RADIO SCIENCE

Vol. 1.—No. 1. FEBRUARY, 1948.

- BUILD A PERSONAL PORTABLE
- LORAN—RADIO NAVIGATION AID
- INTERNATIONAL RADIO DIGEST
- NEW LOW COST AMPLIFIER
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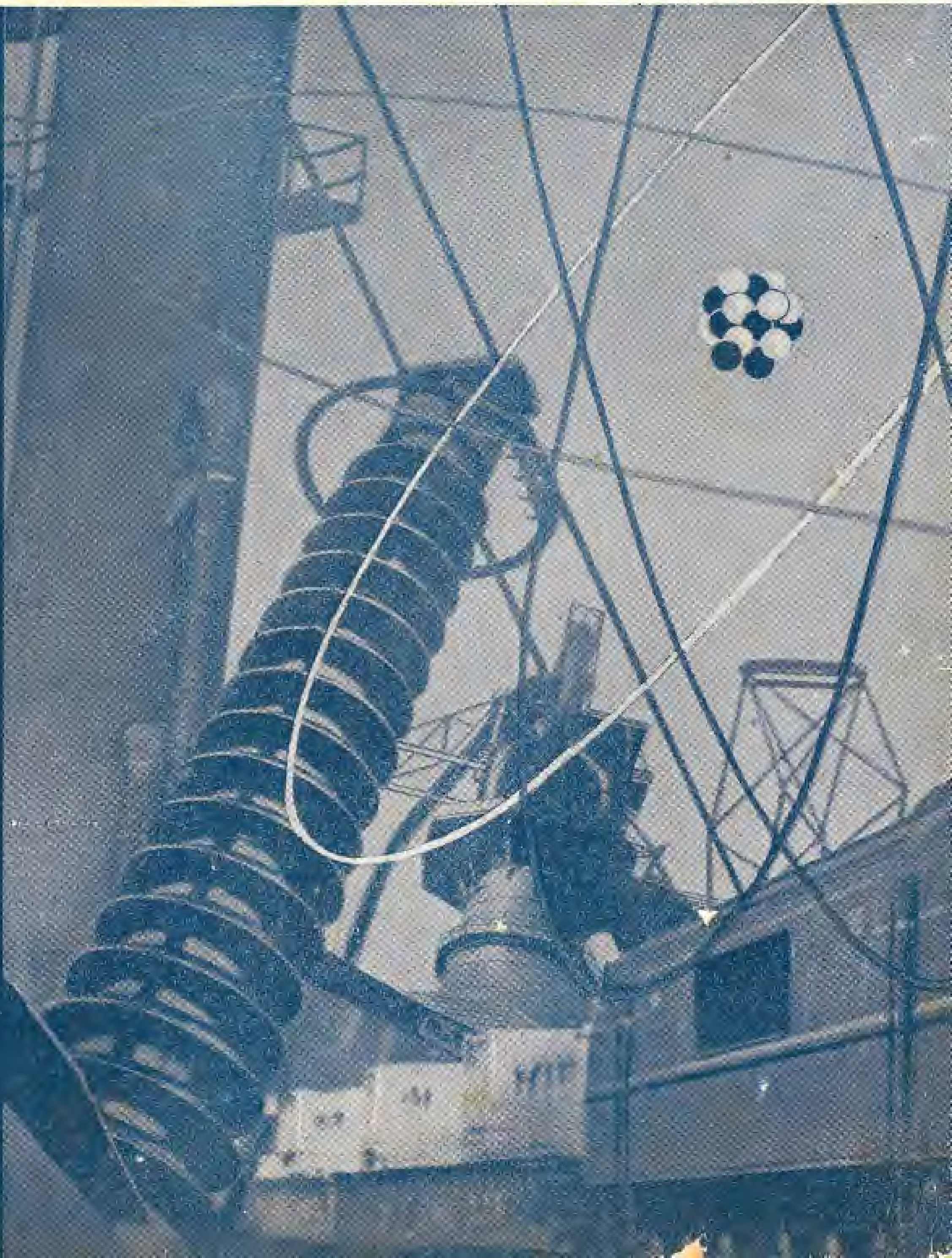

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editorial.

Inaugural Issue . . . . .

It is with justifiable pride that we present this first issue of your latest technical journal—"RADIO SCIENCE."

The introduction of a journal which is intended to embrace all branches of the Radio, Electronic and allied fields should, we sincerely believe, close a long-felt gap in this country and meet with the general approval of every technically-minded reader.

Herbert Spencer's statement in *Education*—"science is organized knowledge"—may well typify the name and spirit of this Magazine, since its prime purpose is the collation and presentation, and consequently the advancement of, radio and electronic knowledge. In this country, for instance, a vast amount of radio research and development is constantly taking place, but unfortunately, due to mental apathy in many quarters, this work receives very little publicity.

In many cases these particular techniques are far in advance of overseas developments, and in view of this, such items will claim a high priority in "RADIO SCIENCE". At the same time, however, to maintain a balanced outlook, news of overseas techniques and developments will be a regular feature, thus making "RADIO SCIENCE" your complete radio magazine.

The Policy of the magazine—the outcome of many ideas formulated whilst in the Services—is to provide a complete technical service to all readers. Whatever your interest in the radio and electronic field may be, and irrespective of whether you are an engineer, technician, amateur, radio serviceman or radio enthusiast, then "RADIO SCIENCE" will feature the articles you wish to read.

To enable us to fully implement such a broad policy, we earnestly seek the co-operation of all readers. Only by receiving your letters and your constructive criticism can we ever hope to make each issue just what you require. So then, after reading this issue, will you write and let us know your opinions, and what features and improvements you would like to see included.

As far as possible, a nucleus of most regular features has been included in this issue, and around these we will expand and improve the magazine. To present a wide coverage of subjects, contributions dealing with any technical aspect of the radio and electronic field will be considered, and if accepted, paid for at our current rates.

In addition to the theoretical side being catered for by contribution from well-known writers, the practical aspect of the subject has not been overlooked. Each month, constructional articles of some practical value will be detailed, and these will form a regular section of the magazine.

Although no small amount of hard work has gone into the production of this first issue, we know that there is always room for improvement, and this will be carried out in accordance with the reader's wishes.

So, now then readers—this is YOUR magazine; write in and let us know just what YOU want included.

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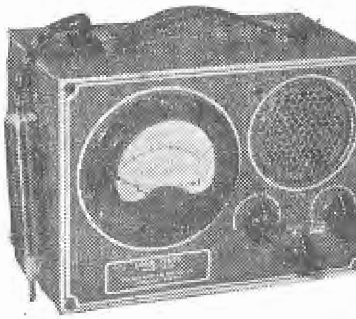

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RADIO SCIENCE

FOR THE ADVANCEMENT OF RADIO AND ELECTRONIC KNOWLEDGE.

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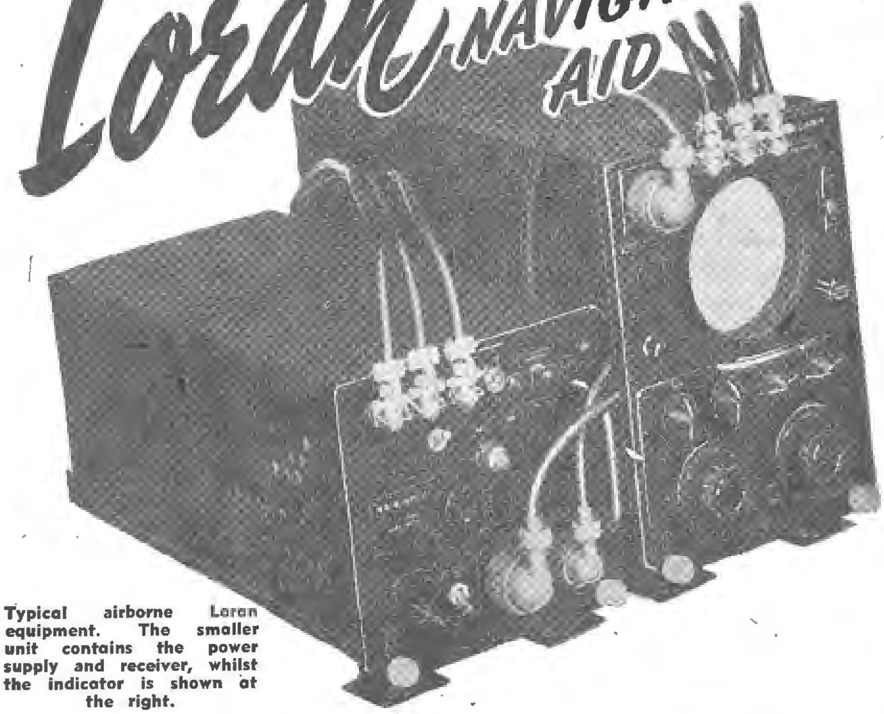
Loran RADIO NAVIGATIONAL AID



Typical airborne Loran equipment. The smaller unit contains the power supply and receiver, whilst the indicator is shown at the right.

Loran, derived from LOng RAnge Navigation, is a highly dependable system of radio position finding for long range over-water use. It is unique in providing a means of quickly and accurately ascertaining geographical position regardless of weather conditions.

Whilst primarily a wartime development, recent ICAO conferences have recommended the adoption of the system as the standard long-range navigational aid for post-war Civil Aviation.

★

Whilst Loran is basically an American development, it should be mentioned that English scientists in 1939 also realised the potential value of a system which would utilise the constant velocity of radio waves. By 1942, both countries had developed systems exploiting these characteristics, the British calling their system GEE.

This operated between 20 and 120 megacycles with resultant line of sight propagation characteristics, having a range of 300-400 miles. The American development on the other hand was planned for Long range operation. Consequently it made use of medium frequencies in the neighbourhood of 1900 Kcs, which unlike VHF waves, do not pass off into space, but are reflected by the ionosphere.

R.D.F. Faults

Prior to the introduction of this system, radio navigation aids in general depended upon some form of direction finding—that is, they operated by determining the direction of the received radio waves.

Because of this and the fact that the direction of such radio waves were subject to unpredictable vagaries of propagation, such as night effect and coastal refraction, these radio aids, after some twenty-five years of research, have not reached any high degree of dependability. This is borne out by occasional accidents due to the failure of beams or receiving apparatus to provide a true indication of position.

The basic difference between the usual RDF aids and the Loran system is that the latter utilizes a pulse transmission instead of continuous waves. The advantage of such a system enables the TIME of travel of signals to be measured instead of only their direction and phase differences. Since the velocity of radio waves is more reliable than the propagation characteristics, the pulse system has a decided advantage over the RDF system by avoiding for the first time the dangerous vagaries of propagation.

Briefly, the basic features of a Loran system may be summarised as:

(1) **Ground based transmitting stations broadcast a steady succession of pulses in all directions at the speed of light.**

(2) **These signals are received aboard the aircraft or ship by means of a specially designed Loran receiver.**

(3) **The difference in time of arrival of the signals is then measured on the Loran indicator.**

(4) **This measured time difference is utilized to determine directly from Loran charts a line of position on the earth's surface.**

Actual Operation

To overcome any ambiguity of two lines of positions having the same difference to be resolved, as would be the case in simultaneous pulsing the actual Loran system uses a method of staggered pulsing. See figure (1 and 2).

In this case station A1 designated as the master station transmits a pulse. The second station B1 (slave station), also receives this pulse from the master station, waits a designated interval equal to one half the recurrence interval plus a small delay known as the coding delay and then transmits its pulse. The "recurrence interval" is simply the interval between the pulses of that particular station.

The result of this staggered pulse sequence ensures the time interval from a Master station pulse to the next slave station pulse, is always greater than the interval from the slave station pulse to the next master station pulse. At the receiving end this difference in time intervals provides a positive method of identifying which signal is from which station,

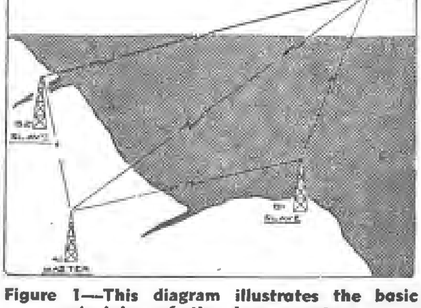


Figure 1—This diagram illustrates the basic principles of the Loran system.

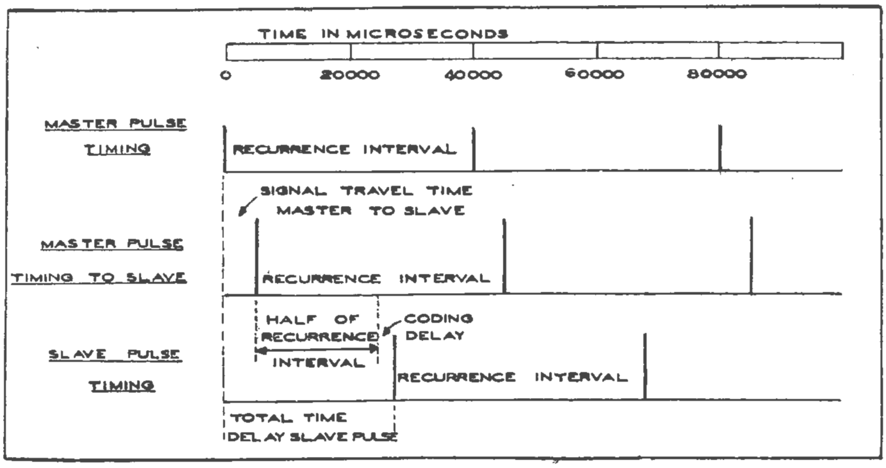


Figure 2—To provide a ready identification of the transmitted signals a system of staggered pulsing is used.

even though the two signals look alike, and it is measured to the accuracy of one microsecond.

Using the measured value of time difference, the navigator consults a Loran chart and finds on it a line (or interpolates between lines where necessary) associated with station pair A1 B1 marked with the corresponding value of time difference. The ship or aircraft is located on this line.

So, by an exactly similar procedure, the navigator then measures the time difference between the two pairs of pulses, originating in stations A1 and B2. Using this value of time difference, the navigator consults the same chart and finds (or interpolates) another line, associated with the station pair A1 B2. The intersection of this line with the line found previously is the position of the aircraft or ship. Thus, by two measurements of time difference on synchronized pulses arriving from two pairs of stations, the navigator finds his position. See figure 3.

Transmitter

The transmitter, figure 4, consists of a self excited oscillator, cathode keyed, which can be adjusted to operate at any frequency between 1700 & 2000 Kc/s. The timer supplies a trigger pip to the input transformer which steps up the voltage, and delivers it to the grid of a pulse forming gas tube. The gas tube circuits produce a keying pulse which is amplified and passed onto a mixer.

The modulator actuated by this signal keys the oscillator circuit and the radio frequency pulses pass through a coaxial transmission line to the transmitting antenna. Transmission lines and antenna coupling network are standard—the antenna itself being of a quarter wavelength and usually consisting of an inverted "L" vertical wire or a guyed tower about 110 feet high set upon a good ground system. With such an arrangement there is little tendency to instability and successive pulses are not only similar in shape, but start always in the same radio frequency phase.

Timer

The timer (Figure 5) can well be considered the very heart of the Loran system, since this initiates the transmitter triggering pulses. If these pulses do not recur accurately and constantly, the final signals are meaningless.

The pulse frequency is held sufficiently constant by means of low frequency quartz crystal, maintained at 60° C (within $\pm\frac{1}{4}$°). This enables synchronism with another similarly operated station to be held within one microsecond for at least three minutes at a time without any adjustment—this means a watch having the same precision would need to be no more than one second wrong after six years' continuous operation!!

Probably the most important section is the oscillator unit. This is equipped with a *phase shifter,* permitting the manual addition or subtraction of whole numbers or fractions of cycles from the oscillator output. Manipulation of this *phase shifter* effectively advances or retards the position in time of the transmitted pulses relative to that of the received pulses.

If there is a gradual drift away from the desired position it is then the duty of the slave station to correct its crystal frequency, so that it exactly coincides with the master station and within certain operating limits this correction will be automatically applied.

If at any time during operation the master and slave stations should fall out of synchronism it is necessary for the slave station operator, who ordinarily is the first to become aware of the fault, to warn all users within range that the station pair is temporarily unserviceable.

The warning is conveyed by interrupting the transmission of the slave station at regular one second intervals—the interruption being referred to as *blinking.* At present two forms of blinking are in common use, both of which have exactly the same significance and give a very positive indication.

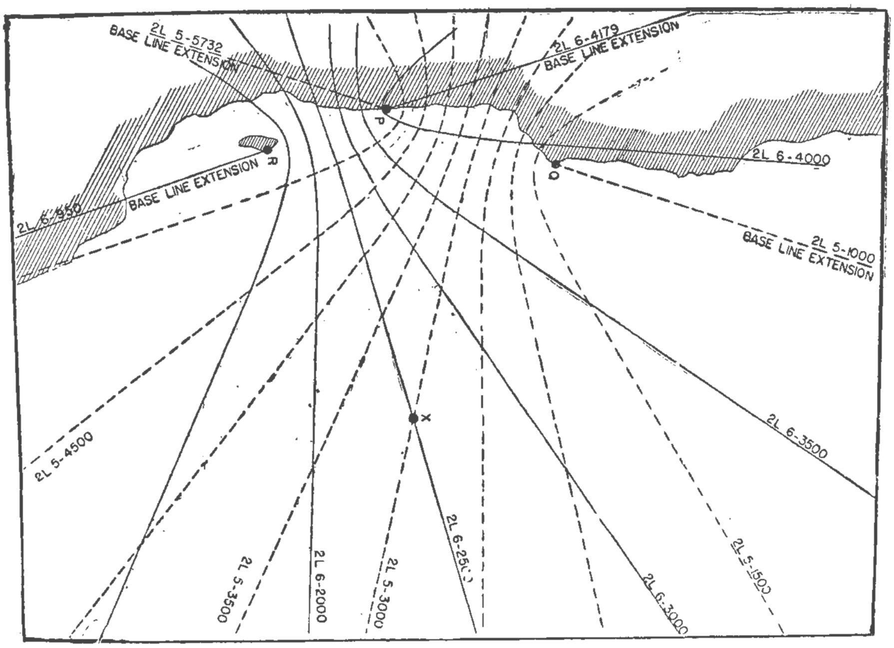


Figure 3—The method of obtaining a Loran fix using two pairs of stations. Using stations P and R gives the line 2L6-2500, whilst the line 2L5-3000 is obtained from stations P and Q. The intersection of these two lines provides the Loran fix, and indicates the position of aircraft or ship.

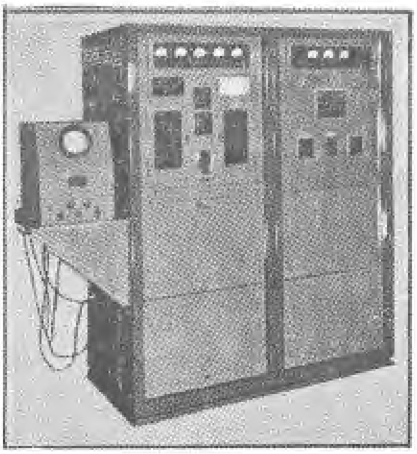


Figure 4—The main transmitter unit. Note the monitor 'scope mounted on the left hand ledge.

Firstly there is the On-Off type—introduced by switching the transmitter on and off at regular one second intervals. This causes the corresponding pulse on the screen to disappear and then reappear. The second is the *shift* type of blinking. This is a more recent development and introduced by altering the pulse timing by 1000 microseconds at regular one second intervals. The pulse then appears to jump from left to right on the indicator screen and back again.

Description of Equipment

Loran airborne receiver equipment consists of two units—a RECEIVER which detects and amplifies the pulses received from the ground stations, and an *INDICATOR* unit containing cathode ray tube which displays the pulses and enables the time interval between the pairs of pulses to be measured.

As indicated in figure 6 the Loran indicator has two horizontal traces, and these are formed by a moving spot of light controlled by the electrical circuits within the indicator

When the pulse signals are received and amplified by the receiver unit they are applied to the Loran indicator in such a way to cause a spot of light to be jerked upward whenever a pulse is received.

Between the pulse from station A and one from station B the spot runs over half of its path and a little more, so it can be seen that if the "pip" caused by the pulse from A appears on the UPPER trace the "pip" caused by station B will appear on the *LOWER* trace and a little to the *RIGHT* of the other.

When the rate of formation of the traces corresponds exactly with the transmitted pulse rate from a particular pair of stations the indicator is then said to be *synchronised* with that station pair. By this means, therefore, it is possible to identify a particular pair of stations from among many pairs transmitting simultaneously on the same radio frequency.

The time difference measurement is taken as the horizontal distance from the master pulse to the slave pulse as shown in figure 6. This convention automatically cancels out the fixed delay of one half of the pulse recurrence period which was added at the slave station and gives smaller or more convenient numbers to deal with.

Although, as a rough measure of the time difference, this distance could be scaled off and compared with the total trace length (known to be equal to nearly one half the recurrence interval) much greater accuracy is needed and so a more complicated system is used.

This is done by magnifying electrically certain portions of the traces, positioning the signals accurately at corresponding places on these magnified positions and then measuring accurately the relative displacement of these portions.

The complete sequence of operations necessary to obtain a reading on the indicator is detailed in figure 9.

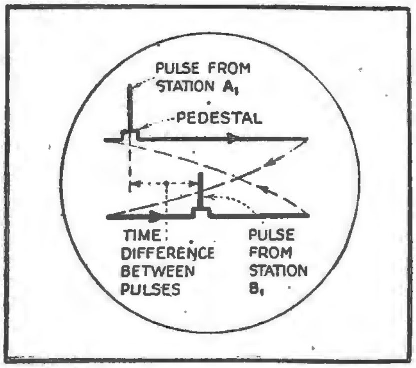


Figure 6—The basic pattern traced out on the C.R. tube in the Indicator unit. The time difference is measured between the two pedestals and expanded sweeps are used to give one micro-second accuracy.

Ground and Sky Waves

Standard Loran was developed primarily for overwater navigation, operating on any one of several frequencies between 1700 and 2000 Kc/s, and therefore possesses propagation characteristics determined primarily by soil conductivity and ionospheric conditions.

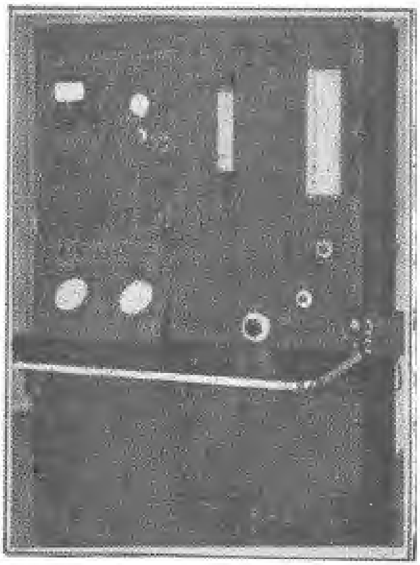


Figure 5—The timer, which controls the accuracy of the transmitted pulse.

Many factors enter into the reception and range of sky and ground waves, chief among these being distance from transmitter, time of day, geographical and atmospheric conditions, signal path over land and water and the altitude of aircraft.

When signals are transmitted from the Loran station some of the waves parallel the surface of the earth and are known as *GROUND WAVES.* Other waves travel upwards, encounter electrified layers of the atmosphere known as the ionosphere, which under favourable conditions may reflect them back to the earth. These reflections are usually known as *SKY WAVES.* See Figures 7 and 8.

In figure 8 the receiver is receiving both ground and sky waves from the transmitter. Since these waves travel different distances to the receiver they arrive at different times and appear as a series of pulses on the scope, the shortest path wave appearing first. The first pulse will be the ground wave followed multiple hop E. Layer and F layer pulses. Very rarely, however, do

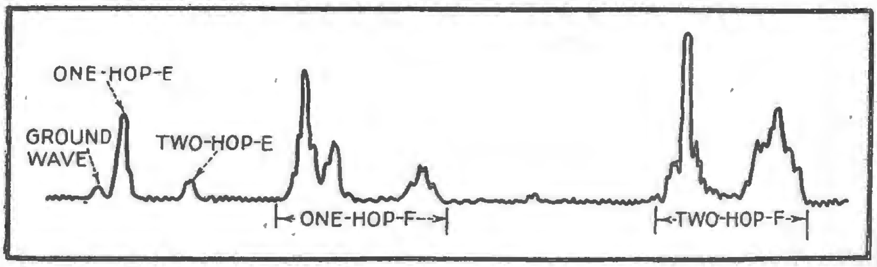


Figure 7—Typical ground and sky-wave pulses as seen on the Loran oscilloscope.

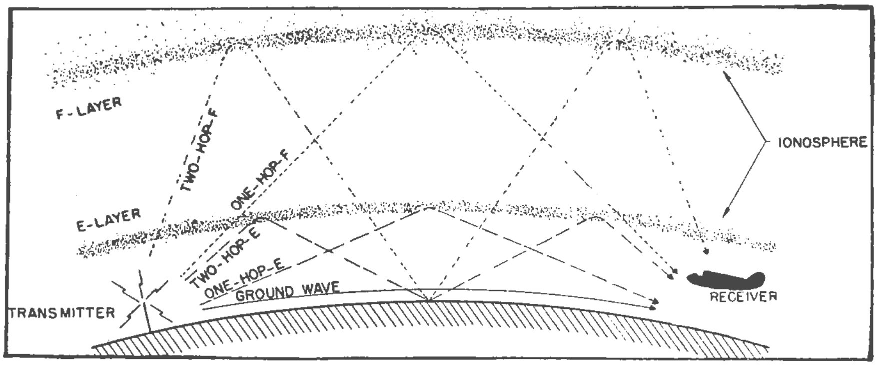


Figure 8—Both sky and ground waves may be received from the ONE transmitted pulse when ionospheric reflection is present. Owing to the greater distance travelled by the sky wave this latter signal will arrive after the ground wave.

all of these pulses ever appear at the same time.

The ground waves are strongest near the transmitter and may be received for a distance of about 700 nautical miles by day over the sea. At night this may decrease to about 450 nautical miles, but will vary with noise conditions. The day time range over land is seldom more than 250 miles, even for high flying aircraft, and barely 100 miles at the surface of the earth.

At night when the ground wave range over sea water is reduced due to the increase in atmospheric noise, the sky waves which were almost completely absorbed by day become effective, increasing the reliable range to about 1400 miles. Sky waves vary greatly with the time of day, seasonal, and geographical conditions, but generally speaking, the best range is from 300 to 1200 miles from the station.

For night operation a correction factor is added to the microsecond readings. This is to compensate for the additional distance travelled by the skywave which is reflected from the ionosphere, and which accordingly takes slightly longer to arrive than a ground wave.

The one hop E sky waves become weak beyond 1200 miles and only multiple hop E waves and F layer waves are received beyond 1400 miles. Various waves may be received at distances of 2-3000 miles, but since their path length and times of travel are too uncertain they are rarely, if ever, used.

Loran positions are now regarded to be accurate within 1% of the distance of the transmitting station. This figure is calculated by resolution of the longest diagonal of a quadrangle, sides of which are arcs of the hyperbolas one microsecond plus or minus on all sides of the plotted position.

At the extreme range of about 1400 miles this diagonal is about 14 miles or one per cent as the aircraft approaches the station error is reduced to less than one per cent because of the improved cut of the Loran lines.

As a matter of interest it can be mentioned that skywave Synchronized Loran —the most accurate form—was used by the RAF for blind bombing and achieved an accuracy of hits within 100 yards!!

Reliability

Since the velocity of radio waves is the most reliable single characteristic of propagation, Loran may be said for this reason to surpass all other systems for reliability of functioning.

It is susceptible only to extreme precipitation static, which blots out or makes impossible discrimination of the transmitter pulses. Considerable study is being made of devices to overcome this precipitation static, and if developed, should help to eliminate the trouble. However, in actual practice it is worthwhile noting that complete loss of the Loran signals is a rarity.

The Future

From the foregoing you may consider this is, at last, the answer to scientific navigation, but actually in its present stage of development it is only another valuable aid subject to well defined limitations.

The equipment is complicated and consequently subject to mechanical failure, whilst frequent adjustment is necessary to maintain the close tolerances. Unless this is done by skilled and properly trained personnel, the entire system becomes worthless and perhaps worst of all, entirely unreliable. However, at the moment large stage developments are taking place with this type of equipment, and it appears most certain that the future holds great possibilities for the system.

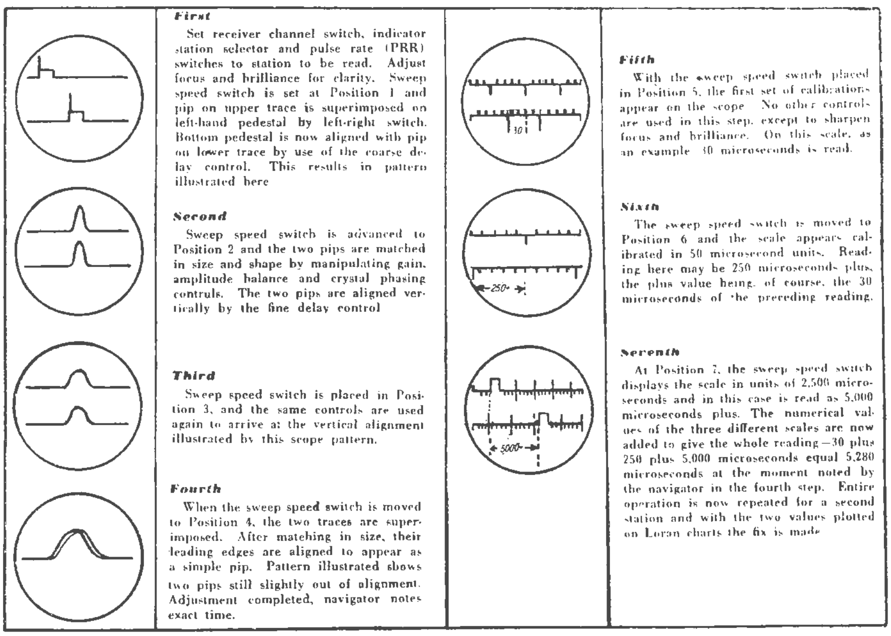


Figure 9—This chart illustrates the complete operational procedure in determining a Loran position line. The whole procedure can be completed in a very short space of time by a skilled operator.

ELECTRONICS IN INDUSTRY—

MULTI-COLOUR REGISTER CONTROL

The versatile Photo-electric Cell has now been adapted to multi-colour printing presses to ensure accurate colour register at all times.

For some years, progressive printers have considered the idea of using an electric eye or photoelectric tube to check the condition of register. However, it has been only within the last two or three years that the design of photoelectric equipment has progressed to the point where such an equipment is practical.

Previously, it had always been necessary for the pressman to be ever on the alert to correct mis-register before spoilage resulted. Even under such conditions, it has been impossible to hold register through splices, or during periods of acceleration

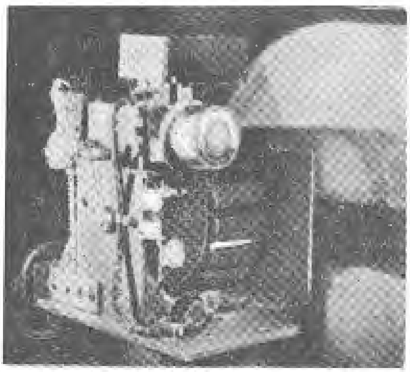


Figure 1—The gravure-cylinder disc scanner with cover removed.

and deceleration, in which the paper tension was changing appreciably.

The fundamental requirements for photoelectric color register are two. First, the control must determine accurately the relative positions of the previously printed matter and the printing cylinder to be registered. Second, it must apply an adjustment to the cylinder or the sheet in the right direction and amount to correct the mis-register.

To ensure a uniform indication, a series of register marks are etched in the first-color cylinder, usually the yellow cylinder. These are inconspicuous marks about 0.020 in. wide, and about ½ in. long across the sheet. They are located in the margin or fold, if possible, in a clear track away from the other printing. Scanning heads to view these marks are then placed as close as practical to the other cylinders to be registered to this color.

Since all other cylinders are registered to this color they will, of course, be registered correctly to each other. Most readers are entirely unaware of the presence of the register marks until these have been pointed out to them.

The position of the printing cylinder is indicated by a disc or drum which is attached to one end of the cylinder shaft. and which contains slits accurately spaced to correspond to the position of the register marks in the paper. Another phototube views light projected through the slits, thus producing an electrical impulse which is compared with the impulse caused by the passage of the register mark past the first phototube. It is the usual practice to place 16 marks around the circumference of a typical 43-in. cylinder.

Mixing Panel

The impulses from the cylinder phototube and the web phototube are fed into a "mixing" panel where they are compared. In this mixing panel, the signal from the passage of the cylinder disc slit causes a second signal to be set up, which occurs immediately after the slit signal has finished and which is approximately as long.

Thus if the web signal occurs during the same time as the signal from the slit, it indicates that the web is too far advanced and a signal is set up to retard it. If the web signal occurs during the time of this new trailing signal, the web must be advanced. However, if the web mark passes so that it divides evenly between the slit and trailing signals from the cylinder, the advance and retard indications are balanced and no correction is necessary.

Where an indication of mis-register is given in the mixing panel, a signal indicating the amount and direction of correction needed is immediately generated and transmited to the motor panel.

It is important to note that the register is held between the centre of the web mark and the trailing edge of the cylinder disc slit. Thus, the intensity of light through the disc slip, the color of the printing, or the depth of the etching or doctor-blade setting have little effect on the position of register.

The phototubes scan the mark and slit through optical systems similar to those used on telescopes and gun-sights. This not only insures an accurate and permanent setting, but also, since the image is magnified four or five times before it reaches the phototube, makes possible an accuracy of indication of 0.001 in. or 0.002 in. without the use of extremely narrow slits.

Since the presence of the web register mark is necessary for a correction indication, if one or more marks should not print for any reason, the equipment simply ceases to operate and cannot cause a false correction, which may lead to excessive waste before it is detected.

The mixing panel also includes an indicating tube. This is a fluorescent "magic-eye" similar to those used in a radio receiver for tuning a station to the best advantage. This indicates when the equipment is in register, or in which direction it is out. It is also a further check on correct functioning of equipment.

The next step is to correct the mis-register which has been found.

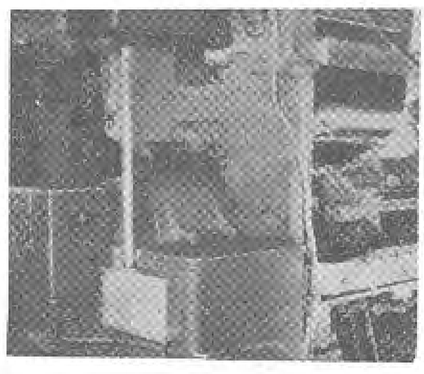


Figure 2—The complete colour-unit equipment mounted on the drive side of the press.

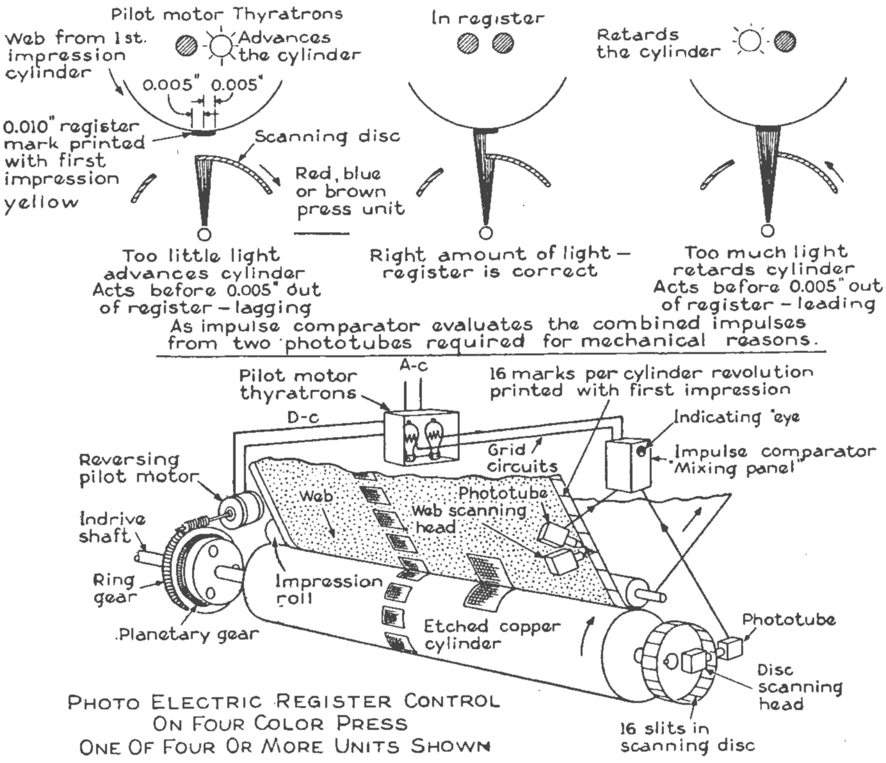


Figure 3—Automatic register control diagram showing general location of parts.

This is done by using thyratrons to operate the correcting motors. Thyratons may be operated from the small signal voltage produced by the mixing panel, and in turn can control the power required to drive the one-half horse power motor. Two thyratrons are needed for each motor, one of which controls the motor's speed in each direction.

Applying Correction

The motors used are of the standard d.c. shunt type, operated from the regular a.c. supply through the rectifiers and thyratrons. The correction may be applied either to the cylinder differential gear or to the compensating rolls. It is usually preferable to apply it to the differential gear, since this leaves the compensating rolls completely free for manual operation, if desired. Gear motors are used to obtain the desired rates of correction. This is found to be between 1 in. and 1½ in. per min. Greater speeds than this may cause the paper to be torn.

Interlocks are provided so that the correcting motors cannot be operated unless the press is turning over. This prevents the possibility of backing the cylinder into the "doctor-blade" at a standstill and thus damaging the cylinder.

A Technical Survey of Latest Overseas Developments

THE "FIX-IT YOURSELF" RADIO.

The latest development in receivers is news of a compact AM receiver in which all the elements of a superhet. circuit have been made plug in. The r-f, oscillator and i-f units are pretuned and there is sufficient tolerance to make interchangeability of units quite practical. All normal under chassis resistors and capacitors are included in their respective cans, leaving nothing underneath but the filament wiring.

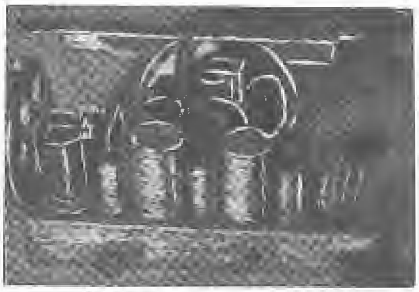


Figure 1—The chassis layout differs little from a conventional receiver. The complete plug in units can be seen mounted along the back of the chassis.

According to the inventor, this arrangement will allow the owner to service his own set, making him completely independent of the serviceman. When the set develops a fault the owner will simply take it along to a store and (to quote) "interchange its components with new ones until he localises the trouble himself and then pay a modest fee for the new component."

Difficulties

Whilst the idea on paper may be basically sound, the complete success of such an arrangement seems very doubtful—both from the serviceman and customers points of view. It is most unlikely that mass produced components assembled in the plug-in units can be so uniform and held to such close tolerances that substitution can be effected without any re-alignment.

Then again the servicemans reaction to the situation is not hard to visualise. It seems hardly likely that he will allow his merchandise to be subjected to this trial-and-error treatment by every inexperienced set owner that may come in with a faulty set. Whilst the set owner may locate one fault in the set, there will certainly be difficulties should a twin fault develop, and in this case it is hard to see how the serviceman can be dispensed with.

Apparently the point not generally appreciated about service work in general is that technical knowledge is essential during diagnosis. Certainly anyone who can handle a soldering iron can replace a faulty component—but to locate that fault still requires theoretical knowledge.

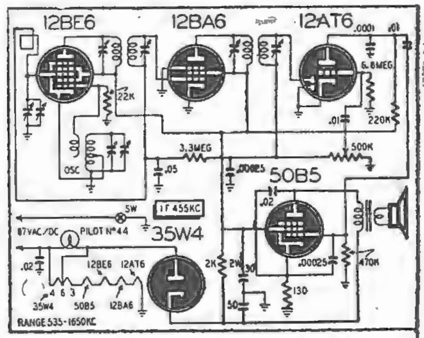
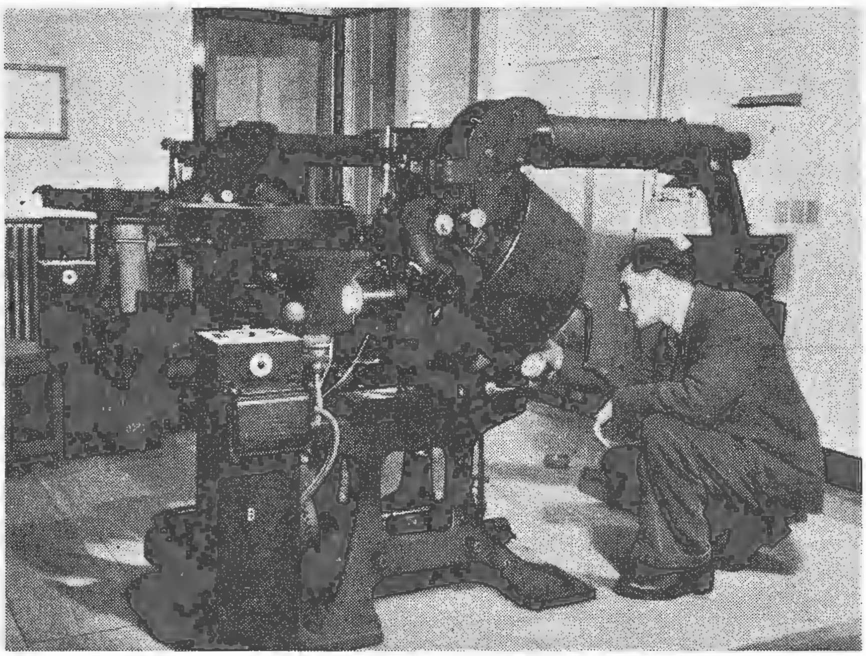


Figure 2—The circuit follows standard practice, and gives no indication of the final form of the set.



This massive and elaborate machine is a Telecine, installed at Alexandra Palace, headquarters of the BBC Television Service. Developed in Britain before the war, the Telecine enables any standard cinema film to be televised for reception by home television receivers.

Infra Red Ensures Secrecy

A new form of communications—infra red beamcasting—makes possible secret two way conversation in ship-to-shore communications, blackout flying, or in disaster areas where telephone lines are cut off, as it is unaffected by weather conditions or static.

The invisible searchlight beam is produced by a caesium vapor lamp, which is a poor visible illuminant, but a very efficient infra red generator. The ability of the caesium vapor lamp to alternately dim and brighten thousands of times per second called it modulability, is almost 100% over the audio-frequency range from 200 to 3,000 cps. This makes it suitable for practically instantaneous transmission of words at normal conversational speed with good telephone quality.

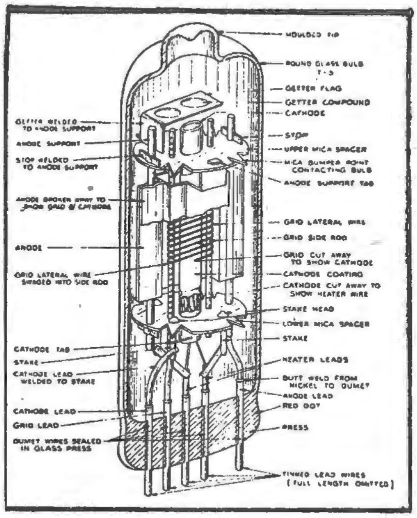
This infrared apparatus provides a new form of communications unaffected by weather conditions.

Television Frequencies

From the Allen B. du Mont Laboratories comes the report that television transmission frequencies have almost attained a billion megacycles. Such high frequency waves are of course ordinary light which is being used in a new system of relaying television programmes.

A cathode ray tube transmits the television modulated light beam whilst a photocell receives it and converts it back into electrical impulses for re-transmission from local television stations. It is considered that the system will reduce costs as well as simplifying the transmission of colour signals and improving the fidelity of the telecast images.

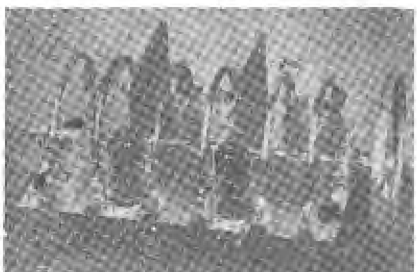
Subminiature Triode



A triode four-tenths of an inch in diameter and one and a half inches long has been developed by the Raytheon Manfg. Co. It is a high mutual conductance triode, with a 200 ma 6.3 volt heater, and an output of about 1 watt at approximately 25% efficiency. It has been designed for operation on the 460 to 470 mc Citizen's Radio Band, and with a reduced output will operate up to 800 mc.

New FM Tuner

A new and different FM tuner unit has recently been developed. The system from the mixer through the 10.7 mc i.f. circuit is of conventional design, but the front end assembly features a completely new tuning system. It consists of a modified form of long lines using an L-C combination in series to cover the 88 to 108 mc. range. The line tuners are semicircular brass rod assemblies with .0005 inch silver overlay, and with the use of temperature compensating condensers offer relatively negligible initial drift.



The semi-circular rod assemblies form the line tuners of this new FM tuner unit.

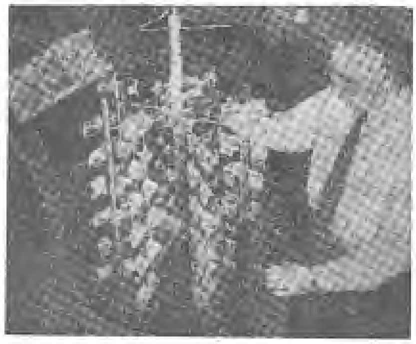
Synthetic Crystals

In the past years the use of quartz and Rochelle salt crystals in electronic devices has been well known. Now artificial crystals, grown in the laboratory from ordinary chemicals, are starting to be used in telephone networks as a substance for scarce, but indispensable natural quartz.

In a few years, the artificial crystals are expected to replace as much as 90 per cent. of the natural quartz used in long-distance telephone systems and do as good a job as its scarce natural brother.

The new crystals, ethylene diamine tartrate, are familiarly known as EDT. Although these crystals differ markedly from quartz in chemical composition, both are piezoelectric in character; that is, they can convert mechanical energy to electrical energy or they can reverse the process.

A small slice, or plate, of such crystal will vibrate with unvarying frequency when electric current is applied to it. Telephone engineers employ this characteristic of quartz—and now of EDT—in sending many telephone conversations over the same wires at the same time, but at different frequencies, using crystal filters to guide each conversation into its proper channel.



Checking a batch of synthetic crystals.

Another newcomer to the crystal field is ADP (ammonium di-hydrogen phosphate) which has been used in some war time electronic devices.

This new crystal is free from non-linear response and hysteresis effects and is unusually stable with temperature changes, often a weakness of the pieze electric crystals. Furthermore it cannot de-hydrate like Rochelle salt.

ADP is stable at temperatures as high as 100°C. as contrasted with the limit of 55°C. for Rochelle Salt. It is also effective at low temperatures, although it shatters at the extreme low of -125°C.

These new crystals are the direct result of long-range research on growing artificial crystals which has been in progress for a quarter of a century.

★ A STAR PERFORMER

for Endless Enjoyment

Here is a "really" personal portable receiver which can be easily duplicated by the home set builder.

Using a loop aerial, high gain iron core intermediates and four miniature valves it is capable of excellent results.

Measuring approx. 8½ x 5¼ x 3ins. it is comparable in size to most types now around the city, and will provide hours of entertainment where a larger receiver would be out of place.

FULL CONSTRUCTIONAL DETAILS OVERLEAF

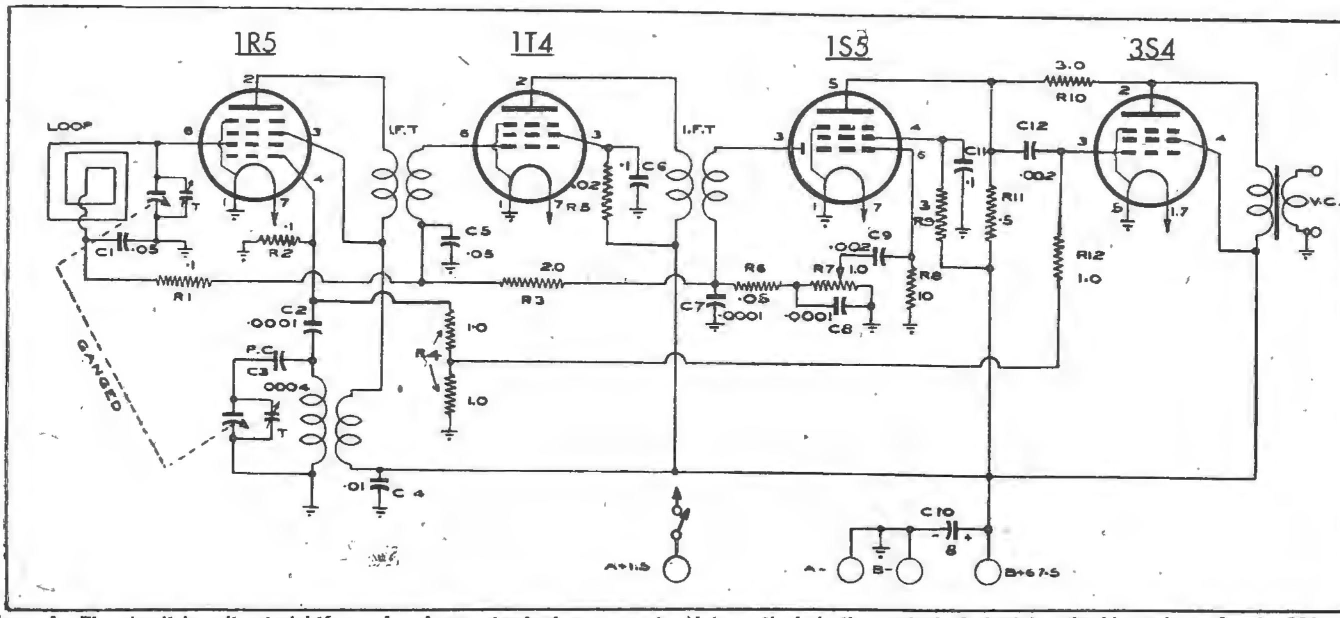


Figure 1—The circuit is quite straightforward and uses standard components. Note particularly the method of obtaining the bias voltage for the 3S4.

As the basic requirements of a set of this type are low operation costs, portability, good reliable performance as well as an attractive appearance, much time and thought were devoted to the actual design.

To achieve popularity, small size becomes a major consideration, and it was apparent from the outset that the usual type of chassis layout was out of the question if the full advantages of compactness were to be achieved At the same time realising that the set would come in for a lot of rough handling and probably finish in many odd spots, the construction had to be of a rugged nature and yet be readily duplicated by the average home constructor.

It is considered that all these features have been achieved with this little receiver, and whilst the layout may appear complicated at first sight, it will be found that the actual construction is relatively simple, and with a little care and attention to detail should cause no trouble.

Circuit Details

Reference to the circuit will show that for the main part the design is quite conventional. The valves used are: 1R5 as converter, 1T4 as I.F. amplifier, 1S5 as combined detector and audio amplifier and 3S4 as output valve. The power requirements are a 67.5 volt B battery for the high tension, and two torch cells for the filament supply.

Although the addition of a tuned RF stage would have improved signal pickup and provided a better signal-to-noise ratio, this was found to be impracticable, due to the non-existence of suitable midget three gang condensers.

PORTABLE RECEIVER PARTS LIST

1 cabinet.
1 dial plate.
1 special chassis.
1 loop aerial.
1 Oscillator coil (midget).
2 Iron Core I.F.T. (midget).
1 two gang tuning condenser.

CONDENSERS.
1 8 mfd electrolytic.
2 .1 mfd tubular.
2 .05 mfd tubular.
1 .01 mfd tubular.
2 .002 mfd tubular.
1 .0004 mfd mica.
3 .0001 mfd mica.
2 trimmers.

RESISTORS.
1 10 meg ½ watt.
2 3.0 meg ½ watt.
1 2.0 meg ½ watt.
3 1.0 meg ½ watt.
1 0.5 meg ½ watt.
2 0.1 meg ½ watt.
1 0.05 meg ½ watt.
1 0.02 meg ½ watt.
1 1.0 meg volume control.

1 3 inch speaker to match 3S4.
4 midget sockets.
1 rotary switch.

VALVES—1R5, 1T4, 1S5, 3S4.

BATTERIES—1 67.5 volt minimax, 2 Torch cells.

SUNDRIES — Hookup wire, braided wire, small rivets, nuts and bolts, solder lugs, etc.

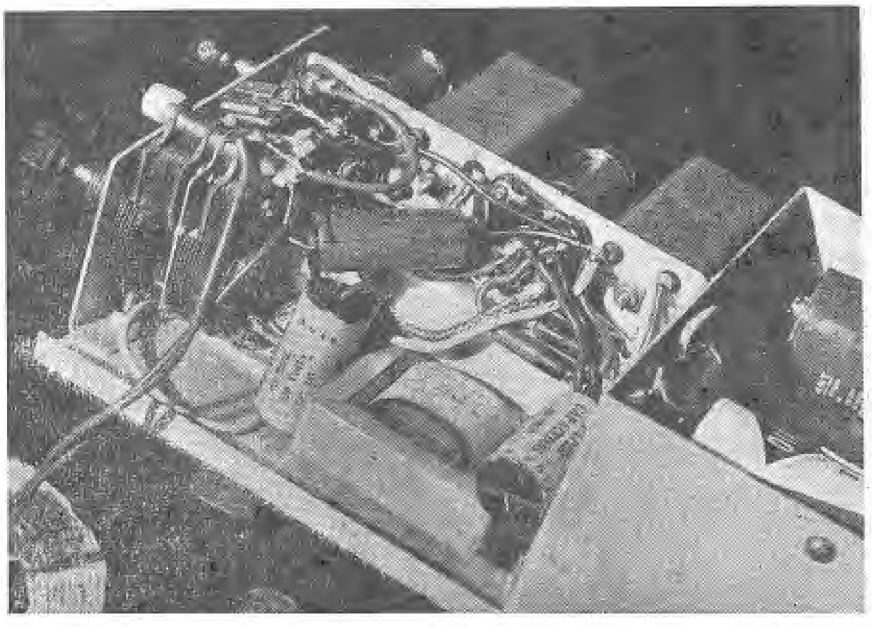


Figure 2—The wiring of the IF bracket and tuning end of the set are shown in this photograph. For clearness the 1S5 and 3S4, which are located immediately above the condenser in the right hand corner, have been removed from their sockets.

A standard type of tuned loop aerial is therefore used, and this is connected direct to the 1R5 grid circuit. During the initial stages it was decided to use the carrying strap shown on the finished cabinet as a low impedance loop, but this was finally discarded in favour of the present idea mainly because of the lack of a suitable aerial matching coil.

The I.F. amplifier circuit is standard and the 1T4 is operated at a reduced screen voltage, mainly in the interests of economy. The second I.F. transformer feeds into the diode section of the 1S5 and this provides for detection as well as the AVC voltage. The rectified output is then taken via the volume control R7 and coupling condenser C9 to the 1S5 pentode grid. Note that the grid resistor in this circuit is 10 meg. and provides the necessary bias voltage for this valve.

The 1S5 is the output valve and as will be noticed a small amount of negative feedback has been provided. This may appear unusual in a set of this type, but it will make the tone much more pleasant. In any case, the gain reduction is only slight, resulting in ample output still being obtained from the small three inch speaker.

Output Bias Voltage

Probably the only section of the circuit calling for any particular comment is the method of obtaining the output valve bias voltage. The normal DC current flow in the 1R5 oscillator grid circuit has been utilised to provide this, and whilst some criticism in the past has been levelled at the arrangement, in practice it will be found quite reliable and efficient.

The fundamental principles of operation are simple: the DC grid current flow in the mixer stage causes a voltage drop across the grid resistor R2 and by providing a suitable voltage divider network this can be tapped off to provide the desired bias voltage. In practice the voltage will be found to be approx. 14 volts, and so by using the two 1.0 meg. resistors as shown and connecting the 3S4 grid return to the junction, the correct bias of 7 volts is neatly obtained for the output valve.

In place of this arrangement the only other practical system would be to use the familiar back bias, but this has the inherent disadvantage that the bias voltage must be subtracted from the available high tension supply. This means that a new 67.5 volt battery is immediately reduced to some 60 volts—that is the total efficiency of the circuit is reduced by approximately 11%—and is a rather unsatisfactory state of affairs just to provide a bias voltage.

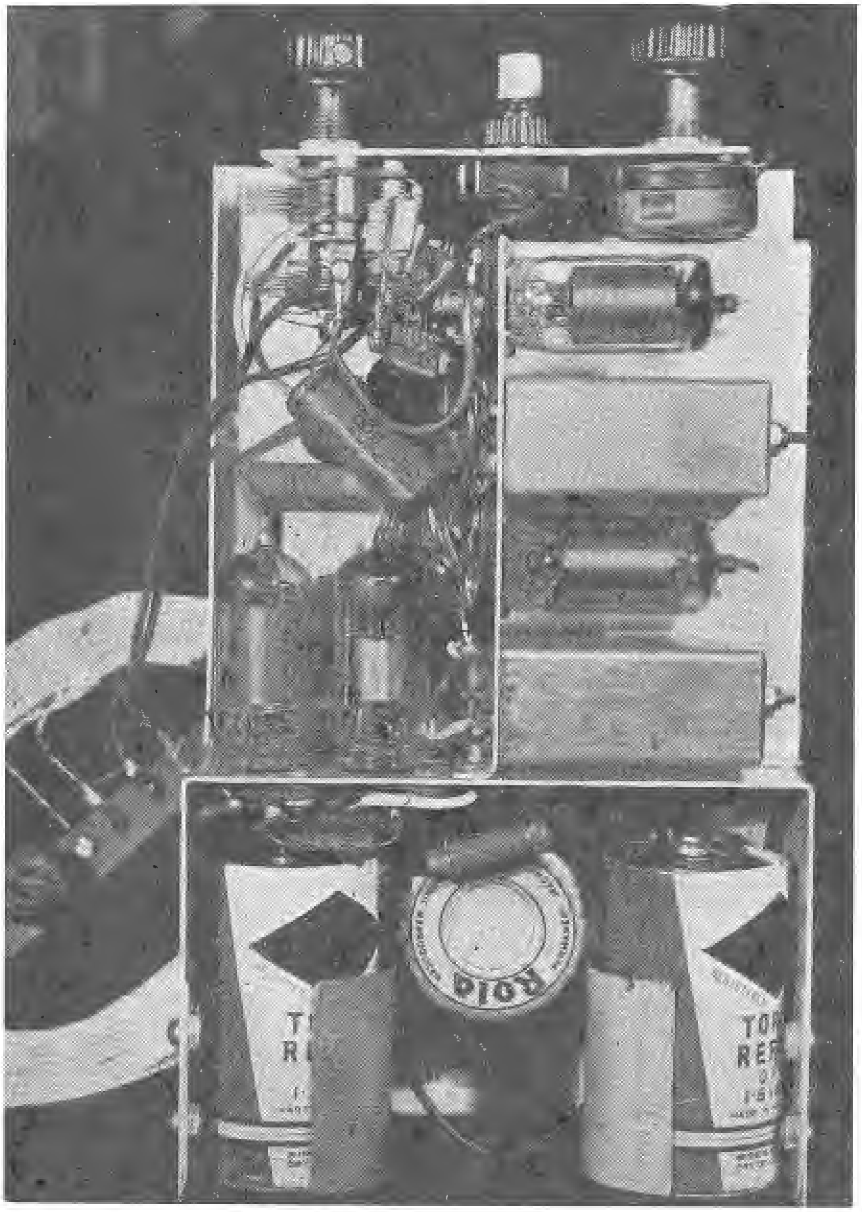


Figure 3—Use this photograph as a guide to the layout and wiring up of the components.

Because of this the method adopted seemed to offer the best possibilities although as mentioned it is held in disfavour by many. One point frequently brought up is that at low "A" battery voltages, the OG current will decrease, resulting in a decreased negative bias being applied to the output valve. This then will cause an increase in current consumption giving a decreased battery life. However, our tests with this set showed that this theoretical consideration did not work out quite as expected.

As the "A" battery voltage decreases the actual rise in plate current was insignificant, and the only marked increase (approx. 1 ma on the electronic voltmeter) took place when the A battery reached approx. 0.9 volts. This surge, however, was almost immediately counterbalanced by the set ceasing to function because of the low filament voltage. At all voltages above this 0.9 figure the current drain as well as the output valve bias voltage remained substantially constant throughout the entire tuning range.

So it will be found that this method of obtaining the grid bias voltage will allow the full 67.5 volts to be utilised for the high tension supply—a very important factor in a small set of this nature where it may well be considered that every volt counts.

The only point to watch is the position of the padding condenser and this should be connected as shown in the circuit diagram. If it is connected in the usual position—that is between one end of the oscillator coil and earth, it will be found that the oscillator grid current will vary considerably over the entire tuning range resulting in a widely fluctuating bias voltage.

Chassis Construction

Whilst it is anticipated that a ready cut chassis will be available for this receiver, full details of the measurements are included for those who may wish to bend their chassis from scrap aluminium. Five separate sections are required, and these should be bent using 20 gauge aluminium. A lighter gauge will not have the necessary structural strength whilst a heavier gauge will make the bends difficult—so as far as possible make sure you keep to this gauge requirement.

The base measures $7\frac{5}{8}$ x 4.15/16, and has $\frac{1}{4}$ inch flanges marked along each edge. Cut out the $4\frac{5}{8}$ inch section along one side—to enable the B battery to slide into its compartment—and bend the flanges up by clamping the metal between two pieces of flat timber held in a vice. Cut out the $3\frac{1}{2}$" diam. speaker hole.

Part B—is constructed from a piece of aluminium 10.13/32 x 2.11/16. Mark and

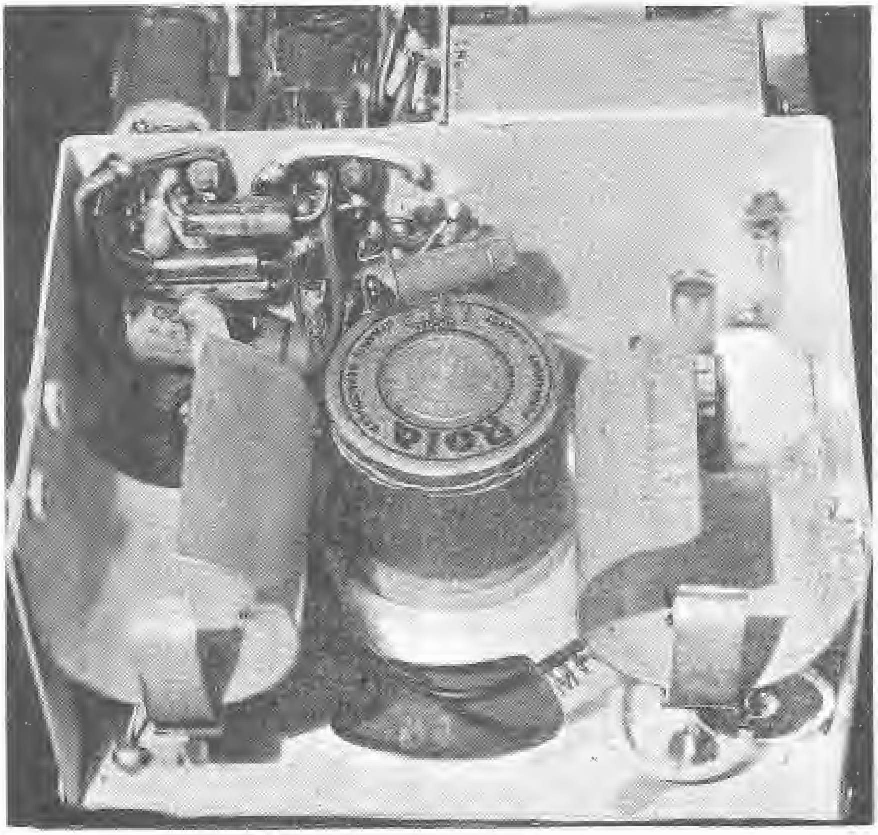


Figure 4—This close up shows how the two A battery clips are made and fitted. The 8mfd electrolytic condenser is located immediately below the right hand clip.

cut out the two valve sockets—using a ¼ inch drill and round file. Cut out the flange as indicated—bend the centre section back and then cut out the speaker section. Next mark off 3" from each end and bend back along these lines.

Part C—battery cover—measures 4.7/16 x 4¼ and after removing the sections indicated—make the various bends in the order marked—checking the final measurements are correct.

Part D—IF bracket—first mark out the position of the two valve sockets and intermediates and cut out these holes. Next mark off two ¼" flanges, cut out one corner and bend the two flanges back in the same direction.

Part E—this is the front control plate and consists of drilling out the three control holes and then bending the ⅜" flange.

Assembly

With all the sections completed the next step is to assemble them. This is quite easy if taken in the following logical order. Place the base plate on a flat surface and slide part B into position. Drill the mounting holes and rivet together.

Next the battery support is riveted to the centre screen, using two rivets along each of the flanges. On top of this place part D with the flange level with the edge of part C and rivet into position. Next position the front plate and fasten by two screws. Reference to the completed drawing will show just how these sections fit together.

It will be noticed that in assembling the sections, rivets have been used instead of the usual nuts and bolts. This permits a lighter and neater type of construction and the small rivets used are now available from most radio shops.

As regards the chassis dimensions it should be pointed out that these are quite critical and care must be taken to ensure they are strictly adhered to. Owing to the limited space, "near enough" is not good enough, and unless this point is watched then you may have trouble in fitting the chassis into the cabinet.

The A battery clips should be made from springy brass or dural, but not aluminium. These can be easily bent up and fitted in the position shown in the photograph using two small nuts and bolts. The connections are riveted to the bottom using a small piece of fibre as an insulator between the positive and negative connectors.

WIRING UP

The mounting of the components is quite straightforward and their general location can be readily seen from the various photographs. Mount the valve sockets and IF transformers in the position shown ensuring they are positioned to keep the plate and grid leads as direct as possible. This is particularly important and should minimise the possibility of any feedback troubles. Note that the output transformer is mounted immediately behind the tuning condenser.

The wiring is commenced by connecting up the filament circuits earthing the A minus leads to some convenient point. Also earth the centre shield of the valve sockets, otherwise instability will result. In connecting up the filaments take particular care with the output valve as this has provision for either series or parallel operations, using a centre tapped filament. As the parallel connection is required in this set, pins 1 and 7 are connected together to form the A plus lead whilst pin 5 is the A minus lead.

The A plus lead from the battery is taken via the switch and this completes the filament circuit.

Now wire up each stage in turn placing the relevant resistors and condensors as close as possible to the valve socket The oscillator coil used was already mounted on the oscillator grid resistor, and as one end of this is earthed it forms a convenient support for the coil. The volume control leads are shielded and taken to their respective connections by the shortest path.

Actually there is no crowding of components in any section, and providing small parts are used then you should have no difficulty in fitting them in. The loop is mounted on the rear cabinet lid and leave the leads approximately six inches long so that this can be removed easily when A battery changes are required.

Since only a numerical scale is used for this set the actual dial calibrations are not important and for this reason a fixed padder is used. A small trimmer should be connected across the oscillator and aerial section of the gang for lining up purposes.

The standard Efco dial plate has been used on the finished model and in our particular case this was cut in halves so that the switch could be placed between the two controls to give a balanced appearance. Those who do not wish to cut the plate can easily move the switch immediately below it making sure that the front plate is drilled to suit this change.

(Continued on page 27.)

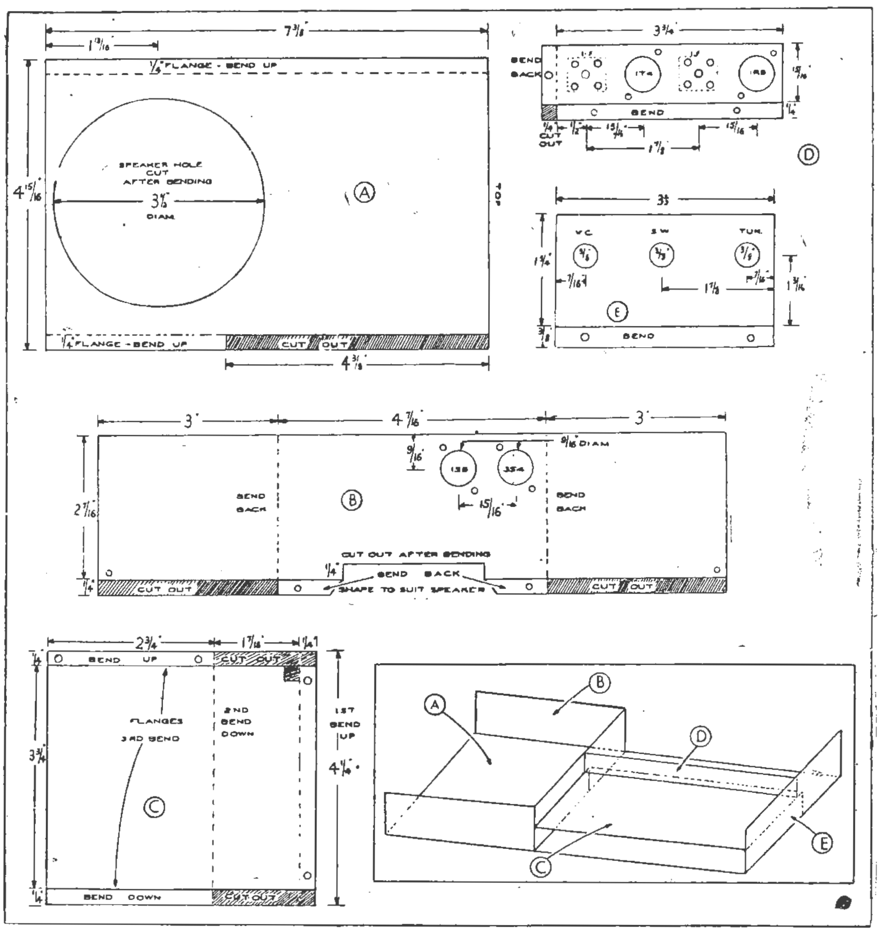


Figure 5—Here are the complete chassis details for those who may wish to make their own chassis.

RADIO SCIENCE QUIZ

With quiz sessions fast becoming the Nation's No. 1 pastime, here is such a feature to test your general radio knowledge. The rules are simple:—Take 10 points for each question answered correctly and 5 points if only half right, and then total up your score.

As a guide to your I.Q. average, scores are:—Beginner, 50% and under, Experimenters and servicemen, 50 to 75%, Experts, 75 to 95%, and over 95% Genius.

Which are you?

Q. 1. *Just to start you thinking along the right lines write down the correct nominal voltage rating of each of these cells*:
(a) Standard torch cell.
(b) Edison alkaline cell.
(c) Clark cell.
(d) Lead-acid storage cell.

Q. 2. *Being a technical man you should know that Lenz's Law deals with*:
(a) magnetic circuits.
(b) optical lens systems.
(c) capacity effects.
(d) has nothing at all to do with radio.

Q. 3. *From your technical studies you must have learned that a space charge is*:
(a) the magnetic field set up around a coil by an alternating current.
(b) your radio shop rental.
(c) the effect in a radio valve due to free electrons not being attracted to the plate.
(d) the effect on radio waves travelling from the transmitting station to the receiving aerial.

Q. 4. *The term "cone of silence" as applied to radio refers to*:
(a) a broken loud speaker.
(b) a "no signal" area above a vertical radiator.
(c) a position near the speaker where the bass notes are poorly heard.
(d) the poor pickup area of a unidirectional microphone.

Q. 5. *Technical articles often make reference to a wobbulator. If you had to get a wobbulator, you would bring back*:
(a) a dial complete with "backlash."
(b) a unit used for transmitting frequency variations to ensure secrecy of communication.
(c) a slightly inebriated gentleman.
(d) a device included in a cathode ray oscilloscope to vary frequency in synchronism with the horizontal sweep.

Q. 6. *Conversion factors are easy, or then again are they? Anyhow, conversion from metres into kilocycles may be effected by*:
(a) Multiplying the metres by 186,000.
(b) dividing the metres into 300,000.
(c) dividing the metres into 186,000.

Q. 7. *A buffer stage is*:
(a) an RF amplifier.
(b) a go-between between the wholesaler and retailer.
(c) a prop used in certain broadcasting studios.

Q. 8. *When we speak of "skin effect" we usually refer to*:
(a) the tingling sensation received on touching the antenna of a low powered transmitter.
(b) RF current travelling along the outside surface of a conductor.
(c) that fine set of goose pimples often seen on a cold morning.
(d) the shock received on touching those apparently "dead" filter condensers after the transmitter has been switched off.

Q. 9. *According to the electron theory how does the electric current flow*:
(a) from positive to negative.
(b) from negative to positive.
(c) from the centre of the conductor and flowing in both directions.

Q. 10. *Radio waves are least absorbed when travelling over*:
(a) rocky mountains.
(b) lake water.
(c) sandy soil.
(d) rich soil.
(e) sea water.

Q.11. *Although not introduced into Australia at the moment, you probably know that the picture on a home television receiver appears in or on*:
(a) motion picture screen.
(b) Iconoscope.
(c) kinescope.
(d) a ground glass screen.

Q.12. *Whilst on the subject of television, a "ghost" in T-V parlance is*:
(a) an unemployed actor.
(b) star performer's stand in.
(c) a spurious image in the television picture.
(d) a nightwatchman who guards television equipment.

Q.13. *If you are superstitious, this one may be unlucky for you, since "M" is also the 13th letter of the alphabet. However, try and tell what the "m" stands for in the following abbreviations*:
(a) mc (b) mf (c) ma (d) mmf
(e) m (f) mh.

Q.14. *If you heard a technician remark that a lot of "wows" came over station XYZ last night you would know that he meant*:
(a) super programmes.
(b) latest recordings.
(c) very funny jokes.
(d) records reproduced at an imperfectly controlled speed.

Q.15 *If, on reading through a technical journal, you noticed that new apparatus was going to be fitted with P-BT, you would know that it meant*:
(a) pre-band transmission.
(b) push button tuning.
(c) pentodes or beam tetrodes.

FOR ANSWERS SEE PAGE 48.

The A.B.C. of FREQUENCY MODULATION

With the possibility of an early decision being given regarding the future of FM transmissions in this country, now is the time to learn about this form of broadcasting. Although of an elementary nature, this discussion will serve as an introduction for subsequent more technical articles.

The basic principles of FM have been known for many years, but it is only recently that they have been utilised to any serious extent. Far from being a revolutionary new invention, records show the first patent covering the basic method of FM for transmission and reception was issued in 1905! The method proposed under this patent was to shift the carrier frequency by means of a voice actuated condenser and then use an off-tuned circuit in the receiver for converting the FM modulated waves into waves of varying amplitude. With refinements, this is basically similar to the methods in use nowadays.

Although the system was used in long wave transmitters up to the 1914 war, it gradually fell into disuse after the introduction of the triode valve, as this solved many of the AM problems. In the early '20s a mathematical treatise on FM further handicapped research, since it proved (erroneously) that an FM system required an even wider percentage of band width than the conventional AM system, and because of this finding the system was more or less forgotten.

A.M. Static Problem

The effect of static, man made interference, etc., has always been a major problem associated with AM transmissions, and many attempts have been made to find a solution to this problem. However, since all these forms of interference cover the same frequency spectrum, as well as having the same polarisation as an AM wave, it soon became apparent that the only method of completely eliminating this trouble was by the use of some new form of transmission.

Consequently, in 1925, Major E. H. Armstrong considered that the FM type of circuit might hold possibilities. By using a wide band frequency transmission he found there was greater discrimination against static, and in fact, the wider the band width, the greater the useful signal strength, with a considerable increase in the signal to noise ratio. Also he proved that instead of an infinite band width being required for such a system, that the significant band width was in fact less than that at broadcast frequencies.

Further tests and experiments were carried out over a period of years, culminating in the erection of the now famous FM transmitter at Alpine, N.J. This did much to demonstrate the possibilities of this type of transmission and the results are now well known to all technicians.

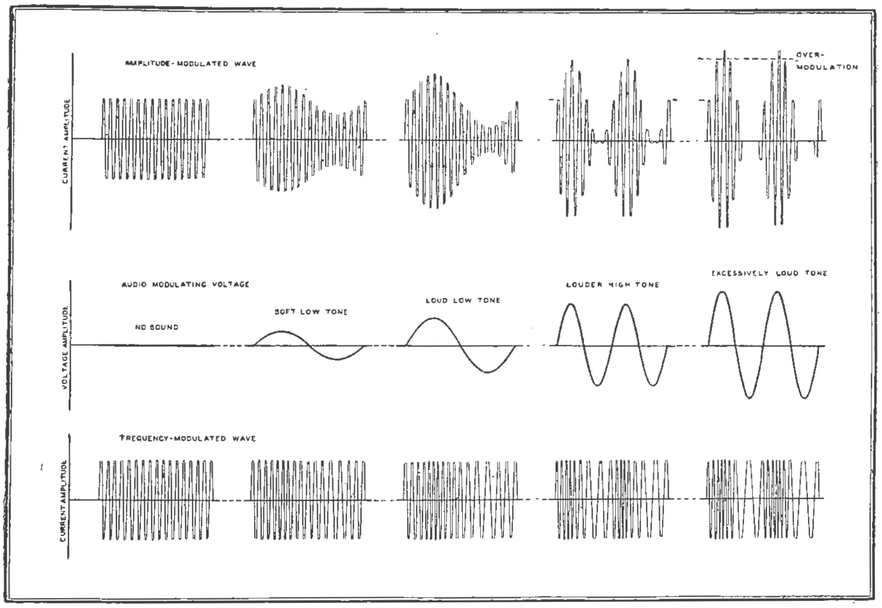


Figure 1—This diagram illustrates the basic difference between the amplitude and frequency method of modulating the carrier wave of the transmitter.

F.M. Versus A.M.

The two terms *amplitude modulation* and *frequency modulation* are largely self explanatory. The type of transmission used in this country is known as the amplitude-modulated (AM) system, and in this the waveform of the current in the transmitting aerial—and also the receiving aerial—is similar to that shown in figure 1.

The unmodulated wave is known as the *carrier*, and as can be seen, the amplitude of which varies in accordance with the audio frequency signal being broadcast. The effect of modulating the carrier in this way produces sidebands which extend up to 5 kcs above and below the carrier frequency. This means that the transmitter only occupies a band 10 kcs wide in the ether spectrum—this limitation being necessary to allow the maximum number of stations to operate at the one time.

On the other hand, the carrier amplitude in the FM system is kept constant but its frequency is varied by the modulation above and below an average value —the number of swings made per second corresponding with the audio frequency signal.

Similar to the AM transmission, this system also generates sidebands in considerable number, and they can occupy a total band width of about 150 kcs. Because of this, use of FM has been restricted to the ultra short wave lengths where the roomier spectrum enables such wide band widths to be utilised. For this reason it is found that the operating frequencies are between 40 and 50 mcs and more recently the 88-108 mcs band has been opened up for the FM system in this country.

F.M. Receiver

The actual FM receiver may be either TRF or superheterodyne, providing it meets the basic requirements of being able to tune to the high frequencies used, as well as accepting the wide bandwidth. In addition the receiver must also include a suitable detector to convert frequency fluctuations into voltage fluctuations so that a normal AF amplifier can be used. Such detectors are known as *discriminators,* and incidentally, are to be found in the better class of high fidelity AM receiver for automatic frequency control.

To illustrate how an FM receiver differs from the normal AM receiver, a block diagram is shown in figure 2. It will be seen that up to the IF amplifier the circuits are identical. Then, whereas with the AM receiver this IF amplifier would be followed by a detector and the audio amplifier stage, you will notice that the FM receiver requires two additional stages—namely, the limiter and discriminator. The operation of these two units will be discussed further on in this article.

Since the RF and mixer stages of the FM receiver are more or less standard except from perhaps the point of view that much higher frequencies are being dealt with, the remainder of this discussion will be confined to the IF, limiter and discriminator stages.

IF Stage

Under present standards the frequency swing of the FM carrier for 100% modulation is 75 kc. either side of the centre frequency, and consequently, in order to receive signals faithfully, the receiver system must be capable of passing a band of frequencies up to 150 kc wide. This is done by using a wide band type of I.F. transformer.

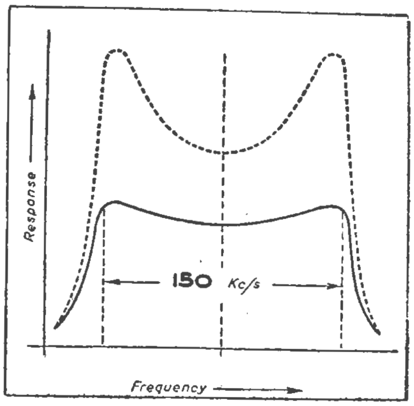


Figure 3—A typical IF response curve. Close coupling of the coils produces the double hump (dotted line) and this is flattened (solid line) by the use of loading resistors as explained in the text.

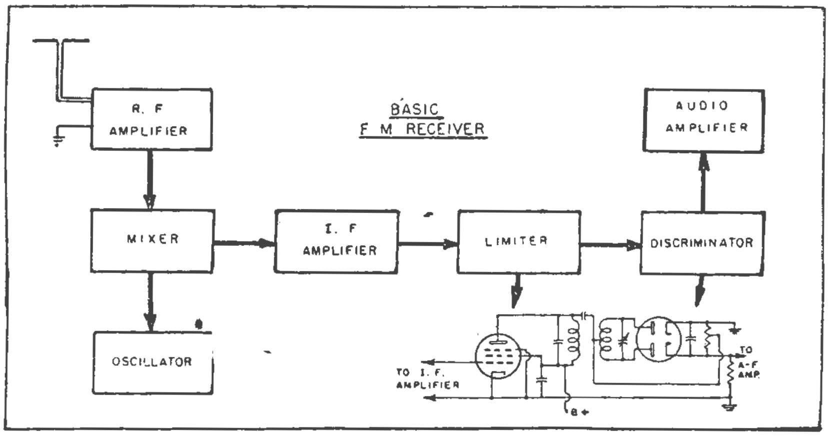


Figure 2—The FM receiver differs from the AM type by using a limiter and discriminator circuit.

On the 88-108 mc FM band the tuned windings of the IF transformer are usually 10.7 mc, and have an effective band width applicable to the system. This can be obtained by employing close coupling between the primary and secondary windings as well as resistance loading across the tuned winding.

The close coupling results in widely separated peaks in the bandpass response whilst the resistances damp the response giving a substantially flat characteristic. See figure 3.

The effect of this loading which is accomplished by placing resistors of the correct value across one or both of the transformer windings is to effectively lower the Q of the coils. At the same time the amplification of the circuit is materially reduced, and so it is usual to find at least two IF stages being used in the receiver.

Limiter

In the block diagram for an FM receiver a limiter stage may be seen. This consists essentially of an IF valve arranged so as to deliver constant signal output despite wide variations in signal input. Whilst not an essential part of the receiver, the inclusion does ensure the quiet background which is an attractive feature of FM reception.

The limiter valve is usually a pentode having sharp cut off characteristics and operated at low plate and screen voltages (about 50 volts). This means the plate current cut off occurs with relatively small grid bias or signal input.

The operation is quite simple: with an input signal the grid voltage will swing considerably above and below the linear portion of the valve's characteristic curve. Any positive peaks beyond the range of the limiter valve will be clipped by grid bias limiting whereas the negative signal peaks will be clipped due to plate current cut off.

In this manner any signal voltage variations which are greater than the operating limits of the valve are clipped and have no effect upon plate current.

Since any static interference or valve noise is primarily of AM character, this clipping action removes the AM effects, but leaves the FM signal unaltered. However, in order to accomplish this noise free operation it is essential that the input signal is sufficiently great to saturate the valve, otherwise the noise interference will pass through.

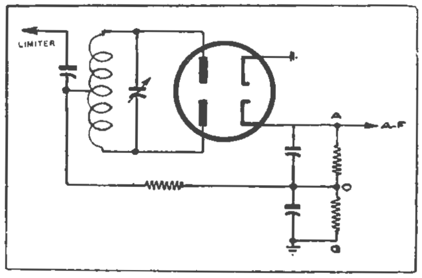


Figure 4—A widely used type of discriminator circuit.

Discriminator

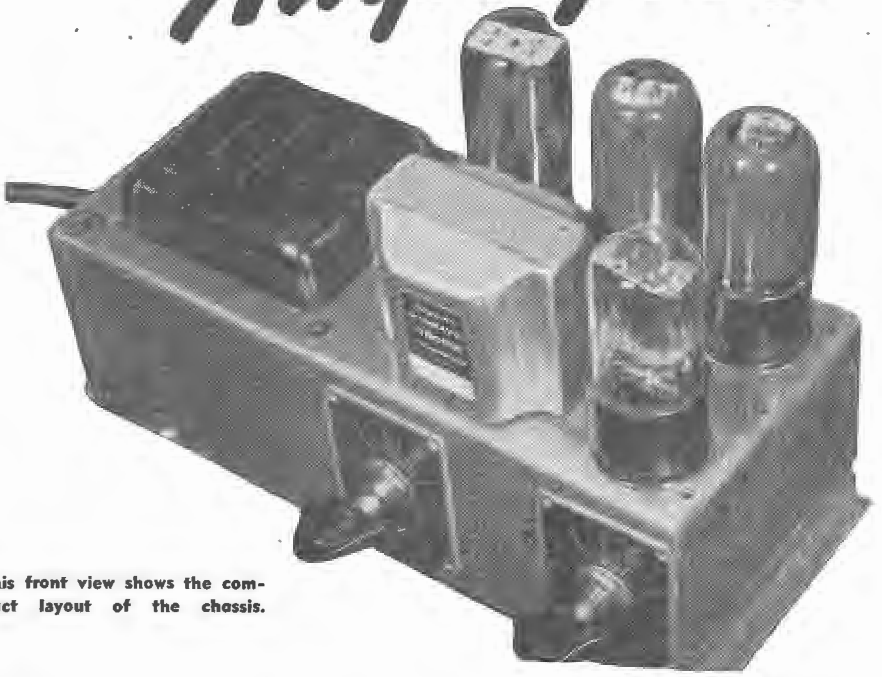
The final point of difference between the AM and FM receiver lies in the type of second detector being used. In the FM receiver it is usually referred to as the "discriminator" stage and a typical circuit arrangement is shown in figure 4.

The detector transformer is connected to the push pull diode detector and in addition to the usual magnetic coupling between coils, also has capacitive coupling between top of primary and centre tap of secondary. This results in two voltages being developed between the plate of each diode and centre tap of the transformers.

(Continued on page 48.)

"A low cost Amplifier"

Construction details for an audio amplifier that is easy to build and requires only a minimum of parts. Ideally suited for the record enthusiast, it features push pull output and is capable of excellent results.



This front view shows the compact layout of the chassis.

In playing over recordings it is often convenient to have available a greater reserve of power output than is provided by the average audio section of the home radio receiver, and this small unit is admirably suited for such purposes.

Realising that the cost factor is a very important point to be considered these days, the amplifier was specially designed to give a high output and yet require only a minimum of parts for its construction. The result is the circuit shown, a four valve unit, featuring push pull output, which is capable of excellent results and should please the most ardent record enthusiast.

Circuit Details

As will be noticed the circuit used is quite conventional, although not very often encountered. In most cases where a push pull output stage is used an extra audio stage is added to provide additional gain. However, this gain is rarely fully utilised in the average home, and as low cost was a prime factor to be considered, the idea was waived in favour of the present scheme.

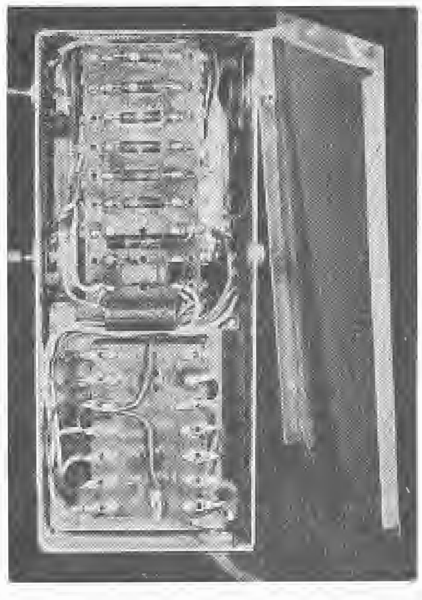
Here the input from the crystal pickup is fed via the .5 meg volume control to the grid of the first triode section of the 6SN7-GT. The amplified output is then applied in the usual manner to the grid of the 6V6-GT (A) via the resistors R3, R6 and coupling condenser C2.

The excitation voltage for the grid of the second triode section of the 6SN7-GT is obtained from a voltage divider network arranged in the grid circuit of the first output valve. Using the constants shown, the gain of each triode section is approximately 12, which means the voltage available at R6 is twelve times the input voltage.

Consequently, to obtain the equal but opposite voltage necessary to drive the grid of the second 6V6-GT only a portion of this available voltage is used otherwise unbalanced operation will result.

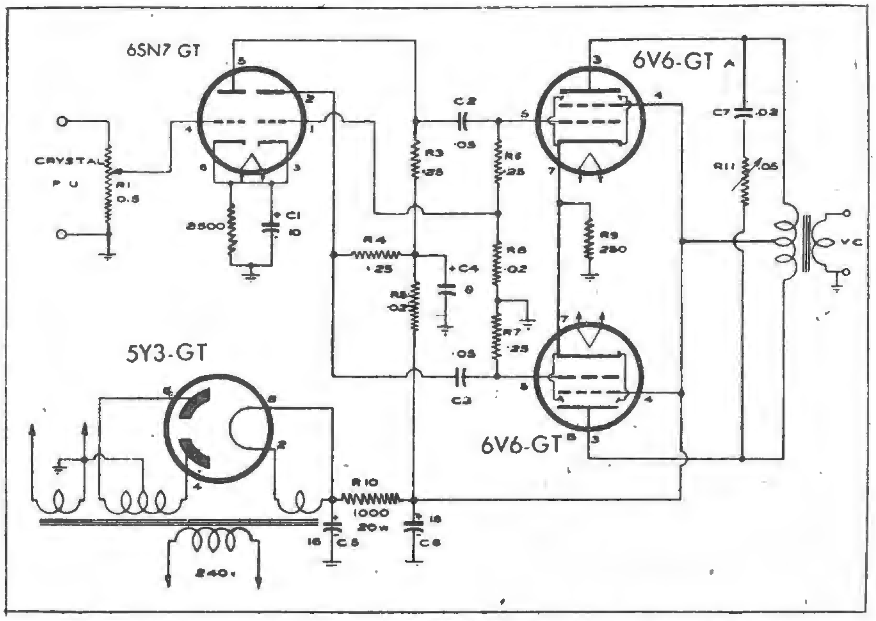
So in this case, the tap on the voltage divider is arranged so that approximately only one twelfth of the voltage across it is fed back into the grid of the inverter. Since R6 is 0.25 meg, it can be seen that R8 should be approximately 20,800 ohms to give the requisite voltage. However, as the tolerance rating of the usual resistor is $\pm 10\%$, a 20,000 ohm resistor will be satisfactory in this position. The net result is that the grids of the two output valves receive approximately the same driving voltage.

The push pull stage itself is quite conventional, although inverse feedback has



The wiring up has been simplified by mounting many components on the resistor strip.

AMPLIFIER CIRCUIT



The circuit used is standard. The value of R10 will have to be changed if a 385v power transformer is used.

not been used. The usual method of feedback— that is from the plate of the output valve to the plate of the preceding stage is not applicable in this case, since the AF amplifier is a triode. To be effective, it is essential that the plate load be reduced below the actual plate impedance, and whilst this is satisfactory with a pentode audio stage, the effect with a triode is to introduce severe distortion.

Inverse Feed Back

However, those who may wish to provide feedback can do so in the following manner:—remove the cathode bypass condenser C1, and wire in a separate bias resistor for each cathode circuit, then by returning the 6V6-GT plate to the cathode of its respective triode amplifier unit, current feedback will be introduced.

To provide some measure of control over the tone, a simple form of variable condensor-resistor network has been used. In the amplifier a .05 meg potentiometer and a .02 mfd condenser provided satisfactory control, but these values can be experimented with as desired. Remember, the smaller the value of the resistor, the less the high frequency response.

The power supply may cause some misgiving to those used to having a choke or field coil in the smoothing section. To make the amplifier as compact as possible it was decided to omit the choke and use a 1000 ohm 20 watt resistor to reduce the high tension voltage to the correct value. Using 16 mfd electrolytics and the decoupling systems R5 C4 this arrangement was quite satisfactory and no trace of hum could be heard on the 10" speaker mounted on a large baffle.

Layout and Assembly

From the photographs it will be seen that the lay-out of the amplifier has been

AMPLIFIER PARTS LIST

1 Chassis $8\frac{1}{2} \times 3\frac{5}{8} \times 2\frac{3}{4}$.

1 power transformer 325v HT. 6.3v @ 2 amp, 5v @ 2 amp.

CONDENSERS

2 16 mfd electrolytic (525 or 600v).

1 8 mfd 525v electrolytic.

1 10 mfd electrolytic 25v.

2 .05 mfd tubular.

1 .02 mfd tubular.

RESISTORS

1 .5 meg volume control.

4 .25 meg.

1 .05 meg potentiometer.

2 .02 meg.

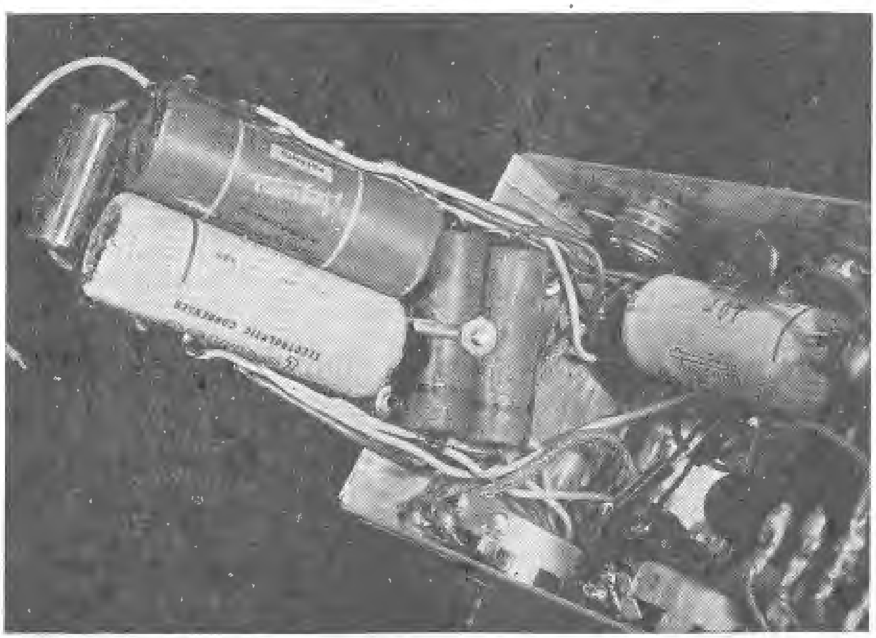
1 1000 ohm 20 watt wirewound.

1 250 ohm wire wound.

4 octal sockets.

1—6SN7-GT, 2—6V6-GT, 1—5Y3-GT.

SUNDRIES—Hookup wire, indicator plates, two knobs, 4 terminals, plug jock, nuts and bolts, etc.



This photograph shows how the condensers were mounted underneath the resistor strip.

kept very compact, but at the same time there has been no overcrowding of components with resultant wiring difficulties. The chassis measures $8\frac{1}{2}$x$3\frac{5}{8}$x$2\frac{3}{4}$ and is fitted with a bottom plate, allowing the unit to be moved around whilst in operation without any fear of shocks.

Assuming you have a ready cut chassis, the first step is to mount the components. The power transformer can either be fitted as shown or mounted with the laminations above the chassis. The former method was used simply for compactness, as during operation the power transformer is only moderately warm and consequently presents no heat problem.

The two 6V6's are mounted along the back of the chassis with the 5Y3-GT immediately next to the power transformer. The 6SN7-GT is mounted on the front right hand side of the chassis, whilst the output transformer is placed alongside. Next the tone and volume controls are fitted, making sure the indicator plates are not forgotten before screwing into position.

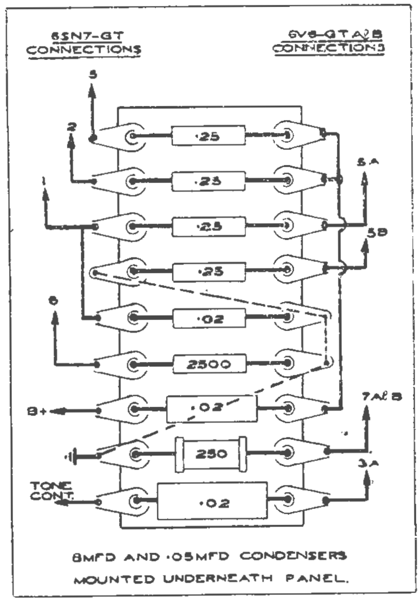
Wiring Up

The wiring up should present no difficulties—wire in the rectifier filaments and high tension leads as well as the 6.3 filament leads to the 6V6's and 6SN7. As can be seen from the underneath photograph, most of the load resistors, coupling condensers and grid resistors are mounted on a resistor panel. Wire this panel separately as shown, making sure that the various leads are colour coded to obviate any misconnections. These leads can be cut to the respective length and soldered into position as soon as the panel is bolted down.

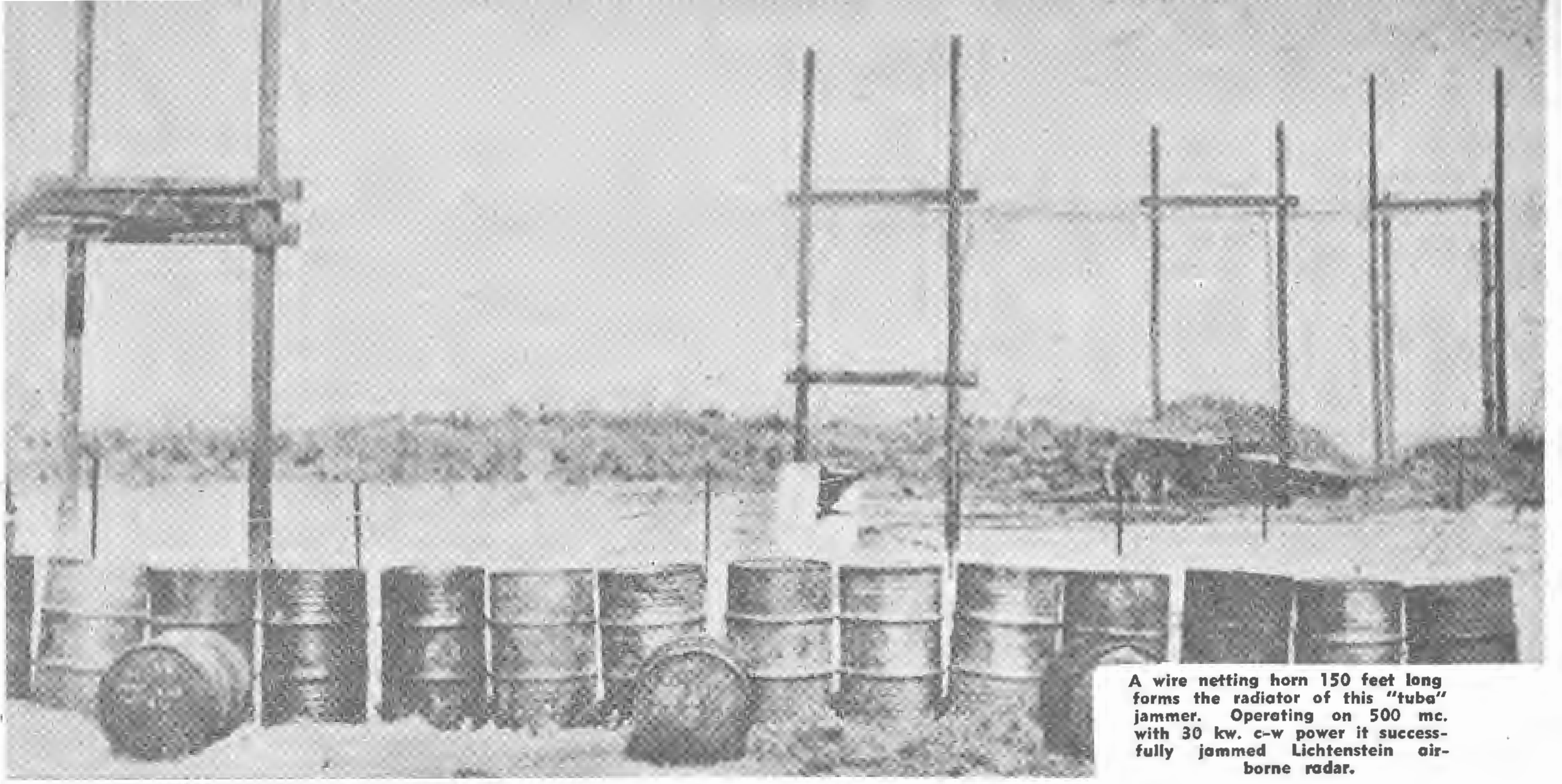
The voice coil leads are connected to a telephone jack mounted at the rear of the chassis, and make sure that one lead is earthed. With the wiring completed, the next step is to check all connections against the circuit diagram before switching on. Having assured yourself that everything is correct, plug in the 6SN7 and 6V6's, not forgetting the speaker connection and switch on. The filament should light up in a second or two, so then place the 5Y3-GT in its socket, watching for any flashes or heating of the plates, which could indicate trouble in the high tension section. If no mistakes have been made in the wiring, the usual throbbing noise should be heard in the loud speaker as the volume control is advanced and the pickup terminals are touched. Final test of course is to play your favourite recording, and frankly, you should be more than pleased with the results.

For maximum output it is essential that a crystal pickup be used with this amplifier, although the magnetic type can be used. In this case it should be remembered that the output will be much less.

Panel Wiring



The resistor panel should be wired up as shown in this diagram. Make sure the leads are left long enough to connect into the set.



A wire netting horn 150 feet long forms the radiator of this "tuba" jammer. Operating on 500 mc. with 30 kw. c-w power it successfully jammed Lichtenstein airborne radar.

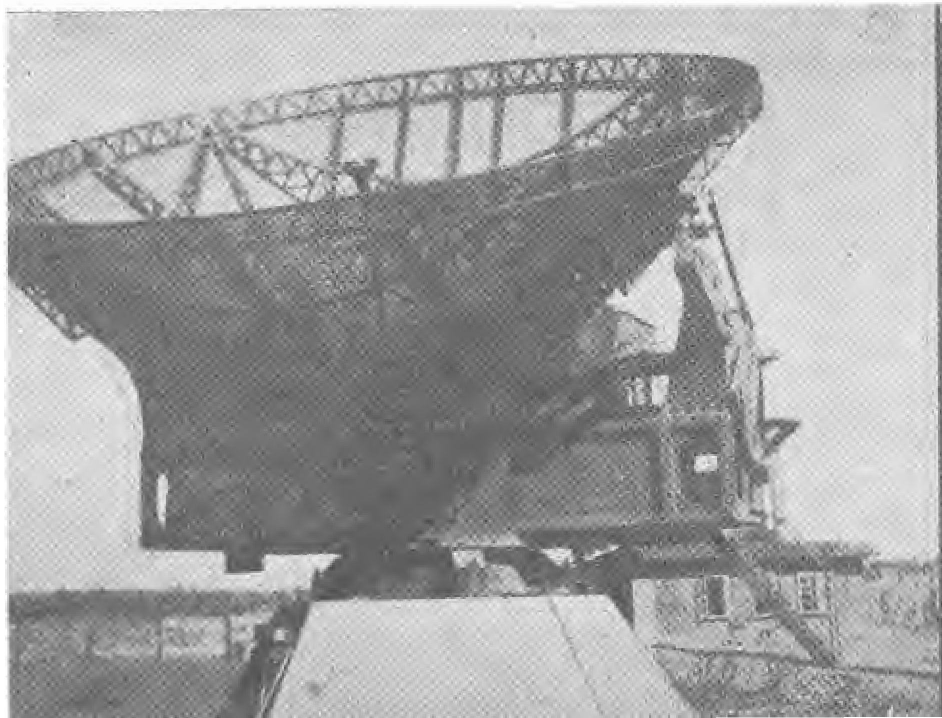
RADAR COUNTERMEASURES

A pictorial presentation of equipment used by Allied forces to effectively disrupt enemy radar systems.

RADIO SCIENCE, February, 1948

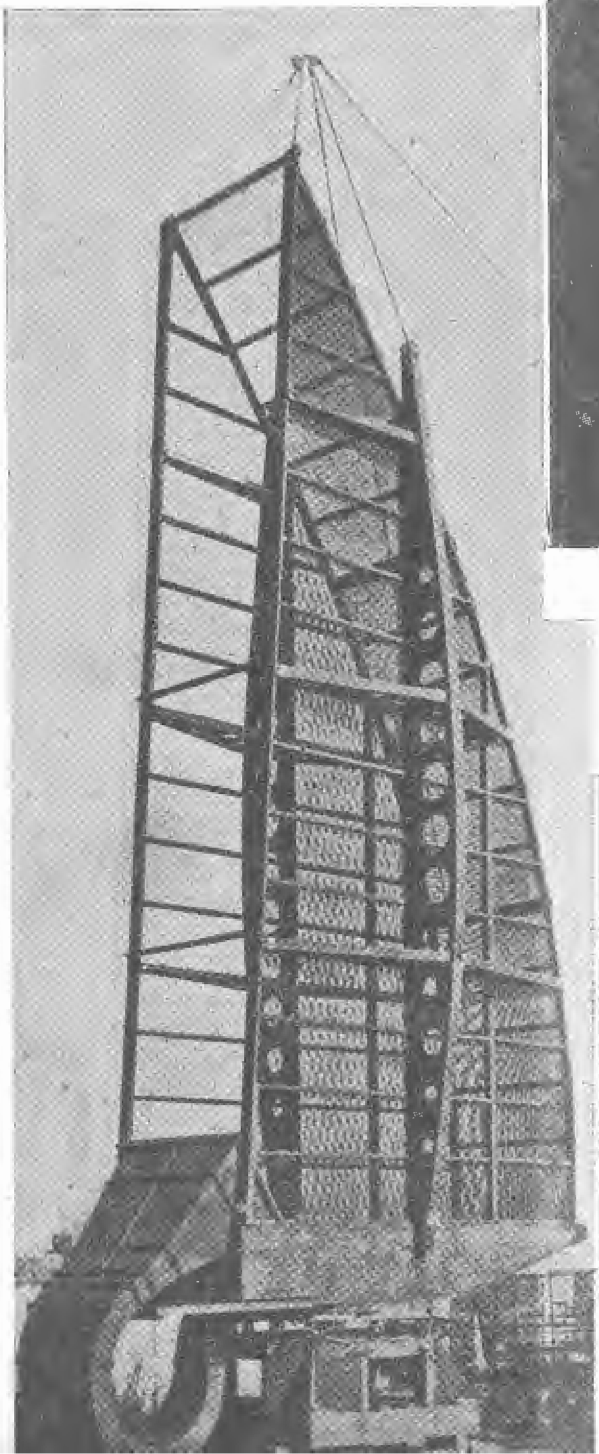
Mainstay of the German radar defence, the "Wurzburg" unit depicted was principal target of Allied countermeasures. Use of window and carpet jamming reduced their effectiveness to less than 25% normal.

Regardless of polarization of an enemy antenna, it could still be jammed by this "fish-hook" wideband antenna which radiated circularly polarized signals. →

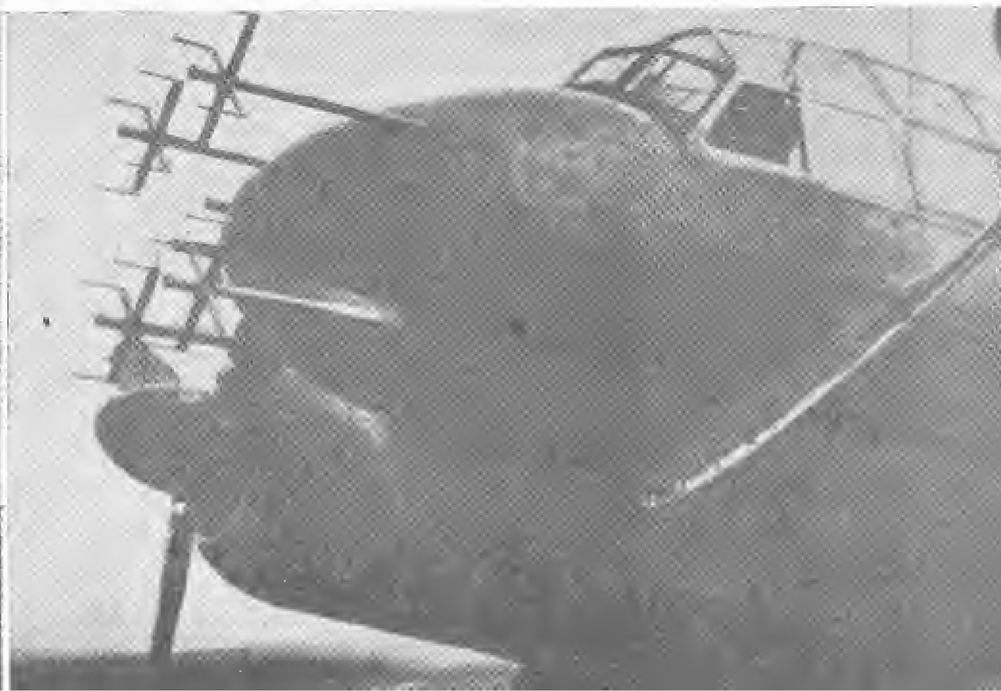


Releasing packets of "window" from an aircraft to provide a radar smokescreen. Each bundle consists of thousands of thin aluminium strips which effectively blanket the radar 'scopes by creating false impressions.

This unusual antenna unit forms part of this "tuba" jammer. Excited by waveguide and horn at lower left it will operate over a wide frequency range.



The antenna system of Lichtenstein airborne radar fitted to the nose of a German night fighter. Operating in vicinity of 500 mc. it was effectively countered by use of "tuba" jammer.



POST-WAR PICKUP DESIGN

This article deals with the latest overseas post-war pickup developments. In most cases output level has been sacrificed in favour of frequency response and needle pressure. Of the new designs probably the most interesting is the Strain-gauge pickup.

This new pickup is based on the principle of the strain gauge—a device widely used for the measurement of strain in mechanical systems. It operates on a variable resistance principle modulating a direct current instead of creating a voltage in itself.

Basically, the pickup consists of a flexible cantilever beam rigidly attached to the tone arm at one end and driven at the other end by means of a stylus engaging the record grooves. The strain, or elongation and compression of the outer fibres of the beam, is proportional to the lateral displacement of this stylus, provided the tone arm has sufficient mass to be considered a rigid body. Along one surface of the beam, as indicated in figure 1 is the thin resistive layer of carbon.

Lateral motion of the stylus produces a proportional change in the length of the carbon layer with corresponding change in resistance. Such changes in resistance may be converted to changes in voltage in a number of ways; probably the most convenient method being to apply a voltage to the layer by means of a d-c source and a series load resistor R, as shown in the diagrams.

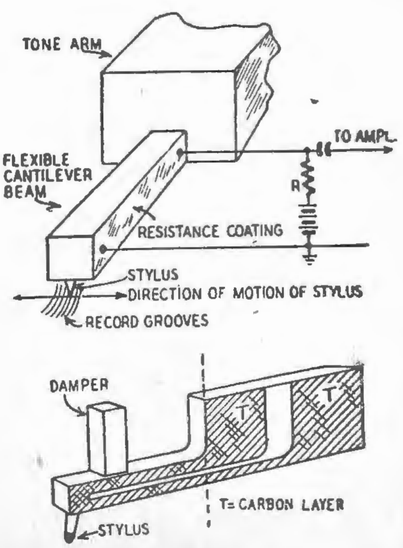


Figure 1—Details of the strain gauge pickup.

With this arrangement a voltage proportional to the lateral displacement of the stylus is developed across the load of resistor R. It should be pointed out that vertical motion of the beam does not produce a change in resistance, since elongation or compression of the coating on the upper half of the beam is balanced by an opposite strain on the lower half, hence the average change in resistance is zero.

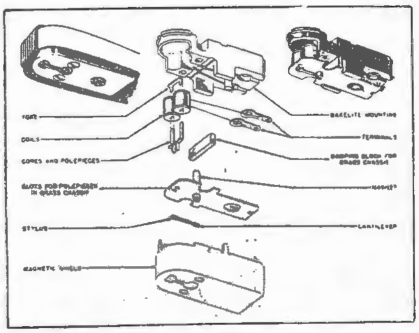


Figure 2—A structural view of the G-E variable reluctance pickup.

Simple as the above structure may seem, it meets the requirements of a quality reproducer and under suitable conditions the response can be extended to about 8000 cycles.

Variable Reluctance Pickup

One of the simplest and most efficient pickups designed is the General Elctric variable reluctance pickup. This is a magnetic type having a high fidelity response up to 10,000 cycles without resonance.

A natural sapphire stylus is mounted on the end of a small cantilever spring—the lateral motion of which directs the magnetic flux alternately through the cores of two coils which are connected in push pull.

The structural view is shown in figure 2 and this illustrates the mechanical design of the pickup. As the stylus is driven laterally in the record groove the cantilever spring moves correspondingly with respect to the pole pieces, so that it divides equally between them, providing the stylus is centred.

At the opposite end the cores are joined by metal yokes. The flux passes from these through the air to the other pole of the magnet. As the cantilever moves off centre the flux increases through one coil and decreases proportionately through the other.

The output voltage generated in the coils is directly proportional to the rate of change of flux, and in this way the pickup responds accurately to a constant velocity signal. However, it requires an equalisation circuit in the constant amplitude region.

As the output voltage from the average record is approximately 11 millivolts at 1000 cps, a gain of approximately 40 db. at 1000 cps is needed for a pre-amplifier and equaliser to make the output compare with the average pickup.

An extremely low needle scratch results with this pickup and by eliminating any resonant response in the unit low distortion and low needle talk is provided. The extremely small mass permits excellent high frequency response and the damping effect of the high vertical spring compliance contributes a great deal to the clean quality of the response.

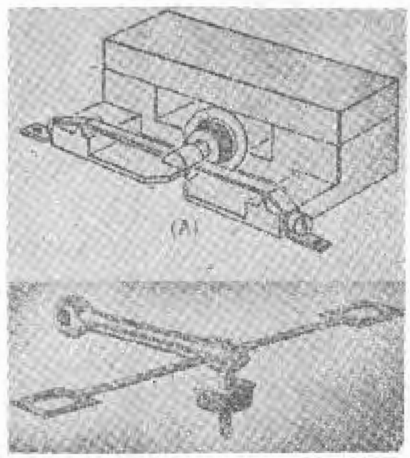


Figure 3—A general view of the Audak tuned ribbon pickup is shown at A. Immediately below is the armature and magnet assembly.

Tuned Ribbon Pickup

The unconventional Audak tuned ribbon pickup is a recent contribution to the field of high quality reproduction, especially of soft and pliable discs.

A novel carrier structure from which the oscillating member is suspended is the heart of the system. This is shown in figure 3, which illustrates the principle of operation of the vibrating system.

A small piece of magnetic material is fixed to the armature just above a permanent stylus. Motion of this armature is limited by the two ribbons, made of Invar or similar material approx. .002 inch thick, and these are tuned to a high frequency, giving a straight line response up to 15000 cycles.

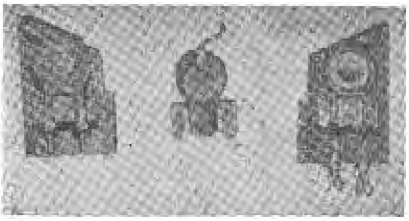


Figure 4—Component parts of the Zenith "Cobra" r-f pickup.

As can be noted, any stylus displacement imparts a rotational motion around the axis of a horizontal member, known as a "limiter," located just above the stylus and between two horizontal metallic ribbons. These ribbons are secured at both ends, whilst a universal ball and socket bearing is fitted to the other end of the limiter bar.

This design allows the limiter to rotate freely and as the ends of the ribbons start to move in arcs away from each other greater displacements occur and rotation of the limiter accompanying it. By allowing the stylus to move freely a distance of approximately .002 inch each side of the centre portion is attained or far more than enough to take care of the widest amplitude to be expected on disc records. As the stylus can also move freely in the vertical direction for the same distance as it moves laterally, this type of pickup may be used on either vertical or laterally cut records.

One of the features of this assembly is that the dynamic mass of the system is that truly remarkable low value of 4.43 milligrams. Standard impedance is 200 ohms, whilst the output is approx. 0.2 volts to a perfectly matched load.

The Zenith Cobra Pickup

Although similar to the condenser type of pickup the "Cobra" unit (Figure 4) operates on AM principles.

A round flat vane is attached to the top of the permanent stylus and mounted in the field of an R.F. coil next to the vane. This coil is connected electrically to an oscillator.

The high resistance vane moves in direct relation to the inductance of this R.F. resonant circuit, and by varying the mutual inductance between the coil and the vane, the resistance reflected into the coil changes. This varying eddy-current loss produces AM waves in the oscillator which are then detected and passed on to an amplifying system. This generally uses a twin triode—the first triode being a Hartley oscillator tuned to about 2.5 mc as well as a grid leak biassed detector. The second triode is a straight audio amplifier.

This pickup has a low mechanical impedance—not more than fourteen grams weight being necessary for proper tracking on the record. This feature makes long record life possible, as there is little wear to the groove.

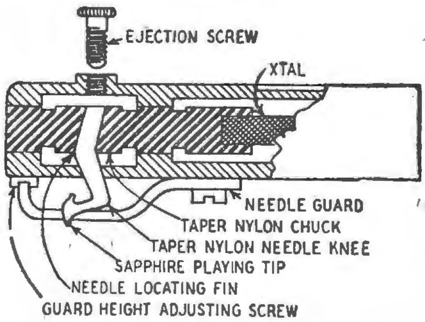


Figure 5—The latest crystal head using a nylon needle with sapphire tip.

Crystal Pickup

Irrespective of changes and new developments in the pickup field, the crystal pickup is still one of the leaders in popularity. This is mainly because it gives high fidelity and plenty of output at a moderate cost.

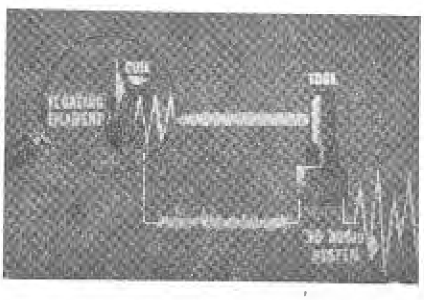


Figure 7—A symbolic representation of the Zenith "Cobra" pickup.

Whilst most new crystal cartridges are available with a permanent sapphire-tipped needle, one model (Astatic) features a nylon needle held in a nylon chuck (figure 5). The nylon needle has a very low weight as well as self damping properties which reduce resonance effects.

The needle can be removed by the ejector screw fitted into a hole in the mounting and a new needle fitted into the tapered groove.

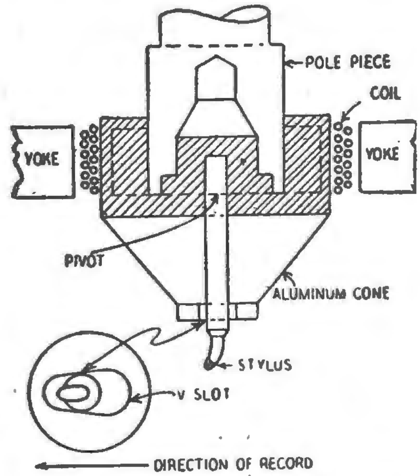


Figure 6—Another newcomer is the Philco dynamic pickup.

Philco Dynamic Pickup

The Philco dynamic pickup (figure 6) operates like the movement of a d'Arsonval meter. A thin dural cone carries two layers of aluminium wire wound up to a resistance of 3 ohms, and this coil vibrates in the field of an Alnico magnet. The rubber damping is designed for cut-off between 4 and 5000 cycles.

The coil is of the low resistance type and requires the use of a special matching transformer. The replaceable sapphire-tip stylus is used and this can be used for about 2000 playbacks. A needle guard is provided to protect the stylus as well as preventing excessive side motion of the needle.

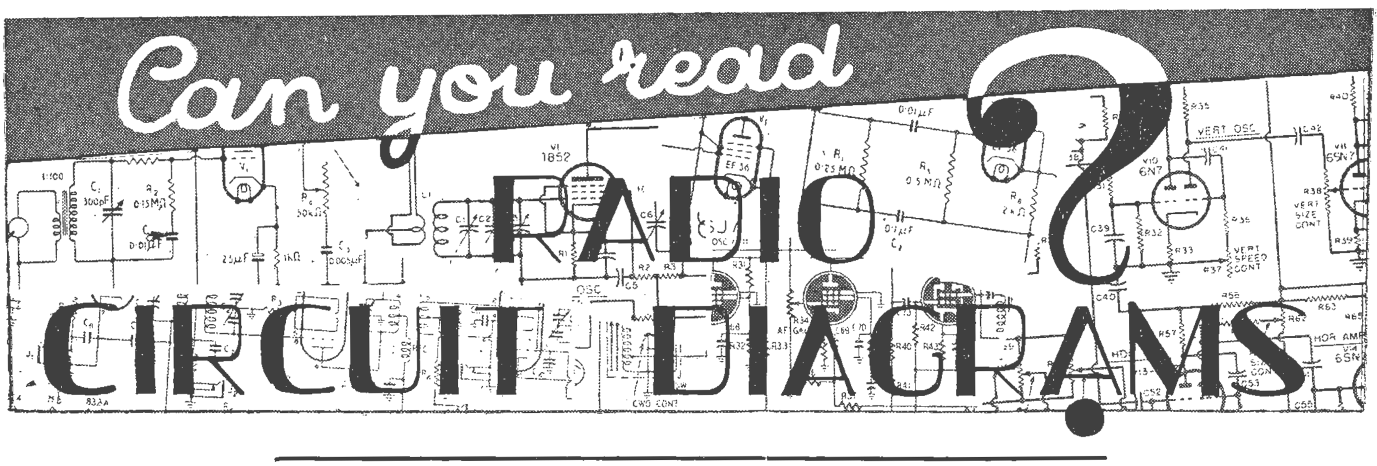
PORTABLE RECEIVER

(Continued from page 17.)

Having completed the wiring up, recheck all connections for any possible errors. If you are satisfied, plug in the valves and check the filament circuit by connecting up the A. Battery.

Next, connect the Minimax battery and if everything is in order at least one or two stations should be picked up as the set is tuned across the band.

The alignment of the set is quite simple. Set the oscillator trimmer at the high frequency end using 2SM as a guide, and then peak the aerial trimmer. As a fixed padder is used there is no adjustment at the low frequency end other than to check the aerial trimmer.



Can you read RADIO CIRCUIT DIAGRAMS?

The ability to read and wire direct from schematic diagrams is the "open sesame" to a wider radio knowledge. This article presents a brief outline of the method of reading such diagrams and should prove interesting to the radio newcomer.

By definition it will be found. a schematic circuit diagram is a graphical representation, with the use of equivalent symbols, of the electrical connections comprising radio and electronic apparatus.

These schematic drawing can be regarded as the radio technician's "shorthand," and whilst not providing data on physical appearance or actual component placing, do show the correct electrical relationship of the various components.

As most readers are readily aware the radio circuit (or "hookup," to quote a common term), may be illustrated either by a pictorial wiring diagram or by the use of appropriate symbols representing the essential parts of that circuit.

Typical Example

An example of both of these methods is clearly illustrated in the following diagram. The pictorial wiring diagram, figure 1 (a), is simply a representation of the necessary parts in location and shown properly connected by wires called "leads." In the example shown the dry cell is the source of power, the switch is the control unit, whilst the bulb signifies the source or device to be operated. This is the type of drawing generally used by a layman and as can be seen, simply shows the apparatus as seen by the eye.

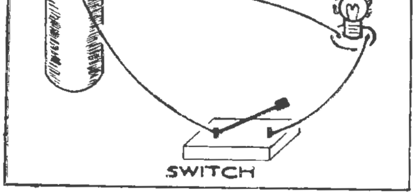


Fig. 1 (a)—The pictorial type of wiring diagram shows the physical form of the components being used.

In the case of complex circuits it will be readily apparent that this method of representation would be very cumbersome to handle, and consequently a simplified form by utilising graphic symbols is frequently resorted to. In figure 1 (b) the same example previously mentioned is shown using "schematic" symbols, and this is the way a radio technician would indicate the same hookup.

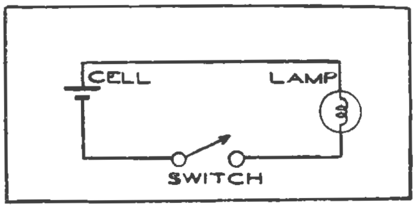


Fig. 1 (b)—By using "schematic" symbols, the circuit in fig. 1 is considerably simplified.

The resulting simplification is quite obvious. Besides clearly showing the basic operation of the circuit, it is consideraby easier to draw. Although the symbol representing some particular component does not indicate its physical form, but merely its function as a part of the circuit, this point is relatively unimportant to the person merely interested in critical analysis.

The value of being able to appraise circuit performance from studying a schematic diagram cannot be over estimated, and the only royal road to this end, is to firstly memorise the symbols given in the accompanying chart. Whilst the majority of these symbols are self explanatory, the following additional notes may be of some assistance to the younger reader. In many cases it will be noticed that more than one symbol is used to designate a single component—this is due to a lack of standardisation in the past—and as a result many manufacturers, etc., have their own particular method of indicating a specific component. However, if the forms illustrated here are known and understood, you should have no difficulty in interpreting most circuits likely to be encountered.

ANTENNA—both single AM types are frequently used to designate the aerial system of a receiver or transmitter. The doublet form is merely a double representation of the single form—whilst the FM and television forms merely indicate that a dipole system is used. The loop type aerial is frequently shown with an additional winding to indicate that it can be used with an outdoor aerial system, the loop then merely acting as an aerial coil.

CAPACITORS—nowadays in radio, all capacitor symbols are made with one curved electrode, and this represents the side connected to earth. This is identical with the outside foil of a capacitor and marked "connect to ground," and the negative electrode of the electrolytic type capacitors. In some cases the alternative symbol is shown as two parallel straight lines.

In the case of variable condensers, such as main tuning condensers, trimmers, etc., the curved section is fitted with an arrow head as shown. If a trimmer, then the letter T appears alongside to show the difference.

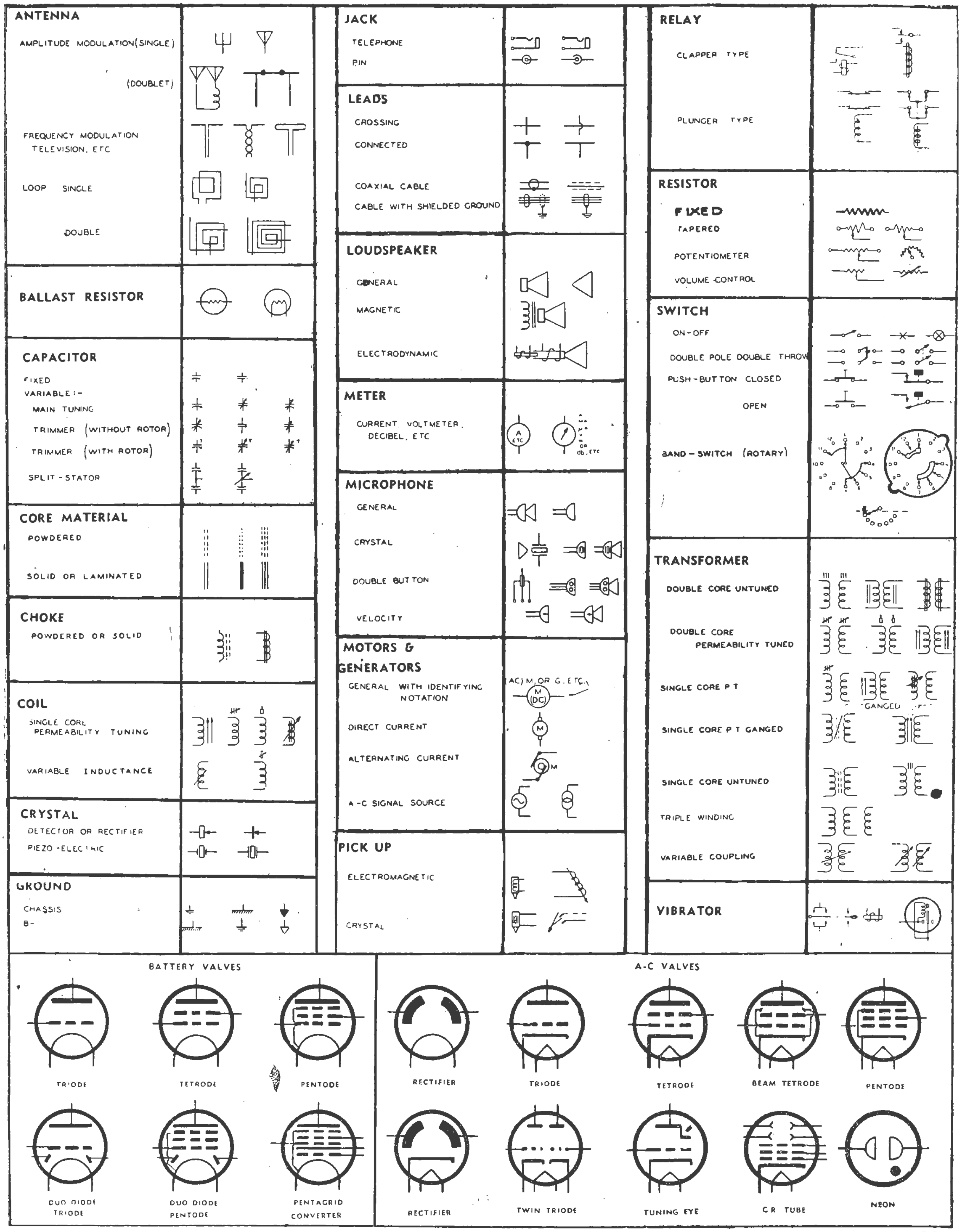
CHOKE AND COILS—these are of two fundamental types—those having an air core and those using a powdered iron core, or wound on an iron core or laminations. Representative forms of core materials are shown and these are used in conjunction with the appropriate coil symbol to indicate a particular coil function.

LEADS—all connections are indicated by an easily seen dot at the junction of the wires, whilst a small semi-circle is frequently used for a cross over. In some cases the blob or dot is used to indicate the connection, and the cross over merely being indicated by the lack of this dot.

Binding posts and terminals are usually shown by a small circle at the termination of the lead, with the appropriate label attached.

RESISTORS—the conventional symbol for a fixed resistor is a series of short zig-zags. Where this is a variable quantity, such as in the case of a volume control an arrowhead is used as shown.

TRANSFORMERS—most of the forms are self explanatory and a little thought will soon indicate the application.


ANTENNA
AMPLITUDE MODULATION (SINGLE)
(DOUBLET)
FREQUENCY MODULATION TELEVISION, ETC
LOOP SINGLE
DOUBLE
BALLAST RESISTOR
CAPACITOR
FIXED
VARIABLE:-
MAIN TUNING
TRIMMER (WITHOUT ROTOR)
TRIMMER (WITH ROTOR)
SPLIT-STATOR
CORE MATERIAL
POWDERED
SOLID OR LAMINATED
CHOKE
POWDERED OR SOLID
COIL
SINGLE CORE PERMEABILITY TUNING
VARIABLE INDUCTANCE
CRYSTAL
DETECTOR OR RECTIFIER
PIEZO-ELECTRIC
GROUND
CHASSIS
B-
JACK
TELEPHONE
PIN
LEADS
CROSSING
CONNECTED
COAXIAL CABLE
CABLE WITH SHIELDED GROUND
LOUDSPEAKER
GENERAL
MAGNETIC
ELECTRODYNAMIC
METER
CURRENT, VOLTMETER, DECIBEL, ETC
A ETC
db. ETC
MICROPHONE
GENERAL
CRYSTAL
DOUBLE BUTTON
VELOCITY
MOTORS & GENERATORS
GENERAL WITH IDENTIFYING NOTATION
AC) M, OR G, ETC
M (DC)
DIRECT CURRENT
ALTERNATING CURRENT
A-C SIGNAL SOURCE
PICK UP
ELECTROMAGNETIC
CRYSTAL
RELAY
CLAPPER TYPE
PLUNGER TYPE
RESISTOR
FIXED
TAPERED
POTENTIOMETER
VOLUME CONTROL
SWITCH
ON-OFF
DOUBLE POLE DOUBLE THROW
PUSH-BUTTON CLOSED
OPEN
BAND-SWITCH (ROTARY)
TRANSFORMER
DOUBLE CORE UNTUNED
DOUBLE CORE PERMEABILITY TUNED
SINGLE CORE P T
GANGED
SINGLE CORE P T GANGED
SINGLE CORE UNTUNED
TRIPLE WINDING
VARIABLE COUPLING
VIBRATOR
BATTERY VALVES
TRIODE
TETRODE
PENTODE
DUO DIODE TRIODE
DUO DIODE PENTODE
PENTAGRID CONVERTER
A-C VALVES
RECTIFIER
TRIODE
TETRODE
BEAM TETRODE
PENTODE
RECTIFIER
TWIN TRIODE
TUNING EYE
C R TUBE
NEON

FOR THE BEGINNER—

A ONE VALVE RECEIVER

Here is the ideal first valve receiver for the radio newcomer. Using plug in coils, it will give efficient operation on both broadcast and short wave bands.

Before describing the actual construction of the set, a few general remarks regarding the layout and circuit will not go amiss and these should prove useful to the beginner.

A glance at the photograph of the completed set will show that instead of using a special chassis, a standard 4 v chassis has been pressed into service. This was used because sooner or later you will want to add additional stages to your "one valver," and having one suitable already on hand allows such additions to be readily made.

For the same reason in place of the usual single gang condenser a two gang condenser has been stipulated. Although only one section is required for this set, the additional gang section will readily be available should you ever wish to add an RF stage.

Plug in coils have been used, as this is the simplest method of changing bands without having to wire in complicated switches. Providing these are wound in accordance with the specifications given, then you should have little trouble with the tuning end of the set.

Standard Circuit

The circuit used is quite standard and capable of very good results. The valve is the twin triode 1J6G type, and this is used as a combined detector and audio amplifier with choke coupling being used between the two stages. The first triode stage is a regenerative detector, having the usual condenser and grid leak in the grid circuit. The amplifier output is taken via the reaction winding on the coil to the plate load—in this case the choke coil. Coupling to the grid of the second triode section is effected by means of the .01 mfd coupling condenser, and 1.0 meg grid leak.

The audio voltage is then amplified in this stage and passed on to the phone connections. So much then, for the circuit details.

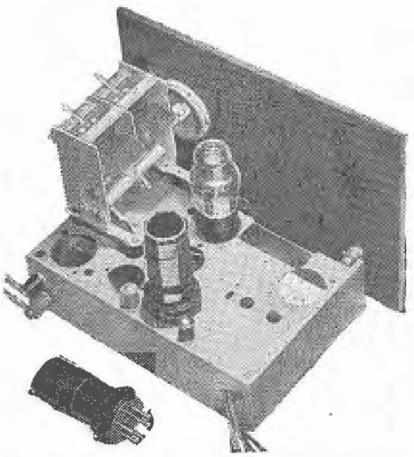


Figure 1—This view of the completed receiver clearly shows the layout of the components.

Assembling

Having obtained the necessary components, the next step is to mount them in position. First of all bolt the tuning condenser on the right hand side of the chassis, making sure the mounting feet are fitted in the correct manner—that is, turned inwards as shown in the photograph. Depending on the type of dial being used, adjust the vertical height of the gang as necessary above the chassis.

With the gang in position, next mount the two sockets—the valve socket at the front and the coil socket at the rear of the chassis. Screw the two black and green terminals on top of the chassis and these form the aerial and earth connections respectively. Make sure the black terminal is earthed to the chassis, whilst the green terminal must be insulated.

The .25 meg. potentiometer, filament switch and tuning dial shaft are all mounted in the positions shown in the photograph. The dial drum is screwed to the gang condenser shaft. After the dial cord has been fitted, adjust the dial drum by loosening the screws and turning it until the line is horizontal when the gang is fully closed.

Wiring the Receiver

The wiring up should present no difficulties providing care is taken. First of all connect up the filament leads, the A plus lead connecting to pin 2 octal socket, whilst the A-lead is taken to the ON-OFF switch mounted on the front of the panel. Earth one side of the switch as well as Pin 7—octal socket. Before proceeding connect up the A battery and check that the valve lights up—this should be visible quite easily in a darkened room.

The coil socket is wired up next, the connections being as follows: Pin 1 to aerial terminal, and one side of trimmer, Pin 2 to trimmer, Pin 3 to Pin 3 on octal socket, Pin 4 to centre lug of potentiometer, and one side of the .0005 mfd condenser, the other lead of the condenser is earthed. Pin 5 to fixed tuning condenser plates, Pin 6 earthed.

Next the octal socket connections. Pin 1 No connection Pin 2 filament A plus, Pin 3 connect to one side of the potentiometer, Pin 4 to .0001 mfd condenser and across this connect the 1 meg grid leak. Pin 5—1 meg resistor to earth, also .01

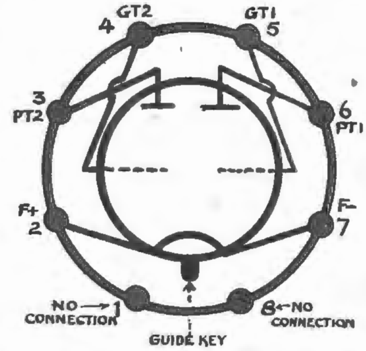


Figure 2—Here are the base connections for the 1J6G valve.

mfd condenser to centre of potentiometer. Pin 6 to phone terminal, Pin 7 earthed and Pin 8 no connection.

The only remaining connections now are to/connect one choke lead to the centre lug of the potentiometer and the other choke lead to the phone terminal. A lead is taken from this terminal to the B plus connection of the 45 volt battery. The negative B lead is soldered direct to the earth wiring and connected to the negative side of the B battery.

Coil Winding

This completes the wiring, leaving only the coils to be wound. Full details for doing this are shown in the two diagrams, and the dimensions given should be adhered to, since the final results will depend to a large extent on the accuracy of these windings. The reaction and grid winding of the broadcast coil should be wound with 34 SWG Enamelled wire, whilst the aerial winding is 27 gauge enamelled wire.

The short wave coil uses the 22 gauge enamelled wire for the grid winding and this is wound on first. The reaction winding is placed at the bottom whilst the aerial winding is interwound between the grid winding turns. Both these are wound with 27 gauge enamelled wire. Note that the connections to the coil former pins are not identical so make sure you follow the connections as shown.

Setting in Operation

Plug in the broadcast coil, connect up the batteries, phones and aerial and earth, then you are ready to air test the set.

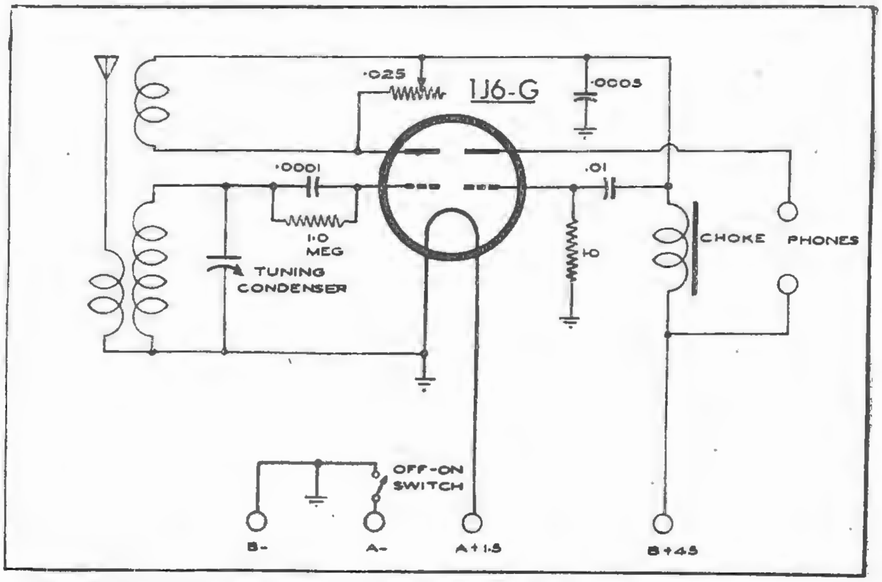


Figure 3—The circuit is not complicated and will be found quite easy to follow.

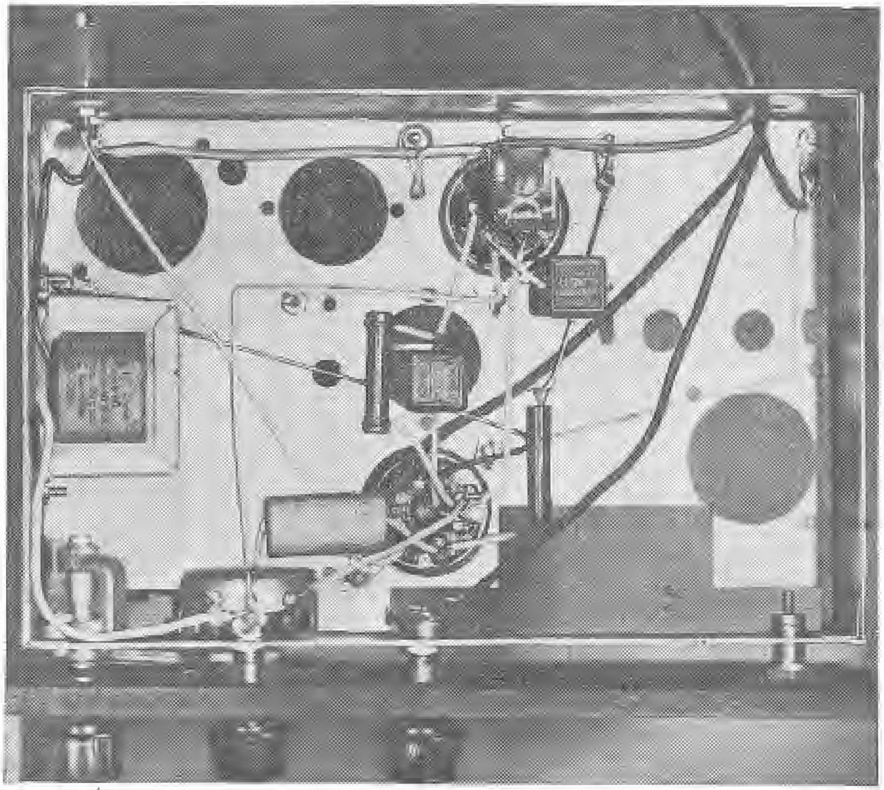


Figure 4—An underneath view of the receiver. All the parts are easily recognised, and note that the leads are kept as short as possible.

ONE VALVE RECEIVER PARTS LIST

1 chassis.
1 two gang condenser.
1 dial unit.
1 pr. headphones.
1 .01 mfd tubular condenser.
1 .0001 mfd mica condenser.
1 .0005 mfd mica condenser.
1 trimmer condenser.
1 .025 meg potentiometer.
2 1.0 meg resistors.
1 power choke.
Valve—1J6G.

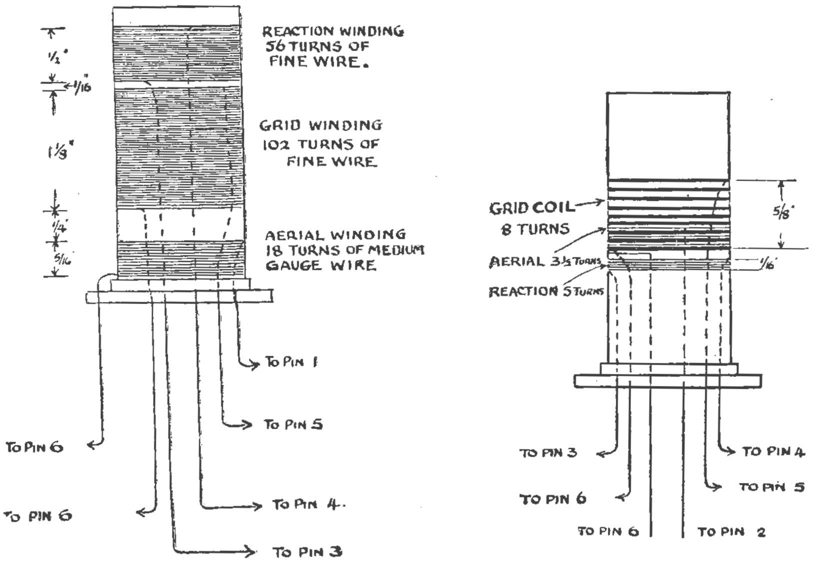
Sundries—1 octal, 1 six pin socket, 4 terminals, 3 knobs, 2 coil formers, coil winding wire, hookup wire, nuts and bolts, solder lugs, 1 45volt B battery, 1 1.5volt A battery.

Turning the volume control in a clockwise direction should produce a faint click or pop and then a rushing noise in the phones. This will indicate the valve is oscillating.

Tune across the band, making any necessary adjustment to reaction control to keep the set oscillating, and providing all your connections are correct you should have no difficulty in hearing the local stations.

Should the valve refuse to oscillate, check up on the reaction winding connections. If these are reversed it will almost certainly prevent the operation of the set.

When listening on the short waves don't forget to use a good aerial system at least 50 feet long and as high as possible, together with an earth. Remember these stations are not on at all hours of the day, so check up with the Short Wave notes as to the best listening times.



BROADCAST COIL | SHORT WAVE COIL

Figure 5—Follow these diagrams when winding your coils. Ensure the spacing shown is adhered to otherwise inefficient operation will result.

DISC SEAL TUBES

Successful operation of circuits on the ultra high frequencies has required many radical changes in valve design. Probably one of the most unusual is the disc seal family— of which the familiar "lighthouse" tube is an outstanding member.

These disc seal tubes are in general simply space charge control tubes such as triodes or tetrodes, except their design is basically different from the normal type of valve. This change was necessary because factors such as electron transit time, internal capacitances, etc., which are completely negligible at the low frequencies, become important and even dominant factors at the higher frequencies. Since it is impossible to obtain high efficiency, stability, ease of coupling, ease of tuning and other features simultaneously in any circuit, the designer has to compromise and sacrifice some of one characteristic to realise enough of the other.

To achieve the kind of performance desired, designers found it was necessary to consider the high frequency tube, not as an individual device connected to another individual device called the circuit, but rather as a single electrical system having one section walled off and evacuated to house the electronic activity. This idea led to the development of the lighthouse tube as we know it to-day.

To understand the development of this type of valve it is best to begin by considering a simple resonator, as shown in figure 1. This consists of a short squat metal cylinder fitted with two opposing metal studs at the axis. There is a specific frequency at which this cavity will display all the properties of an ordinary parallel resonant circuit if excited by connections made to the two surfaces "S". An electric field will be established be-between the flat top and bottom covers of the cavity being most intense at the axis

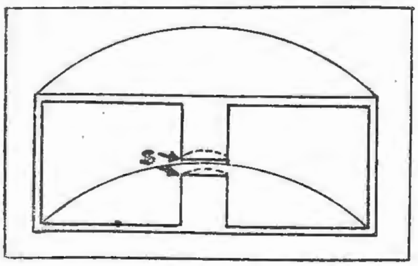


Figure 1—At some specific frequency this simple resonator will display the properties of a parallel tuned circuit.

and decreasing uniformly along all radii to zero at the periphery.

This cavity may be excited electrically from an electron stream by converting the surfaces "s" into the grid and plate of a valve structure. If this is done and the surrounding volume walled off to permit evacuation the arrangement of figure 2 is reached.

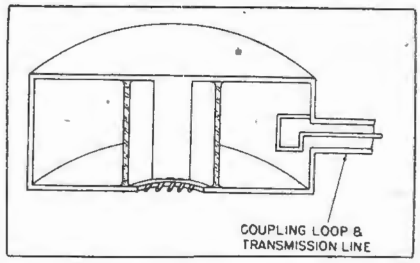


Figure 2—With slight changes, fig. 1 is converted into a workable grid-plate section.

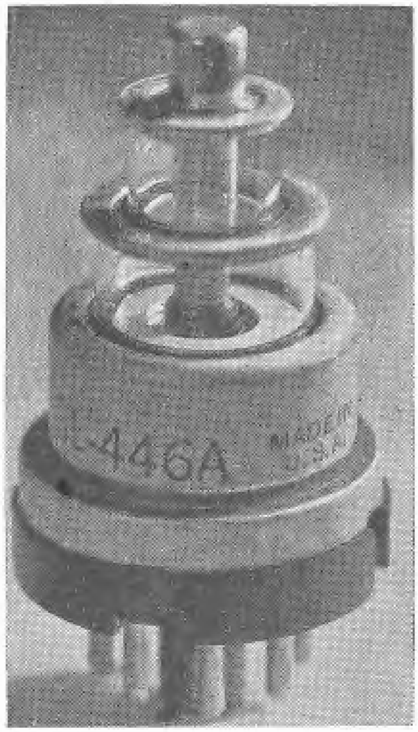
The next step is then to provide a similar cavity for the grid cathode circuit. Figure 3 shows such an arrangement comprising a double resonator and, as will be noticed, this is the essential outline of the lighthouse tube. Part of each metal resonator end plate has been made part of the tube with a metal to glass seal structure which has given this general design its name.

There is no anode or grid lead inductance in the ordinary sense, neither is there unwanted capacitances except that caused by the active part of the electrodes.

Dual Purpose Circuit

The system of cavities in figure 3 is the microwave counterpart of the so called grounded grid or grid return circuit. More recently it has come to be known as the grid separation circuit since the grid and the central cavity wall divide the system cleanly into an input and output circuit both mechanically and electrically.

Although possessing some disadvantages, practically all application of the lighthouse tube use this basic circuit. With the aid of appropriate feedback methods,



The unique construction of a "lighthouse" tube is clearly shown in this excellent photograph.

it becomes a self-excited oscillator useful for many purposes. In other cases, the same basic circuit is provided with an input and output coupling system to provide a microwave amplifier which can be made perfectly stable in most cases without neutralizing circuits.

Constructional Details

A cross sectional drawing of a typical valve is shown in figure 4. The vacuum element consists of two parts—the stem and the body. The stem is identical to that used in conventional metal receiving tubes.

The body of the valve is unusual in that the r-f cathode connection, the grid con-

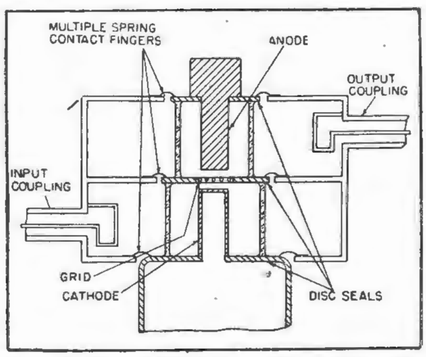
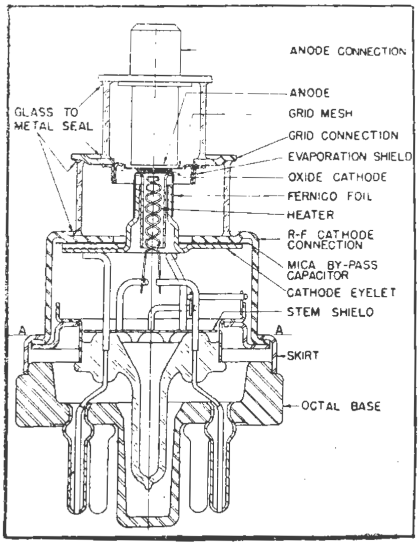


Figure 3—The addition of a grid-cathode unit now shows the basic "lighthouse" tube structure.



nection and the plate connection are pyramided on each other and graduated in size to form a structure which is particularly adapted for the attachment of concentric lines or other cavity resonator circuits of the grid separation type. The disc seals are made with a special glass specifically developed for these tubes, which has a low loss in the microwave range.

Special Cathode

The cathode construction is particularly unique—the flat surface permitting very close spacing. This type of construction maintains the concentric parallel plane feature throughout the electrode structure.

Figure 4—Cross section drawing of a typical "lighthouse" tube showing relative position of elements.

The grid is a woven mesh of .002" tungsten wire on .010" centres and this is brazed to a cup. The fabricated grid is telescoped into a cathode evaporation shield and welded in place.

The plate is a single steel part machined from solid stock and silver plated. This one piece includes the current collecting surface, the flange for making the glass seal and the external anode connection.

All external parts are silver plated to provide minimum r-f loss, good circuit contacts and excellent protection from corrosion. The base is a standard octal, six pin base which permits all d-c connections through a standard octal socket. The r-f connections are most conveniently provided by spring fingers or split ferrules which are in turn attached rigidly to the external circuit.

TECHNICAL DATA

2C40

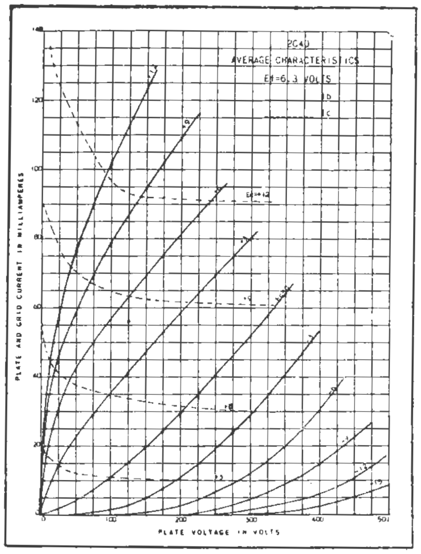
The 2C40 is intended for use as an r-f amplifier, converter, or local oscillator in a receiver.

TYPICAL OPERATING CONDITIONS

	Typical Operation	Maximum Rating
Class A Radio-frequency Amplifier		
Grid Separation Circuit		
D-c Plate Voltage	250	500 Volts
Cathode Bias Resistor	200	Ohms
D-c Plate Current	17	25 Milliamperes
Plate Dissipation		6.5 Watts
Power Gain (small signals)	15	Decibel
Frequency	700	1200 Megacycles

Intended primarily as a local oscillator in the frequency range of 100-3370 megacycles.

	Typical Operation	Maximum Rating
CW Oscillator		
D-c Plate Voltage	250	500 Volts
D-c Plate Current	20	25 Milliamperes
Plate Dissipation		6.5 Watts
Plate Power Output	0.075	Watt
Frequency	3370	3370 Megacycles



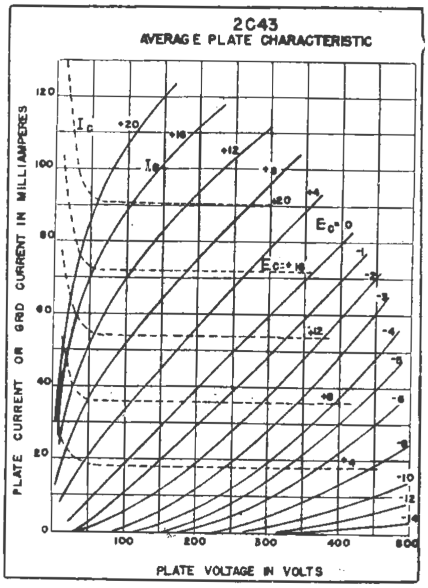
2C43

The 2C43 is a triode similar to the 2C40 except with larger cathode area and a higher average current rating. It is used in transmitter and signal-generator applications where relatively large signal levels are required.

TYPICAL OPERATING CONDITIONS

	Typical Operation 2 Tubes		Maximum Ratings Per Tube
CW Oscillator			
D-c Plate Voltage	360	470	500 Volts
D-c Plate Current	28	38	40 Milliamperes
Plate Dissipation	5.3	8.9	12 Watts
Cathode Current			55 Milliamperes
Frequency	350	350	1500 Megacycles
Approximate Power Output	47	9	Watts

	Typical Operation	Maximum Ratings
Power Oscillator—Plate-pulsed		
Peak Anode Voltage	3000	3500 Volts
D-c Plate Current, average	2.4	Milliamperes
Peak Plate Current	2.5	Amperes
Average Cathode Current During Pulse		4 Amperes
Plate Dissipation, average	6.0	12.0 Watts
Peak Power Output	1300	Watts
Duty Cycle	0.001	0.006
Pulse Width	1	10 Microsecond
Frequency	2600	3370 Megacycles



FOR THE EXPERIMENTER

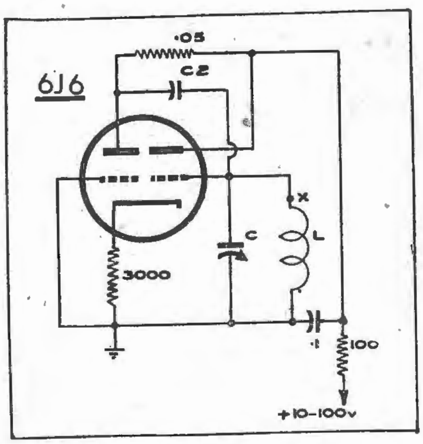
By A. G. NICHOLLS, VK2NI

Cathode Coupled Oscillator

The new miniature twin triode type 6J6 lends itself to a very useful cathode coupled oscillator. With suitable LC combinations the tube will oscillate from 20 cycles to 60 mc, with as low as 15 volts on the plate and still give good waveform.

This unit will key up to 30 w.p.m. and be quite devoid of clicks, chirps, etc. The coils may be bandswitched at "x", a simple procedure since only one point has to be switched.

Typical values for C2 may be 50 mmfd for RF, but if unit is to be used at lower frequencies a 0.01 mfd would be necessary with an iron-cored inductance. C may be from 35 mmfd to 500 mmfd.



The connections for the 6J6 are simple. See text for values of C and C2.

Crystal Filter Failure

The failure of the crystal filter unit in BC-348 receivers now being used by many amateurs can be readily rectified. This fault seems to happen more frequently in the models converted for AC operation, where the excessive heat melts the gummy substance covering the holder. This seeps into the crystal unit causing poor operation.

The remedy is simple. Unsolder the crystal holder which lies to the rear of the crystal switch. Carefully take holder apart and clean the crystal with soap and warm water. When dry re-assemble in holder, taking care not to handle with the bare fingers. Cover with ordinary duco household cement and replace in original position. Results are surprisingly good.

Solder Kink

A handy arrangement for wire solder can be made by winding the solder around a pencil for its entire length starting at the point of the pencil. After removing the pencil the end of the solder is passed back through the coil and out through the opening in the pointed end. The coil is then used as a handle, and as the solder is used more may be pulled out.

Drilling Glass Panels

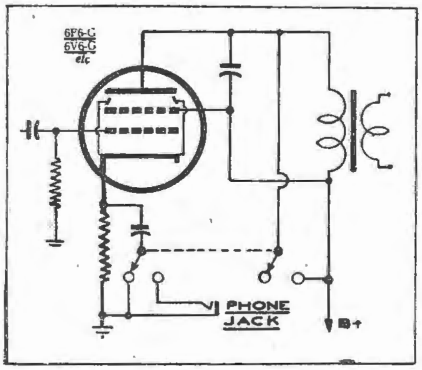
Obtain an old drill of the size required and use a high speed electric drill. Place panel on flat, smooth surface, and apply moderate pressure.

In a short time the drill will become red hot and then nearly white hot. Switch off, but before the drill stops rotating push the molten glass portion through. The hole will be a little rough, but the usual stand off or knob will cover it satisfactorily. The drill may be used on glass again, but is useless for steel or even wood.

Low Impedance Phones Connection

Some very good quality headphones at present available through disposal sources are often ignored because of their low impedance. Here is a simple method whereby they can be connected to a normal receiver to give satisfactory results.

The switch is a DPST type, and as can be seen is wired into the cathode circuit of the output valve.



This circuit shows how to connect the low impedance phones for satisfactory operation.

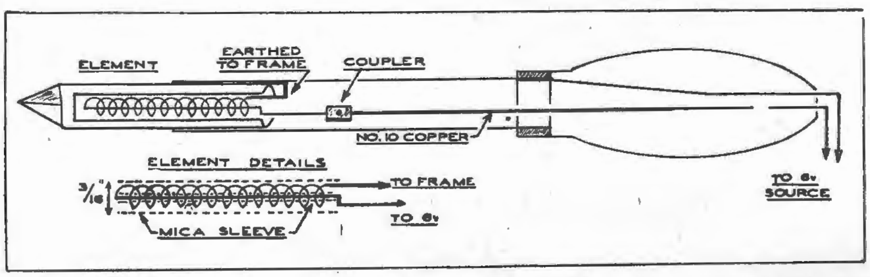
A 6-volt Soldering Iron

Here is an easily made soldering iron which will operate satisfactorily from either a 6-volt filament transformer or 6-volt storage battery.

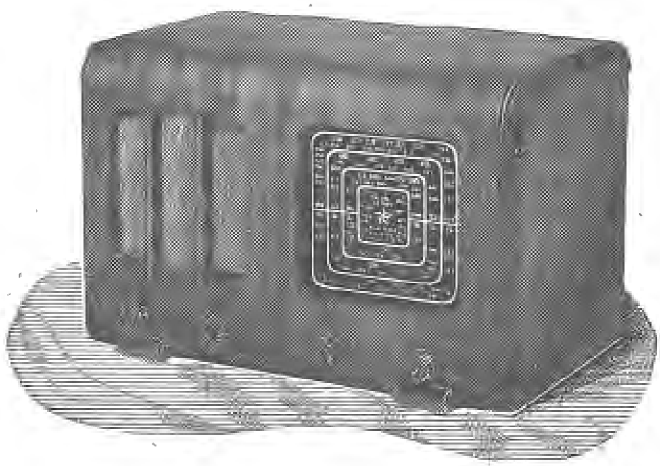
Procure a 3-inch length ⅜ in. diameter copper rod and shape tip to desired chisel, spot or fine taper point. This may be done by heating to red heat over an ordinary gas stove and beating out on a piece of flat iron. The centre is then drilled out to a depth of 2¼ in. using a ¼ in. drill.

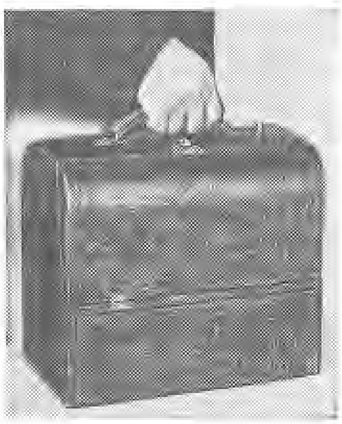
The heating element is a 12 in. length of No. 25 nichrome wire wound in a spiral, outside diameter 3-16 in. One end is pulled back through the spiral coupled to the piece of No. 10 hard drawn copper wire which in turn connects to the heavy flex and two battery clips. The other lead is connected direct to the metal frame as shown.

The element is insulated with thin sheet mica and a piece is also wrapped around the centre lead. The whole unit is forced gently into the hole in the bit. A piece of brass tubing ⅜ in. inside diam. is then crimped on to the bit and fixed to the wooden handle.



Here are the main details of the soldering iron. The actual overall measurements are not critical and can be easily adapted to your own needs.





SERVICE DATA SHEET

S.T.C. MODEL 141.

VALVES:

Freq. Ch. 6J8G.
I.F. Amp. & Det. 6G8G.
Pow. Out. 6V6GT.
Rect. 6X5GT.

ALIGNMENT FREQUENCIES:

1400 kc and 600 kc.

CHECK POINT:

1000 kc.

I.F. SENSITIVITY:

Freq. Conv. Grid—350 m.v.
I.F. Grid—35mv.
Overall average—80 microvolts.

These figures are related to an audio frequency output of 14 volts measured between plate of V3 and earth.

TUNING RANGE:

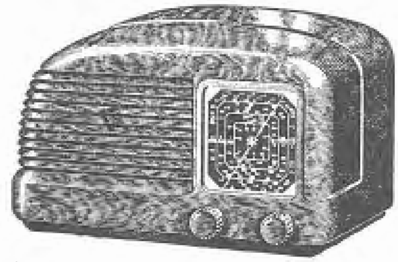
540 to 1620 kc.

POWER SUPPLY:

200-240 v., 50 cps.

LOUD SPEAKER:

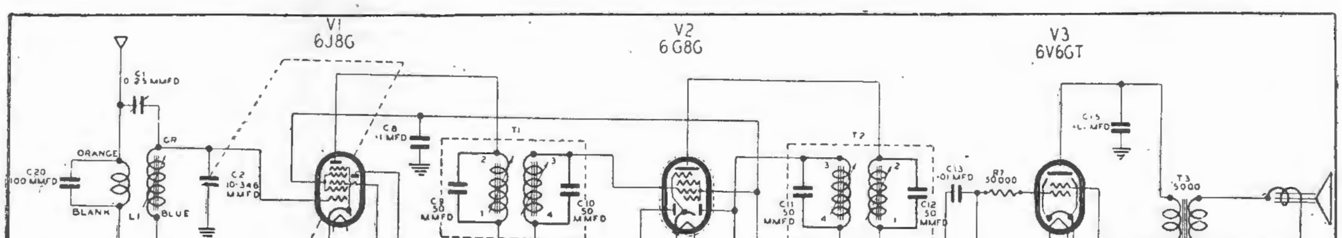
Permag. 5" cone.
5000 ohms input.



Circuit Voltages.

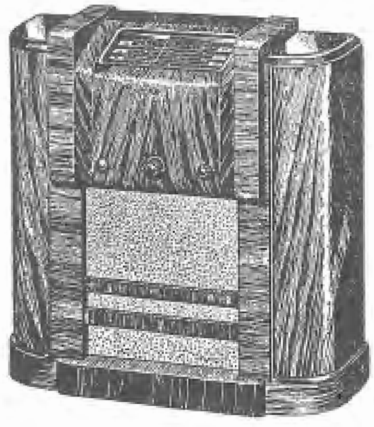
	Plate	Screen	Osc. Plate	Cathode	Heater
V1	220	100	140	—	6.2
V2	220	100	—	—	6.2
V3	210	220	—	14	6.2
V4	220 ea.	—	—	220	6.2

These voltages must be measured to receiver earth with voltmeter having resistance of at least 1000 ohms per volt. Tolerance ± 5%. Volume control must be turned to maximum.



SERVICE DATA SHEET

S.T.C. MODEL 262.



TUNING RANGE:
Broadcast 540-1620 Kc/s.
Short Wave 5.9-18.2 Mc/s.
Bandspreod 11.8-12 Mc/s.
9.5-9.8 Mc/s.

INTER. FREQ.:
455 Kc/s.

POWER SUPPLY:
200-240 volts.
50 cycles A.C.

LOUD SPEAKER:
Permag. 12" cone.
2500 ohms transformer.

SENSITIVITY:

I.F. V1 grid	15 microvolts
I.F. V2 grid	500 microvolts
I.F. V3 grid	27 millivolts
Broadcast	4 microvolts
Short Wove	15 microvolts

These figures are related to an audio frequency output of 11 volts, measured between plate of V5 and earth, through series condenser of .1 MFD capacity.

ALIGNMENT FREQUENCIES:
1400 Kc/s and 600 Kc/s Broadcast.
16 Mc/s ond 6 Mc/s Short Wave.
Bandspread. Set oscillator to 9.5 Mc/s., and aerial to 12 Mc/s.

CHECK POINTS:
Broadcast 1000 Kc/s.
Short Wave 10 Mc/s.

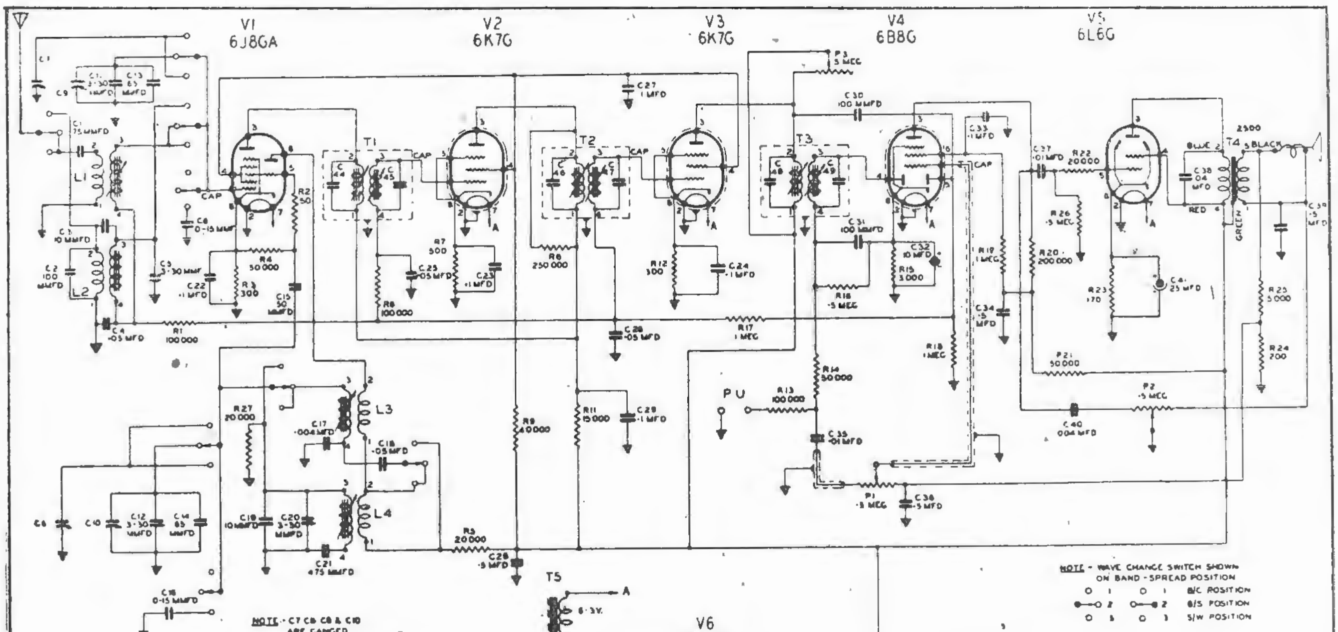
Valve Complement

Freq. Conv.	6J8GA
1st I.F. amp.	6K7G
2nd I.F. omp.	6K7G
Det. audio	6B8G
Power output	6L6G
Rectifier	5Z4G

Circuit Voltages.

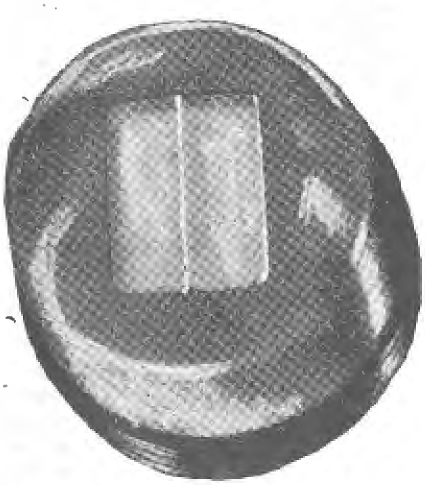
	Plate	Screen	Osc. Plate	Cathode	Heater
V1	175	80	140	2.7	6.2
V2	175	80	—	2.7	6.2
V3	260	80	—	2.3	6.2
V4	40	25	—	1.5	6.2
V5	240	250	—	13	6.2
V6	245/245	—	—	278	5.0

These voltages must be measured to receiver earth with voltmeter having resistance of at least 1000 ohms per volt. Tolerance ± 5%. Volume control must be turned to maximum.



6AL7-GT-FM/AM TUNING INDICATOR

Although the FM transmissions in this country are still of an experimental nature, this description of a recently developed tuning indicator should prove of interest to many.



The translucent screen of the 6AL7-GT on which the fluorescent patterns appear as two varying rectangles.

To realise the full advantage of the FM system it is essential that the FM receiver be accurately tuned in to the received station. Unless this is done the audio quality will deteriorate, becoming very distorted, and in addition, there will be a heavy background noise.

To minimise such distortion and allow the average listener to tune the receiver more accurately than is possible by ear alone, some means of visual indication should be provided. Whilst the 6E5, 6G5 type of indicator can be used for such a purpose, they have certain inherent faults and for this reason the 6AL7—GT was produced.

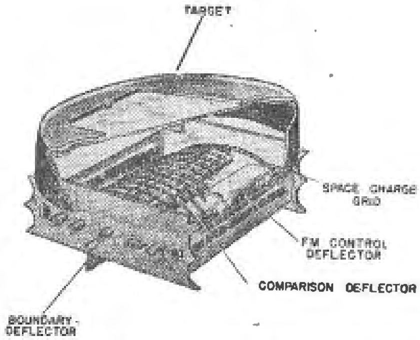
It might be pointed out that the requirements of an FM tuning indicator are much more stringent than those of the AM counterpart. In this latter application the indicator is only required to respond to the AVC voltage in the receiver, tuning for a maximum, whereas in the FM receiver it is usual to compare one voltage with a reference voltage and then indicate when these two voltages are equal. Such is the case when the discriminator voltage is being used since when a station is properly tuned in the average potential is equal to zero—that is, the d-c components of the voltages are equal.

In the average discriminator circuit the output voltage varies from plus 10 to minus 10 volts with respect to the ground when the set is tuned through the signal. This gives a frequency voltage characteristic of approximately 10 kc. per volt for the standard 200 kc. band pass.

To provide distortionless signals the carrier should be tuned within 2 kc. of the centre of the discriminator—that is within 0.2 volt. The tuning indicator must therefore be capable of detecting a voltage difference of plus or minus 0.2 volt with respect to ground.

Description of Indicator

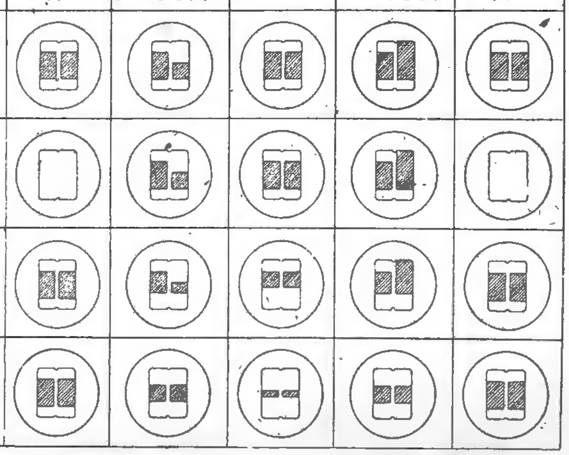
The general appearance of the 6AL7-GT is shown in the accompanying photograph. Located near the end of the glass bulb is a translucent screen consisting of a glass disc with a transparent conducting coating and on this the fluorescent material is deposited. The screen is divided into two parts causing the fluorescence to appear as two rectangles. Control electrodes vary the size of the rectangles, one electrode usually being maintained at a fixed voltage and the other varied by the voltage to be indicated.



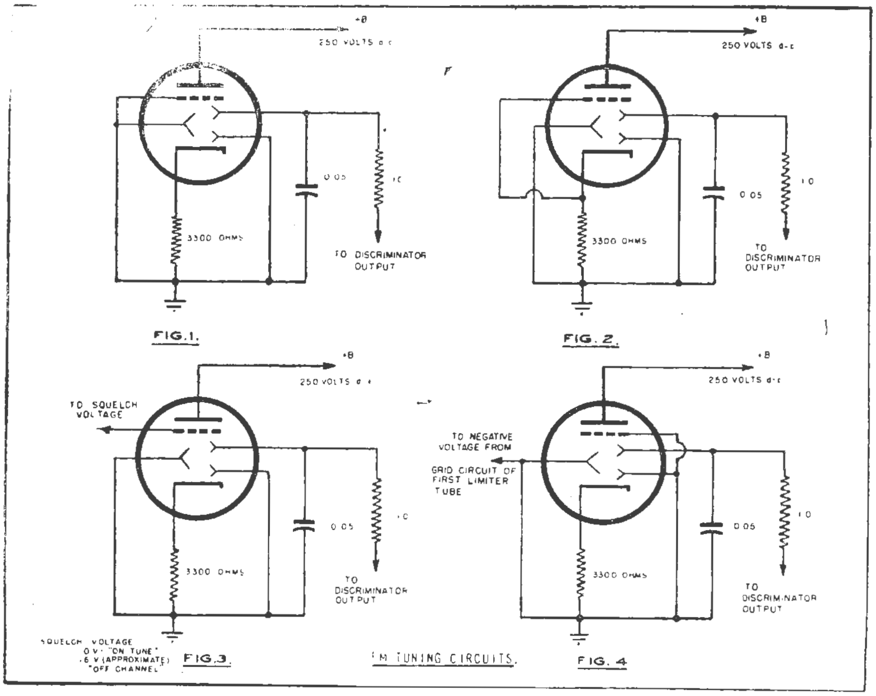
This cut-away diagram shows the internal arrangement of the various electrodes.

The cutaway drawing shows the cathode, deflection electrode, space charge grid, and target assembly. The three deflection electrodes are adjacent to the cathode and the cathode-deflection electrode assembly is separated from the target by the space charge grid. This space charge grid is operated at cathode poten-

CONTROL VOLTAGE SOURCE	SIGNAL	CIRCUIT (SEE FIGURE)	OFF CHANNEL (−)	ON CHANNEL OFF TUNE (−)	ON TUNE	ON CHANNEL OFF TUNE (+)	OFF CHANNEL (+)
DISCRIMINATOR	FM	1 AND 2					
DISCRIMINATOR AND SQUELCH	FM	3					
DISCRIMINATOR AND LIMITER	FM	4					
AVC	AM	5					



These are typical tuning patterns produced by the circuits discussed in the article.



Four circuit applications suitable for use with an FM receiver. Figure 3 is widely used since tuning pattern disappears from the screen when set is off tune.

tal, or, in some cases, at a few volts negative with respect to the cathode.

The deflection electrodes effectively control the position of the electron beam on the target due to the low electron velocity in the region between the cathode and the space charge grid. By increasing the negative voltage on the grid with respect to the cathode the electrons are slowed down still more and at the same time the sensitivity of the deflection electrodes is further increased.

Without this space charge grid the electrons in the vicinity of the deflection electrodes would move towards the target at relatively high velocity with the result the deflection sensitivity would be reduced.

By controlling the bias of the space charge grid the target current and pattern brightness can be effected. Six volts negative grid bias is sufficient to black out completely the pattern if the target voltage is 315 volts d-c or less.

The actual voltage used on the target may be any value between 200 and 400 volts d-c and is usually in the region between 240 and 300 volts d-c. The higher the target voltage, the brighter the pattern will be, but on the other hand the deflection electrode sensitivity is decreased as the target voltage is increased. For this reason the target voltage should be kept as low as is commensurate with adequate pattern brightness.

Circuit Application

The sequence of patterns obtained as the receiver is tuned through a signal is shown in figure 6. Three different FM tuning presentations are given in addition to the AM tuning pattern. The following description gives the circuit arrangements suggested to obtain such pattern sequences.

Figure 1 shows the circuit for one arrangement of the elements for FM tuning. Here the grid and deflection electrodes 1 and 3 are tied to ground. Deflection electrode No. 2 is used as the indicator for the discriminator voltage and deflection electrode No. 1 is used as the reference element. The .05 capacitor in conjunction with the 1.0 meg resistor provides a filter which keeps the audio voltage from appearing at deflection electrode No. 2. The cathode resistor is necessary to maintain adequate cathode bias and so prevent current from flowing in the No. 2 deflection electrode circuit.

The circuit in figure 2 is similar to figure 1 with the exception of the grid connection. Here the grid connection is returned directly to the cathode rather than to the ground. When the grid is returned to ground there is approximately 1.7 volts difference in potential between grid and cathode and somewhat improved deflection electrode sensitivity.

Use of Squelch Voltage

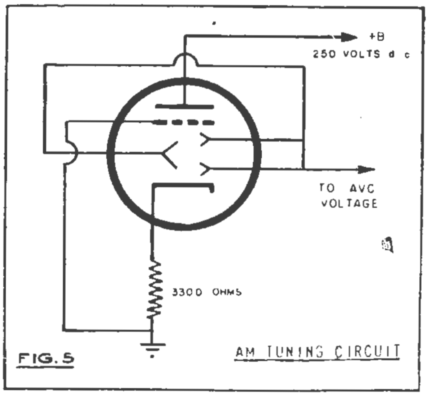
Perhaps the most desirable circuit for FM tuning is shown in figure 3. In this case all fluorescence disappears from the screen while the receiver is being tuned between stations. As the stations begin to come into tune, normal fluorescence appears and the patterns move in response to the d-c voltage from the discriminator output.

The target current is cut off by the application of squelch voltage to the space charge grid, about 6 volts negative d-c for *Off-Channel* and zero for *On-Tune*. The electrons in the vicinity of the deflection electrodes between the grid and cathode have lower velocity when the grid is biassed near visual cut-off. Consequently the sensitivity of the discriminator voltage presentation is greater than normal at the point where the screen just begins to fluoresce as the signal is tuned in.

A circuit arrangement suitable for indicating the difference between pattern presentation *On-Tune* and *Off-Channel*, where the squelch voltage is not available in an FM receiver is shown in figure 4. In this case deflection electrode No. 3 may be connected to a tap on the grid resistor of the first limiter tube to provide a maximum of about minus 20 volts d-c.

Figue 5 shows the connection recommended for the AM system. Here all three deflection electrodes are tied together and connected to an AVC voltage. Thus the pattern will become narrower as an AVC voltage increases or as correct tuning of the AM signal is approached. The tube is designed so that an AVC voltage of minus 20 volts d-c (corresponding to an exceptionally strong signal) will not cause visual cut off of the pattern.

Technical information in this article has been based on bulletins GE-ETB14 and ET-T207A, supplied by courtesy of the General Electric Co., U.S.A.



The recommended connections for an AM tuning indicator.

SPEAKER NETWORK DESIGN DATA

The factors involved in using dual speaker networks is something more than simply connecting the high and low frequency units in parallel.
This authoritative article reprinted from the Aerovox Research Worker treats the design and construction of networks which are used to obtain the proper frequency division between the "woofer" and "tweeter."

Modern high-fidelity audio systems make use of separate high frequency and low freqency loud speakers. In order to obtain maximum efficacy from this dual reproducing arrangement, dividing networks are connected between the ampli fier output transformer and the voice coils of the *tweeter* (high frequency speaker) and *woofer* (low frequency speaker).

These networks separate the frequency components in the amplifier output voltage into two bands, so that only frequencies above a certain cross-over frequency are transmitted to the tweeter, and only those below this cross frequency are transmitted to the woofer. Each speaker thus operates only at those frequencies at which it is most efficient and faithful.

The cross-over frequency is selectable at will, but most commercially available dividing networks operate at cross-over frequencies of 400 or 800 cycles.

Basic Network Facts

The basic facts concerning practical dividing networks may be summed up in the following brief comments.

(1) Each such network comprises a low-pass and high-pass filter with their input circuits connected either in series or in parallel. The output circuit of the high-pass filter section feeds the tweeter; that of the low-pass filter, the woofer.

(2) At the cross-over frequency, the high and low frequency power outputs are equal.

(3) With respect to the attenuation at the cross-over frequency, the dividing network provides 12 db minimum attenuation one octave from the cross-over frequency.

(4) The constant-resistance type of dividing network is a specific form which, when terminated in the proper resistance load, will offer a constant input resistance over a frequency band. The constant resistance type network is convenient in some instances, since each of its capacitor components are identical in value, as are also each of its inductor components.

Circuit diagrams of dividing networks are given in Figures 2 and 3, together with the formulae for obtaining the values of their capacitor and inductor elements. The arrangements shown in Figure 2 are the conventional series and parallel connected filter type networks. Those given in Figure 3 are constant resistance networks. In the later groups, two of the circuits (3-A and 3-B) will provide only about 6 db attenuation at 1 octave from the cross-over frequency, and should be employed only in those specific cases where this low attenuation may be tolerated.

Position of Network in Amplifier

The band-separating action of the dividing network might be obtained at several points in a conventional audio amplifier. In standard practice, however, the dividing network is connected almost always between the secondary winding of the amplifier output transformer and the loud speaker voice coils, as shown in Figure 1. In this way, one output amplifier stage is made to serve both loudspeakers.

Each network section must carry the full power delivered to the loudspeaker which it supplies. Network components accordingly must be capable of handling safely these power levels. At the same time, the resistance of the inductors must be of the lowest possible value, consistent with required inductance, in order to minimize insertion losses.

The impedances out of, and into which the practical dividing network operates are identical with the rated voice coil impedance of the loud speakers. This is the R_0 value that appears in the formulae.

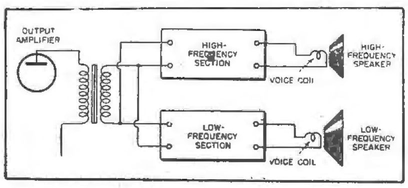


Figure 1—The dividing network is usually connected between the output transformer secondary and the speaker voice coils.

Use of the Tables

All component values for dividing networks may be calculated by means of the formulae given in Figures 2 and 3. How ever, we are printing here two tables which list these values calculated with sufficient accuracy for critical applications.

Tables I and II list all capacitor and inductor values required respectively in conventional and constant resistance type dividing networks. These tables are based upon an R_0 value of 10 ohms and a *m* of 0.6. All capacitance values are given in microfarads and all inductance values in millihenries, for common cross-over frequencies every 50 cycles apart from 100 to 1000 cycles.

When working with systems in which $R_0 = 10$, all C and L values may be read in the corresponding frequency column directly from Chart 1 for conventional networks, or from Chart II for the constant resistance type. For R_0 values other than 10, the chart values may be operated upon to yield values required for the new impedance, thus for a value (Rx) other than R_0 (10 ohms), multiply all L values corresponding to the desired cross-over frequency by Rx/R_0, and divide all C values by this same factor.

Using Rx/Ro Factor

As an illustration of the use of the Rx/R_0 factor, consider the following example: A conventional dividing network is required to work between 16 ohms at a cross-over frequency of 450 cycles. At 16 ohms, $Rx/R_0 = 16/10 = 1.6$. All L values in the 450 cycles column of Chart I must be multiplied by 1.6, and all C values in the same column must be divided by 1.6.

$C_1 = 70.76/1.6 = 44.22$ mfd.
$C_2 = 22.11/1.6 = 13.19$ mfd.
$C_3 = 35.38/1.6 = 22.11$ mfd.
$C_4 = 17.69/1.6 = 11.05$ mfd.
$C_5 = 56.61/1.6 = 35.38$ mfd.
$L_1 = (5.66)\,1.6 = 9.056$ mh.
$L_2 = (3.54)\,1.6 = 5.664$ mh.
$L_3 = (1.77)\,1.6 = 2.832$ mh.
$L_4 = (7.08)\,1.6 = 11.328$ mh.
$L_5 = (2.21)\,1.6 = 3.536$ mh.

To find the capacitance and inductance values required at 10 ohms for some cross-over frequency (f in cycles per second, other than one of the 19 frequencies given in the two charts, first locate the C and L values in the 100 cycle column, then multiply each of these values by 100/f. If a different impedance (Rx) as well as a different frequency (f) is required, locate both the capacitance and inductance values in the 100 cycle column of the chart, and multiply the capacitance thus obtained by 1000/ (fRx), and the inductances by (10Rx)/f.

As an illustration of the use of these last two formulae, consider the following example: A constant resistance dividing network is required with a cross-over frequency of 500 cycles, to work between 16 ohms.

Using the above formulae, first obtain:

1000/ (fRx) = 1000/ (500x16) = 0.125.

(10Rx)/f = (10x16)/ (500) = 0.32.

These factors are then used to multiply the 100 cycle values (chart II) thus:

C_1 = 159.15 x 0.125 = 19.89 mfd.
C_2 = 225.04 x 0.125 = 28.13 mfd.
C_3 = 112.52 x 0.125 = 14.06 mfd.
L_1 = 15.91 x 0.32 = 5.09 mh.
L_2 = 11.25 x 0.32 = 3.60 mh.
L_3 = 22.50 x 0.32 = 7.20 mh.

The only problem not covered is the design of the inductance and whilst the formulae are available in most standard radio texts, the following notes are included for reference.

Inductance Design

When no direct current component is present the iron core inductance may be made by using interleaved laminations. In this instance the inductance may be calculated from the formula:

$$L = \frac{3.2 \times 10^{-8} \times N^2 \times uA}{l} \text{ henry}$$

where N is the number of turns, u the AC permeability, depending on the type of iron used as well as the AC and DC flux densities, l is the length of the magnetic circuit path—that is the distance travelled on a complete circuit of the core. Transpositions of this formula will allow the number of turns to be calculated once the inductance is known.

In the case where the direct current is considerably greater than the peak AC current a different method must be used. The formula is:

$$L = \frac{3.2 \times A \times N^2}{a \times 10^8}$$

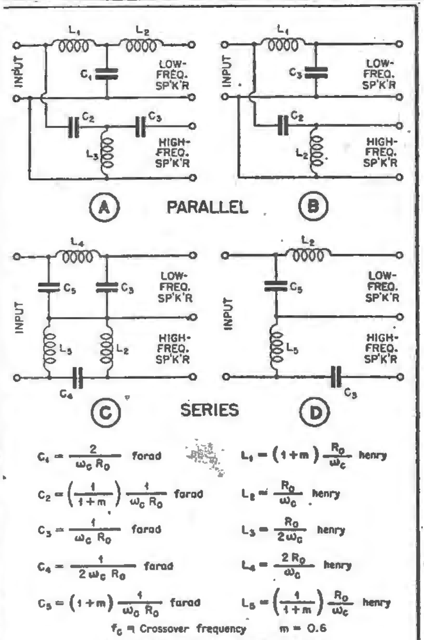
where the symbols have the same meaning as above, except a. This is calculated as the actual air gap plus the air gap equivalent of the iron core:

$$a = (\text{air gap}) + \left(\frac{l}{u\,(ac)}\right)$$

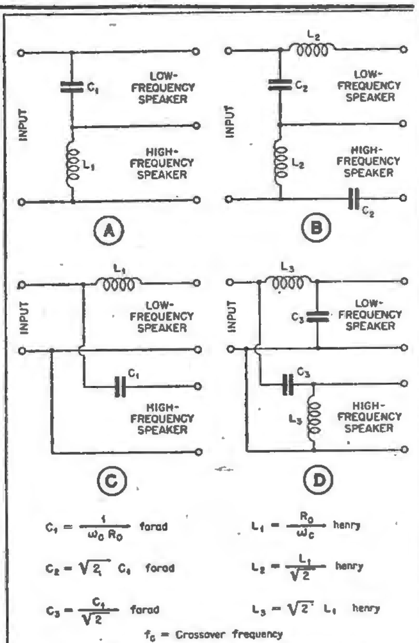
CHART I. Conventional Dividing Networks (See Fig.2)

f_c=	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
C_1	318.5	212.30	159.24	127.38	106.16	90.98	79.62	70.76	63.70	57.90	53.08	48.98	45.48	42.46	39.80	37.50	35.38	33.52	31.85
C_2	99.47	66.34	49.76	39.81	33.17	28.43	24.88	22.11	19.91	18.09	16.59	15.31	14.21	13.27	12.44	11.72	11.06	10.47	9.95
C_3	159.15	106.15	79.62	63.69	53.08	45.49	39.81	35.38	31.85	28.95	26.54	24.49	22.74	21.23	19.90	18.75	17.69	16.76	15.91
C_4	79.57	53.07	39.81	31.84	26.54	22.74	19.90	17.69	15.92	14.47	13.27	12.24	11.37	10.61	9.95	9.37	8.84	8.38	7.96
C_5	254.64	169.84	127.39	101.90	84.93	72.78	63.69	56.61	50.96	46.32	42.46	39.18	36.38	33.97	31.84	30.00	28.30	26.82	25.46
L_1	25.46	16.98	12.74	10.19	8.49	7.28	6.37	5.66	5.10	4.63	4.25	3.92	3.64	3.40	3.18	3.00	2.83	2.68	2.55
L_2	15.91	10.61	7.96	6.37	5.31	4.55	3.98	3.54	3.18	2.89	2.65	2.45	2.27	2.12	1.99	1.87	1.77	1.68	1.59
L_3	7.96	5.31	3.98	3.18	2.65	2.27	1.99	1.77	1.59	1.45	1.33	1.22	1.14	1.06	0.995	0.937	0.884	0.838	0.796
L_4	31.85	21.23	15.92	12.74	10.62	9.09	7.96	7.08	6.37	5.79	5.31	4.90	4.55	4.25	3.98	3.75	3.54	3.35	3.18
L_5	9.95	6.63	4.98	3.98	3.32	2.84	2.49	2.21	1.99	1.81	1.66	1.53	1.42	1.33	1.24	1.17	1.11	1.05	0.995

C mfds. L mh m 0.6 R_o 10 f cycles



CONVENTIONAL NETWORKS
FIG. 2



CONSTANT-RESISTANCE NETWORKS
FIG. 3

CHART II. Constant-Resistance Dividing Networks (See Fig.3)

f_c=	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
C_1	159.15	106.15	79.62	63.69	53.08	45.49	39.81	35.38	31.85	28.95	26.54	24.49	22.74	21.23	19.90	18.75	17.69	16.76	15.91
C_2	225.04	150.10	112.58	90.06	75.05	64.32	56.29	50.03	45.03	40.93	37.53	34.63	32.15	30.02	28.14	26.51	25.01	23.69	22.50
C_3	112.52	75.05	56.29	45.03	37.52	32.16	28.14	25.01	22.51	20.46	18.76	17.31	16.07	15.01	14.07	13.25	12.50	11.84	11.25
L_1	15.91	10.61	7.96	6.37	5.31	4.55	3.98	3.54	3.18	2.89	2.65	2.45	2.27	2.12	1.99	1.87	1.77	1.68	1.59
L_2	11.25	7.50	5.63	4.50	3.75	3.22	2.81	2.50	2.25	2.04	1.87	1.73	1.60	1.50	1.41	1.32	1.25	1.19	1.12
L_3	22.50	15.00	11.26	9.00	7.50	6.44	5.62	5.00	4.50	4.08	3.74	3.46	3.20	3.00	2.82	2.64	2.50	2.38	2.24

C mfds. L mh R_o 10 f cycles

Figure 2—Complete data is included for both conventional and constant resistance networks. See text for method of calculating values for frequencies other than shown here.

ON THE BROADCAST BAND

In this regular feature, our correspondent Mr. Roy Hallett will provide the enthusiastic Broadcast DX listener with the latest news and items of interest regarding these stations.

The reception of broadcasting stations operating great distances from a radio receiver seldom fails to provide a thrill for the enthusiastic radio man and the casual listener alike. Consequently, it is hoped each month to provide readers particularly interested in this DX (or long distance) listening with a summary of stations most easily heard in this country, together with any other pertinent facts about them.

One of the main reasons for the apparent popularity of this long distance listening is that it provides the owner of a broadcast receiver (or even a dual wave receiver) with an added listening feature which can provide hours of entertainment over and above the normal broadcasting stations.

Whilst DXing is normally not possible with a crystal set, the results obtained from a very small AC and battery operated receivers is often very surprising. However, the use of a superheterodyne will prove advantageous to the ardent DXer, enabling many of the weaker long distance signals to be located even whilst the local stations are still on the air.

Although there are many more stations on the band to-day than a few years ago, it is still possible to hear overseas stations during our evenings on the few remaining unoccupied channels, whilst many others may be tuned in after our local stations close their nightly transmissions. A careful search across the band should enable you to receive at least some of the stations listed as being audible in this country at the present time.

Verifications

Like the Short Wave stations, many of these broadcast stations send out verification cards or letters acknowledging your report. Make sure when writing to include an International Reply Coupon (in the case of foreign countries) or an Imperial Reply Coupon for stations within the British Empire, otherwise your letter may not be answered.

In a later issue it is hoped to be able to cover in more detail the method of sending off your reports to obtain these "coveted" verifications.

By ROY HALLETT

Try for these

During the next few weeks the following stations operating on the few frequencies unoccupied by Australian transmitters should be heard at reasonable strength.

NEW ZEALAND

2YA, Wellington, the powerful 60 kw. station operating on 570 kc. (between 3WV and 6WA) is perhaps one of the strongest. The news bulletin is given at 7 p.m., followed by musical and other programmes, closing down around 9.25 p.m. Wellington's alternative National station—2YC, 840 kc. (between 2NA and 2CY) is also heard well at many locations.

Are you interested in Broadcast DXing? If so, you are invited to send in reports of your latest logging, equipment being used, as well as any suggestions regarding the information you would like included in this page. All letters should be posted direct to Mr. Roy Hallett, 36 Baker Street, Enfield, N.S.W.

ASIA

Probably the best signal from this continent eminates from the All India Radio transmitter at Dacca, VUY, on 1167 kc. (near 7ZS). It is heard best around 1 a.m. with generally Asiatic type programmes, but regular news bulletins and other items are announced in English.

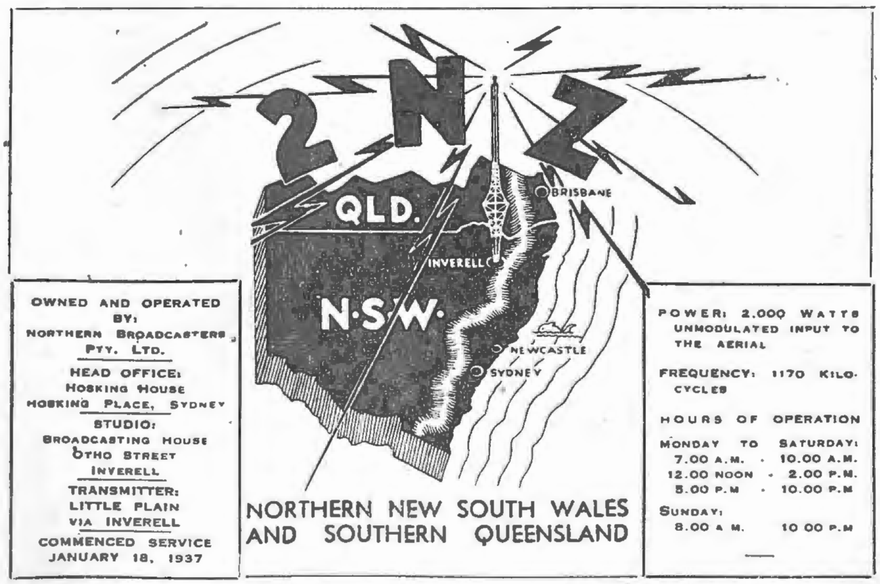
Stations in Malaya, Phillipine Islands (for example KZRH; 710 kc.) China, Thailand, Japan, etc., may also be heard around this hour, with weak to fair signals. Phillipine Island stations usually present American type programmes, plus sessions in local and Asiatic dialects.

NORTH AMERICA

Signals may be received during our summer months around midnight with KNX, Los Angeles, 1070 kc. coming through fairly well after 6WB closes at 12.30 a.m. XERB, 1090 kc., with studios in San Diego, California, but transmitting from Reynosa, Mexico, and KFI, Los Angeles, 640 kc., are also being heard quite regularly.

EUROPE

Stations can be frequently heard in most locations during our summer mornings, from 5 a.m. onwards. It is not long, however, before the sun begins cutting off the signal at our end, with the result that there is only about two hours listening time for these stations.



This attractive verification card, in green and black, is used by Station 2NZ (1170 kc.) to confirm reception reports.

CONDUCTED BY TED WHITING

The birth of Short Wave Broadcasting as we know it to-day is considered to date from 1924. In that year history was made when station KDKA, located in Pittsburgh, U.S.A. transmitted signals which were heard in Great Britain. These signals were transmitted on a wavelength of 300 metres but further experiments proved that the use of a lower wavelength (higher frequency) gave more satisfactory reception over the then long distance covered.

This experiment, coupled with the excellent work done by the amateurs and the early broadcasting organisations laid the foundations for regular and reliable broadcasts. As a result we are now able to tune in stations from most parts of the world on even the simplest of radio receivers.

These stations are found within the short wave spectrum on definitely limited frequency bands allocated by agreement between all countries of the world. Although the radio spectrum extends, for all practical purposes from 1 to 30,000 metres, it is only that section which lies between 5 and 100 metres to which your attention is drawn and to which your listening will be confined.

The most popular frequencies used for short wave broadcasting and on which most of your listening will be done are indicated in the accompanying chart. These frequencies it will be noticed are those covered by the average dual wave receiver and within their limits much can be achieved.

This magazine would not be complete without the inclusion of a special section for the Short Wave Listener. Our Short Wave Correspondent, Mr. Ted Whiting, hardly needs an introduction, since he has been an ardent and enthusiastic listener for many years, and is now regarded among the S.W. fraternity as an authority on the subject.

To make this section as comprehensive as possible your co-operation is sought. All readers are invited to send in reports of any station heard, together with any other items of interest. These reports should be sent direct to: Mr. Ted Whiting, 16 Louden Street, Five Dock, N.S.W., and will be acknowledged by him, through the columns of this magazine.

Suitable Times

Most Broadcasting Organisations beam their transmissions to the required areas at a time when they will receive the maximum listening audience, and thus it will be found that these stations are to be received at times most suitable to the listener. However, many weaker signals are to be heard at irregular times and these provide many interesting hours of listening to stations in the more remote parts of this troubled world.

Therefore, we suggest that our readers devote, for a start, time for listening in the forenoon, afternoon, and evening. In another section will be found suggested stations will be heard with regularity on practically any receiver, and also at very fine strength.

SHORT WAVE BAND.	FREQUENCY. Kilocycles.	Megacycles.
13 Metre	21750 to 21450	21.75 to 21.45
16 Metre	18450 to 17650	18.45 to 17.65
19 Metre	15790 to 15000	15.79 to 15.0
24 Metre	12400 to 12000	12.4 to 12.0
25 Metre	12000 to 11540	12.0 to 11.54
30 Metre	10000 to 9670	10.0 to 9.67
31 Metre	9670 to 9370	9.67 to 9.37
48 Metre	6250 to 6122	6.25 to 6.122
49 Metre	6120 to 6000	6.12 to 6.0

Identification

Most stations frequently announce their location and call sign, together with the frequency of operation, and are easily identified; others merely by means of a slogan as in the case of some of the South American stations, but by a close study of the frequency and type of programme these are readily identified. The B.B.C. do not give their call sign, only frequency, as they are usually operating simultaneously on several frequencies beamed in various directions. Their schedules are given weekly over each service, but, owing to the consistency of their operation they become regular points of reference to the constant listener.

Reports

Most stations send out, in reply to useful reports, a letter or a verification card, many of which are of great interest. Always make sure that a correct report is submitted, giving details of a part of the programme heard, say for a period of one half hour. Quote the time of reception in G.M.T. or in their local time, if known, frequency, strength of signals, fading, weather conditions at the receiving end, strength of signals from nearby stations operating on neighbouring frequencies, if any, and any other relevant information which may be of interest to the engineering staff of the station.

Such reports as this will rarely fail to bring back the coveted verification Remember that it is only by these reports that the staff of the station can learn as to how their transmission is being received in other parts of the world.

Since it is of no use sending Australian stamps to cover the cost of the reply, it is wise to purchase an International Reply Coupon (for use in foreign countries or a British Empire Reply Coupon (for use within the British Empire). We will be pleased to hear of your successes, as it is only by your letters that we will be able to include those features you desire. All information you can send us will be welcome and recognition will be given in these pages.

AMATEUR BANDS PROVIDE GOOD LISTENING

Much pleasure and interest can be obtained by listening on any of the bands allocated to the amateurs, signals from many countries are to be heard at suitable times and at good volume. These bands cover a well-defined section of the spectrum, and, as in the case of the Short Wave Broadcast bands, are allocated by International agreement.

At present Amateurs are to be heard on 3500 kc, 3800 kc, 7000 kc-7200 kc, 1400 kc-14350 kc, 28000 kc-30000 kc, 50 megacycles-54 megacycles.

The first-mentioned band is outside the coverage of the average dual wave receiver, and is known as the 80 metre band. Reception on this band is excellent in the evening, the stations being heard consist of Australian and New Zealand stations, with occasional reception of American stations on CW. The 7000 kc-7200 kc band, known as the 40 metre band, provides good reception throughout the 24 hour period, stations being heard on phone from all over Australia, and, when conditions are right CW signals from more distant parts.

20 Metres Popular

Possibly the most popular of all Amateur bands is that which lies between 14000 kc and 14350 kc, known as the 20 metre band. This is truly an International band, Europeans being heard in the early morning, Interstate stations in the forenoon, and stations from the Americas in the afternoon and at night, with occasional reception of European stations at around nightfall. These latter two bands are, of course, within the coverage of the average receiver.

The 10 Metre band, 28000 kc-30000 kc, is an excellent band for long distance reception, many American and New Zealand stations being heard in the forenoon, while at nightfall African stations are frequently heard and at night European signals are received at good level. Conditions are variable on these frequencies, varying from one day to another making a regular watch on this band desirable. We also mentioned the 50 M/c-54 M/c band, which is an excellent one for local contacts of a few miles. The Amateurs are, however, working on these frequencies in an endeavour to cover great distances. In pioneers, we feel that these contacts will some cases this has been done already, and as more knowledge is gained by these be more frequent.

Converter Necessary

Since the frequencies used in these latter two bands are higher than those of the other mentioned bands, it is desirable to use more specialised equipment, with due regard to reduced capacities in the tuning circuits, and a simple converter can be built up using one of th popular Converter valves, such as the ECH35, which give really good results.

Other allocations have been made on even higher frequencies; these will be announced when ratified by the Governments concerned, and possibly equipment suitable for reception on these frequencies will be described in this magazine.

We would suggest that any readers who are interested in these or any other Amateur frequencies would write to us, we will endeavour to comply with your wishes, and feature those articles which will interest you most.

Identifying Amateur Stations

All Amateur stations are identified by call letters which consist of one or two letters, a number, followed by two or three letters.

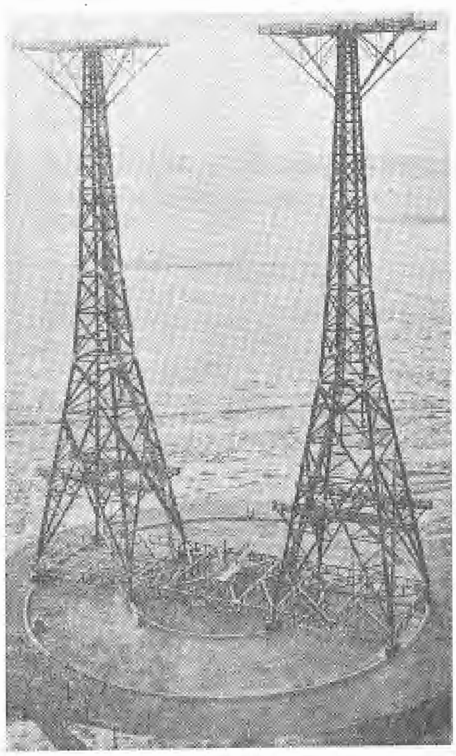
The first two letters denote the country of origin, the number denotes the district of that country, and the following two or three letters are the particular identification of the station.

For instance, the prefix for Australia is VK, this prefix precedes the call of all Australian stations. Australia is divided into eight districts each allocated a number. New South Wales 2, Victoria 3, Queensland 4, South Australia 5, Western Australia 6, Tasmania 7, Central Australia 8, and finally New Guinea and Papua 9.

Therefore, a station giving the call VK4AAA, is known to be located within the boundaries of Queensland, Australia.

Some of the more frequently heard prefixes are as follows:—

C — China	J — Japan
D — Germany	PA — Holland
F — France	SM — Sweden
G — Great Britain	U — Russia
HB — Switzerland	VU — India
I — Italy	W — America



The unusual antenna system used by Station PCJ, Hilversum, Holland. The two masts can be moved around on the circular track, allowing the transmission to be beamed in any desired direction.

Courtesy Philips (Aust.) Ltd.

WWV SCHEDULES

National Bureau of Standards (America) makes available a continuous service of Standard Frequency transmissions over its station, WWV, the following being the schedule now in operation.

The accuracy of all frequencies, radio and audio, is better than one part in 50,000,000; the time interval marked by the pulse every second is accurate to 1/1,000,000 second.

These frequency standard transmissions are invaluable in checking the calibration of a receiver, since at least one is always audible a continuous check is available.

The call of the station is given by voice at precisely the hour and half-hour, together with details of location, frequency and power. The National Bureau of Standards will acknowledge reports on its transmissions.

Frequency.	E.P.S.T.	Power Output (Kw).	Audio Frequency.
2.5 M/c	4 a.m.-6 p.m.	1	440
5.0 M/c	4 a.m.-4 p.m.	10	440
5.0 M/c	4 p.m.-4 a.m.	10	440 & 4000
10.0 M/c	Continuously	10	440 & 4000
15.0 M/c	„	10	440 & 4000
20.0 M/c	„	.1	440 & 4000
25.0 M/c	„	.1	440 & 4000
30.0 M/c	„	.1	440
35.0 M/c	„	.1	440

LISTEN FOR THESE STATIONS

Chungking Radio

The International Broadcasting Station, Chungking, China, is one of the many stations heard consistently in this country, but few realise the difficulties under which this station operated throughout the war years.

China, over-run by the Japanese, was no healthy spot for the station staff, but the whole station was moved to a mountain hide-out, and was, in fact, installed in a tunnel far under the mountains, only the aerial systems remaining on the surface. Elaborate precautions were taken with the construction, with the result that XGOY, Chungking, was heard continuously over a very wide area.

New transmitters have now been installed, and XGOY now operates on many frequencies, the following being their schedule at the time of writing. 11913 kc, 25.18 m.: 6.55 p.m.-8.30 p.m., beamed to Australia, New Zealand, and S.E. Asia. 7153 kc, 41.96 m.; 8.35 p.m.-10.35 p.m., to Eastern Asia and the South Seas. 9658 kc, 31.06 m.: to Eastern Asia and the South Seas. Other frequencies which are used are 6143 kc, 6154 kc, 9653 kc, 15175 kc.

XGOY verifies correct reports, the address being as at the head of this paragraph.

PCJ, Hilversum

Possibly one of the most colourful stations operating over the past years, PCJ, is heard extremely well in its Pacific Service, on 15220 kc, and 17770 kc, daily, between 7 p.m. and 8.30 p.m. The announcer, Edward Startz, is one of the real personalities of radio, a multi-linguist, and has the rare capability of pleasing all types of listeners.

Mr. Startz is always ready and very willing to call his listeners in his sessions, and a nice verification is sent out in reply to reports.

Your reports should be addressed to Nederlands Overseas Service, Station PCJ, Hilversum, Holland.

Vienna

From the City of the Waltz news comes that a short wave service is in operation, but, unfortunately, the power used is only low. No schedules are available at this stage, but indications are that these stations would be heard in the early morning in this country.

The following are the details: WEIN 1, 6155 kc, 300 watts; WEIN 2, 7175 kc, 250 watts; WEIN 3, 9664 kc, 250 watts; WEIN 4, 11785 kc, 200 watts.

Reports on their transmission will be welcomed and should be sent to Mr. H. Hartuer, General Secretary, Osterradiover kehrs, Rovag, Argentinaerstrabe 30a Vienna 4.

A.F.R.S., U.S.A.

Fine programmes will always have a vast listening audience, this applies as much to the Armed Forces Radio Stations as to any other, the excellence of their presentations being unequalled by any from any other station. Their programmes are designed to entertain the members of the American Forces scattered throughout the world, and with this end in view are carried on a number of channels. Practically all are heard at good level, the details being as follows:

KCBA	15150 kc	1.15 p.m.- 6.45 p.m.
KCBF	11810 kc	1.15 p.m.- 6.45 p.m.
KGEI	15130 kc	3.30 p.m.- 8.30 p.m.
KGEX	17780 kc	3.30 p.m.- 6.45 p.m.
KWID	11900 kc	3.30 p.m.- 9.30 p.m.
KWIX	11890 kc	7.00 p.m.-12.30 a.m.
KCBA	15330 kc	7.00 p.m.-12.30 a.m.
KCBF	9700 kc	7.00 p.m.-12.30 a.m.
KGEI	9530 kc	8.45 p.m.-12.30 a.m.
KNBX	15330 kc	3.30 p.m.- 6.45 p.m.
KWIX	9570 kc	1.15 p.m.- 6.45 p.m.

All these stations broadcast a news bulletin on the hour, just prior to which individual station identification is given.

C.B.C. Schedules

Located at Sackville, with studios in Montreal and other centres, the Canadian Broadcasting Corporation maintains a short wave service which is heard well in Australia.

The latest in radio equipment and the ultimate in aerial design—a vast system of Beam Aerials being employed—all combine to the excellence of transmission.

The stations and schedules at present in use are:

CKNC—17820 kc—11.45 p.m.-9 a.m. (Monday from midnight).

CKCS—15320 kc—2 a.m.-9.5 a.m.

CKCX—15190 kc—Midnight-2 a.m. To Latin American countries 9.20 a.m.-10.10 a.m., 10.35 a.m.-12.5 p.m.

CKRA—11760 kc—9.20 a.m.-10.35 a.m.

CHOL—11720 kc—7.15 a.m.-9.5 a.m.; Sunday only, 5.45 p.m.-7 p.m.

CHLS—9610 kc—5.45 p.m.-7 p.m., Sunday only.

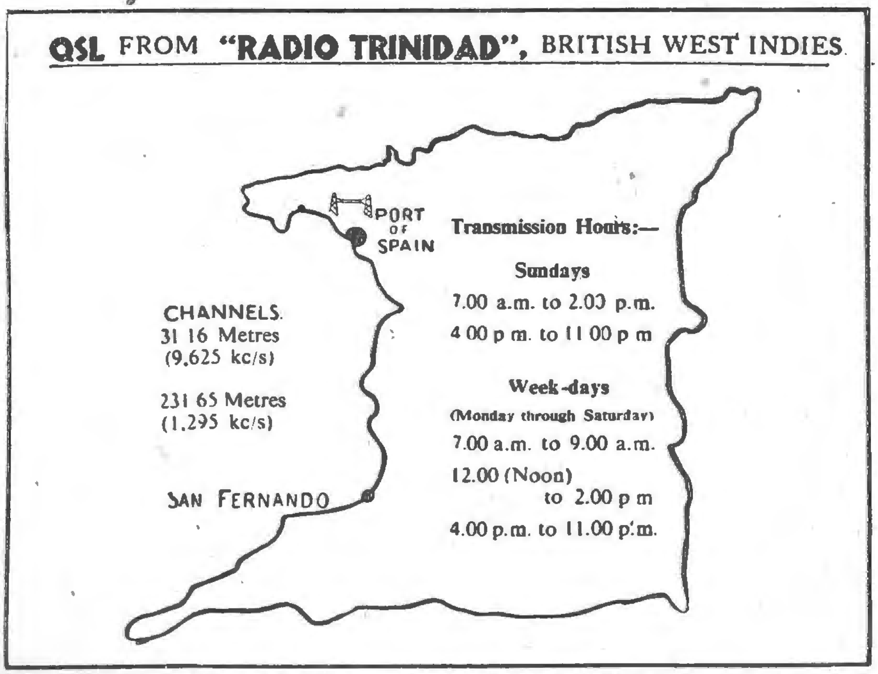
Send all reports to Canadian Broadcasting Corporation, Montreal, Canada.

Port-of-Spain, Trinidad

A little-heard country is Trinidad, but recently a station located at Port-of-Spain has been heard weakly.

The station identifies with the call letters VP4RD, and operates on 9645 kc, its announced frequency being incorrect at 9625 kc. The schedule is 9 p.m.-11 p.m., 2 a.m.-4 a.m., and 6 a.m.-1 p.m. Best time to listen for this one is from 9 p.m. and at 6 a.m. The address is Radio Trinidad, Broadcasting House, Port-of-Spain, Trinidad, British West Indies.

In this case it is advisable to send an International Reply Coupon.



The verification card issued by the recently heard "Radio Trinidad" located at Port-of-Spain, Trinidad.

Technical BOOK REVIEW

FREQUENCY MODULATION ENGINEERING

By Christopher E. Tibbs, A.M.I.E.E., A.M. Brit.I.R.E.; published by Chapman and Hall Ltd. Stiff cover, 310 pages. Price, approx. 48/6, plus postage.

As stated in the preface, "this book is intended to provide students, engineers and all those interested with a concise and readily digestible survey of the whole field of frequency modulation engineering." This it does in an admirable manner.

Although mainly treated from the radio engineer's point of view, and making a wide use of mathematics, the style is particularly lucid with the result even the not-so-technical reader can obtain much valuable information from this book.

The treatment of subjects is orthodox—after commencing with a discussion of the various forms of Modulation and their relative advantages, chapters on Interference Structure and Suppression, Propagation and Aerials are dealt with in turn. This is followed by actual equipment details—FM transmitters, Limiters and Discriminators, FM receivers and an interesting chapter on FM equipment measurement and alignment.

The final chapter deals entirely with some practical applications of this system, and whilst considered from the 40-50 mc. band point of view, is equally applicable to the 88-108 mc. band now being used.

An excellent book for all interested in this improved form of broadcasting.

RADAR AIDS TO NAVIGATION

Radiation Laboratory Series. Published by the McGraw-Hill Book Co. Inc. Stiff cloth cover, 389 pages. Price, approx. 35/- plus postage.

This is the second book in the series of twenty-six now being produced by the M.I.T. and covering the electronic research and developments carried out by that Institute during the war years.

As the title suggests, this book is primarily devoted to the description of the advantages and limitations of radar equipment as applied to either land, sea or air navigational problems. It is the concentrated effort of some thirty-three authors and others—all specialists in this field, and consequently the reader is given a comprehensive and accurate picture of all available radar techniques.

Although written mainly to provide those expressly interested in this field of research with a sound knowledge of developments to date, non technical language is used for the main part, making it of interest to the general radio enthusiast.

WIRELESS DIRECTION FINDING

By R. Keen, M.B.E., B.E. Published by Iliffe and Sons Ltd. Stiff cloth cover, 1,059 pages. Price, approx. 77/6, plus postage.

Now in the fourth edition, this text is still probably the most authentic and widely read book on the subject. The scope is most comprehensive, covering all phases of direction finding, and as a complete bibliography is included, is a valuable aid to students, radio operators, DF maintenance and construction personnel as well as to the non specialist reader.

Much of the present text has been revised and re-written to incorporate post-war developments, and new sections include those dealing with the design and testing of HF radiogoniometers, Adcock aerial transmission line theory and hyperbolic navigation systems. This section describes the operation of Gee, Loran, Decca and Consol systems, which were originally developed for wartime application.

The entire subject has been presented in an orderly and progressive fashion, and is well recommended to the technician interested in this field.

All copies from Angus & Robertson Ltd., 89 Castlereagh Street, Sydney.

FREQUENCY MODULATION

(*Continued from page 20*)

Under the conditions when the carrier frequency is exactly the same as the frequency to which the primary or secondary windings are tuned—usually the IF frequency—the voltage developed by magnetic induction will be almost exactly 90 degrees out of phase with that developed by means of the capacitive coupling. Since these two voltages are equal in magnitude the rectified voltage will be equal and opposite in value between the two cathodes and point O. Consequently the voltage across AG is then zero and no audio voltage will be developed.

If the frequency changes due to an impressed signal the capacitive voltage fed to each plate will be the same, but that due to magnetic induction will shift in phase and so the voltage drop across the load resistors will be unequal as the modulated frequency varies above and below the resonant frequency, usually referred to as the centre frequency. The resultant voltages across both diode load resistors are no longer equal, so the difference between the rectified valves appears between points A. and G. An increase in frequency results in A becoming negative with respect to ground whilst a decrease makes A positive with respect to ground.

The degree of modulation or frequency swing determines the magnitude of this voltage difference as well as the rate at which the IF signal swings above and below the centre frequency. This produces the audio voltage, which is then amplified in the usual manner.

F.M. ENGINEERING TERMS

ANTENNA GAIN

The ratio of power radiated in a desired direction by a directive antenna to the radiation in the same direction by a non directive antenna.

CENTRE FREQUENCY

The FM carrier frequency before modulation. The modulated signal is impressed on this carrier, and the instantaneous frequency varies constantly about this centre frequency as a mean value.

DE-EMPHASIS

The decrease in loudness of high notes in a receiver.

DEVIATION RATIO

The ratio of the number of cycles per second change in carrier frequency to the number of cycles to the highest modulating signal when the latter is at maximum amplitude. In this country thePMG has set a maximum of 75 kc. deviation above or below the centre frequency. Consequently, if the highest frequency signal used is 15 kc., the deviation ratio is 75/15 or 5.

DISCRIMINATOR

The valve and associated circuit in the FM set used to convert the frequency modulated wave to audio amplitude modulation.

FREQUENCY DEVIATION

The frequency shift each side of the mean carrier frequency. It is proportional to the amplitude of the modulating signal.

INTER-CHANNEL INTERFERENCE

Interference with reception in one channel caused by radiation in nearby channels.

A special circuit used to prevent amplitude variations from reaching the discriminator. Even though the FM waves are transmitted at constant amplitude they frequently become amplitude modulated by noise, undesired carriers, etc., before reaching the receiver. This AM effect must then be removed by the Limiter to prevent distortion.

MODULATION INDEX

The ratio of the frequency deviation to the modulating frequency for any signal being considered.

POLARIZATION

Generally refers to the plane of the electric field of an electro-magnet wave with respect to the direction of propagation. For example in the case of a wave consisting of an electric field whose lines of force are vertical and a magnetic field whose lines of force are horizontal, both being at right angles to the direction of propagation then the wave is said to be vertically polarised. If the electric field and magnetic field are interchanged the wave is said to be horizontally polarised.

PRE-EMPHASIS

The boosting of loudness of high notes over low notes in a transmitter so as to equalise signal to noise ratio over the audio frequency band.

REACTANCE TUBE MODULATOR

The valve and circuit used to change amplitude modulation to frequency modulation by variation of the plate circuit reactance in step with changes in the amplitude of an impressed signal.

SQUELCHING

Eliminating noise reception when no signal is present. Unless a squelch circuit is incorporated to shut off the receiver at such time a roaring sound will be heard.

TIME CONSTANT

The standard set for pre-emphasis—at present 76 microseconds.

QUIZ ANSWERS.

(1) The nominal voltage ratings are (a) 1.5 volt, (b) 1.2 volt, (c) 1.34 volt, (5) 2.0 volt,

(2) a. The law states—in every case of electromagnetic induction the induced current will flow in such a direction that the magnetic field produced by it tends to oppose the "motion" producing the current.

(3) c. The term usually applied to the negative cloud of electrons surrounding the filament or cathode in a valve.

(4) b. Immediately above a vertical radiator there is a no signal area—a fact made use of on airway radio range systems to provide a positive identification point to aircraft.

(5) d. (6) b.

(7) a. Usually operated under class A conditions and used between the oscillator and PA stage in a transmitter.

(8) b. A high frequencies this constitutes a loss source because the current only travels over the skin or surface of the conductor, thereby decreasing the effective current carrying area and so increasing the resistance to current flow.

(9) b. Early experimenters compared the current flow to water—that is it flowed from the source of highest potential to the lowest, and named these two terms positive and negative. Later research proved the existence of the electron as the actual moving particle and as this moved from negative to positive sources apparently contradicted the old analogy.

(10) e. This is due to the higher conductivity of the sea compared to the land masses.

(11) c. Although this image may later be projected by a lens system onto another surface it is primarily received on the face of the kinescope—that is cathode ray tube.

(12) c. Interference, late signal reception due to reflections, etc., all cause a break up of the picture element and this is generally referred to as "ghosts."

(13) (a) mega, (b) micro, (c) milli (d) micromicro, (e) metres, (f) milli.

(14) d. (15) b.

WHEN A WIRELESS MAN IS IN TROUBLE

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