edge of the chassis.

The entire instrument may be built comfortably into a case of approximately 12 inches long, 7 inches high, and 7 inches deep, although smaller dimensions may readily be employed where desired. So nearly foolproof is the instrument, that extreme compactness and latitude of layout will not seriously affect its operation.

From the operating principles, described earlier, it is apparent that tubes and components other than those specified might be employed where individual stocks demand these changes. If, for example, a small available cabinet has insufficient space for the line-up as shown, a twin triode, such as the 6C8G, might be substituted for the two tubes V_3 and

V_4 and another for V_5 and V_6. If tubes other than the 6C5 are substituted for V_3 and V_4, however, it may be necessary to readjust the grid bias, by moving the ground-slider on R_{17}, in order to obtain cutoff of plate current in these tubes.

Series-filament operation with a voltage-doubler power supply is also possible. But this type of operation is not recommended for reasons of safety and general utility. With such arrangements, power-line short circuits are apt to occur when working with signals from other a-c and d-c devices, and the danger of electric shock is ever present.

Elaborate calibration and adjustment is not necessary with the electronic switch. After the assembly and circuit wiring has been checked and approved, the switching-tube bias must be adjusted. A d-c milliammeter is placed successively in the two switching-tube (V_3, V_4) plate leads, and the tap clip on R_{17} adjusted so that, zero plate current is obtained in each tube for 250 plate volts.

If a signal is then fed into either terminals T_3-T_4 or T_5-T_6, no deflection should be obtained on an oscilloscope connected to T_7 and T_8. If a deflection is obtained, the switching-tube bias must be adjusted to a still higher negative value until the deflection disappears completely.

When a sine-wave signal is fed into terminals T_1-T_2 with switch S_1 in the EXT. position, however, a signal applied at either T_3-T_4 or T_5-T_6 should be traced upon the oscilloscope screen. The amplitude of this trace may be controlled directly by the corresponding gain control—R_7 or R_{12}. If signals are applied to both inputs, T_3-T_4 and T_5-T_6, and the sine-wave signal is applied to T_1-T_2, both traces should appear upon the oscilloscope screen.

If the traces are dotted or are composed of disjointed lines, the frequency of the sine-wave signal at T_1-T_2 must be increased to obtain faster switching. The most satisfactory sine-wave signal source will accordingly be a variable-frequency audio oscillator connected to terminals T_1 and T_2. In some instances, sixty switchings per second will be rapid enough. And in these cases, the external oscillator may be dispensed with and switch S_1 thrown to the 60-cycle position.

Final Remarks

The electronic switch offers many opportunities for private investigation. To the circuit of Fig. 4, numerous additions may be made in the interest of wider utility and versatility.

No claim to originality is made by the writer with regard to the basic circuit of the instrument. It is well-known among electronic men, and has appeared previously in radio literature. Hoag, among others, refers to it in his textbook *Basic Radio*. There are also a number of more elaborate means of achieving electronic switching, some possessing more merit for certain applications than the experimental unit described herewith.

The writer will be pleased to cooperate with any builder of this apparatus who desires any information which by oversight or space requirements has unintentionally been omitted from this article.

-30-

QTC

(*Continued from page* 48)

cial Telegraphers' Journal" of much interest to members and with many interesting features, probably the most votes going to the page "SOS to the Rescue" which consists of chapters taken from the popular book of that name by Lt. Comdr. Karl Baarslag.

WAYNE PASCHAL of the New York ACA office has obtained leave from his duties and has gone pounding brass at sea. Likewise with Jack Winocur, of the same who shipped out on a Liberty, which just goes to show that these men are not looking for soft berths during wartime but are willing and glad to step up and do their part. The best of luck to you fellows. Roy Roberson, in broadcast work ashore recently took to double harness as did Sammy

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Schiffer who recently shipped out again after some years ashore. Sy Mantel, one time "msg" editor of ACA graduated from Gallups Island recently, looking for a "Liberty." Leon Goodelman is also looking about for a "production" vessel of the same type. Van Ordstrand, in for a while, is also ready to ship out again. Corby Paxton, formerly NMU "Pilot" editor is now an ACA radioman. Kennie Goss, freshly repatriated, recently torpedoed, wants to take another crack at 'em. Percy Scambler is once again ready to be assigned to a job of brass pounding on the briny deep. Tony Vitacco was recently in town with his missus to "see the sights" before he shoved off.

THERE still seems to be some misunderstanding by men about to take license exams and those who have recently passed the tests, requesting information regarding the necessary papers, etc., for shipping out. The following information from the New York office of The Radio Officers Union may help: The following papers must be in your possession. 1. Certificate of Identification. This may be obtained at any office of a U.S. Shipping Commissioner. Officers who will issue same may be found in all principal shipping ports of Atlantic, Gulf, Pacific and on the Great Lakes. 2. A certificate of service. Obtained at same place as the above. 3. A U.S. Coast Guard Identification Card. Obtained at any Coast Guard office at the various ports. 4. Seaman's Passport. Obtained from the Department of State-offices of information at all principal cities and ports. 5. You must possess a Commercial Radio Operator's license, first class, second class, or one of the new Temporary Limited Commercial Radio Operator licenses. The latter is good for the duration of the war and for six months thereafter. If you are under 18 years of age you will require written permission from your parents or guardian before your shipping papers will be issued.

The temporary limited class license will be issued to the following: 1. Any person who formerly held a commercial radiotelegraph first or second class license, provided such person can copy 16 words-per-minute in code groups. No theoretical examination is required, but one must have definite proof of citizenship. 2. Any person who has been in the Army, Navy, Coast Guard, or any other person who can copy 16 words-per-minute in code groups and who can pass a theoretical examination and obtain a passing grade of 50 percent on each element. Proof of citizenship is also required. It is suggested that a new man get in touch with one of the unions, who will be able to advise and help him get started. The two largest are, The American Communications Association, 10 Bridge Street, New York, N. Y., and The Radio Officers' Union at 265 West 14th Street, also in New

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WANTED—Complete amplifier for 6 or 110 V. Late type tube tester, Rider Manuals, V-O-M, etc. Emerick J. Sepic, 2510 Harrison Ave., Eureka, Calif.

WANTED—Thordarson transformers, high-fidelity series #15R05—90A04—90S13, also Jensen coaxial speaker JHP-52. Murray J. Douglas, Concord, Calif.

FOR SALE—Complete radio repair laboratory: Supreme set analyzer #385 modernized for latest tubes; Supreme 561 oscillator; Solar C.D. condenser analyzer; Triumph #830 oscillograph; wobbulator; Tobe condenser analyzer. Also a lot of tubes, resistors, condensers, etc. Send self-addressed stamped envelope for reply. George C. Anderson, 1443 Columbine St., Denver 6, Colo.

WILL SWAP—RCA portable recorder #MI-12701 to trade for University speakers or what have you? Lewis Radio & Sound Service, 226 W. Liberty St., Louisville 2, Ky.

WILL TRADE—Underwood #4 typewriter or Savage 32 automatic for signal generator, tube checker, or V-O-M. Sell or trade Westinghouse DC BX filament meter 5-0-1 amp. J. P. Hyde, Fairfax, Va.

WANTED—Supreme #562 audolyzer. Give details & price. Louis Bauerfeind, Hortonville, Wisc.

DC METERS FOR SALE—3 Weston #301 0-5 volts (used); one each of following: Readrite #55 0-100 ma.; ditto 0-200 ma.; one ditto 0-100 (zero adjust.); one ditto 0-150; Reliance type S, 0-5 & 0-50 amps. less shunt; Ditto 0-15 & 0-150 volts; P.T.C. Co. differential #361A 100-0-100 ma.; Jewell #54 galvanometer, 50-0-50; also six var. condensers (13 plates), 3 with matched coils; and six Marco vernier dials 4″ to match condensers. Readrite items are new. All in 1st class shape. Ted Solarz, 3033 S. Pulaski Rd., Chicago 23, Ill.

WANTED FOR CASH—Analyzer, tube tester, or multi-tester, or any other test eqpt. G. J. Hubler, 112 Charles St., Pittsburgh 10, Pa.

FOR TRADE—Equal value of popular type tubes for late model multi-range tester (Precision preferred). Will consider other test eqpt. Describe fully. J. B. Abernathy, 667 Ave. D, Boulder City, Nev.

WANTED—Channel analyzer, also 3″ occilloscope, and capacitor tester. Max Platau, 447 E. 86th St., New York, N. Y.

FOR SALE—All of the following are brand new: 20 synchronous vibrators, $2 ea.; 15 non-synchronous vibrators, $1.50 ea.; 10 I-F trans. 455 kc., 55c ea.; 10 ditto 465 kc., 55c ea.; 40 8-mfd. 350 v. condensers, 35c ea.; 10 #89 Kenrad tubes, 60c ea.; 1 K-K 4″ dial, 40c; 6 coil forms (4 or 5-prong), 5c ea.; 5 lightning arresters, 10c ea.; 1 5″ P.M. dyn. speaker and output trans., $3.50; 17 vol. controls 1 meg. with switch, 75c ea.; 36 1-amp. fuses, 7c ea. Send supplier's certificate. N. J. Cooper, 4617 N. Damen Ave., Chicago, Ill.

FOR SALE—Hi-standard 6½″ barrel .22 cal. target gun with holster, like new, $40; Johnson 70CD130 var. condenser for 1 Kw. also two National 1 Kw. neutralizers, double-spacing var. condensers, Meissner de luxe signal shifter with all coils, ⅙ h.p. motors, 110 AC to 110 DC generators. Write for list. Nelson K. Stover, 1357 Hill St., York, Penna.

WANTED—New or used ribbon microphone, also oscilloscope. Fred L. Hoyt, 417 Perrine Bldg., Oklahoma City, Okla.

WILL TRADE—Underwood S-11 14″ carriage typewriter with high-speed keyboard in superb condition for a modern comb. set and tube tester V-O-M in good shape, plus 12 popular type 12SA7, etc., tubes. Superior #1280 or equivalent desired. Raymond J. Rowell, Apt. 103, 613-5th St. S.W., Birmingham 7, Ala.

WANTED FOR CASH—Supreme Veedolyzer in good condition. Carl's Radio Shop, 5103 Fleet Ave., Cleveland, Ohio.

FOR SALE—Readrite point-to-point tester #730-A with Readrite A-C meter 10-25-150-750 volt and Triplett #223 DC voltmeter 15-150-300-600 volts at 1000 ohms per volt, 15-150 ma. Nearly new. All attachments. Fred Walter, 52 High St., Montrose, Pa.

FOR SALE—Tested used tubes, types 36, 80, 26, 89, 37, 1S4, 1S5, 1T4, 1R5, 1G4, 12A7, etc.; also 10″ dynamic speakers; transformers; AC-DC radio chassis, 5-tube, no speaker. Write for details. B. Paine, 1186 Lexington Ave., New York 28, N. Y.

TRADE—Will swap 1 pair new Crossley Chatterboxes in orig. cartons for one Carron signal tracer, Model CCH. Nip's Radio Service, Grove & Madison, Eldorado, Ill.

WANTED—Jr. Voltohmyst or Precision EV-10 vacuum tube voltmeter or other good V-O-M. Also capacity analyzer. Ralph Yoder, 146 E. Church St., Orrville, Ohio.

FOR SALE—Complete N.R.I. course in practical radio-television. 65 books including reference books. Ray Williams, 4405 Arlington Ave., Ft. Wayne, Ind.

WANTED—Complete used set or any volume of Rider's Manuals. Also want signal generator and test eqpt. Maurice McCann, 712 Romayne Ave., Racine, Wisc.

TUBES FOR SALE or trade. All Nos. of 2-volt series in sleeves, in good cond. Some new, some slightly used. 30-1C6-951-1H4G-1C7G-34-1AY and many others. Also car radio control panel kits '35 and '40 models at 25c ea. North East Radio Service, 339—13th Ave. N.E., Minneapolis 13, Minn.

EQUIPMENT FOR SALE—RCA TMV97C signal generator, $15; RCA #9572 crystal calibrator, $15; G-E #26F82 Pyronol condenser, 1500 V. 2 mfd., $4; Weston #674 counter type tube tester, $20; Sylvania 860 tube, $7.50; also lots of used metal and glass tubes. Fred Craven, 2216 S. 7th St., Philadelphia 48, Pa.

URGENTLY NEEDED—Signal generator, tube tester, set analyzer or combination AC-DC V-O-M or what have you. Give details. David Gailey, Worthington, Pa.

FOR SALE OR TRADE—Wilcox-Gay Recorder Jr. Sell for $65 cash or take part or all in 1A7, 1H5, and 50L6 tubes. Recorder good as new. Will pay $15 cash for all small radios (electric sets only) in good cond. Phoenix Radio Service, 519 W. Forsyth St., Jacksonville, Fla.

URGENTLY NEEDED—Superior #1240 tube tester (used). Also want small AC-DC set. Cash. B. Paine, 1186 Lexington Ave., New York, N. Y.

FOR SALE—#505 Supreme tube checker completely factory-modernized. Through some error in the modernization, it does not seem to work properly on all types of tubes, but believe this can be easily corrected. Valued at $49.50. What do you offer? Pfc. Bert E. Zielesch, Station Hosp. Med. Sec., 1879th Unit, Area-C, Bks. B-1, Camp Livingston, La.

WANTED—Supreme Veedolyzer or Hickok RFO-5. Will pay cash or arrange trade. Have following items to offer: Superior channel analyzer, modernized Supreme #89 set tester; Philco signal gen. bat. with station-setting switch. Also want good V-O-M. Boyers Radio Service, 1305 S. 9th E St., Salt Lake City, Utah.

WANTED FOR CASH—University speakers or what have you? Lewis Radio & Sound Service, 226 W. Liberty St., Louisville 2, Ky.

WANT CATHODE RAY TUBE—5″, either white or green screen in perfect cond. Cash. Wm. Domuray, 614 N. 13 Ave., Melrose Park, Ill.

WANTED—A dial escutcheon and panel assembly or dial escutcheon only for Midwest model #7-36. Radio Dept., Eugene Vocational School, Eugene, Ore.

WANTED FOR CASH—Condenser analyzer such as Sprague Tel-O-Mike, Solar CC-160 or CE, C-D BF-50, etc. Jack's Radio Service, Lindenhurst, L. I., New York.

RIDER CHANALYST FOR SALE—Excellent cond., used very little, $105 C.O.D. Want Solar capacitor analyzer, RCA Voltohmyst, and Green Flyer dual speed phono motor and turntable for 110 V. A.C. York Electric Co., 420 Lincoln Ave., York, Nebr.

FOR SALE—Four Weston meters: One model 476 AC voltmeter with 3 scales, 0 to 3, 0-15, and 0-150; one model 301 DC voltmeter, 1000 ohms per volt, 3 scales, 0-10, 0-100, and 0-600; one model 301 meter having 2 scales 0-125 ma. and 0-2.5 amps. These 3 in good condition. Also have one Weston model 301 0-1 ma. meter that needs new pointer. Best offer takes them. Bob Parkhurst, Pittsford, Vt.

FOR SALE: ONE OF THE BEST STOCKED RADIO SERVICE SHOPS IN MICHIGAN—1500 tubes (including all scarce numbers); thousands of resistors and condensers. Well stocked in AF, IF, and power transformers. Up-to-date high-grade equipment. Streamlined servicing console and complete Rider's manuals. Only service shop in an area covering 12,000 people. Owner is in poor health and leaving for Arizona. Best offer over $5,000 cash takes it. For details, write to: M. K. Tanner, 1659 High St., Cuyahoga Falls, Ohio.

YOUR OWN AD RUN FREE!

The "Trading Post" is Sprague's way of helping radio servicemen obtain the parts and equipment they need, or dispose of the things they do not need during this period of wartime shortages. Here then are a few hints which may help you benefit from it:

Answer interesting ads while they are "fresh." Don't wait until the magazine is several weeks old. Do not send letters in reply to advertisements to Sprague. Write direct to the advertiser.

Study the "For Sale" ads first to see if what you need is listed before sending in your "Wanted to Buy" ad. The Trading Post appears regularly in Radio Retailing - Today, Radio Service - Dealer, Radio-Craft, Radio News, and Service.

Please do not specify the magazine in which you would like your ad to appear. We'll do our best to get it in one of the leading publications, but it only complicates matters when a certain publication is specified.

Please don't ask us to run an ad in which you ask more than the normal price for parts or a piece of equipment.

Don't offer to accept C.O.D. telegraphic or telephone replies to your ad. Some individual Trading Post classified advertisements have pulled as many as four and five hundred answers!

Answer ALL inquiries to your advertisement promptly—even though some of them may have arrived too late. This is only common courtesy.

When sending your ad to Sprague, please address it to the department number shown below. This serves as a valuable guide to our advertising department.

Obviously, ads featuring equipment "For Sale or Trade" generally bring better results than those wanting to buy hard-to-get equipment. Preference will thus be given to ads offering parts or equipment for sale.

Write your ad carefully, clearly and keep it short. Many ads received are unintelligible or hard to decipher—and this causes unnecessary trouble.

"Emergency Ads" will receive first attention and Sprague, of course, reserves the right to eliminate any ads which do not seem to fit in with the idea behind this special wartime emergency advertising service.

Dept. RN-312*, SPRAGUE PRODUCTS CO., *North Adams, Mass.

SPRAGUE CONDENSERS
KOOLOHM RESISTORS

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

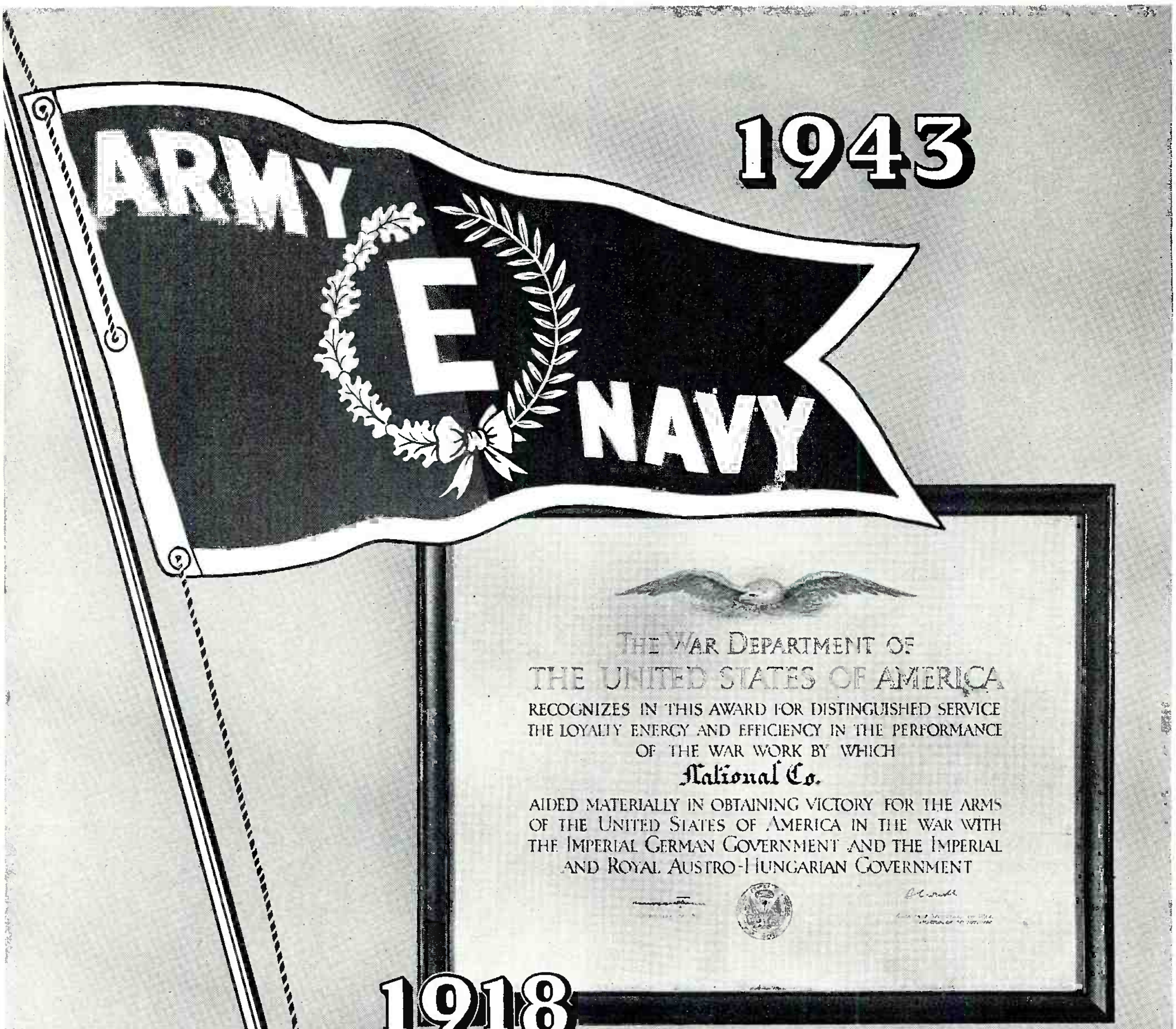
York, N. Y., both have offices in various ports. ACA is CIO and ROU is AFL and both are organized to help you in your chosen profession and to improve conditions generally for radio ops.

LOTS of fellows just out of Gallups are rarin' to go and to do their stuff for Uncle Sam. A good many yards formerly engaged in construction of Liberty ships have now turned to the newer "Victory" type cargo vessels and also to tankers. First six months of 1943 produced many more ships than were constructed in the entire year of 1942 and things were not exactly at a standstill at that time! David Gibbons of the Seattle ACA office was in San Francisco a while back for a vacation. "Red" Davis on the beach four months, then got himself a nice C-3 job; one trip and the Army has had 3 Navy men take over the job. Going to try a C-1 next time, with better luck we hope. Rudy Asplund is shuttling around in the South Pacific and expects to be there for some time we hear. In New York, Murry Winocur, Jack's brother, has taken over at ACA for a while during Jack's present leave of absence. Murry is just in from the far east. Harry A. Morgan of ACA has been appointed alternate CIO member to the recently established War Shipping Panel of the War Labor Board, which will have jurisdiction over all maritime wage dispute which may arise throughout the nation.

Jerome J. Papke, Lindsey C. Evans, Jr., and Lowell Dibble, all from Gallups Island, shipped out a while back, as have D. H. Thoreson, C. D. Smithley and T. J. Barcikowski. C. J. Amato, marine inspector in New York doing service and repair work, expects to be called for Army service. Understand MRT in the big town has recently lost one of its best men and the local board is eyeing another to fill up their quota. G. B. Cox, M. J. Hand, George Wiman and R. M. Talbot, all recent graduates of Gallups Island school, have shipped out lately.

THE U.S. Government is building hundreds of new ships, and will need hundreds of radio ops to man them, for beginners or those who have been telegraph operators can easily get into radio operating by studying the equipment and code at a good radio school, of which there are several throughout the country. One should also obtain the necessary instruction books as suggested by the various schools. You can do your part by becoming a radio officer in the U.S. Merchant Marine as well as in the purchase of war bonds. So far we have not heard much from the boys in broadcast and aviation, if any of you fellows can get these ops started it will be appreciated.

—30—


1943
ARMY
E
NAVY
THE WAR DEPARTMENT OF
THE UNITED STATES OF AMERICA
RECOGNIZES IN THIS AWARD FOR DISTINGUISHED SERVICE
THE LOYALTY ENERGY AND EFFICIENCY IN THE PERFORMANCE
OF THE WAR WORK BY WHICH
National Co.
AIDED MATERIALLY IN OBTAINING VICTORY FOR THE ARMS
OF THE UNITED STATES OF AMERICA IN THE WAR WITH
THE IMPERIAL GERMAN GOVERNMENT AND THE IMPERIAL
AND ROYAL AUSTRO-HUNGARIAN GOVERNMENT
1918

Audio-Frequency Meter

(*Continued from page* 39)

stability, (3) isolation from d-c components in signal circuits, (4) light loading of all signal circuits, (5) sharpness of null indication, and (6) sensitivity.

The parallel-T network in the final arrangement (Fig. 4) is comprised of C_1, C_2, and C_3, R_1, R_2 and R_3. The input amplifier is a single 6J5 which is transformer-coupled through T_1, to the network. R_4 is the input gain control.

The vaccum tube voltmeter circuit is built around the 6SQ7 tube and a 0-500 d-c microammeter, M. Calibration curve for this meter circuit is given in Table III. Alternatively, a conventional magic-eye circuit might be employed in lieu of the v.t. voltmeter circuit shown in Figure 4.

Amplifier and vacuum-tube voltmeter stages are activated by the self-contained power supply. The output of this stage is 250 volts d-c and the current drain is quite low. The power transformer, T_2, may accordingly be small in size.

The entire instrument is built into a case 7" x 10" x 5". Panel size is 7" x 10". Front panel layout is shown in Figure 5. By mounting the various components directly upon the back of the panel, no chassis will be required.

TABLE III
Calibration Data for the Voltmeter

VOLTAGE (RMS)	METER READING
3.00	500
2.80	450
2.50	400
2.30	350
2.10	300
1.80	250
1.60	200
1.40	150
1.10	100
0.00	000

The dial controlling the network is graduated directly in cycles-per-second, the points being determined during the calibration process to be described later. It is recommended that the largest available dial be employed on this instrument, in order to insure maximum readability. The writer employed a standard 4-inch dial, over the face of which was cemented a disc of white Bristol board which was covered with transparent celluloid after being marked off.

No particular precautions are to be observed in the construction of the instrument, except that the two transformers must be mounted as far apart as practicable.

Network Details

Capacitance values for C_1, C_2, and C_3 will depend upon the maximum re-

sistance values of R_1, R_2, and R_3. If the entire audio-frequency spectrum is to be covered in one rotation of the dial, C_1 and C_2 will each be .0159 μfd., C_3 .0318 μfd., R_1 and R_2 500,000 ohms ,and R_3 250,000 ohms. This data may, of course, be obtained from Chart I.

If lower-resistance resistors are employed, frequency and capacitor data may be obtained from Chart II, and a 3-position, 3-pole rotary selector switch must then be included in the network circuit to permit switching capacitors for changing ranges.

Calibration

After construction and checking are completed, calibration may be undertaken:

(1) *V.T. Voltmeter.* Open the lead "X" and switch on the power supply. As the 6SQ7 tube comes up to operating temperature, meter M will be deflected. After a 5-minute warm-up period, set meter pointer to zero by means of potentiometer R_{11}. Introduce, between the top of R_6 and ground, an alternating voltage variable between 0 and 4 volts, comparing the up-scale meter deflection with the data in Chart III. After calibration, reconnect the circuit at "X".

(2) *Frequency.* The frequency calibration may be performed in two ways: (1) directly against a variable-frequency audio oscillator, or (2) by measurement of network resistance values at the various settings of the tuning dial and calculating according to Chart I or Chart II. The oscillator method will be the most accurate; connect oscillator directly to the input terminals of the audio-frequency meter. Switch on latter. Set oscillator dial at first calibration frequency. Swing meter dial until sharp downward deflection of vacuum-tube voltmeter indicates resonance. Mark first calibration frequency on dial at this setting. Repeat procedure for a number of calibration frequencies throughout the audio range.

Use of Instrument

Use of the improved audio-frequency meter is simple and straight-

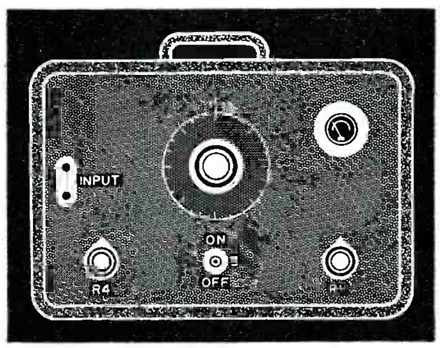


Fig. 5. Panel layout of A-F Meter.

forward. (1) Switch-on instrument and set vacuum-tube voltmeter to zero; (2) connect instrument input terminals to the source of unknown frequency; and (3) rotate instrument

Sit in with Majestic's post-war planning conference

Majestic's "post-war planning conference" in form of a $1,000 idea contest was announced last August. It's been going, going—soon it will be GONE. But where's the bid from YOU?

Men, this is your opportunity to express yourself on what you consider sound technical developments for post-war years. You probably have ideas about the devices and developments which you think should be embodied in the radio of the future. Let this contest be an incentive to put your ideas down on paper. Your reply may win a prize and you may have the satisfaction of helping to create a better radio and a better industry for the years to come.

Put on your thinking cap. If you can't answer all the questions below, answer the one on which you feel qualified to speak and your reply will still be considered. These questions should stimulate your own post-war thinking — and will be a valuable check against Majestic's Post-War Plans.

$1,000 PRIZES IN WAR BONDS FOR MOST HELPFUL ANSWERS TO THESE THREE QUESTIONS

1st Prize $500 maturity value; 2nd Prize, $250 maturity value; 3rd to 13th, $25 maturity values. Every one is eligible. Contest ends December 31, 1943. To stimulate YOUR post-war thinking, and to check OUR post-war plans, Majestic offers prizes for the most helpful answers to these questions: (1) What types of radios will be in large demand in YOUR locality immediately following victory? (2) In what new features or new merchandising policies are you most interested at present? (3) What kind of advertising support do you believe will be most helpful to you?

Competent judges will read your answers. It's facts and ideas, not rhetoric, that will count. If any two prize-winning letters are considered by the judges to have equal merit, duplicate awards will be made. Write your answers to these three questions—mail them to me personally, today!

E. A. TRACEY, President

Majestic MIGHTY MONARCH OF THE AIR

MAJESTIC RADIO & TELEVISION CORPORATION
2600 WEST 50th STREET
CHICAGO 32, ILLINOIS

Builders of the WALKIE-TALKIE, "Radio of the Firing Line" dial, until sharp downward deflection of the v.t. voltmeter indicates resonance. The unknown frequency may then be read directly on the calibrated dial. If the input signal is too intense, so that excessive deflection of the vacuum-tube voltmeter results, reduce the setting of the gain control, R_1.

If the frequency of an audible sound, rather than of a voltage is to be determined, a carbon microphone, with battery and transformer, may be connected to the input terminals and the sound directed to this microphone. The unknown frequency is then determined in a manner already described.

—30—

Serviceman's Diary

(*Continued from page* 46)

"Why don't I just tear my hair and shout at this woman," thinks our hero, "Why the blankety-blank, does she bring her radio to me if she and her neighbors know more about it than I do. Why do most people think a radio consists of some tubes and loose wires," his thoughts run on.

"How much will this cost me?" asks the lady. "Will it be as good as new if I let you put this—er—'What you call it' in?"

You painstakingly try to explain to her that you can gauarantee the parts you put in but can't, naturally, tell how much longer the rest of the set will perform. You wonder again, why the public seems to think a radio man is a fortune teller. The lady, finally, with much uncertainty, decides to leave the precious thing with our Busy Bee Service Man.

Our next customer to arrive, carrying a set all wrapped up in dark brown wrapping paper, carefully tied with cord, is an elderly man. He hands you the set with the half-formed sentence, "It's just a tu—." By this time, our Busy Bee Service Man's nerves are frayed and he almost rudely snatches it up and proceeds to unwrap it. After removing two or three layers of paper, he sees two or three loose wires dangling around and he instantly knows a would-be radio fixer has been at work. A preliminary examination shows that this job will take concentration. All the time, our elderly gentleman is bent over peering into the set, his white hair almost touching the black hair of our Busy Bee Man.

The old man says, "You know my Grandson is so interested in radio. He was sure he could fix this set when it stopped. I do hope he didn't leave any parts lying on the living room floor. Don't you think it's grand for young boys to be so interested in Radio?"

You sadly think, "It might be grand, if they would only stop bringing them to a radio shop and expect us to repair, in five minutes, damage that will take a good day's steady work."

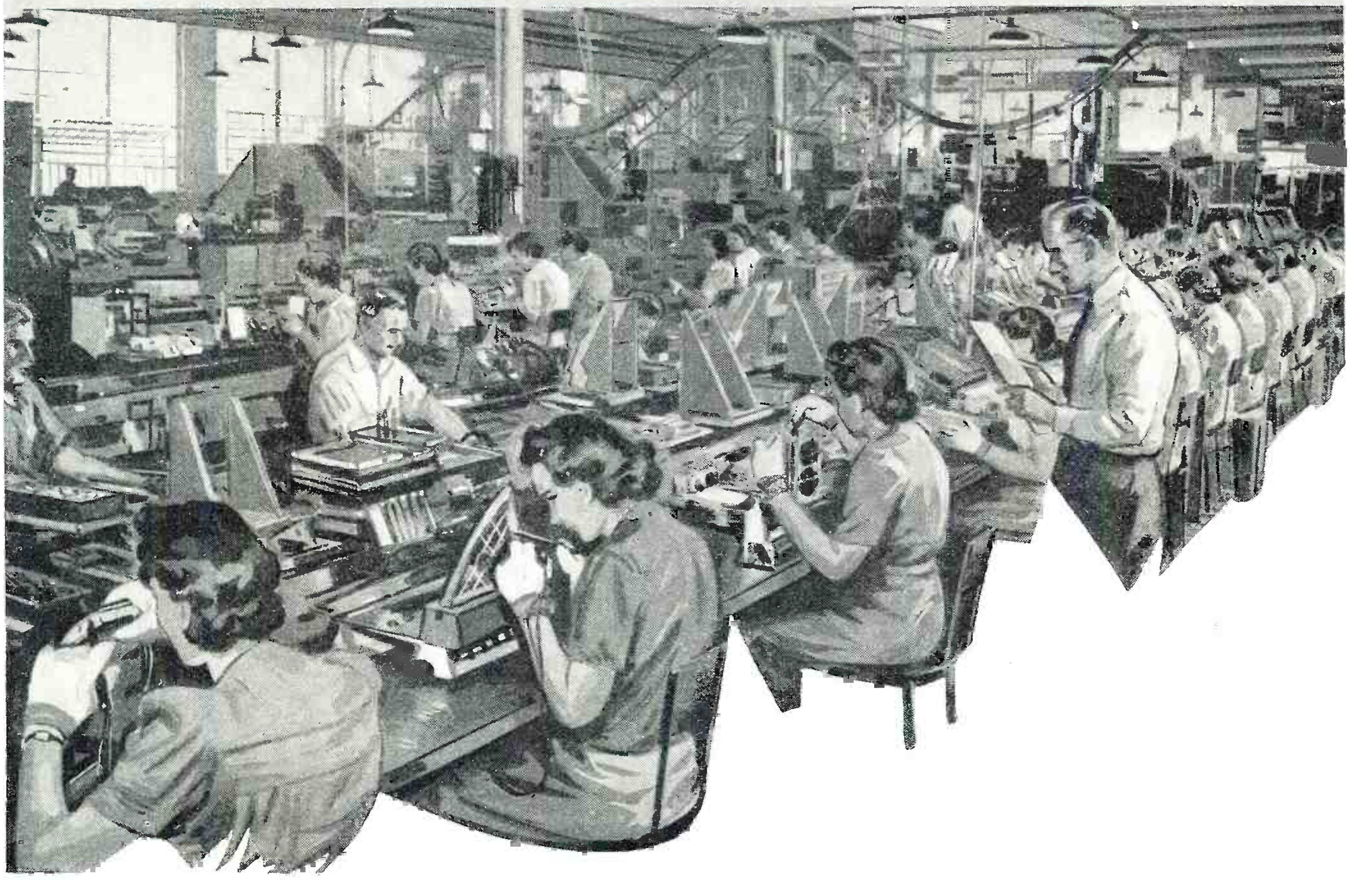
The old man rattled on until you decide you must get rid of him or go stark staring mad. Slowly it seeps into the old fellow's head that this might be a longer and harder job than he had anticipated so he cautiously suggests he will leave it and henceforth his grandson shall not be allowed to "fix" radios.

About this time, the phone rings out again and our harassed man ambles out and answers it, "Busy Bee Radio Service," he says, with forced cheerfulness.

"Do you service 'so and so' radios?" a woman's voice asks. He tells her that his shop takes care of all makes of sets and she says, "Well, last night, our radio was playing good and all at once, we heard lots of static, and it stopped. Can you please tell me what's wrong with it and how much it will cost to fix it?"

"I'm sorry," said our radio man patiently, "it would be too difficult and a wild stab in the dark to even try and tell you what the trouble it. We can come up and check the set and

There's More to Engineering than Design



It's one thing to concentrate the combined forces of research and engineering on a problem, and thereby come up with the answer—and quite another thing to put that answer into mass production on an assembly line.

This teamwork between research engineering and mass production is a Delco Radio specialty, developed through years of experience in the exacting manufacture of peacetime automotive radios. It is being applied to highly intricate wartime assignments which include volume production of receivers and transmitters for mobile artillery and tanks . . . straight-line assembly of push-button tuning for vehicular radio receivers . . . mass manufacture of relays, plugs, receptacles, rotary switches, shock mountings . . . and volume production of components for air-borne communication and electronic navigation equipment.

Today, when the ability to discover and design must be teamed with the ability to produce in great quantity with highest quality, Delco Radio finds itself well prepared for wartime industry's needs. Delco Radio Division, General Motors Corporation, Kokomo, Indiana.

Back Our Boys By Buying Bonds!

Delco Radio
DIVISION OF
GENERAL MOTORS

bring it back to the shop to repair it."

"Bring it in?" chirps the lady. "I should say not!! That radio is not leaving this house. I want it fixed right here. I read in the 'Reader's Digest' that all radio men are gyps and you can't gyp me. Never mind, I'll call someone else." And up goes the receiver.

Our Busy Bee Radio Man happens to look at the clock and with a feeling of intense joy and relief. He sees it's six o'clock and closing time. He disconnects the soldering irons, neon signs, etc., checks the register and closes up. Another hectic day ended! He looks forward to a quiet evening at home reading radio magazines. He turns on the radio in his car, and notices with a start, that it still needs a new volume control. The scratching is so great that he snaps it off as fast as he can.

He arrives home, puts the car in the garage, and wearily walks up to the door. Just as he is about to turn the knob, the door opens and friend wife greets him with:

"Darling, both radios stopped, dead, will you hurry and fix one, as my favorite program comes on in just a minute. It's probably just a tube or loose wire."

Oh, boy, you just can't win.

—30—

Mfrs.' Lit.

(*Continued from page* 46)

ideas present a summary of the ten best ideas submitted by servicemen in response to a recent nation-wide contest.

In addition to the volume control data, involving repair methods both by change of circuit and mechanical changes, the booklet contains valuable information on figuring resistor substitutes; formulas for finding wattage, current and resistance values; a listing of preferred ranges; a standard RMA color code chart, and a resistor determination chart.

The booklet is offered free of charge and may be obtained either by writing direct to *International Resistance Company,* 401 N. Broad Street, Philadelphia, Pennsylvania, or from any *IRC* distributor.

AIR CONDITIONING AND INDUSTRIAL REFRIGERATION BOOKLET

Controlled temperature, humidity and air cleanliness mean uniform quality, precision, fewer rejections and faster production, according to a new booklet on air conditioning and industrial refrigeration announced by *Westinghouse Electric and Manufacturing Company.*

In machining work, optical goods grinding and assembly, flying suit storage, instrument assembly, X-ray film developing, capsule manufacture, airfield traffic control and other industrial processes, the booklet shows how air conditioning and industrial refrigeration solves production problems.

This 20-page booklet illustrates and describes the exclusive Hermetically-sealed Compressor, and traces its development from the 1932 models up to the present design.

A copy of booklet 3AC-0201 may be secured from *Westinghouse Electric and Manufacturing Company,* East Springfield, Mass.

Signal Corps Issue

(*Continued from page* 50)

including a group of natural color reproductions of Kodachromes, will be among the highlights of the issue. Each of these pictures is a story in itself and will illustrate dramatically the function of communications equipment in the war.

We sincerely believe that this authentic issue will for the first time tell the complete story of all branches of the Signal Corps and the part that the American manufacturer is playing to maintain an endless supply of material required to fight a modern war.

—30—

WANTED—MORE SIGNAL CORPS EQUIPMENT

THE Army Signal Corps is still in need of many types of radio and test equipment. Short wave radio equipment already purchased from private owners is now in service on many battle fronts as well as in the continental United States; however, more of a number of specific items is still urgently needed.

The Signal Corps, Army Service Forces, made a special appeal to radio "hams," dealers and others who possess certain high-grade or scarce items to sell them as a means of aiding the war effort. Owners who wish to offer equipment for sale should write to: *Emergency Purchase Section, Philadelphia Signal Corps Procurement District, 5000 Wissahickon Avenue, Philadelphia, Pennsylvania.* Price consideration is based upon the net cost less reasonable depreciation for use, age, and condition of equipment. Inasmuch as all equipment is being purchased FOB Philadelphia, cost of packing and shipping can be shown separately so that allowance for the cost can be made when material is accepted. In no case, however, should they ship any of it unless they receive requests from that agency to do so.

Persons from 44 states have already made a total of more than 6,000 offers, and more than 1,000 purchase orders have been placed.

Some of the short-wave sets thus obtained have been allocated to the Federal Bureau of Investigation.

Much of the equipment goes to troops overseas for use in operations against the enemy. Other equipment is utilized in the Army training schools.

Some of the equipment desired includes items no longer manufactured. Some could be used in greater quantities than are produced.

While the greatest need in radio items at present is for testing equipment, (oscilloscopes signal generators, tube-checkers, etc.), the list of wanted instruments ranges from standard and commercial short-wave sets to ordinary meters. This equipment is being shipped both to troops overseas and to Army training schools.

The following list shows the many types of radio equipment needed by the SIGNAL CORPS.

NATIONAL RECEIVERS
- HRO (Complete with coils and power supply—both rack and table)
- HRO-Jr. (Complete with coils and power supply)
- NHU (Complete with 5856 power supply)
- NHU-20 (Complete with 5856 power supply)

NHU-B	NC101XA	NC-200
NHU-20B	NC-44	NC-80X
NC-100A	NC-44A	NC-81X
NC-100XA	NC-44B	
NC-101X	NC-45	

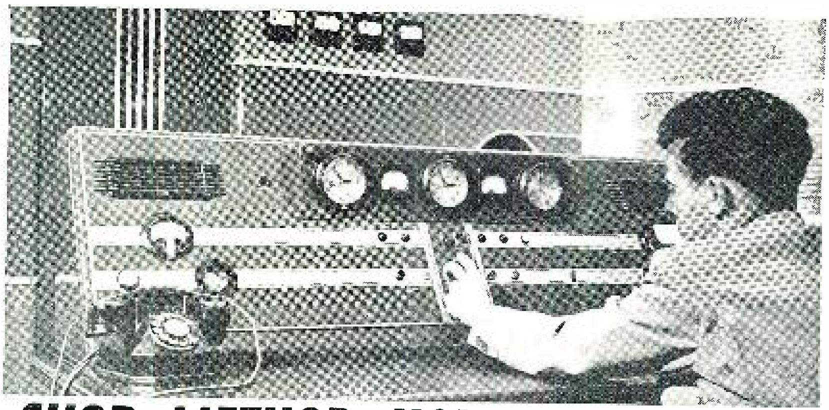
HAMMARLUND RECEIVERS

HQ-120	SP-210-SX	SP-220-SX
HQ-120-X	SP-220-X	SP-200
SP-210-X		

HALLICRAFTER RECEIVERS

Typical equipment needed by the Signal Corps.

...Ge In o RADIO ELECTRONICS TELEVISION now!



SHOP METHOD HOME TRAINING
by a Real Established, Technical Trade School

GET READY FOR YOUR OPPORTUNITY . . . IT'S HERE! Radio technical men are needed everywhere; afield in action, and at home in industry! Trained men are needed in the Army, Navy and Air and Signal Corps, Government Defense Service and Civilian fields. Now, in answer to repeated demands for Trained Radio Technicians, National Schools has extended its famous Shop Methods so you can qualify right at home. You can quickly prepare to be of greatest service to your country and yourself. Yes, right at home, in your spare time. National's time-tested plan of Home Training will definitely establish you, in a short time, so you can hold a good job in this fascinating field. Furthermore, you become equipped for an even bigger career in the years of reconstruction after the war.

Prepare for the future. Get ready now for an interesting career in Radio, Electronics and Television, the gigantic industry now known in its entirety as R-A-D-I-O-N-I-C-S. The field of Today and Tomorrow!

More than 50,000,000 Radios in use. More than ever before, because of the shortage of new equipment, they must be serviced. Over 800 Broadcasting Studios employ trained Radio Technicians. Electronics, a whole new industry, based on Radio principles, is growing at an amazing pace. Television, too, will soon need its own corps of trained men. Get READY NOW. Here is your opportunity to get into a permanent field of fascinating and profitable employment.

TRAIN DURING MILITARY SERVICE

Prepare for Radio Service in Army and Navy. In U. S. Govt. service you install, operate and maintain most technical equipment such as secret ultra-high frequency apparatus to locate airplanes, submarines, etc. Get promotion in rank and increased pay almost from the start.

KEEP PRESENT JOB WHILE LEARNING

Regardless of previous education or age, you can Train for Radio. Continue your present job. Earn while you learn. If subject to Military Service, all the more important that you get pretraining.

COMMAND ANY OF THESE JOBS

- Radio Expert
- Electronics Engineer
- Radio Broadcasting
- Studio Technician
- Television Technician
- Aviation Radio
- Ship & Harbor Radio
- Remanufacture
- Industrial Sound

BIG OPPORTUNITY FOR NATIONAL GRADUATES

For 38 years National Schools has trained ambitious men for Top Pay trades. Squarely behind you are the modern, completely-equipped Training Shops of National where we *pre-test* and *prove* every instruction sent to you. Training in your home is comparable to actual laboratory practice.

GET ON THE TECHNICAL FRONT

Unique training facilities give you Home Training based on Resident School Shop principles —*methods not available from any other source,* to our knowledge. You'll be amazed when you receive our Free Lesson and full details. MAIL THE COUPON TODAY!

2 BOOKS FREE

Mail Coupon for new Opportunity Book which gives full details about the big future of Radio, Electronics and Television, and how you can qualify. Also, Free Lesson to demonstrate how easy you can learn. No obligation.

RADIO EQUIPMENT INCLUDED

You receive modern experimental apparatus

NATIONAL GRADUATES WIN GOOD JOBS

Radio Lab. Specialist

Douglas Nielsen Jamaica, N. Y.

"I got a job with International Telephone & Radio Co. in their laboratory developing new Radio equipment. It's a good salary job."

National Training Helps

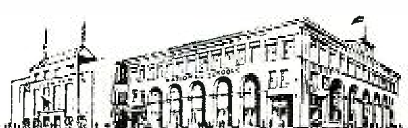
"Promoted to Instructor in Circuit Analysis at U. S. Army Air Corps here. You have helped me and are responsible for my success."

Leland Gillen, Scott Field, Ill.

NATIONAL SCHOOLS

Los Angeles California

ESTABLISHED 1905



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4. Meissner analyst
5. Audio, Signal Generators, frequency variable between 30 and 15,000 cycles, output 5.2 volts into 250 ohm load, 37.5 volts at no load. Output impedance 250,-500 and 5,000 ohms. Frequency calibration to be within 3% or 1 cycle, all standard makes acceptable
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   Precision 844, 864
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   Weston 778

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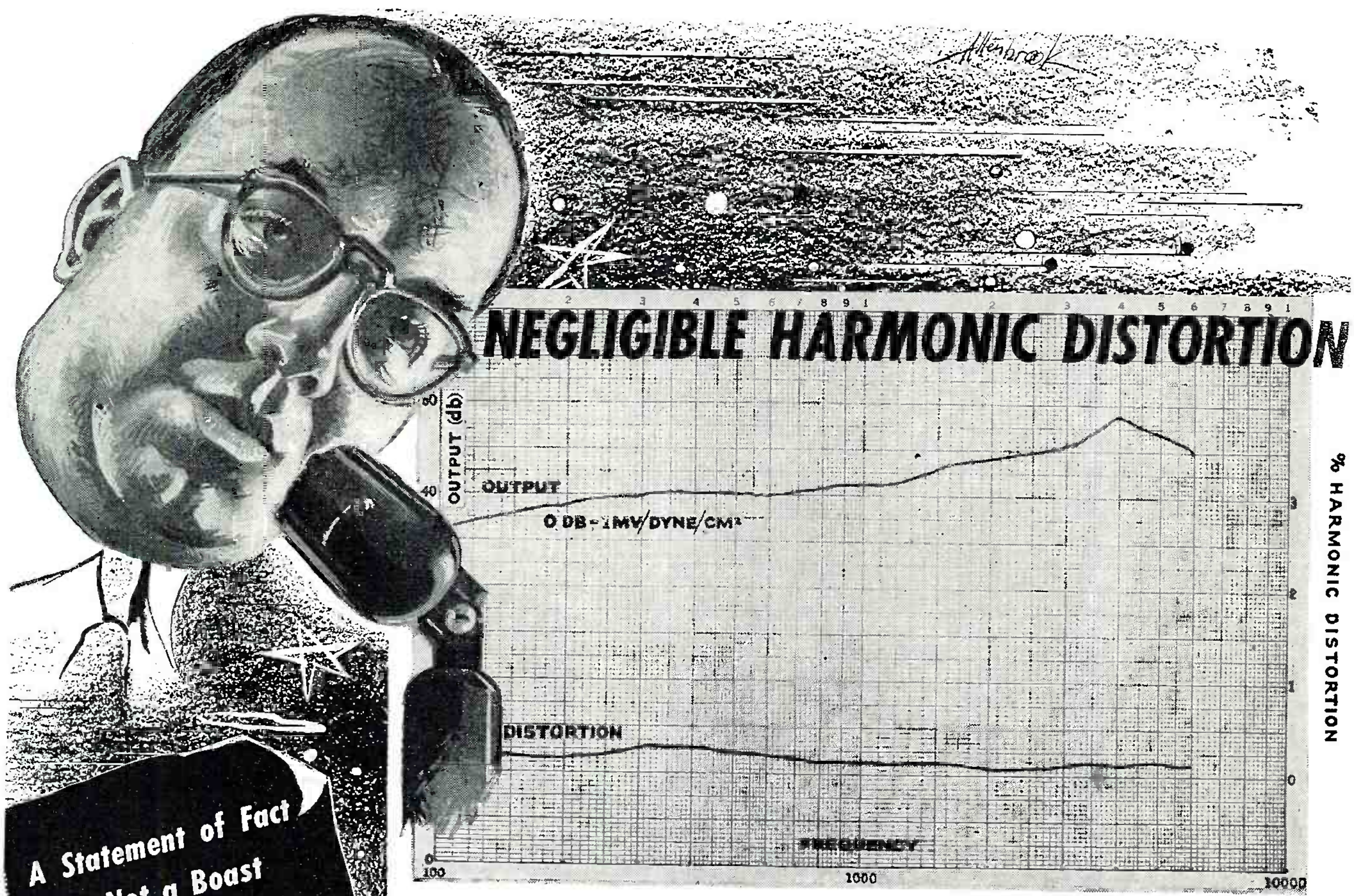

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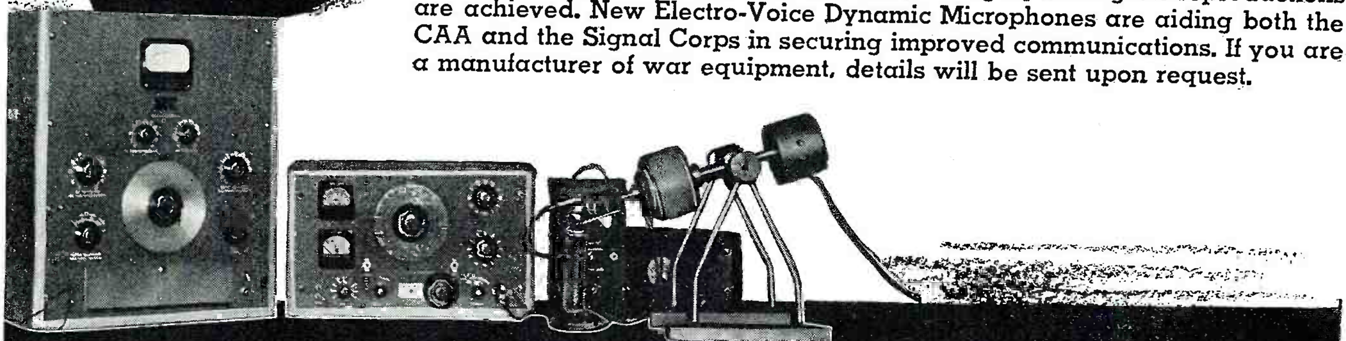
Every microphone manufactured by Electro-Voice has been designed and developed by our engineers—many in collaboration with the U. S. Army Signal Corps.

Harmonic distortion is the addition of spurious frequencies to the fundamental in definite harmonic relationship. Though the frequency curve may be excellent, harmonic distortion turns up as raspy reproductions, with an unnatural twang, in microphones, amplifiers and speakers. Five percent is considered a satisfactory upper limit for good reproduction, and as much as fifteen percent is allowable for speech communication.

Now come new Electro-Voice Dynamic Microphones with radical innovations in diaphragm fabrication, reducing harmonic distortion to a lower degree than hitherto possible. Cleaner, crisper, more highly intelligible reproductions are achieved. New Electro-Voice Dynamic Microphones are aiding both the CAA and the Signal Corps in securing improved communications. If you are a manufacturer of war equipment, details will be sent upon request.



The Harmonic Wave Analyzer measures the presence of spurious frequencies introduced by microphone distortion. To the ear, such frequencies give the feeling of ragged and false speech quality that may be unintelligible under the stress and strain of battle.

Electro-Voice engineers have found a way to eliminate harmonic distortion in microphone design, as proved by the Wave Analyzer; and the completely natural reproduction from the new Electro-Voice microphones.

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Code Practice Oscillator

(*Continued from page 25*)

R_1 with a 2 megohm variable resistor. The one disadvantage of this arrangement is that the amplitude or volume of the signal will not remain constant at all frequencies. Another means of frequency selection would be to employ a small multi-position tap-switch in conjunction with various selected condenser values to be shunted across half the primary winding in place of C_4. The keying of the oscillator is accomplished by inserting the key in series with the speaker.

Another use for this unit is that of an audio-test oscillator for radio and amplifier service work. An audio voltage of approximately 2.5 volts is available, if the PM speaker is replaced with a wire-wound potentiometer of approximately 5 to 10 ohms. The wave shape of the signal voltage available is quite free from harmonics, and should prove satisfactory for work of this type.

The component parts of the oscillator may be enclosed in a small metal cabinet approximately 4½"x 6"x3½". If such a case is not readily available, one can easily be made of either masonite or plywood. To help simplify the wiring of this unit, all connections to the tube base should be made before either the filter choke or output transformer is mounted on the inner two sides of the case. It is suggested that the unit be so wired that the chassis is not grounded to the line potential, especially if a metal cabinet is used. The oscillator will operate satisfactorily at line voltages down to about 75 volts.

As all types of tubes are not readily available these days, the following tubes may be satisfactorily substituted in lieu of the 117N7GT: 12A7, 25A7GT, 32L7GT or 70LGT. Of course, if this substitution is to be made, it then becomes necessary to place a dropping resistor in series with the tube heater circuit so that the correct potential is applied to the filament.

—30—

AM vs. FM

(*Continued from page 45*)

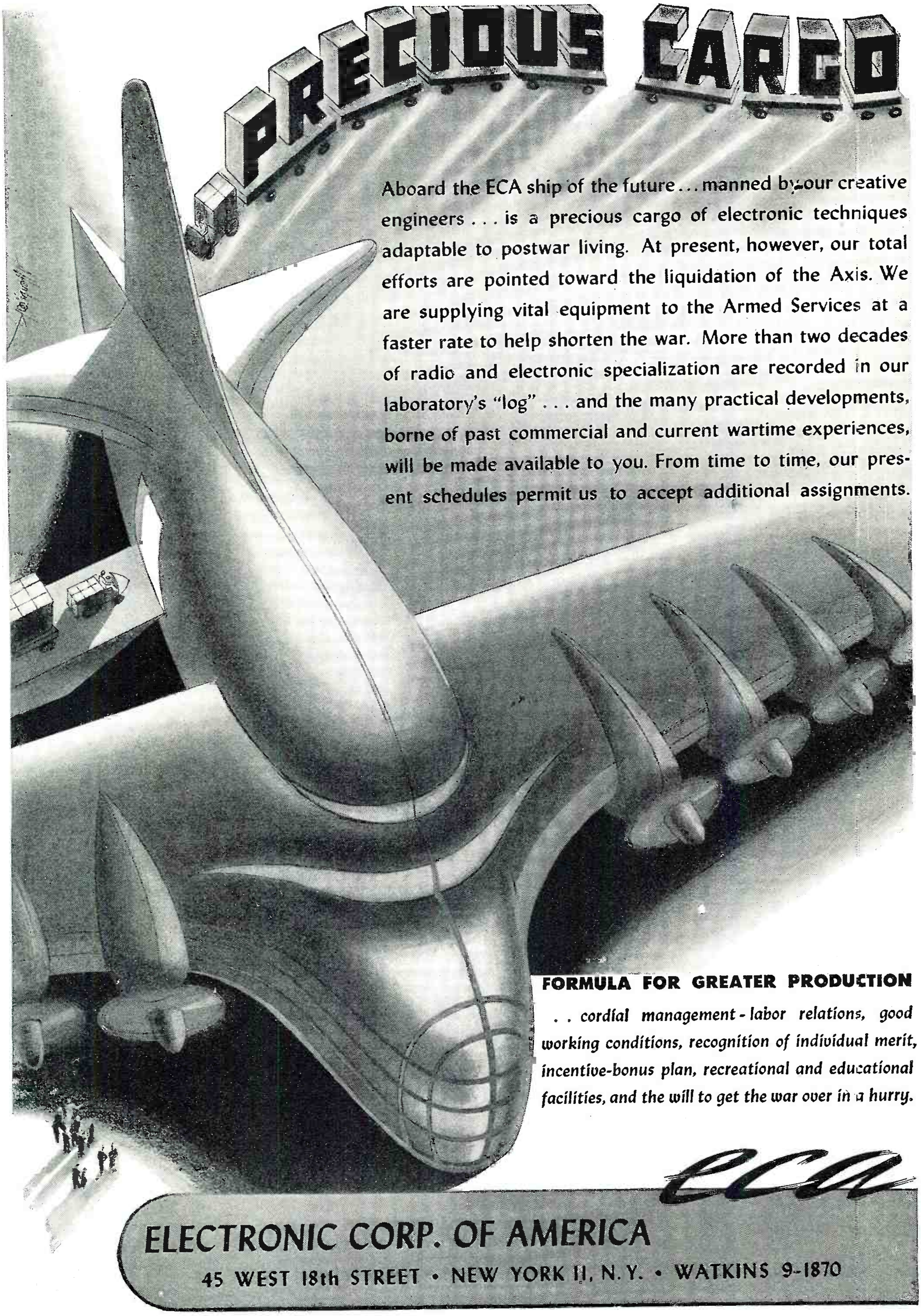
local conditions. They affect both AM and FM. FM better benefits from same, because FM receivers can be operated at full sensitivity rather than be cut back on account of interference and low signal to noise ratio as is the case for AM type superheterodynes.

Radio telegraphers know, that a code signal, watt for watt is many times more effective than voice. An FM signal without modulation is equivalent to a steady dash on a telegraph transmitter or to AM without modulation on the carrier. AM and FM differ only when modulation is imposed on the carrier.

To aid readers in appreciating the limitations of AM and FM in actual practice, the writer summarizes in Fig. 2 actual range tests made in the State of Maine, car to car.

Super-regenerative receiver. Because of their low cost, simplicity and receiving range, the original ones still remain in service even though they squeal to nearby stations and have background hiss.

The writer is indebted to Major Edwin H. Armstrong for personal permission to use his FM patents and


PRECIOUS CARGO
Aboard the ECA ship of the future . . . manned by our creative engineers . . . is a precious cargo of electronic techniques adaptable to postwar living. At present, however, our total efforts are pointed toward the liquidation of the Axis. We are supplying vital equipment to the Armed Services at a faster rate to help shorten the war. More than two decades of radio and electronic specialization are recorded in our laboratory's "log" . . . and the many practical developments, borne of past commercial and current wartime experiences, will be made available to you. From time to time, our present schedules permit us to accept additional assignments.
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10-watt AM transmitter used by Maine State Police in mobile units.

enter into negotiations with his licensees in designing the first FM system in Maine. When Major Armstrong dropped in to inspect the setup at South Portland, he estimated the range should be six miles in view of local conditions. He was given a car to car demonstration of 12 miles airline from Cape Elizabeth across South Portland, then right through the toughest and noisiest parts of Portland's street car, neon light and Christmas shopping district into the next town of Yarmouth, Maine. He said "enough" by that time, although we were prepared to demonstrate 25 miles and secretly knew that we could do 40 to 50 miles.

When the writer asked the Major why it was possible to work so far beyond the horizon, he tactfully replied "radio can work beyond the horizons, in fact several horizons, for the same reason that when the sun goes down, it still is not dark." The writer does not know all the answers either, other than to say that "it's just the nature of the beast." Anyhow, it has been a lot of fun working out these systems and observing the results obtained. The war will end some day, and much more 2-way radio will be needed.

—30—

Theory of U.H.F.

(Continued from page 37)

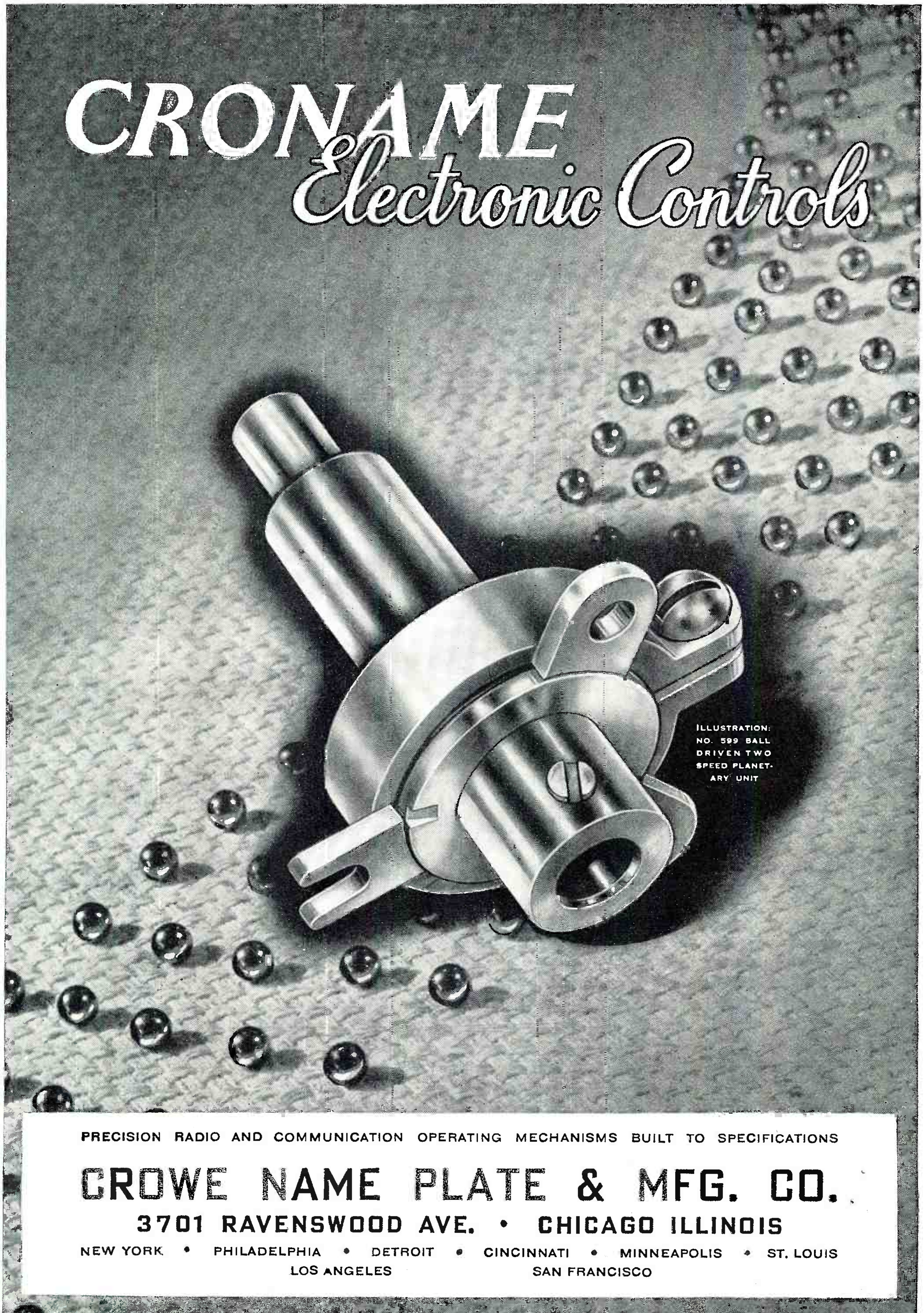
erated frequencies were not independent of the external circuit but varied slightly with it. The formula for the frequencies of oscillation put forth by Gill and Morrell was:

$$\frac{\lambda^2 I_g}{E_g^{1/2}} = K$$

which reduces to the B-K formula if the grid current, I_g, varies as the 3/2 power of E_g. The point to be noted is that in the Barkhausen-Kurz set-up the frequency of oscillation does not change by changing the Lecher wire tuning system attached to the tube, while in the Gill-Morrell oscillator the circuit will not work correctly unless the electron oscillations in the tube are properly related to the period of the tuned circuit. It is quite obvious that the types of oscillators are interrelated, and it has been found that when one goes from the G-M oscillator to the B-K oscillator, the transition is smooth and gradual, whereas the reverse is not true. The reason for this strange behavior is still not completely known. Transit time, which caused the conventional type of oscillator to fail at the high frequencies, is the operating principle of these two generators. Most of the oscillators to follow in this series of articles will usually have transit time of electrons as an asset rather than a liability.

The operation of a positive grid oscillator (shown in Fig. 8) may be explained by studying the motion of the electrons between the cathode and plate under two conditions—(1) when the grid and plate potentials are constant, and (2) when the grid has an alternating voltage applied to it with respect to the cathode. The frequency of this alternating voltage should be close to the time it takes an electron to travel from the cathode to a point near the plate where the electrons reverse their motion.

Dealing with the first condition, the electron from the cathode is accelerated by the positive grid, and if it isn't caught by the grid wires, will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continue on toward the plate. The electron, however, now is moving away from a highly positive potential and toward a slightly negative voltage. Its velocity will, therefore, decrease until the electron stops somewhere near the plate. It will be attracted again to the grid and so speed toward it. If the grid is again missed, the cathode will probably receive it. This completes one cycle and the net energy change of the electron is zero. This important point will be mentioned again in the next few paragraphs.

Our next condition calls for the superimposing of an alternating voltage upon the direct potential of the grid. The period for a complete cycle of this alternating voltage will be equal to the travel time of the electron from the cathode to the vicinity of the plate. In order to visualize the following discussion, refer to Fig. 9A where the position of the electron is indicated at various times of the a.c. grid voltage.

Consider first time t_1, when the electron is leaving the cathode and the voltage on the grid is increasing. Because of the increased voltage, the electron will be accelerated more than it normally would have been without the superimposed a.c. voltage. At time t_2, the electron is just passing the plane of the grid, and since the grid is now less positive than normally, the electron will travel on toward the plate with less deceleration and probably strike the anode. The electron, it can be seen, has gained more energy than in the case referred to under condition 1 and this energy must have come from the alternating voltage on the grid. In case the electron does not gain enough additional energy to strike the plate, then at time t_4 it will return past the grid and at t_5 will strike the cathode with excess energy. Whether or not an electron strikes the plate, on its first trip under the above conditions, depends on the grid to plate distance and the alternating voltage on the grid. In any event, if the electron starts out at the time postulated above, it will absorb energy and so be useless as far as we are concerned. We need electrons that give up energy, not absorb it.

Referring to Fig. 9B, we see that an electron, leaving the cathode when the grid a.c. voltage is zero and going negative, will be accelerated less than if no a.c. voltage were present. It should not be forgotten that although the a.c. voltage is going negative, there is a much larger d.c. potential on the grid which is positive and thus, the resultant voltage on the grid is always positive. All the a.c. voltage does is to vary the positive potential on the grid above and below a certain fixed value. Returning to our discussion of the electron, at time t_2', the electron has reached the plane of the grid and is advancing toward the plate. Since the grid is now more positive than normally, the electron will have a greater deceleration and so will not approach as close to the

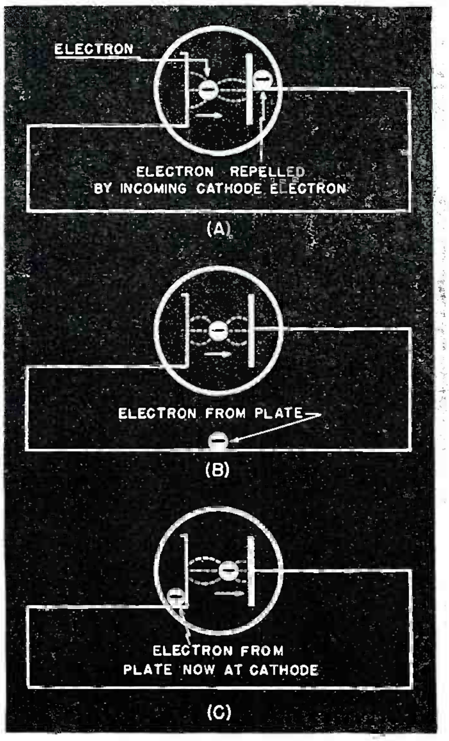

Fig. 7. The electron path through a vacuum tube and its external circuit.

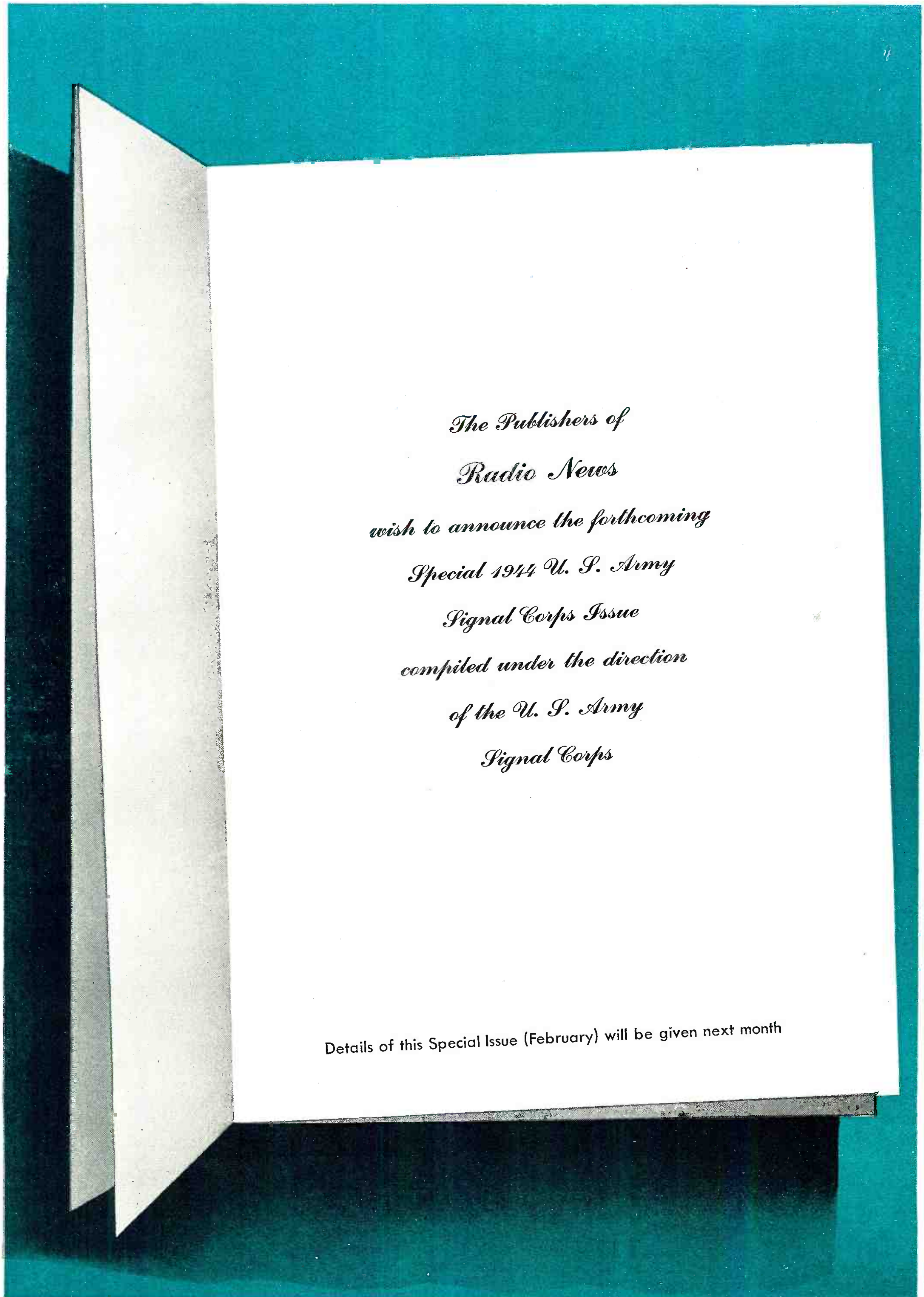
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plate as with constant grid voltage. On the return cycle, time t'_4 will again find the electron at the grid and time t'_5 will find it coming to a halt some distance from the cathode. The fact that the electron came to rest at a point further from the plate than it normally would have with constant grid voltage, indicates that it had lost some energy and the recipient of this energy was the source of alternating voltage on the grid.

Some readers may be a bit puzzled as to why the electron will hit the plate on one trip and come to a stop some distance from it on another trip. The answer all lies in the fact that when the electron is going away from a grid that is more positive now than it was before, this electron being negative in nature and so attracted to a positive grid, will suffer a greater deceleration than it formerly did. Likewise when it is going away from a grid that is less positive than it was before, will suffer less deceleration than formerly and so now go further before being stopped. In each case the electron will be decelerated, but in varying amounts.

Returning now to the electron that did not reach the cathode because of its greater deceleration, since this electron is in the interelectrode space it will continue to make trips to the plate and then back again to the cathode, each time, however, losing some energy and so getting closer and closer to the grid. Fig. 10 shows the motion of an electron that gives up energy to the grid. It is thus possible for the electron to keep on oscillating about the grid for a considerable time. This, however, is undesirable for two reasons:

1. As the period of the electron decreases, less and less energy is delivered by the electron to the grid.
2. Eventually the electron may even start absorbing energy which would work against the above process. In order to guard against this tendency, the grid is so designed that it will on the average capture an electron by the time the phase has shifted sufficiently to cause absorption of energy.

Although we have taken two special cases to describe the action of the B-K oscillator, yet it can be shown that all electrons leaving the cathode, when the alternating voltage on the grid is going positive, will absorb energy and either strike the plate and be lost, or return and strike the cathode and meet the same fate. On the other hand, all electrons leaving the cathode when the a.c. grid voltage is going negative will lose energy and so vibrate back and forth in the interelectrode space until they are caught by the grid. Since equal numbers of electrons leave the cathode when the grid is going positive as when it is going negative, and since the electrons that gain energy are taken out of the cathode to plate space after one cycle while the other electrons (those that lose energy) remain in the space for several cycles, it can be seen that the alternating voltage source of the grid gains more energy than it loses. This is important and differs from the first case described where there was only a constant voltage on the grid. Here, you may recall, there was no resultant gain or loss of energy. It is this energy gain by the alternating voltage source of the grid that allows oscillations to take place. It may be wondered just where this energy is coming from. The answer is simple enough—from the direct positive voltage source on the grid. Hence, the d.c. grid voltage source supplies energy to the alternating voltage source of the grid. Remember, this is true in all oscillators.

The efficiency of this device is low, with values of from one to three per cent being typical values. This is due to the fact that most of the electrons leaving the cathode are caught

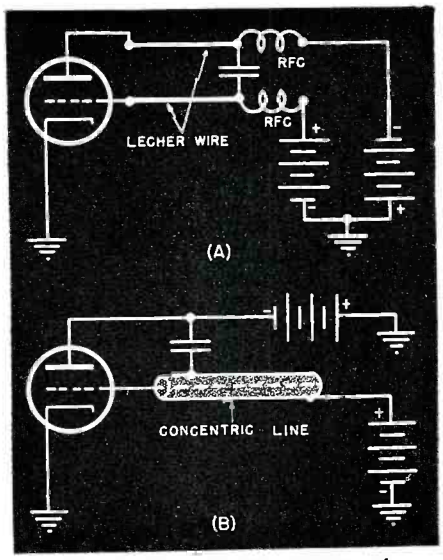
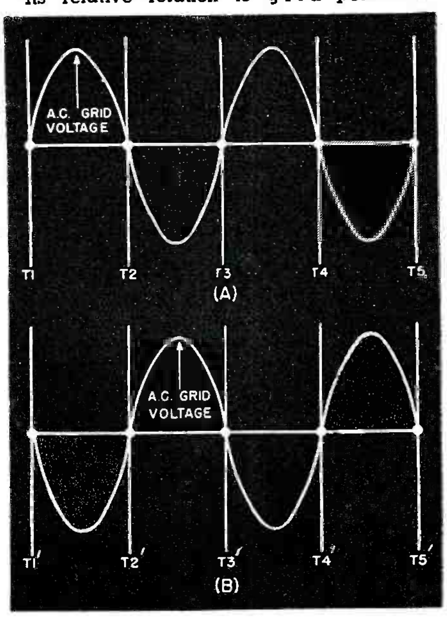
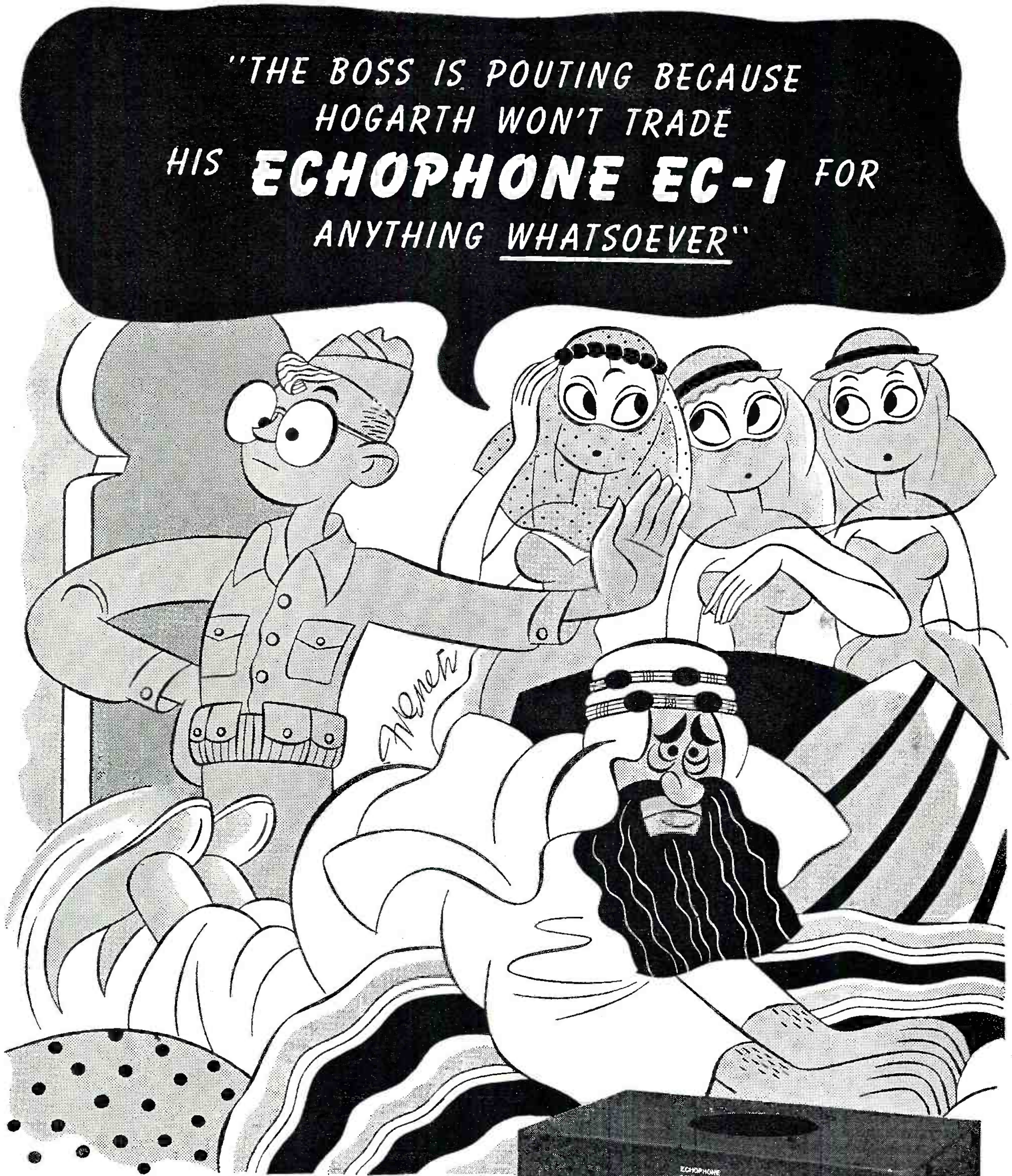


Fig. 8. Two possible circuits of the Barkhausen-Kurz oscillators.

Fig. 9. Explaining the principle of the path of an electron in a vacuum tube in its relative relation to grid potential.

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by the grid, therefore, resulting in a low ratio of a.c. grid current to direct grid current. In addition, a tremendous amount of energy must be dis-

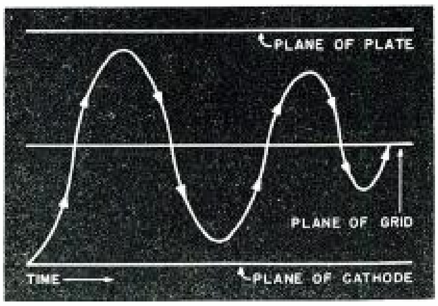

Fig. 10. Motion of electron that gives up energy to grid a-c voltage source.

sipated at the grid. As the frequency is raised, the elements must be brought closer together and higher voltages must be used. These are two conflicting considerations since higher voltages mean more heat dissipation. Although the practical application of these oscillators is limited where very short wavelengths are concerned (30 cm. and less), they represent the first attempt to cope with the difficulties of transit time in ultra-high frequency generation. There are more efficient devices that are being used and these we shall presently consider.

(To be continued)

Spot News

(Continued from page 14)

didate even succeeded in passing the measurement and television parts of the examination, because of a lack of up-to-date information. Mathematical deficiency was also responsible for failure in the measurement section, explained the examiners.

Oddly enough the same technical deficiencies seemed to prevail over here for some time . . . deficiencies that were prompted by lack of study of the latest in literature and application problems. Constructive comment not only improved the resultant percentages of students, but their field work, too, when the courses had been completed. The severity of the examiners' report in England serves its purpose too, for in most instances the candidates not only receive exceptionally good grades during the second examination, but improve their usefulness in the field too.

Examinations will be also used to judge the merits of the British repair man, beginning next May. During that month . . . the date set now is May 20 . . . a 6-hour examination will be held in the principal technical schools throughout Great Britain. Three hours of the examination will be of a written nature and the other three will be devoted to a practical test. To be eligible for the examination, according to the examining board which consists of RMA, RTRA, SRRA and British IRE representatives, a candidate must have been fully en-

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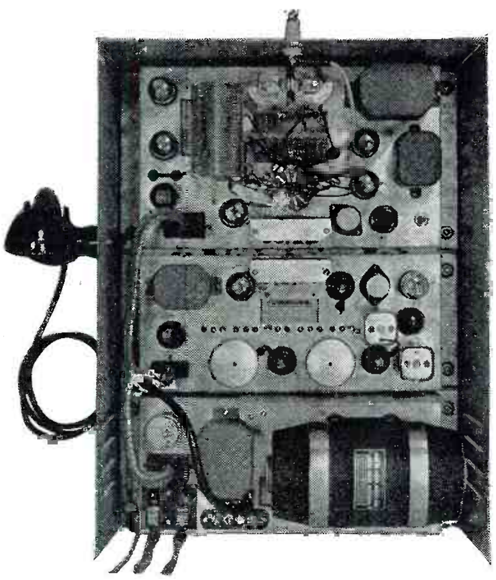

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gaged in radio service work for not less than three years. A full time course at a recognized technical school in radio service or radio engineering will count as one year towards the requisite three year period.

In the written part of the examination the fundamental principles and practical applications of such subjects as current-voltage relationships in a-c and d-c circuits, methods of modulation, tubes, resonance, principles and uses of meters, rectifiers, wave propagation, etc., will be included. Soldering technique, tube testing, use and maintenance of test equipment, realignment will be among the problems included in the practical portion of the examination.

Successful candidates will receive a certificate certifying them as qualified radio service engineers. The trade will also be notified of this certification.

The English plans are being studied closely here. Those who have had an opportunity to read the syllabus agree that the step is an excellent one. Perhaps exam time is coming here too!

A FEATURE-LENGTH FILM PREMIERE in Washington introduced one of the most ambitious sales programs ever devised, to sell the import of broadcasting to retailers. Some 600 merchants, government officials and advertising executives, viewed the film *Air Force and the Retailer* on October 12 in the Presidential rooms of the Hotel Statler. They saw 100 minutes of moton picture devoted to an analysis of the problems of retail selling and distribution. Credit for the brilliant presentation goes to the retail promotion committee of the NAB.

Notables who attended this initial showing included . . . Frank R. Wilson, special assistant to Secretary Jones; Federal Trade Commissioner Robert E. Freer; John Shepard Bartlett, Electric Institute of Washington; Don Stauffer and John Hymes of the Radio Bureau of OWI; Dr. Paul Lazarsfeld, Columbia University Office of Radio Research.

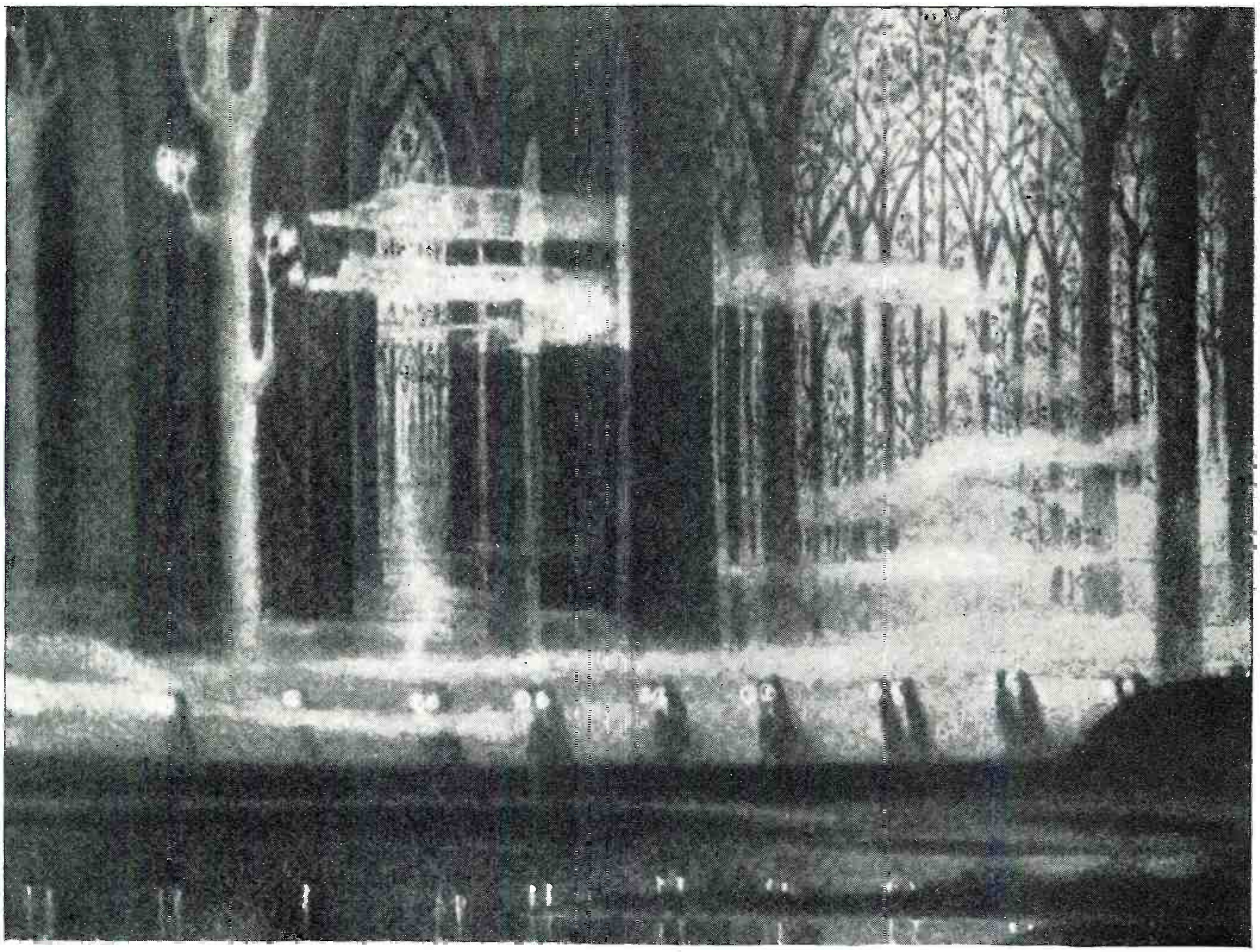
The film will be seen in approximately 100 cities throughout the Nation. Each presentation will be accompanied by effective promotional activities. Such station specialists as Arthur Hull Hayes of WABC, William C. Roux of NBC and Lewis Avery of NAB will appear as masters of ceremonies during the one-day stands of the show.

Selling of the medium of broadcasting has struck a new effective stride!

THE FIRST PRICE CEILING VIOLATION among radio distributors has extracted a substantial fine from the violator . . . the Benjamin T. Crump Co., Inc. of Richmond, Virginia. The company had to pay the Treasury $35,000 as a compromise settlement of a triple damage claim made by OPA. The OPA officials stated that over-charges totaling $23,000 had been made by the company on several thousand radios sold to retailers from August 1942 to May 1943. Authorization for the OPA to sue for three times the amount of any charge in excess of price ceilings appears in the Emergency Price Control Act.

This settlement disposed of one of the largest cases handled by the OPA. The heavy fine emphasizes the power that OPA has to wield . . . a striking power that should prompt all retailers and wholesalers to check their prices carefully to be certain that ceiling price levels are not being violated.

SUBSTANTIAL PROGRESS HAS BEEN MADE by the WERS, and everyone is quite happy about it. Organized over a year ago, many months passed by before some tangible proggress could be noticed. The maze of problems, technical and administrative, that retarded activities, seems to have been ironed out. And to date, there are over 4500 WERS units in 35 States and the District of Columbia. Private and public interests have provided training courses and equipment for those who would become WERS operators. The most recent of these training programs was organized in Cincinnati by the Cincinnati Gas and Electric Company. A six-week course is being given to anyone over 16 years. John E. Dickerson, engineer at WCKY is instructor and in charge of the classes. At the conclusion of the training period, the candidates will take the FCC examination for third-class operator's license. Passing this, they will be able to operate any of the equipment used in the WERS systems. Such apparatus includes fixed stations at the OCD



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What's the word you think most of at Christmas?

THERE'S one word men of good will everywhere associate with Christmas.

That word is *"Peace. Peace on earth"...*

There can be no peace this Christmas. Not one of us would want the only kind of peace there could be, an inconclusive peace.

But we do want the right kind of peace as soon as possible. And this Christmas we can help hasten the coming of that wonderful day, by making War Bonds our chief gift.

Every Bond you buy brightens the chances of a better world than man has ever known.

How, then, could you possibly give a better present than Bonds, Bonds, Bonds? Give them to each member of the family. Give them to your friends. Give them to *everybody—the greatest gift of all!*

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This advertisement prepared under the auspices of the U. S. Treasury Department and the War Advertising Council.

control centers, mobile stations in emergency vehicles, and the familiar "walkie-talkie" stations which can be carried by the operator into the thick of the emergency action.

The "walkie-talkie" units are quite an important item in the WERS. But batteries which constitute the power supply, have been quite scarce. Thus many a WERS unit has found itself stranded. Thanks to the efforts of some of the boys in Washington, including some military gentlemen who realized the import of the WERS system, this battery condition has been alleviated; more than 100,000 batteries of the "shelf-age" type have been made available. The batteries had been gathering dust in one of the supply depots. After a series of consultations, the Army agreed to release them. There are twenty-six different types in the allotment ranging in power from 1½ to 162 volts. Although the batteries have passed their shelf-age expiration date, they are perfectly suitable for the purposes to which the WERS units will put them. The batteries will, of course be available only to licensed WERS stations operating as part of the Communications Unit of a local Citizens Defense Corps. All applications for the batteries must be made to the WERS Aide of the local Defense Corps and not to Washington. The request will be transmitted to the State Radio Aide, who will do the securing.

Our hats are off to the friends of WERS in Washington who have been so cooperative and have helped to establish the system on its firm footing.

CIVILIAN CHANNELS WERE exceptionally close to receiving over a half-million tubes when the Radio and Radar Division of the WPB announced that 576,613 tubes in possession of Phillips Export Corporation for export purposes, could now be sold. Practically immediate distribution through civilian channels was arranged. And just as provisions for distribution were being organized, along came a request from a Government agency for the tubes. This agency said that they had not known of the existence of the stock and needed the tubes badly. This seemed rather odd because the original conferences concerning the tubes included representatives of the Foreign and Domestic branches of the WPB. The decision reached cited that such authorization would in no way affect war activity. In fact the authorization called for the sale of the tubes, without restriction, to the domestic market.

At this writing the government request still stands. There is a possibility, however, that sufficient pressure will be exercised to affect a release of the tubes for Mr. and Mrs. Public, who certainly could use them.

THE WAR HAS NOT RETARDED INTEREST in wired radio in Europe. According to a survey just completed, an increase of 75 per cent has occurred during the past three years. The service, begun in 1931 with some 50,000 subscribers, now has approximately 450,000 subscribers. The amazing part about this growth is that development has been restricted to areas already wired. It has been impossible to extend the services beyond the boundaries of districts already established because of lack of manpower and material.

This rapid growth demonstrates the tremendous strides that this phase of transmission will undoubtedly take in the postwar period. While it is difficult to establish a comparison between the English and American wired-radio systems, because of the difference in design, there is some similarity in the purposes which both systems serve. It therefore appears obvious that we can expect a similarly increased interest in this method of voice and music transmission.

Carrier-current transmission (the use of power lines) will play an important role in wired-radio transmission after the war. Many successful demonstrations have been held in large and small communities employing circuits covering anywhere from one to fifty miles. Many public utilities and emergency systems have adopted carrier-current transmission on a rather substantial basis. The bugaboo of hum and high noise levels is a thing of the past, in view of the effective filtering systems developed. Your correspondent has been present during some of these demonstrations and was delightfully surprised to hear the quality of reproduction. Yes, wired radio offers many possibilities.

IT IS THE BELIEF OF James L. Fouch, of the Universal Microphone Co., Inglewood, Cal., that postwar microphones will not be so radically different in engineering principles as they will be in styles. "There will be," he believes, "more than a score of types and models and, while the all-purpose instrument will continue to be popular, there will be a clearly defined trend towards 'a microphone for every purpose' . . . ranging from lip and throat models to lapel types and hand-held instruments and others, too. Hundreds of thousands of operators in the Signal Corps have been using Universal microphones 24 hours of the day," he says, "and out of their combined experience refinements will be embodied in peacetime microphone styles where mass standardization is not required."

J. L. FOUCH

"AUSTRALIA IS ONE OF THE MOST ADVANCED COUNTRIES IN RADIO thought and practice," said Sir Ernest Fisk, chairman of

Amalgamated Wireless Ltd., in London recently. Sir Ernest described the two Australian broadcasting systems, one of which is known as the National Service, and the other, Commercial Service. The National Service is similar to the BBC System and employs national and regional stations financed by receiving licenses. The Commercial Service is operated by private enterprise and paid for by advertisers similar to the procedure used in America. Sir Ernest explained that Australia makes use of the best features of the British and American systems. "At the present time," said Sir Ernest, "Australia has 140 broadcasting stations, most of which are commercial. The coverage is quite effective, even though low power stations are used. There are at the present time about 1,500,000 license holders, each paying $5.00 per year for the license privilege."

Sir Ernest is no newcomer to radio. He was an assistant to Marconi and has contributed substantially to the progress of radio engineering throughout the world. Australia is mighty proud of Sir Ernest's interest!

ALFRED A. GHIRARDI has announced the sale of the Radio and Technical Publishing Company. The company was sold to Farrar & Rinehart, Publishers, 232 Madison Ave., New York 16, New York, who will continue to publish all of his present books as well as new ones that will appear in the future.

This merger is the outcome of careful study, and the resolution that such a setup could render a service that neither company alone could offer. It is Mr. Ghirardi's intention that after being relieved of many production and administrative details, he will devote his time to editorial pursuits in the radio-electronic book field. He will continue to keep in close touch with the editorial office of the business through his new post with Farrar & Rinehart, Publishers as Editorial Consultant in the field of electronics.

PERSONALS . . . .

Charlie Robbins, general manager of Emerson Radio, now on temporary leave serving the Signal Corps in Washington, was elected a vice president recently. . . . **William A. Bruno,** pioneer radio engineer and chief engineer of the Selectar Manufacturing Corp., died recently after a brief illness. "Bill" Bruno will be missed by everyone. . . . **Parker H. Ericksen** is now with Majestic Radio and Television Corp. as director of sales. . . . **E. K. Cohan,** director of engineering of CBS, is now on leave of absence. **William B. Lodge,** who for the past eighteen months has been associate director of the Airborne Instruments Laboratory of Columbia University, has returned to CBS to supervise general engineering operations during Mr. Cohan's absence. . . . A Mica Capacitor Conservation Industry Advisory Committee has been formed by the WPB. Serving on this committee are **G. M. Ehlers,** Centralab, Inc.; **T. M. Gordon,** Radio Receptor Co.; **Bryon Minnium,** Erie Resistor Co.; **Herbert L. Spencer,** Bendix Radio Corp.; **Jack Davis,** Galvin Mfg. Co.; **M. R. Johnson,** General Electric Co.; **Dorman D. Israel,** Emerson Radio & Phonograph Corp., and **F. E. Hanson,** Western Electric Co. . . . **W. R. David** of General Electric was appointed chairman of the new engineering committee of FM Broadcasters Inc., at a recent meeting. **C. M. Jansky, Jr.** of Jansky and Bailey, Washington, was made technical advisor to the association. Other members elected to serve on the engineering committee are **Franklin M. Doolittle,** W65H, Hartford; **Dr. Ray H. Manson,** W51R Rochester; **Everett Dillard,** K49KC, Kansas City; and **C. M. Jansky, Jr.** . . . **Emil O. Schramm** is now with Clarostat as a purchasing agent. Prior to joining Clarostat he was with the War Department as an ANEPA field expeditor. . . . **Sayre M. Ramsdell,** president of the Sayre M. Ramsdell Advertising Agency, died recently. This agency handles Philco and National Union, among many other radio accounts. . . . **Ben Miller,** former sales manager of Meissner, is now a manufacturer's representative with headquarters in Chicago. . . . **William S. Paley,** president of CBS, has been granted a leave of absence to accept a special assignment with the OWI. Mr. Paley will join C. D. Jackson, director of all OWI operations in Italy, North Africa, and the Middle East. He will operate with the Army Psychological Warfare Branch at Gen. Eisenhower's headquarters. **Paul W. Kesten** has been named executive Vice President of CBS. . . . **McMurdo Silver** has recently been named Vice President and Chief Engineer of the Grenby Manufacturing Company, Plainville, Connecticut. The company has announced that they will extend their development work into the radionics field. This newly developed division will come under the jurisdiction of Mr. Silver.

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Tube Collector

(*Continued from page* 50)

replicas would be will be largely governed by the number of requests or inquiries received. With this end in view, if those who are interested will communicate with "The Tube Collector" c/o RADIO NEWS, 540 No. Michigan Ave., Chicago, 11, Ill. an attempt will be made to investigate the possibility of making up a limited number and arriving at an approximate cost. Dr. Frank E. Butler, Chief Assistant to Dr. Lee de Forest, for several years prior to—*during*—and after his invention of the 3 element vacuum tube is responsible for the making of the museum exhibit. His personal accumulation of hitherto unpublished historical data, dating back 40 years, which did not suffer destruction in the Parker Building fire now enables the accurate reconstruction of this memorable event. It would seem that no tube collection would be complete, regardless of its size, if it did not contain, at least an authentic replica of the "Grand-daddy of them all" . . . since the "original in person" is not in existence.

WE are still receiving listings of rare tubes—offered to serious-minded collectors. We would like to receive many more. If you have even just *one* real antique, please send full data to "The Tube Collector."

—30—

For the Record

(*Continued from page 4*)

great advantage. Furthermore, by sending along American trained personnel the good will of the Americas would follow automatically along with the equipment. These units should give satisfactory service for several years. The American manufacturer would continue to supply replacement parts and tubes for the maintenance of these sets.

The American public, in the meantime, could start from scratch and be supplied with new and latest developments which are sure to follow the conclusion of the war. By the time initial domestic demands have been met, the foreign market would again be in need of newer items to replace those purchased after the war. This would mean a continuous outgoing of material scheduled for foreign consumption. The foreign consumer would know that units made in the United States were capable of giving highly satisfactory performance. He would, naturally, expect that these new units give comparable service.

One thing is certain, the American manufacturer would prefer to start from scratch rather than to be confronted with the problem of finding thousands of outlets for used equipment which might find its way back to the states.

—O. R.

Postwar Electronics

(*Continued from page 24*)

material handling, machine tool and process control.

High-Frequency Heating

The use of high-frequency alternating currents for many individual heating jobs is attracting considerable attention at present. The scarcity of tin in particular, accelerated the use of this form of electronic equipment in the saving of tin for tin plate.

When the Japs took over the Far East, conservation of tin became a real problem in this country. Practically half of the tin used in this country goes into tin plate for tin cans so that it was natural to look critically at the tin plate industry. The hot-dip method of applying tin to steel previously used, required 1½ pounds of tin per 100 pounds of steel. Electroplating, requiring only ½ pound of tin per 100 pounds of steel or approximately ⅓ of the amount of tin, had been known for some years. However, when used in the plating of tin on steel a porous finish is obtained. This porous finish is objectionable because of the possibilities of vegetable and fruit acids attacking the basic metal under the tin.

The problem was to get a smooth, clean coating of tin that would provide a complete seal from the basic steel. Several schemes were considered, such as electric conduction where current was introduced into the tin plate through rolls. This required considerable additional space in the tinning line and also introduced problems in preventing marking of the tin plate as a result of the current flowing between the roll and the tin plate. Use of heat generated by burning gas was considered, but again this requires a great length in the tinplate line and introduces difficulties in getting uniform distribution of heat in the metal. Heating the electrolytically tinned surface by electric induction, the high-frequency for which is generated by electronic tubes, overcame these difficulties and has been generally adopted by the steel industry in the last six to nine months.

Who would have thought that the electronic oscillator developed for the broadcasting industry would be the answer to the tin problem of today? The first trial installation of induction heating for the flowing of tin was made with an obsolete broadcasting set and it is still in regular operation. After the tin is electrolytically deposited on the steel it is passed through a coil energized by high frequency of the order of 200,000 cycles per second. The tin melts and flows slightly and when it again freezes it forms a smooth layer 1/3000 of an inch thick. Designs have been completed for tin flow speeds up to 1300 feet per minute for thirty-inch sheets. This is the equivalent of plating both sides of a sheet the size of a football field in 12 minutes.

This is a fine example of how manufacturers must be willing to recognize a rapid change in industry. The need for conserving tin forced the steel companies to change their methods almost overnight. Orders were placed to install approximately 48 units totalling 10,000 kw. of high-frequency heating in groups up to 1200 kw. in the last six months. Three 1200-kw. units are being installed in one plant. This total is more than 2½ times the amount of power that is produced by all of the commercial broadcasting stations in the United States today. The high-frequency part of the tinning lines has amounted to $2,000,000 of business.

Although almost all the tin-flow applications have been or soon will be completed, nevertheless, the same principle can be used in the processing of plywood, plastics, heat treatment of metals and the like and certainly this market bids fair to be even larger than the tin-flow market. It is one that will require considerable research as well as commercial adaptation of high frequency to the processes, but its future is certain. There are a number of companies in this field, such as R. C. A., Induction Heating Corporation, General Electric Company, Westinghouse Company and others.

Radio and Communications

Latest electronic equipment is being supplied for all sorts of war-time needs. Naturally these developments and techniques are secret. There is a wonderful possible peace-time future for much wartime electronic equipment. It may guide planes over mountain peaks and ships through fog. It may provide a means of dispatching planes in the air and other applications that, because of secrecy, cannot yet be discussed. There are still many ideas for such equipment, in the research and development stages.

Research

Many of the developments in electronics have been conceived in Research Laboratories. The research on welding, tin flow, Precipitron, rectifiers and many secret devices has made possible the commercial development of the electronic device.

One development which is nearing completion is the Mass Spectrometer. This is an electronic centrifuge which sorts different gases on the basis of their molecular masses just as a cream separator does for a liquid. A complete gas analysis, that formerly required days can be done in a matter of minutes. This device bids fair to finding extensive use in the chemical industry as well as in the synthetic rubber production. The application of this device to industrial analysis is being worked out jointly by a number of companies such as Standard Oil of New Jersey, Standard Oil of Louisiana, Humble Oil Company, Shell Development Company, Hercules Powder Company and Westinghouse Research Laboratories.

Tubes

Quite often we are inclined to think of electronics in terms of vacuum tubes. Tubes are the focal point of the industry but they are a small part of it. There was $7,000,000 of industrial tube business last year and a total of $15,000,000 over the past five years not including the larger Ignitrons previously mentioned.

The circuit equipment necessary to apply these tubes will require from 4 to 200 times the value of the tubes themselves. Thus tubes amount to a fair amount of business but there is also other types of electrical equipment that is absolutely necessary to make electronics a commercial venture. Radio and special war tube business is, of course, many times this figure.

In discussing the application of electronics to industry it is impossible to give a complete review of all possible applications past, present and future. Protection of property, protection of men at machines, instruments of all kinds, industrial X-ray, temperature controls, cathode-ray oscillograph, balancing machines are all accomplishments. This phase of the electrical industry is moving at a terrific rate and will continue to do so.

One of the difficulties encountered with the electronics industry in the early '30's was the fact that it was ahead of industrial acceptance. There was not a true appreciation of the limitations of the application of electronics and the headaches that grew out of this resulted in a slowing up of its acceptance in industry. In the meantime, there has been considerable work done of an educational nature not only by the colleges but by industry itself.

The large number of men receiving electronics training in the Armed Forces is also going to create a greater appreciation and acceptance after the war. There is still, however, caution that must be injected into the application of electronics in industry. Let us not try to do everything electronically because of its momentary popularity. Let us use it where it does a better or more economical job for industry. Electronics is doing a mammoth job in industry today. Electronics is at work and if we follow this path of caution the future of electronics in industry is assured.

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Radio Heraldry

(*Continued from page* 54)

by the navigator's "N" brevet, men who qualified for it in the past are still permitted to wear it.

Although not in the Fighting Forces the Radio Officers of the Merchant Navy, who are playing such a vital part in carrying food and munitions of war, are included.

There are three classes of Radio Officers and they are distinguished by waved lines (Fig. 10) of quarter-inch gold braid on the cuffs of their jackets. The standard Merchant Navy cap badge is worn by Radio Officers.

Variations in the number of bands worn by First, Second and Third Class Radio Officers are illustrated.

On the routes of British Oversea Airways may be seen the insignia (Fig. 11) worn by Radio Officers in the employ of the Corporation.

They wear the cap badge of the Corporation and a wing over the left breast pocket of their blue uniforms, as do all members of the air crews. Like their contemporaries in the Merchant Navy their ranks are distinguished by waved lines of gold braid on the cuffs of their jackets.

First Radio Officers wear three lines of braid, Second Officers two and Third Officers one.

—30—

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  Men with experience in mechanical designing, especially of small metal parts and of the automatic machinery to mass-produce them.
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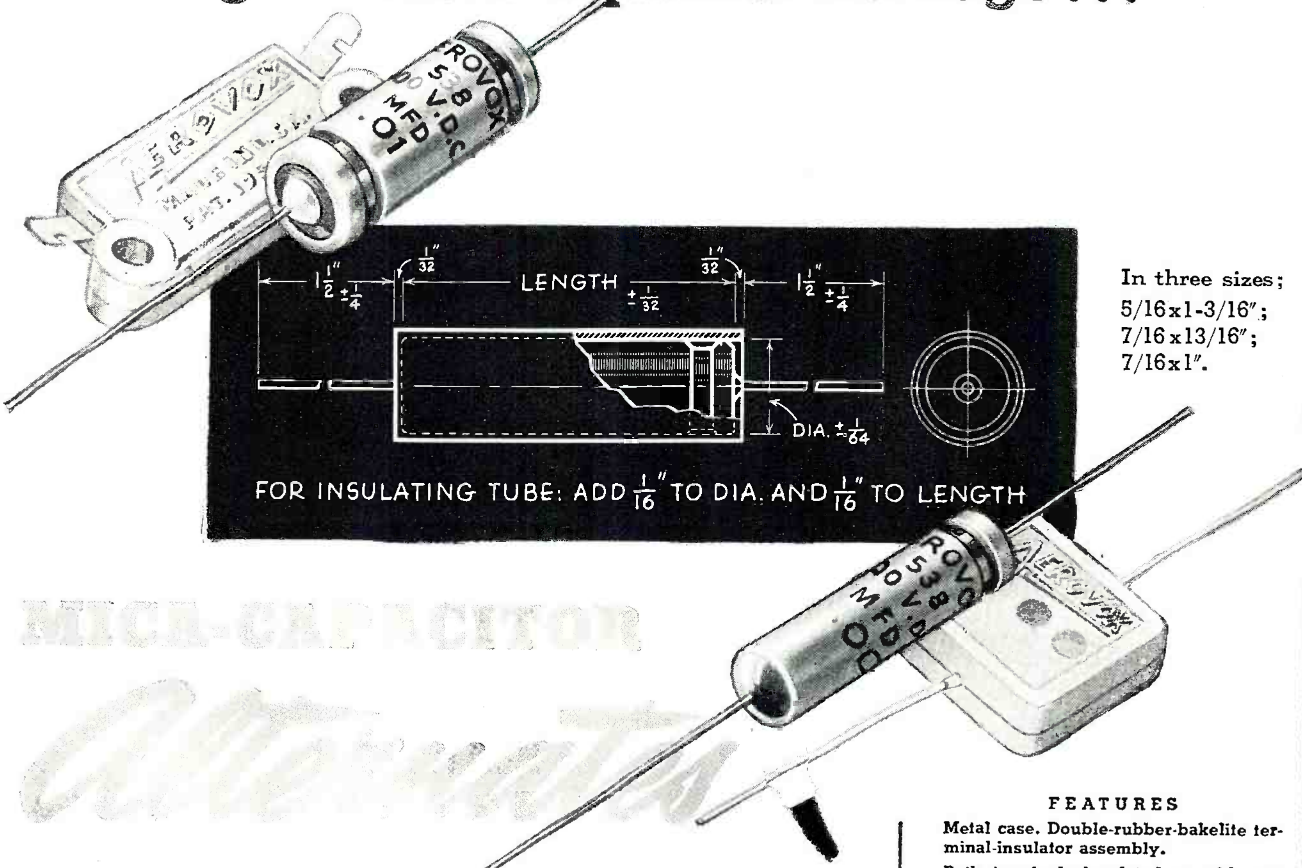

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Various applications were studied. Voltages, capacitances, frequencies, power factor—these and other factors were considered along with dimensional limitations, after the manner of A.A.E.* Out of it all evolved this new Aerovox Type 38 mica-capacitor alternate now in production.

Here is a miniature oil-filled metal-case tubular. Ideal for assemblies where both space and weight are at absolute minimum. Requires no more space than mica capacitor it replaces. Conservatively rated. No skimping of insulation or oil-fill despite minute dimensions (see drawing). Meets all standard specifications for paper-dielectric capacitors used as mica alternates. (See brief specifications.)

Type 38 mica-capacitor alternate is but one of several new wartime capacitors described and listed in our latest Capacitor Catalog. Write on business letterhead for your registered copy.

*Aerovox Application Engineering.

FEATURES

Metal case. Double-rubber-bakelite terminal-insulator assembly.

Both terminals insulated or with one terminal grounded to case. Pigtail terminals.

Normally without outer sleeve. Can be had with insulated sleeve, adding 1/16" to diameter and length. Note dimensional drawing.

Vegetable (Hyvol) or mineral oil impregnant and fill.

300 to 800 v. D.C.W. Capacities of .001 to .01 mfd.

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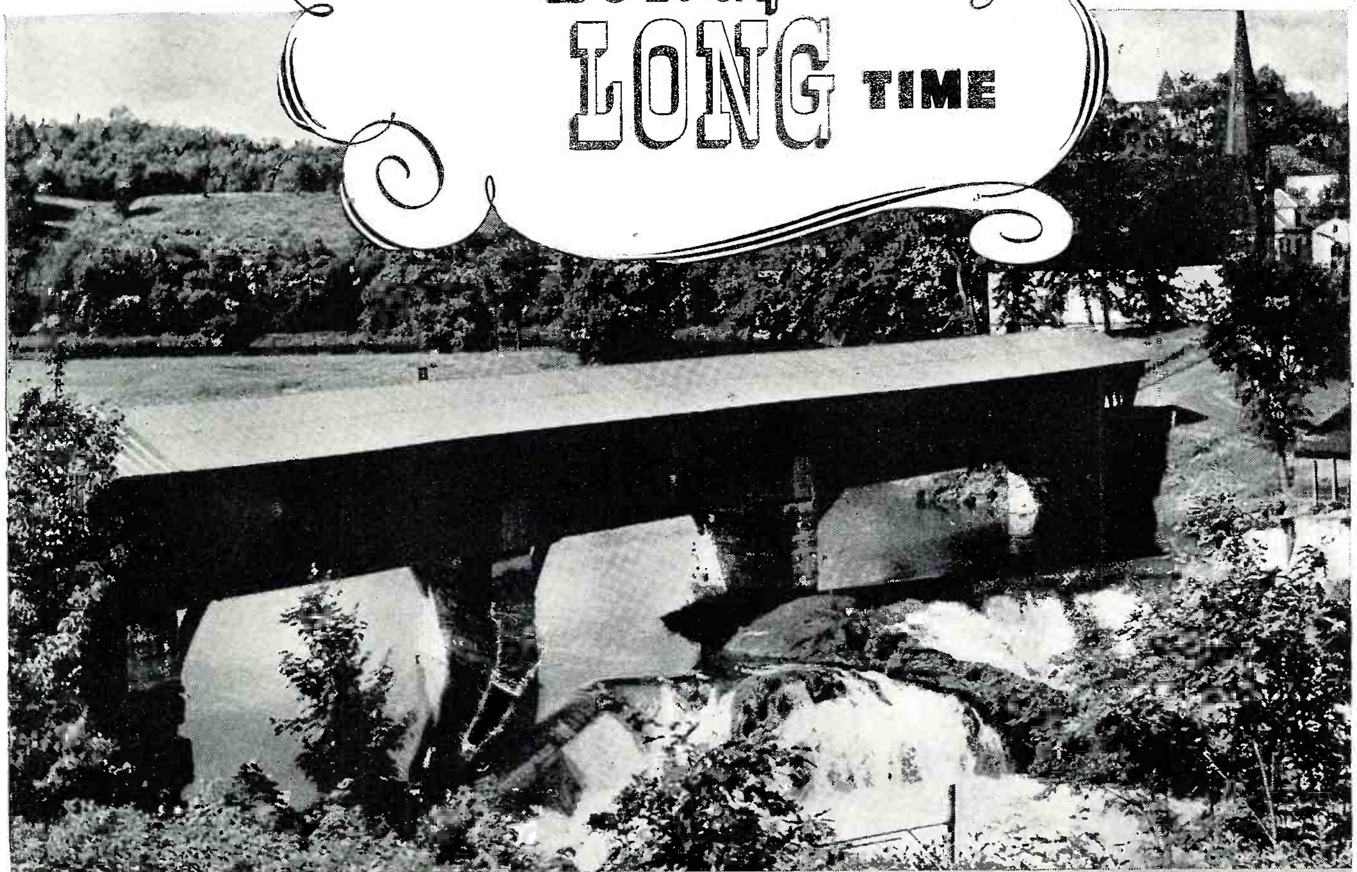

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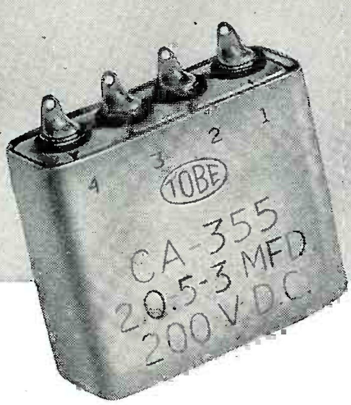
Take as an example the CA—355, shown below in streamlined, hermetically sealed drawn container. It is being used in large quantities by the U. S. Army Signal Corps in front line telephones.

Tobe is the only manufacturer furnishing this capacitor in a drawn container.

The CA—355 is just one instance of Tobe engineering ingenuity in developing and perfecting new devices. However tough your own condenser problems we invite the opportunity for our engineers to help you solve them. Please get in touch with us.



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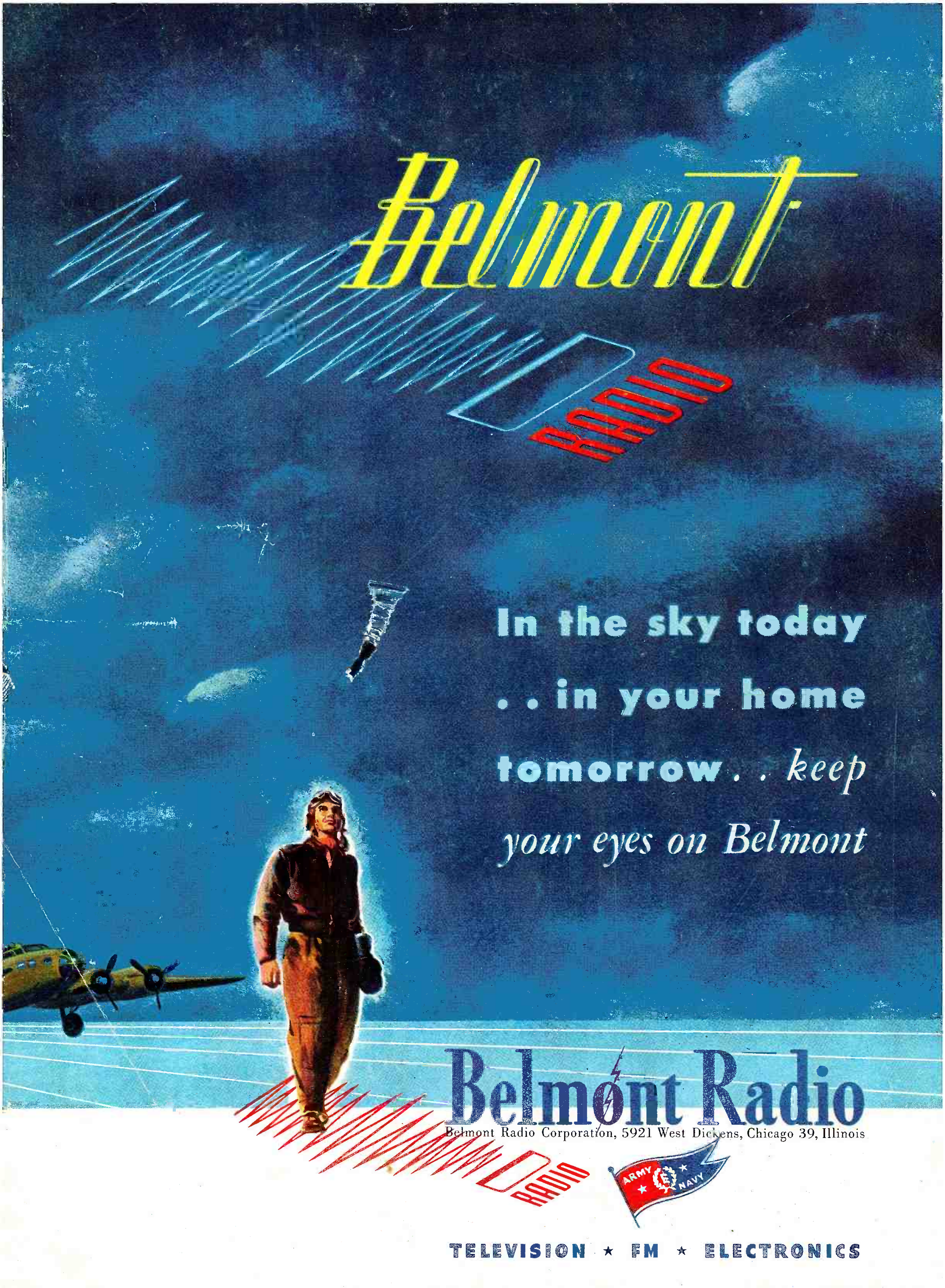
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