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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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EDITORIAL COMMENT

Broadcasting and Television Technique

Two Distinct Arts

WHEN broadcasting first began the technique of microphone performances was new and it took many years of development before broadcasting became a distinctive art, where the disability of the audience was overcome and plays could be produced which in many cases actually gained in entertainment value through the absence of the sense of sight. The same thing, of course, happened—though in the reverse order—with the development of the film. Actors in the silent film had to make up for the absence of sound, and effects had often to be produced in quite an elaborate manner to put over ideas which the addition of speech or sound would have made possible with much less effort. A great deal of the silent film technique was thrown overboard as soon as sound accompanied the films.

This leads us to conjecture what the effect upon broadcasting technique may be of the advent of television.

At first, of course, television will play only a very small part in the broadcasting picture. Transmissions will be of short duration and probably films will supply much of the material of the broadcasts. But if, and when, public interest demands a fuller television programme, it might eventually accompany nearly all broadcasting.

If this happens, will the present highly developed technique of broadcasting have to make way for the new order of things, just as happened with the advent of the talkies?

There is, however, this big difference. When the talkies arrived the change-over was fairly sudden and complete. The silent film died so quickly that it

was very soon forgotten. There was no interval of overlapping. From the nature of things television development will be gradual and may very likely never displace normal broadcasting with its special technique. One of the charms of broadcasting to-day lies in the fact that aural concentration only is necessary on the part of listeners. The idea of having to concentrate on a picture at the same time in order to follow a performance will not be welcomed unanimously.

The technique of broadcasting without television should not be neglected, and this suggests that the production of material for sound broadcasts should not be mixed in with television but be run on independent lines, with independent staffs, at the B.B.C. Unless this is done we stand in grave danger that all the work so far done on developing a special microphone art will be lost to us, whilst television still remains in an undeveloped and not really satisfying state, and therefore unfitted to replace it.

Television

A Free Booklet

NEXT week's issue will, we believe, prove of special interest to our readers.

Recognising the fact that there is at the moment a very widespread interest in television and that comparatively little sound information is available to the public on the subject, we have prepared a booklet for free distribution with the issue of March 8th.

Our aim in compiling the booklet has been to explain the principles of television, with particular reference to the cathode ray high-definition system. The booklet also discusses the general aspects of the subject with a view to giving the public a clear idea as to what to expect when the transmissions begin.

Television Scanning by Cathode Ray

Amplification by Electron Multiplication

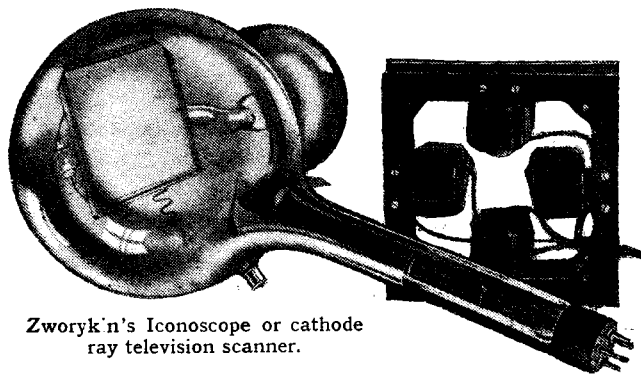
A DESCRIPTION of the "Image Dissector," which comprises a special type of cathode ray tube, used in conjunction with suitable optical apparatus for direct scanning of scenes to be transmitted by television

A PREVIOUS article on cathode ray television¹ dealt with the general principles of two-dimensional scanning by two saw-tooth voltages and the formation of the picture image on the screen by variation of the instantaneous intensity of the fluorescent spot from point to point. The same article referred to methods of cathode ray scanning at the transmitter, where the advantages of absence of mechanical moving parts and the response to very

the camera. Both effects are already familiar in cinema photography, and the exponents of the cathode ray scanner suggest that these effects in studio or outdoors can easily be obtained by electrical means, at least within fair limits.

So far, two main methods of cathode ray scanning of direct scenes have been proposed. Both have common features in that they both use a photo-electric device and a bundle of electrons, but they differ in the manner of their combination.

One of these devices is the Zworykin Iconoscope, developed in America by the R.C.A. Company, with which the E.M.I. Company in this country is allied. As described in a recent article, this essentially comprises the cathode and beam-producing system of a cathode ray tube, in conjunction with a photo-electric anode. The beam is capable of being moved in two dimensions of deflection—for line scanning



Zworykin's Iconoscope or cathode ray television scanner.

high-speed variations are obviously just as important as at the receiver.

One of the greatest problems awaiting solution in the practical working of television is that of the direct scanning of moving scenes, and there are not a few who pin their faith to the cathode ray tube as the most immediate, and possibly also the most final, solution of this problem. Apart from the fundamental advantages mentioned above, there are further attractive points in the use of the cathode ray tube as a direct scanner. From its size and general shape it can very conveniently be accommodated in a camera structure, where the absence of moving parts is again a practical advantage. In the methods so far proposed the image of the scene is normally focused on a photo-electric surface, and another advantage which arises with the cathode ray tube is the ease with which the size of the picture scanned can be varied to give the impression of the backwards and forwards movement of the camera, while it can also be moved about, giving the impression of rotating

and picture framing—by means of saw-tooth voltages, in the manner also discussed in the previous article. The anode consists of a sheet of fine photo-electric mosaic on which an optical image of the scene is focused. The finely pointed cathode beam, under the influence of the scanning motions, then sets up current impulses proportional to the illumination of the different parts of the anode mosaic

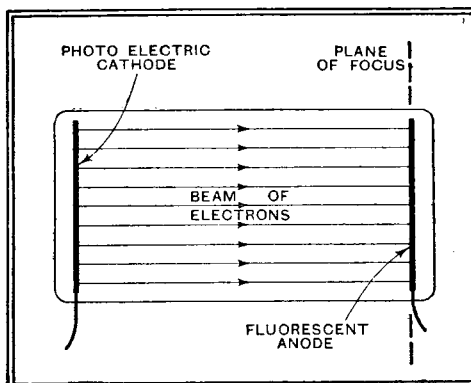


Fig. 1.—Principle of the Farnsworth photo-electric cathode ray tube for television scanning.

over which the beam travels in the course of its scan.

A less-known cathode ray scanner, also of American origin, is the image dissector of P. T. Farnsworth, who has been a consistent exponent of cathode ray methods. So far the device is fairly new in this country, but it is almost an open secret that it will make its public appearance in British practice before long; that is, if Press reports on recent Baird developments are to be logically interpreted.

The Farnsworth scanning unit is also

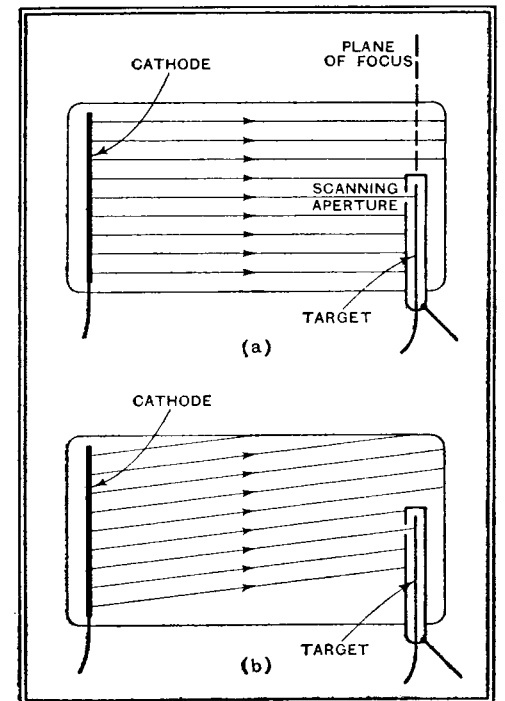


Fig. 2.—Farnsworth photo-electric "image-dissector," illustrating the process of scanning through an aperture in a screen surrounding the anode-target.

essentially a combination of the photo-electric cell and the cathode ray principle, but in this case the photo-electric effect is at the cathode. In this respect it conforms to the conventional photo-cell. It also conforms to the conventional cathode ray tube in that the electron beam given off by the cathode is deflected in the ordinary manner of the cathode ray tube, and different parts of it are caused to give different effects in a "target" anode for purposes of television scanning. The electrons are, of course, generated by photo-electric means instead of thermally, but they are still electrons; they are also in a broad beam instead of the fine pencil of usual cathode ray practice.

The essential features of the Farnsworth image-dissector are illustrated in Fig. 1. The cathode is in the form of a disc

¹ *The Wireless World*, February 22nd, 1935.

Television Scanning by Cathode Ray—

of about ¼ in. diameter, with its surface made photo-electrically active by the normal sensitising methods used for silver-oxide-cæsium cathodes in ordinary photo-cell practice. An image of the picture or scene to be scanned is optically focused on to the photo-electric sensitised surface, when it will be realised that electrons will be emitted from the various points of the surface, in accordance with their respective degrees of illumination. These electrons will be urged in the direction of a positive electrode (anode) at the other end of the tube. They will, however, tend to diverge for a large variety of reasons which need not be considered here, but they can be constrained to form an electron focus of the image in a plane parallel to that of the cathode.

Focusing the Beam

This focusing process is actually done by means of an external magnetic field from a solenoid winding surrounding the tube, the arrangement being one already known as an alternative, or auxiliary, method of focusing the electron beam in the ordinary type of cathode ray tube. Great care is necessary, however, in the case of the image dissector to ensure that an undistorted and focused electron image of the cathode is produced at a plane within the tube, as indicated in Fig. 1. If we have, in this plane, an anode whose surface is coated with a fluorescent material, then an image of the picture optically focused on the cathode is reproduced electrically on the fluorescent anode. This is the condition indicated in Fig. 1; actually the electron beam is not kept parallel all the way (as it is shown in Fig. 1) but is arranged by the outside coil, already mentioned, to be brought to a focus on the anode.

While the electrode system of Fig. 1 is thus suitable for producing an "electron image" in the plane of the anode, it will be seen that it is not suitable for the progressive scanning necessary for television. This scanning is effected by enclosing the anode or target electrode in a screening structure with a very small "scanning aperture" (actually 0.015 inch) as shown in Fig. 2. It will then be seen that only a very small part of the electron beam coming from the cathode can, at any instant, reach the anode through this aperture, giving in the anode circuit an electron-current response proportional to the illumination of that particular part of the cathode.

To obtain scanning it is then only necessary to move the electron beam so that electrons from every point on the cathode are brought successively to

impinge on the target. This is done by additional coils outside the tube which apply a magnetic field giving transverse deflections to the electron beam. This process is, of course, also a well-known method of deflecting the beam of an ordinary cathode ray tube, as was described in recent articles on the cathode ray tube generally. It can be followed by examining the difference between (a) and (b) of Fig. 2, where it will be seen that quite a different part of the photo-electric cathode beam is being allowed to reach the target anode. For scanning of an actual scene two directions of deflection are used, as in general methods of cathode ray scanning, i.e., a low-speed vertical "picture framing" scan and a high-speed horizontal line scan, both being of "saw-tooth" shape and applied by the coils already mentioned. For scanning a cinema film, the framing scan is provided by the continuous motion of the film, and only the line scan is then necessary.

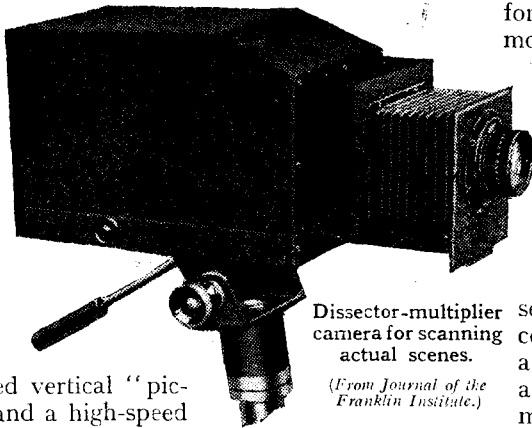
In addition to the image-dissector, Farnsworth uses another interesting device which he calls an "electron multiplier." The action of the device is rather complicated, but it can be stated that it depends on the production of secondary electrons. It is well known that when an electron stream is directed against a metallic surface it tends to cause the emission of secondary electrons. The secondary electrons emitted may actually exceed the primary in number if the latter have sufficient velocity. In practice, in Farnsworth's multiplier, this is used by causing the initial electron stream to be directed against an emissive surface, giving off as many secondaries as possible under the primary impact. These secondaries are then directed against a similar surface, and this process is repeated as many times as desired, and the total electron flow is finally collected. The process is somewhat akin to several stages of valve amplification except that, beginning with small values of electron current, it can be arranged for several stages of the process to occur inside one tube. Farnsworth, indeed, combines the image-dissector and electron multiplier in one tube, which is seen in one of the photographs illustrating this article. The target of the image dissector then becomes effectively the source of primary electrons

used in the multiplier section of the tube. So far the device is new and appears to be relatively little developed. It seems, however, to offer considerable possibilities in the general field of electronic practice. In the application described above its operation is effectively that of ordinary voltage amplification, but it is understood that it can also be arranged for operation as an oscillator, modulator, and also as a

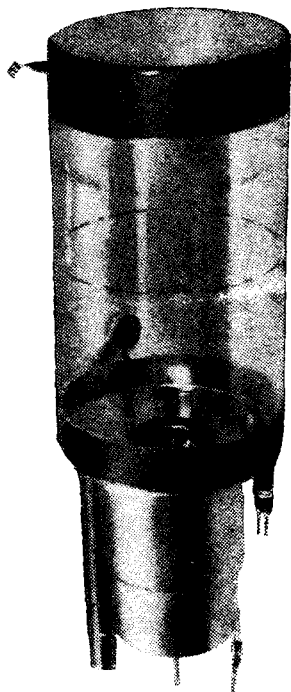
rectifier. Further information on the more general technical development of the device will therefore be awaited with interest.

For practical television working it has the advantage of serving as a very convenient "first amplifier" closely associated with the modulating output immediately at its

point of generation. In scanning a cinema film, where a strong light source is available, it is understood that the simpler type of image dissector (illustrated in principle in Fig. 2) is used. For scanning of a direct scene a tube of the combined type is used, housed in a camera which gives direct focusing of the scene on to the photo-electric cathode. A camera of this type is shown in another of the photographic illustrations accompanying this article, and it is understood that its adherents express great confidence in the combined electronic device as a scanner for direct scenes both in the studio and outdoors.



Dissector-multiplier camera for scanning actual scenes.
(From Journal of the Franklin Institute.)



Farnsworth image dissector and electron multiplier tube.
(From Journal of the Franklin Institute.)

**The Wireless World
TELEVISION GUIDE**

**A FREE BOOKLET
— NEXT WEEK —**

Next week's issue will contain a free booklet on Television, prepared with the object of giving the public a clear understanding of the principles of Television, and in particular the cathode ray system which will be employed in the new high-definition transmissions.

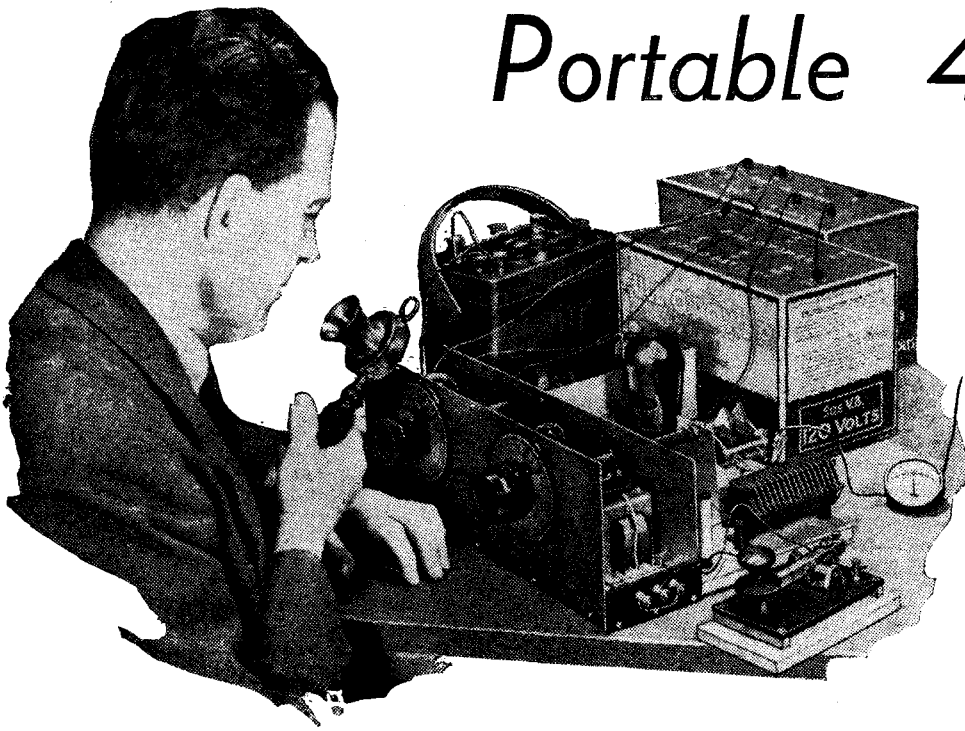
The booklet does not assume technical knowledge on the part of the reader, and is, therefore, suited to the requirements of those of the general public who wish to take an intelligent interest in the new subject.

Please tell your friends, so that they may obtain copies of THE WIRELESS WORLD of March 8th, containing the booklet, for themselves. It would be wise to ask newagents, in advance, to reserve copies.

Portable 40-Metre Transmitter

Circuits and Constructional Details for Low-power Battery- operated Telephony and C.W. Sets

(By courtesy of the General Electric Co., and compiled
by the G.E.C. Research Staff, Wembley.)



THIS short-wave transmitter designed for battery operation embodies the minimum number of valves necessary to obtain a satisfactory performance. The refinement of a master oscillator is justified in that it provides a steady signal which is far easier to copy at a distance than one from a more powerful station but varying in strength. For telephony a Class "B" amplifier gives ample output to modulate the oscillator, yet it is economical in its demands from the battery. A licence must be obtained, of course, from the Postmaster-General before experiments are made with transmitting apparatus.

OF the several wavebands allotted to the amateur transmitter the 7.5 mc, or the 40-metre, is perhaps the best for the beginner, since it is sufficiently high up in the radio spectrum to enable useful data to be compiled on the operation and handling of short-wave transmitters. The scope of the amateur lies mainly in investigation in fields not fully explored by commercial interests, yet experience must first be gained, and this is best acquired on a wavelength which is popular, for in those fields where prearranged experiments are

A low-power set equipped for CW and telephony transmission is ideal for this purpose, and if battery-operated has the advantage of portability for use in the open country when weather permits. Either of the transmitting sets mentioned in this article would satisfy these requirements, for they are battery-operated and economy in HT current is effected by using a Class "B" modulator, while provision is made to key the oscillator for CW work.

Short distance communication which would make use of the ground wave and,

by these sets, good reports of telephone signals having been received from several European countries, but so far the extent of the CW range has not been fully explored.

The three-valve set is the simpler of the two as it embodies a self-excited oscillator, while the four-valve model is fitted with a master oscillator driving an HF power amplifier. The modulating circuit is the same for both, and so also is the keying arrangement. Reports reveal that signals from the drive-controlled set are perfectly steady, being comparable to crystal control, and a swaying aerial appears to have no appreciable effect on the received signals.

The complete circuit of the three-valve transmitter is shown in Fig. 1. A PX4 valve serves as the oscillator while a LP2 and a B21 combine the function of a Class "B" modulating stage. The microphone with its associated battery and transformer are external, but if no more than 4 volts are required in the microphone circuit this may be drawn from the common LT battery. The 2-volt LP2 and B21 valves have their filament connected in series, the driver valve being nearer the LT positive so that it derives a slightly greater negative bias on its grid when coupled up to the 6-volt biasing battery which is common to both valves. A switch is included in the positive LT lead, cutting off the entire filament supply, but if telephony transmission is required only occasionally an

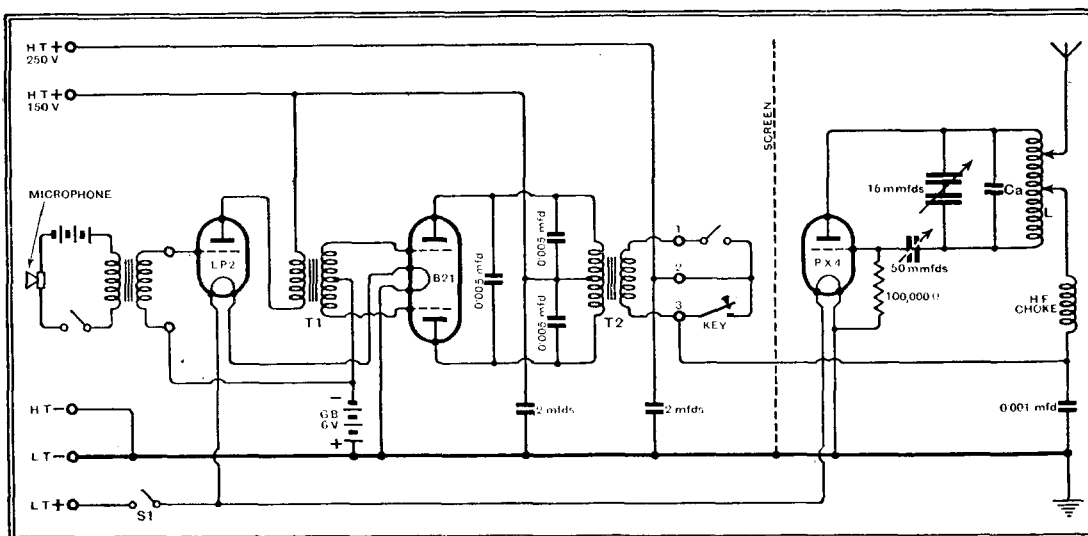


Fig. 1.—The circuit of the three-valve transmitter.

being conducted it may prove difficult to make contacts and obtain reports on the tests the operator has planned.

therefore, not be subject to serious variation, can be taken as about ten miles, but quite long distances have been covered

Portable 40-metre Transmitter—

additional switch could be included to isolate the LP2 and B21 valves.

The LF output from the modulator is fed to the HF power oscillator *via* the

the PX4, which valve is prevented from oscillating of its own accord by a neutralising circuit comprising a portion of the coil L1 and a small neutralising condenser.

The tuning of the drive circuit and of

quired here is 80 micro-microfarads.

A simple baseboard form of construction is adopted, the master oscillator and the power amplifier are assembled at the back with a vertical aluminium partition be-

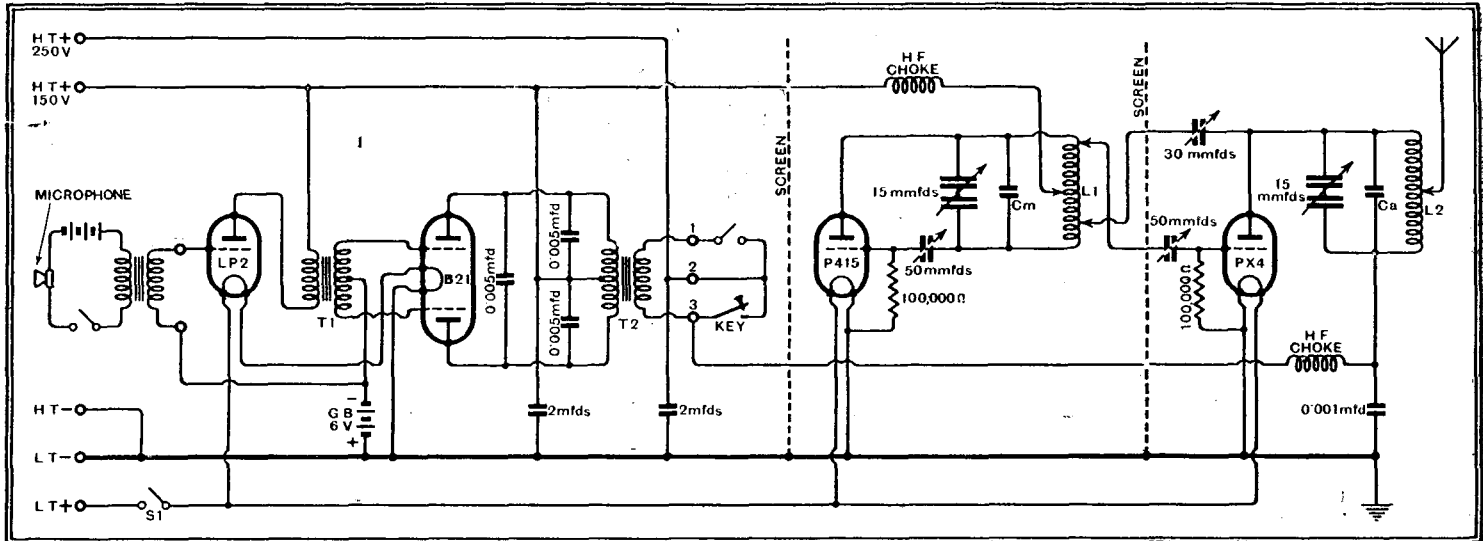


Fig. 2.—The four-valve transmitter embodies a master oscillator, and the complete circuit is shown above.

secondary of the output transformer, which is joined in series with the oscillator valve anode. A switch in the HT feed lead to the oscillator connects either the secondary of the LF output transformer or a signalling key in circuit.

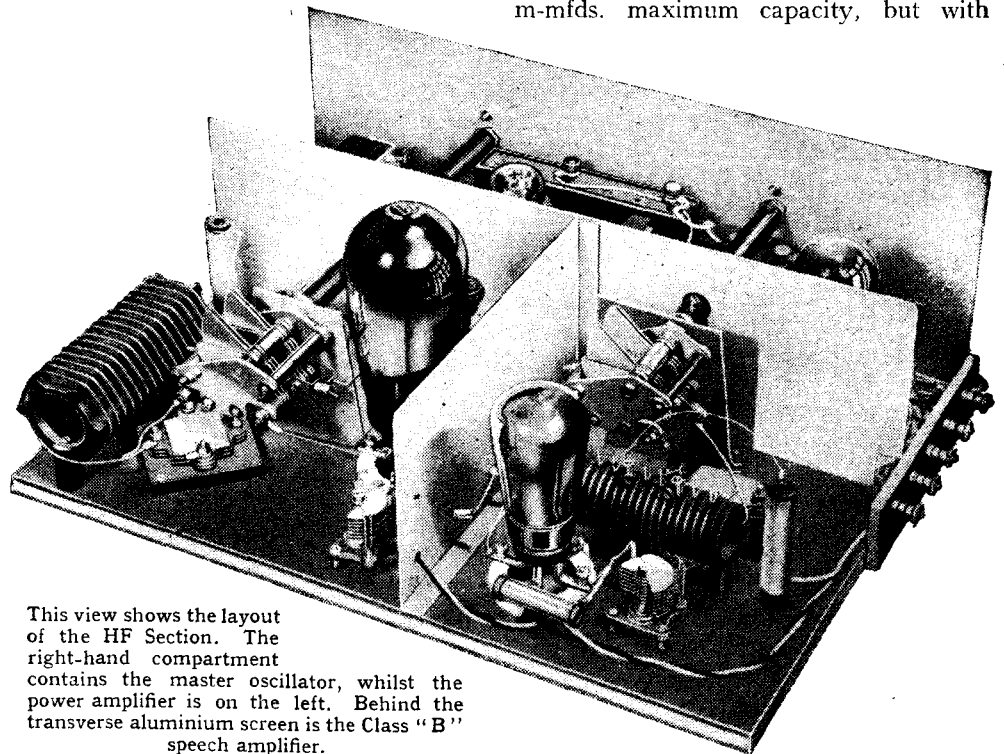
It is not proposed to give very full details of the smaller set, as apart from the modulating equipment the circuit is so straightforward that the theoretical diagram is in itself a sufficiently good guide. The single tuning coil is the same as fitted to the larger set in the power amplifier circuit. Detailed drawings of this coil will be given later. It will suffice to say that the filament consumption is 1.2 amps at 4 volts; the oscillator anode current at 250 volts is 30 to 35 mA., while the modulator requires 150 volts HT and the average current is about 11 mA.

The circuit of the larger set is arranged as in Fig. 2. In this design a low-power oscillator fitted with a P415 valve drives

the amplifier circuit is effected by a fixed condenser, Cm in the one and Ca in the other, with a small variable in parallel. A Cyldon "Bebe" condenser of the series-gap type is used here and connection is made to the fixed plates only. Details of the two fixed capacities are given in the

tween them and the modulation equipment occupies the front part, being separated from the HF oscillator by an aluminium screen extending the full width of the set. The baseboard of this compartment is lined also with aluminium, and a panel of the same material is used.

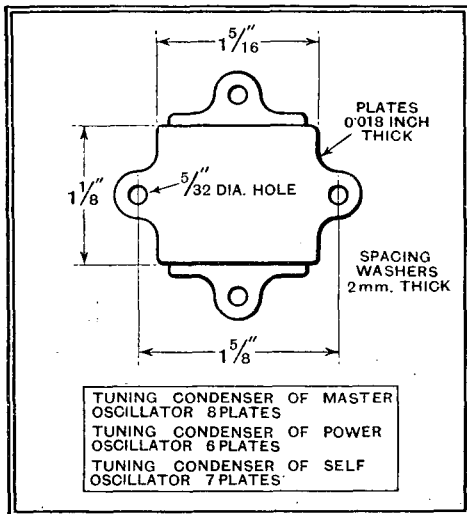
The tuning condensers are each of 25 m-mfds. maximum capacity, but with



This view shows the layout of the HF Section. The right-hand compartment contains the master oscillator, whilst the power amplifier is on the left. Behind the transverse aluminium screen is the Class "B" speech amplifier.

drawings, but if the constructor finds difficulty in cutting the brass vanes it would be possible to assemble them from the plates used in the Ormond air-dielectric condenser. Although this component is now no longer available, plates and spacing washers can still be obtained from the Ormond Engineering Co., Ltd., and four are needed for Cm, which is 60 micro-mfds., and five for Ca as the capacity re-

the series-gap connections the capacity is reduced to about half this value. They are fitted with long ebonite extension rods passing through clearance holes in the vertical screen and terminate in slow-motion drives attached to the front panel. An on-off switch comprises the only other control on the panel, as the variable grid condensers and the small neutralising condenser in the power amplifier circuit are



Dimensional drawings of the fixed capacities that are joined in parallel with the variable condensers to tune the master oscillator and amplifier circuits.

Portable 40-metre Transmitter—

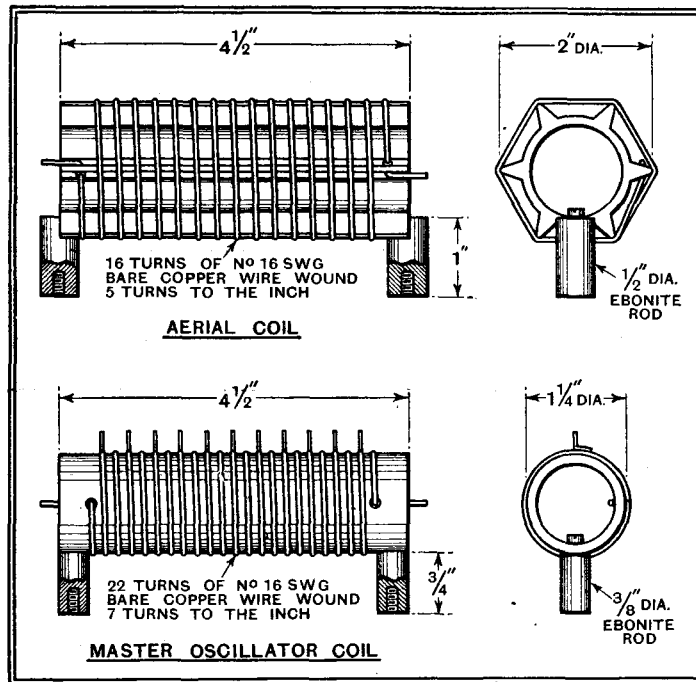
mounted on the baseboard. A long insulated screwdriver consisting of an ebonite rod with a small metal tongue inserted into a saw-cut at one end should be employed for making the necessary adjustments.

Standard short-wave HF chokes could be fitted if desired, though those actually used in the set illustrated were constructed by winding a single layer of No. 40 SWG DCC wire on an ebonite tube $\frac{1}{2}$ in. in diameter and $2\frac{3}{4}$ in. long, the winding occupying $2\frac{1}{4}$ in. One end is plugged with wood to take a screw and they are mounted vertically on the baseboard.

As constructional details of the master oscillator and the aerial coils are given in the drawings there is no need for a full description here; it will suffice to say that if facilities are not available for cutting a screw thread on an ebonite tube for the oscillator coil a ribbed former can be used and shallow saw-cuts made in two opposite ribs to give the correct spacing and to position the turns.

Alternate turns of the master oscillator coil have soldered to them short lengths

of No. 16 SWG wire to serve as tapping points. The coils are mounted on ebonite pillars $\frac{1}{2}$ in. in diameter and cut to the length given in the drawings. They are drilled and tapped each end for 4BA screws. An alternative mounting can be found in the small stand-off insulators obtainable from those firms specialising in short-wave components.



Details of the two coils required for the four-valve set; the aerial coil only is needed for the three-valve model.

LIST OF PARTS

After the particular make of component used in the original model, suitable alternative products are given in some instances.

- 2 Variable Condensers, 25-mmfd., with baseboard brackets **Cyldon "Bebe" Series-Gap**
- 2 Slow motion Condenser drives **Utility Micro-dial W181** (Graham Farish, Ormond)
- 2 Air dielectric trimmer condensers, 65-mmfd. **Eddystone 978**
- 2 4-pin Valve holders, short-wave baseboard type **Eddystone 951**
- 1 4-pin Valve holder, baseboard type **W.B. "Rigid"**
- 1 7-pin Valve holder, baseboard type **W.B.** (Benjamin, Bulgin, Eddystone, Goltone, Wearite)
- 2 Resistances, 100,000 ohms, 1 watt **Amplion** (Dubilier, Erie, Ferranti, Claude Lyons, Polar-N.S.F.)
- 2 Fixed condensers, 0.005 mfd. **T.C.C. Type "S"**
- 1 Fixed condenser, 0.005 mfd. **T.C.C. Type "M"**
- 1 Fixed condenser, 0.001 mfd. **T.C.C. Type "M"**
- 1 Fixed condenser, 2 mfd. **T.C.C. 50** (Bulgin, Dubilier, Ferranti, Graham Farish, Polar-N.S.F., T.M.C. Hydra)
- 1 Neutralising condenser **J.B. 1050**
- 1 On-off Toggle switch **Bulgin S80** (Claude Lyons)
- 1 Class "B" Transformer } Components to specifications given in text available from
- 1 Modulation Transformer } **Scientific**
- 1 Master Oscillator Coil } **Supply Stores (Wireless), Ltd.**
- 1 Aerial Coil }
- 1 Ebonite tube, $\frac{1}{2}$ in. outside dia. x $\frac{1}{2}$ in. bore x 18 in. long
- Quantity sheet brass, 0.015 in. thick for fixed condensers, 4BA screwed rod and nuts
- 1 9-volt GB battery
- 2 Wander plugs **Eelex**
- Quantity sheet aluminium, No. 20 SWG for screens, etc.
- 1 Baseboard, $\frac{1}{2}$ in. thick, 16 in. x 11 $\frac{1}{2}$ in.
- 6 Small brass terminals **Eelex**
- 2 Panel bushes, $\frac{1}{2}$ in. bore **Bulgin**
- 2 Ebonite terminal battens
- Valves: 1 each PX4, P415, LP2 and B21 **Osram** (Marconi)

The only other items that call for comment are the Class "B" driver and output transformers. They are similar in construction to the components described in December 15th, 1933, issue of *The Wireless World*, though slight modifications have been made to the windings. Drawings giving all necessary data relating to the transformers required for the transmitter will be included in the next instalment, when particulars of wiring up, adjusting and operating will be fully dealt with.

(To be concluded.)

DISTANT RECEPTION NOTES

BUDAPEST II, which has been working for some time on 834.5 metres, is well heard by those who possess receiving sets that will tune either up to this wavelength on the medium wave range, or down to it on the long. The plant used is, I believe, that of the original Budapest station which was superseded a year or so ago by the 120-kilowatt transmitter now working on 549.5 metres. One cannot help wondering why the No. II station should select such a wavelength as 834.5 metres when there is no particular overcrowding on what is known under the Lucerne Plan as the intermediate band. As it is, Budapest No. II lies in between two Russian stations, one of which, Sverdlovsk, is 15.5 kilocycles away on the one side whilst the second, Rostov-on-Don, is only 4.5 kilocycles away on

the other. Apparently a small wavelength change would ensure that the station was at all times free from heterodyne troubles.

Readers have probably noticed that in the early part of the afternoon Huizen frequently suffers from background interference which takes the form of a loud and unpleasant hum. By the middle of the afternoon this background has usually disappeared and the Dutch station comes in well. The explanation is that up to 3.40 p.m. the old Huizen transmitter, using only 7 kilowatts, is in action. If the Roumanian station Brasov is transmitting at the same time and nominally on the same wavelength, the ratio of wanted to unwanted signal strength is insufficient to drown the interference. When, however, the change is made to the 50-kilowatt Kootwijk plant the interference from Brasov, if heard at all, is too slight to be really troublesome.

Certain alterations have become necessary in the Strasbourg transmitter, which works on 349.2 metres. The station will close down from Monday, March 4th, until the following Sunday. It is expected that considerable improvement in reception will result from the changes that are to be made. Strasbourg already comes in strongly on most evenings, but for some little time now background interference has been noticeable rather often. This comes from the Russian station Simferopol, which shares the Strasbourg wavelength but is apt to wobble a good deal.

Those Spanish Wavelengths

The interference with Leipzig which used to be such a nuisance but seemed to have disappeared has returned on several evenings. It appears to be due to Barcelona EAJ1, which, like so many of the Spanish stations, is not too good at wavelength keeping. Barcelona, with 7 kilowatts, is at present Spain's most powerful station, but within the next year or two the Spanish Regional scheme, which includes a 150-kilowatt long-wave station for Madrid, and a round half dozen medium-wave transmitters ranging from 30 to 60 kilowatts, should be under way.

At the present time the number of stations that can be relied upon for reception at good strength and entirely free from interference evening upon evening is not large. The list includes Luxemburg, Bero-münster, Stuttgart, Vienna, Prague, Rome, Munich, Hamburg, Frankfurt, Bordeaux, Hilversum, and Lyons Doua. On any evening, however, at least a further dozen stations can be well received, though each day's list is slightly different since heterodynes (some very slight) and background interference crop up now here, now there. Berlin, for example, has had a faint accompanying whistle only once during the fortnight preceding the writing of these notes, and Poste Parisien twice and Radio-Paris once.

D. EXER.

The Push-Pull Quality Amplifier

IT may not be generally realised that the use of *The Wireless World* Push-Pull Quality Amplifier, which was redescribed in last week's issue, is not confined to the QA Receiver, but may be employed with many other types of receiver. Details of the necessary connections for typical cases appeared in an article entitled "Push-Pull Input Systems" in *The Wireless World* for September 21st, 1934.

An Improved S-W Frequency Changer

The Heptode with a Separate Oscillator

By E. J. ALWAY

THE design of a frequency changer for a short-wave superheterodyne receiver presents many problems not encountered on the normal broadcast wavelengths. Not the least troublesome is the interdependence of the oscillator section and the signal portion of a heptode when the latter includes a tuned circuit. In this article the author suggests a modification to the orthodox circuit that avoids these difficulties.

NO doubt many readers have in use a heptode frequency changer in either their S-W receiver or in their converter, which is probably wired up in either of the conventional manners shown in Figs. 1 and 2.

Now the great difficulty in successfully operating a heptode frequency changer on the shorter waves, *i.e.*, 10-30 metres, lies in the fact that there is considerable coupling between the two sections of the valve, the oscillator portion and the screen-grid portion, owing to the imperfect electrostatic screening and to the common anode stream.

In practice, two major defects are noticed: first, it becomes impossible to apply AVC bias to the heptode frequency changer because the volts induced on the control grid from the oscillator exceed the grid bias—and cause grid current to flow—which flow of grid current

grid circuit, and if a grid-circuit trimmer is used it will be found to give what is apparently an indication of very sharp

IF frequency, say, 450 kc/s, and as long as 450 kc/s is a fairly high percentage of the oscillator frequency, no volts will be developed across the grid coil, since, so to speak, the oscillator will be "tuned out."

In practice with an MH4 triode oscillator and a VHT4 as a hexode, this grid-current effect was not observed to start until the oscillator frequency was as high as 15,000 kc/s (20 metres), at which point, with 450 kc/s intermediates, the "selectivity" of the input circuit was insufficient to prevent an HF voltage greater than the fixed grid bias to be induced across it from the oscillator section.

Separate Oscillator

In order to shift this critical frequency above 30,000 kc/s (10 metres), the usual limit of the tuning range of S-W sets, it would probably be necessary to use an IF frequency of about 2,000 kc/s.

It is therefore apparent that AVC must not be applied to either a heptode or a triode-hexode arrangement unless the IF frequency is very high—in fact, far higher than is at present used commercially in all-wave or short-wave receivers.

The greatest advantage of the triode-hexode arrangement, however, is that it completely frees the oscillator from the control of the input tuned circuit, at least down to 10 metres, and the grid-circuit trimmer shown in Fig. 3 only changes the

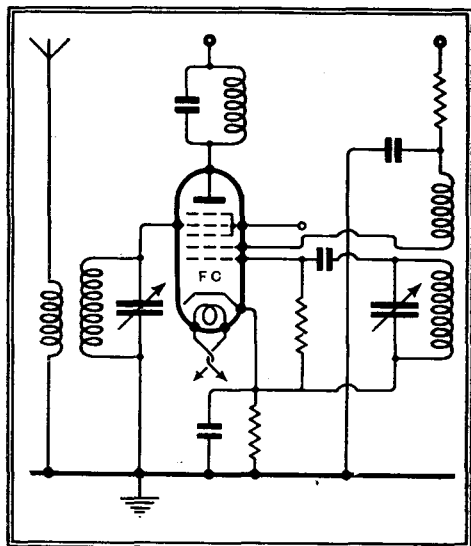


Fig. 1.—Typical short-wave frequency changer with a tuned input circuit in which plug-in coils might be used.

in turn develops high negative potentials across the AVC bias resistances, which are, of course, applied to all of the AVC-controlled valves with a very considerable reduction in sensitivity of the whole system.

The second defect is that the frequency of the oscillations generated in the triode section are controlled by the tuning of the

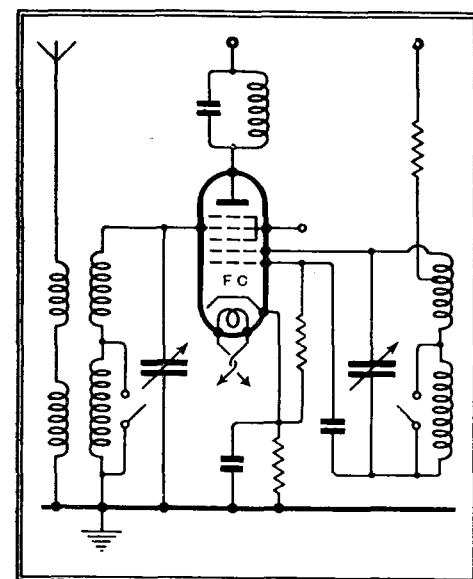


Fig. 2.—This arrangement is an alternative to that of Fig. 1, the main difference being that a Hartley oscillator is employed with dual-range coils.

tuning of this circuit, whereas what is really happening is that the grid-circuit trimmer is in reality tuning in fresh stations or the original one out, because it varies the oscillator frequency. See Fig. 3.

The latter difficulty is almost completely overcome by adopting a triode-hexode combination, and the first difficulty is overcome by also employing a high IF frequency.

Taking the latter point first, if a high IF frequency is employed, the grid input tuning circuit will always be mistuned from the oscillator frequency by an amount equal to the

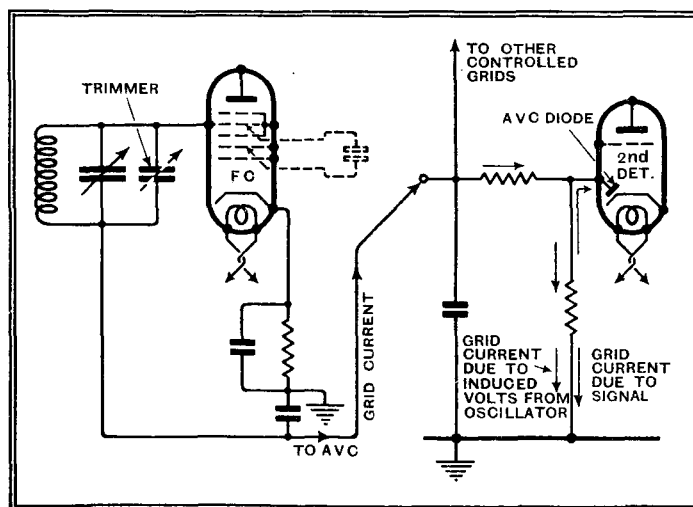


Fig. 3.—When the heptode is included in the AVC chain grid current flowing in the signal-grid circuit is fed back along the AVC line and appears as an additional negative bias on all the valves, thereby lowering the sensitivity.

An Improved S-W Frequency Changer— frequency of the oscillator by a few 100 cycles, for a change in capacity of 0.0001 mfd., whereas in the case of the heptode

is modified by the presence of the 0.01 mfd. Range 1 padding condenser.

On Range 1 the series condenser should have a value of 0.01 mfd., which will

as the case may be—with his own gunpowder, and would throw Caxton into the sea with one of his printing presses round his neck. But who would suspend Hertz by one of the antennae to which his brilliant investigations have led? A rose without a thorn, ointment without a fly—these are the metaphors which rush to the mind when thinking of Telephony Without Wires, as our French cousins delight to call this great gift of science to mankind."

At this point the mind of the leader-writer is apparently assailed by doubt, for he goes on to express the opinion that these eulogistic metaphors "would not be wholly appropriate, for broadcasting can be made an instrument of diabolical propaganda."

But a consulting engineer, surveying recent advances in design and construction of American broadcast receivers, in *Radio Engineering* (New York), has no such doubts as to the beneficial effect of international broadcasting—which is so often propagandist. He concludes his article by saying:—

"This paper would not be complete if it failed to lay final emphasis upon the profound social significance of the advance into the realm of international broadcasts. The engineers, by making the all-wave receiver a commercial possibility, have made much more than a mere contribution to the prosperity of their industry. It is always an easy matter for the historian to look back upon the scientific advances of former years and see what their effect has been. It is important for us, however, as we review the progress of 1934, to realise that with the increasing use of all-wave receivers there will come an increasing international understanding and goodwill that cannot fail to bear fruit in amity and peace.

"The radio engineer . . . made his great contribution to the safety of life at sea. Then came his entrance into the field of entertainment, with a new cultural influence. . . . But in his gift of international broadcasts, by which the soul of all the world is laid bare, and nations can no longer make a successful secret of their plans and ambitions, the radio engineer may well find his deepest satisfactions."

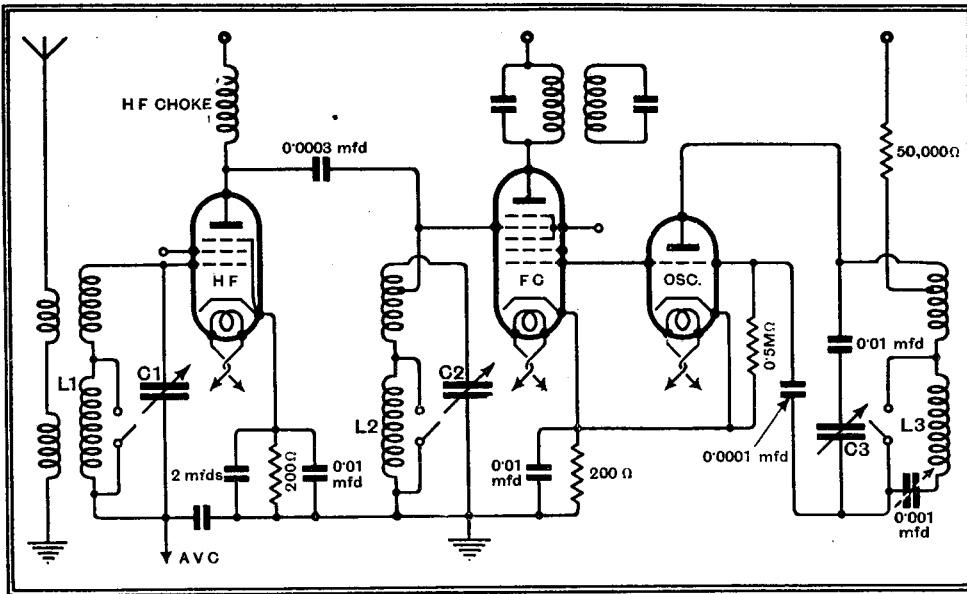


Fig. 4.—Circuit arrangement of a two-valve frequency changer with a stage of signal-frequency amplification, giving good selectivity and embodying ganged circuits and wave-band switching.

(Fig. 3) the corresponding change in the oscillator frequency was 10-20,000 cycles (10-20 kc/s).

The complete circuit for a triode-hexode frequency changer employing two separate valves is shown in Fig. 4, in which details showing the ganging arrangements and an HF stage have been added.

It will be noted that a three-gang condenser is employed, the end section (oscillator) being completely insulated from the first two sections.

The conventional reaction coil system may be employed if desired, when an insulated end-section to the ganged condenser is not necessary, but difficulty may be experienced in making the circuit oscillate below 17 metres, unless separate reaction coils are employed.

It will be noticed that the VHT4 control grid lead is tapped down on its tuning coil, since the incidental capacities due to the HF valve, etc., would otherwise prevent correct ganging on the shorter waves.

Two series padding condensers are used in the oscillator circuit, one fixed, Range 1, and the other variable, Range 2; by this means the oscillator frequency is maintained at approximately 450 kc/s higher than the signal frequency at all points.

On Range 2, for example, the maximum capacity on C2 is 0.00015 mfd., frequency 5,000 kc/s, inductance 6.6 μ H.

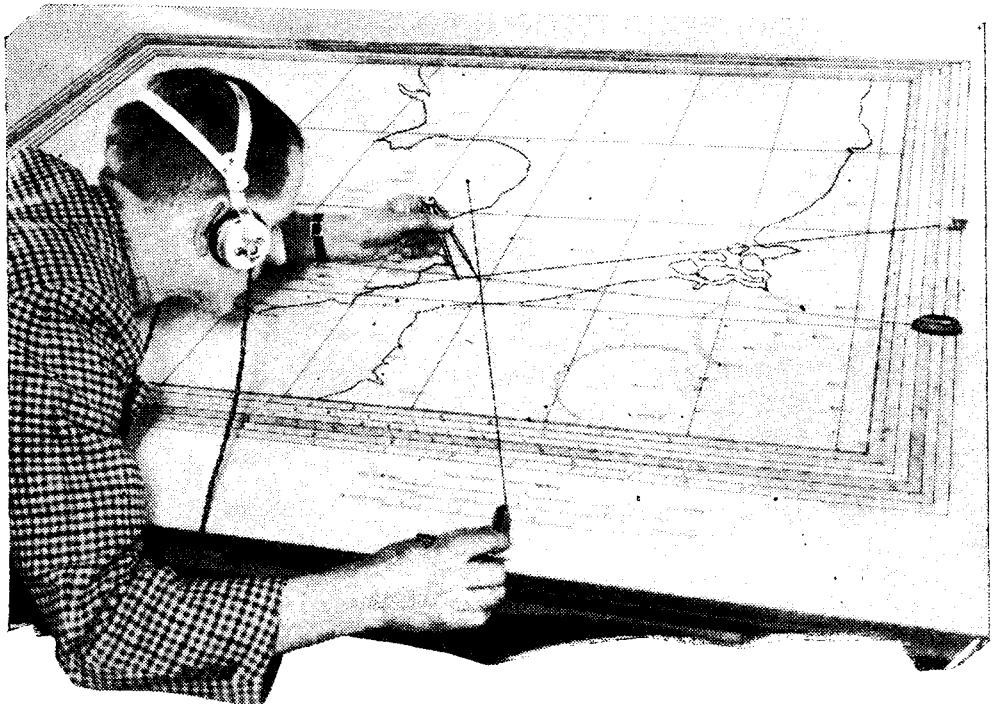
Using the same value of inductance in the oscillator circuit, for 5,000 + 450 kc/s, the value of C3 must be 0.000127 mfd.

In order to reduce the value of the variable capacity (0.00015 mfd.) to this figure, a series padding condenser of 0.00083 mfd. would be required, i.e., a pre-set condenser of 0.001 mfd. max.; in practice this figure (0.00083 mfd.)

be sufficiently accurate in most cases, although the correct value may be worked out if desired.

Blessings of Radio Is Broadcasting Always "On the Side of the Angels"?

IN a recent leader *The Times* expresses the opinion that "There are few inventions which have so much to be said for them, so little against, as wireless telephony. Many can to-day be found who would willingly blow up Roger Bacon—or Schwartz,



DF FOR AIRCRAFT. The Air Ministry DF station at Pulham, Norfolk, now gives assistance to cross-Channel pilots. Here is a wireless man at Pulham locating a plane's position with the aid of bearings from Croydon and Lympne, as well as from the plane direct.