# "Service"

## A DIGEST OF ELECTRONIC NEWS AND VIEWS

THIS magazine is designed to present students with current news and information affecting the field of Electronics. Articles dealing with general business subjects, which in many cases the student finds necessary for his complete success, will also be included. To enable readers to obtain original articles, details of the origin of any condensed matter will be quoted.

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*Keep your mind on the great and splendid things you would like to do and then, as the days go gliding by, you will find yourself unconsciously seizing upon the opportunities that are required for the fulfilment of your desire, just as the coral insect takes from the running tide the elements it needs.*

*Picture in your mind the able, earnest, useful person you desire to be, and the thought you hold is hourly transforming you into that particular individual.*

*Thought is supreme. Preserve a right mental attitude—THE ATTITUDE OF COURAGE, FRANKNESS AND GOOD CHEER.*

*To think rightly is to create. All things come through desire and every sincere prayer is answered. We become like that on which our hearts are fixed. . . . CARRY YOUR CHIN IN and the crown of your head high. We are gods in the chrysalis.—Elbert Hubbard.*

AUGUST, 1947

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# ROBOT TELEPHONE

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In last month's issue of "Service" we made brief mention of the "Ipsophon" robot telephone. We now have pleasure in presenting a much more detailed description of this interesting device. This article

At an all-inclusive rental fee of about 40 dollars a month, Americans will share before long with the Swiss and the rest of the world a robot telephone which electronically answers, remembers and reveals messages recorded automatically during one's presence in, or absence from, home, office or store.

This extraordinary device, called the *Ipsophon*, is connected with the public telephone system in the same way as the ordinary telephone apparatus but, in addition to providing the customary communications facilities, acts as a dependable, critical two-way brain to everything coming through the line when the receiver is not picked up after the bell has rung four times in succession.

The equipment described was invented, developed, and perfected for everyday use by a team of engineers and physicists at the Research Division of the Oerlikon Machine-Tool Works of Buhrle & Company, near Zurich, Switzerland, and is currently being produced in serial manufacture for installation throughout the network of the Swiss Telephone Service.

**PRINCIPLES OF OPERATION.**

The basic concept of the *Ipsophon*, is neither new nor spectacular. Projects to extend and amplify the communications facilities of the ordinary telephone in respect to time and space have been discussed frequently in the past and are as familiar to American telecommunications engineers as to their European contemporaries. In fact, the earliest recorded experiments on telephonographs, as these devices were originally named, date back to the end of the last century.

But progressive efforts to design a workable telephonograph which could automatically accept incoming calls during one's absence, or whenever for one reason or other it was inconvenient to answer personally, presented formidable technical obstacles in practical application as long as no really efficient medium was available for recording, reproducing and cancelling the spoken word.

Recent progress in the recording of sound for news services, broadcasting and films, however, has led to the development of the magnetic metal tape or wire recording process—a durable as well as practically noise-free sound carrier system—ideally suited for the purpose.

As is well known, the physical principle of this process is based on the fact that longitudinal or transverse magnetization of a steel tape or wire takes place as it is drawn at constant speed past the poles of electromagnets. Adapted to the recording of messages in the *Ipsophon*, the magnetic sound system transforms the voice frequency variations into current variations which are fed to the coils of a small electromagnet. A thin moving wire of specially treated steel is drawn past this electromagnet and is magnetized according to the current intensity in the coil. The wire remains magnetized as long as desired for reproducing the spoken word. When needed, these voice frequencies are passed on to the receiver for audible reproduction in the earphones. The magnetism in the wire may be subsequently wiped out by magnetic cancellation.

Thus, there is no wear of either the wire or the reproducer even when the recorded messages require innumerable reproductions because cancellations proceed without mechanical alteration of the wire. In practical application, this means that a recorded message can be reproduced almost indefinitely and a wire reused for any number of recordings after prior cancellation.

Nevertheless, a telephonograph whose automatically recorded messages could only be heard by the subscriber through the device itself would, undeniably, make listening-in extremely tiresome and necessitate physical presence or the aid of servicing personnel.

To eliminate this contingency, and ensure that local and long-distance calls are communicated direct to the subscriber over the ordinary telephone at all times without delay or unauthorized "tapping," an ingeniously uncanny

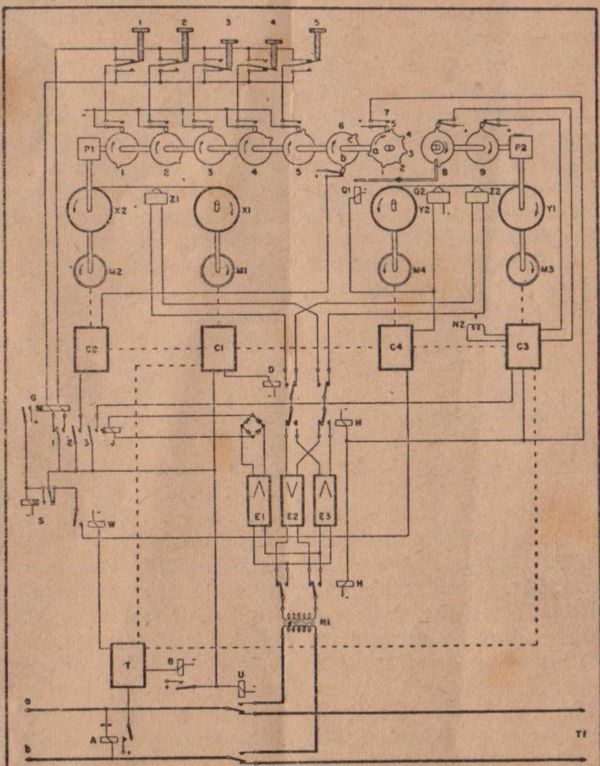



Fig. 1. Schematic diagram shows operation of main functions (recording, reproducing and erasing) performed by Ipsophon.

device is used, known as the acoustic code key.

This device operates not unlike the combination lock on a safe door.

For locking purposes, it merely requires the pressing down of selective buttons on a self-locking, ten-number keyboard which may be arranged to form any one of 1023 different possible cipher combinations.

On the other hand, to make the *Ipsophon* reveal on call from an outside telephone the message entrusted to it, the caller must give the previously selected cipher combination when ringing up his own number. This is done by him acoustically by emitting two vocal impulses at given intervals of time, which set in motion electronically-controlled cams linked with the sound carrier of the call system, thereby activating corresponding relay and contact switches to open or close the appropriate reproduction, recording, or cancellation circuits.

**PRACTICAL APPLICATION**

To illustrate the actual operation of the *Ipsophon,* let us assume that a Mr. Brown is expecting an important confidential call from his friend and business associate, Mr. Black.

Before leaving his home, therefore, he sets the acoustic code combination key on the *Ipsophon* to form, say, the cipher 520.

Some time later, Mr. Black, on dialing his friend's telephone number, receives no reply.

Undismayed, Mr. Black holds the line until the bell at the other end has rung four times in succession and the instrument emits, of its own accord, the words:

"Hello, hello, . This is the residence of Mr. Brown (address follows). This is Mr. Brown's *Ipsophon* speaking. Your call will be recorded automatically. Ready? Please start speaking now!"

From that moment onwards, the instrument acts as Mr. Brown's proxy and faithfully listens to everything Mr. Black is saying, recording it word for word, sentence after sentence.

As soon as Mr. Black has finished speaking and has replaced the receiver, the line is clear for other callers.

Mr. Brown, who at about that time may be anywhere in or out of the country but still wants to know whether his friend and/or anyone else has rung up during his absence, picks up a telephone and dials his own number.

When the connection has been made, he hears the electronic voice emit the already familiar reply:

"Hello, hello. This is the residence of Mr. Brown (address follows). This is Mr. Brown's *Ipsophon* speaking. Your call will be recorded automatically. Ready?"

Immediately after hearing the word "Ready?," and before the instrument can proceed with the last sentence, Mr. Brown says twice, very distinctly, the words "Hello, hello."

Instead of continuing the announcement with the phrase "Please start speaking now!," the *Ipsophon* this time emits, at intervals of about two seconds duration, the range of numbers . . . 1 . . . 2 . . .3 . . . 4 . . . 5 . . .6 . . . 7 . . . 8 . . . 9 . . . 0.

Remembering that the cipher combination he arranged on the acoustic code keyboard before leaving his home was 520, Mr. Brown passes this secret number on to the electronic robot acoustically by repeating the words "Hello, hello" immediately after hearing each one of the relative numbers — 5, 2 and 0 — coming from the *Ipsophon.*

On completion of this code number, the instrument starts repeating without further ado all messages recorded during Mr. Brown's absence, reproducing separate calls in consecutive order of call at intervals of from 2 to 4 seconds and announcing the end of reproductions by a high-pitched note.

**SPECIAL FEATURES**

When reproduction of all recordings has terminated, the instrument again emits a buzz. If the caller, immediately after hearing it, emits two vocal impulses by saying "Hello, hello," he can then dictate his answers to the messages just received.

This tele-answering facility is, of course, particularly valuable whenever the instrument is shared by two or more business partners living miles apart in different localities.

Equally, the tele-cancellation of all recorded messages can be carried out with the utmost simplicity by merely uttering the word "Cancel" into the microphone at the end of reproductions.

Another notable feature of the unit is the use of two separate sound carrier communication units; the first of these provides a recording capacity of five minutes and the second one of twenty-five minutes. This means that the total recording capacity of the instrument — a half hour — is almost always available, since as soon as the capacity of the first recorder has been exhausted, the second unit automatically takes its place. Moreover, while one recording unit is occupied by reproduction, the other one is simultaneously rewound at quintuple speed, so that even when the recording capacity is being utilized to the full, it is never necessary to wait more than a minute for commencement of reproduction.

The diagram (Fig 1) illustrates the control layout of the main functions performed by the *Ipsophon*. Since the automatic section alone comprises 74 relays, a complete blueprint of the entire instrument would involve a wealth of detail inimical to clarity. This diagram, therefore, is confined strictly to the connections necessary for carrying out the actual process of recording, reproducing, and cancelling the spoken word by vocal impulses from a distance.

This is done as follows:

The *Ipsophon* is connected to the telephone circuit at the two terminals *a* and *b* (Fig. 1). The relay *A*, wired in parallel with the calling bell of the telephone receiver $T_f$, is excited at each call, transmitting to the timing device, *T*, direct current impulses coinciding with the ring tones. This timing device, *T*, checks whether four ringing tones mature, which happens unless the receiver is lifted by the subscriber. The timing device engages the relay *B*, setting the mechanism of the *Ipsophon* in motion. The closing of the contacts of relay *B* switches the service line through to the repeater $N_1$ through the relay *U*. The motor control mechanism $C_1$ is then engaged. $C_1$ excites relay *D*, which shunts the sound head $Z_1$ onto the terminals of the output amplifier $E_2$. $C_1$ starts up motor $M_1$ controlling the feed of the spool $X_1$, which carries the sound recording element. The spool $X_2$ is set in motion by the sound recording wire, as a result of which the reduction gear $P_1$ begins to drive the cam-shaft with the cam-discs 1 to 7. Immediately after being set in motion, cam No. 6 opens its contact, thus setting in operation (in motor control mechanism $C_2$) the timing device, in agreement with the impulses sent out by the relay *J*. The feed of the sound recording wire releases (through the sound head $Z_1$, the amplifier $E_2$, the repeater and the service line) the announcement, whose wording is fixed once and for all, made to the inquirer in the following terms:

"Hello, hello. This is the residence of Mr. Brown (address follows). This is Mr. Brown's *Ipsophon* speaking. Your call will be recorded automatically. Ready?"

After the word "Ready?", cam. 7 switches the amplifiers $E_1$ and $E_3$ over, through relays *H*, for a period of 3 seconds, to their recording position. If the inquirer remains silent, the balance of the announcement, after amplifier $E_2$ has been switched on again, is communicated to the inquirer in the following terms:

"Please start speaking now!"

After this sentence has been pronounced, cam $6_c$ again closes its contacts, thus stopping motor $M_1$, through $C_2$ and $C_1$, and simultaneously switching on motor $M_2$, which controls the reverse motion of the sound recording wire. This movement is interrupted by cam $6_b$. At the same time, $C_2$ engages motor control mechanism $C_3$, which controls the feed of the recording unit.

$C_3$, through relays *H*, switches over amplifiers $E_1$, and $E_3$ to recording, and $M_3$ takes care of the feed of spool $Y_1$, which carries the sound recording wire. The cam-disc 9, driven through the reduction gear $P_2$, opens its contact immediately after being started up, while cam-disc 8, mounted on a friction clutch, is held in its initial position by the pawl. The sound recording wire drawn along by $Y_1$ is magnetized by the sound head $Z_2$ (which is connected to $E_3$) in accordance with the vocal frequency applied. The impulse relay *J*, connected to amplifier $E_1$ through a current rectifier, supervises the arrival of the speech impulses. $C_3$ remains in engagement as long as the caller continues to speak. At the end of the call, the caller rings off. Since the relay *J* receives no further impulses, the timing device *T*, through $C_3$, measures off an interval of 12 seconds. If during this period, relay *J* is not again excited, the device *T* drops again, thus switching $C_3$ out of circuit and bringing about, as a result of the dropping of relay *U*, the switching back of the service line to the ordinary telephone receiver. The entire instrument is then back in its position of rest.

The same operations are repeated for each fresh recording, cam-disc 9 performing each time a rotary movement within the limits of an angle corresponding to the duration of the recording.

When the subscriber rings up his own number for the purpose of hearing calls recorded during his absence, he hears the usual announcement after the fourth ringing tone just as if he were going to make a recording. On hearing the word "Ready?", however, he pronounces twice the word "Hello." (For the sake of simplicity, the checking of the double signal, "Hello, hello," is not shown in the simplified diagram; nor, for that matter, is the complete code key of ten buttons shown since it would needlessly complicate it). If, then, after the operation of cam $7_a$ already described, a speech impulse acts on relay *J* through the amplifier $E_1$ contact $J_2$ will close, thus preventing, in motor control device $C_2$ the switching of the latter out of circuit by cam $6_c$ which would otherwise immediately follow. In this case $C_1$ remains in circuit and the text of the announcement is modified. This means that instead of emitting the invitation "Please start speaking now!", the sound recording wire successively enumerates the digits of a series from 1 to 5. (in the *Ipsophon* itself, from 1 to 10; the principle is the same, however, irrespective of the number of buttons used). After each digit, the relays *H* are excited as a result of the closure of the contacts $7_1$ to $7_5$, and the amplifiers are switched over to their recording position. The cams of discs 1 to 5 are closed, one after the other, simultaneously with the cams on disc 7. Thus, for instance, the closure of cam 1 results in the negative pole of the battery being shunted on the first winding of relay *G*, through the intermediary of the cam contact and the non-operating contact of button 1. In the absence of speech impulses, however, relay *G* cannot be lifted, as contact $J_1$ has not effected the transfer. Should the caller emit a speech impulse after the announcement of digit 1, which is not included in the selected code, relay *G* is excited, operating locking relay *S* and thus preventing reproduction. On the other hand, in regard to the button originally pressed by the subscriber to the *Ipsophon*, the closure of cam 3 results in the following circuit being established; negative pole of battery, cam contact, operating contact of button 3, second winding of relay *G*, contact $J_1$, positive pole of battery, through the closed contact of relay *B*. In this case, in the absence of speech impulses, relay *G* would also be operated and, through the locking relay *S*, prevent reproduction. If, however, the caller speaks, this will switch relay G out of circuit, and locking relay *S* will not be excited. This function is made possible by the time delay feature of the two relays, G and *S*.

The caller must, therefore, pronounce the word "Hello" twice, each time a digit originally chosen as a code number is announced, and remain silent when the other figures are announced. If this is done correctly, the emitted impulses set in operation the controls corresponding to the series of figures from 1 to 5, the reclosure of the circuit of cam $6_b$ starts up motor control mechanism $C_2$ which, in turn, sets motor $M_2$ (that which controls the text of the announcement) in motion in reverse, and also simultaneously, sets in motion motor control mechanism $C_4$ which governs the reverse motion of the recording mechanism. Motor $M_4$ drives spool $Y_2$, which carries the sound recording wire. This reversal of the movement of the sound recording wire drives spool $Y_1$, thus bringing about (through the reduction gear $P_2$) the release of the reverse movement of cams 8 and 9. This reverse movement continues until the cam of disc 9 has closed its contacts and, through motor control unit $C_3$, switched motor $M_4$ out of circuit and engaged the forward movement of motor $M_3$. Cam-disc 8 has been driven by friction in this reverse rotary movement, not having been locked by the pawl. Through the forward feed of the sound recording wire, following immediately, the recordings reach the repeater $N_1$ through the sound head $Z_2$ and the amplifier $E_2$. The caller then hears, over the service line, all the messages recorded by the *Ipsophon*.

At the end of the reproduction, cam 8 closes its contact, thus switching motor $M_3$ out of circuit, through the motor control unit $C_3$. At this moment a short, shrill sound is emitted by unit $C_1$, through the coupling transformer $N_2$. This shrill sound notifies the listener that all the recordings on the *Ipsophon* have been reproduced. At the end of this shrill tone, the relays *H* are switched over—by the same unit $C_3$ — to recording. If, at that moment, two speech impulses are emitted, exciting the impulse relay *J* through ampilfier $E_1$, the relays *H* will remain held and motor control unit $C_3$ will again engage motor $M_3$ on "feed." Thus, the caller can record messages to the instrument immediately after the end of reproduction.

If, on the other hand, the caller does not avail himself of this facility, a second shrill sound is emitted after three seconds through the repeater $N_2$, this period of time being measured by the timing device *T*. If two speech impulses are then emitted, impulse relay *J* engages the motor control unit $C_4$, setting motor $M_4$ in motion in reverse and at the same time exciting the electromagnet $Q_1$ of the pawl and the cancelling electromagnet $Q_2$. The result is that cam-disc 8 is held in its initial position (cam contact closed) and cam-disc 9 is driven in reverse until it reaches its position of rest. The electromagnet $Q_2$, magnetically cancels the recording from the instrument, and the entire *Ipsophon*, being returned to its initial position, is once more ready for action. If, however, after the second of the shrill tones, advantage is not taken of the opportunity to cancel the recordings, a third shrill tone is heard after an interval of two seconds, informing the caller that the recordings have not yet been erased. After this third shrill tone, the timing device *T* switches the *Ipsophon* out of circuit again.

A paramount requirement in a device of this type is, of course, the necessity of making it operate as reliably as the ordinary telephone.

Accordingly, no parts needing periodical attention or replacement have been incorporated in the *Ipsophon*.

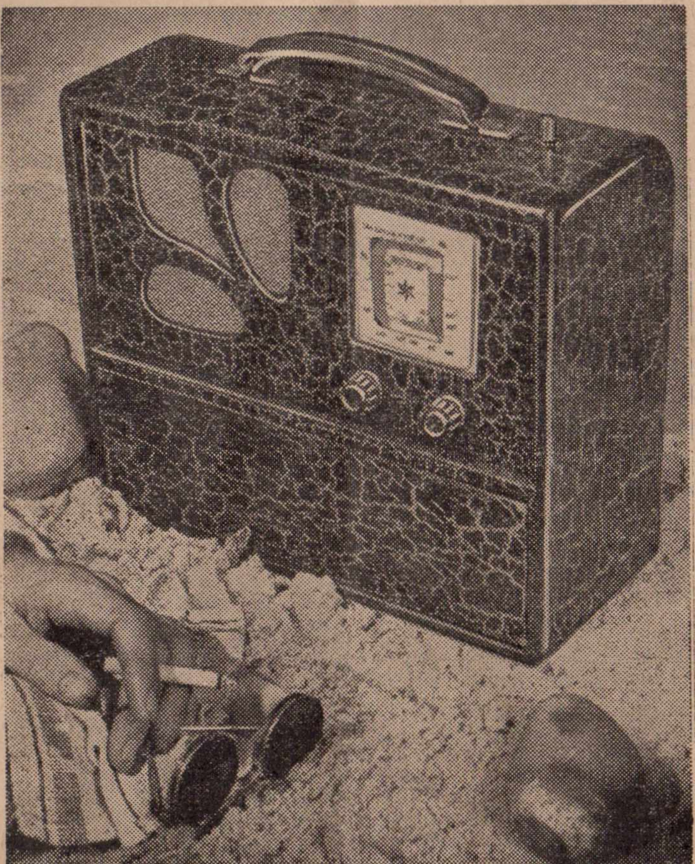
Breakdown through faulty manipulation is precluded by the use of automatic switching arrangements and all electro-acoustic commands are performed by coils controlled by relays and contacts similar to those in common use in telephone exchanges all over the world.

Furthermore, manipulation of the *Ipsophon* is simplified to a considerable extent by making the instrument in two separate units, the main operating apparatus and the recording device, as well as the provision for straightforward dialing arrangements, easy-to-read controls, and luminous signal indicators.

Easy to manipulate, foolproof in operation, and absolutely dependable in engineering performance, the *Ipsophon* robot telephone will undoubtedly become, when popularised, a vital link in tomorrow's world-wide system of national and international telephone communications network.

# FITTING A LOOP AERIAL TO THE 4—VALVE BATTERY PORTABLE

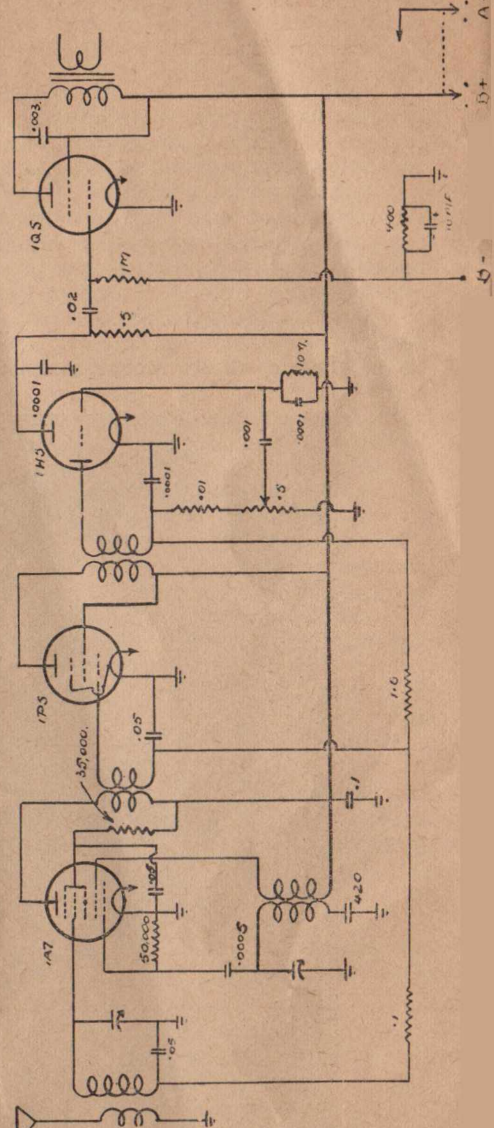
In the May 1947 issue of "Service" we described a receiver under the heading "A New Four Valve Battery Portable." This receiver was designed to operate either with or without an aerial. Actually that statement should have been with or without an outside aerial, because even when no external aerial was fitted to the terminal on top of the cabinet, the short length of wire running from this terminal to the aerial coil inside the receiver really acted as a very short aerial. While the signal pick-up afforded by this length of wire is adequate to bring in all the Sydney stations when the set is used in the metropolitan and suburban area, it is really necessary to use a short length of external aerial to achieve reliable reception when the set is used in some of the outlying districts or in locations where reception conditions are not good.



Usually it is only necessary to use 5 or 6 feet of wire lying on the ground, but even this may not always be entirely convenient. As a consequence, we have during the past couple of months received many queries from people who have built this receiver, asking about the possibility of fitting a loop aerial inside the cabinet. Up till now we were not able to offer very much assistance because all the available commercially made loops were too large to fit inside the existing cabinet. While we could have given instructions for the home constructor to wind up a loop of suitable dimensions, we refrained from doing this because of the doubt which existed in our minds regarding the efficiency of a small loop. Also we were mindful of the poorer efficiency of a home-built job when compared to that obtained from a factory made article. However, we have at last located a loop which has the twin advantages of small physical size and high electrical efficiency. This loop is made by a Melbourne firm and bears the well-known trade mark "Q Plus." The dimensions of the loop are approximately 5″ by 3¾″.

The remainder of this short article will be devoted to a description of the fitting of the loop to the receiver.

The loop is intended to replace the existing aerial coil in the receiver, the first step therefore is to disconnect the aerial coil from the circuit. To facilitate the necessary alterations we are reprinting the circuit diagram of the receiver. This appears in Figure 1. There is nothing at all difficult related to the substitution of the loop for the existing aerial coil, particularly as the colour coding of the loop con-



nections are exactly the same as for the aerial coil already in the set. We repeat these to refresh your memory. The green lug on the loop terminal strip goes to the grid of the 1A7. The black lug goes to the A.V.C. line. The red lug goes to earth or chassis. The blue lug goes to the aerial terminal already fitted to the top of the cabinet. Between the blue lug on the loop and earth it is necessary to connect a resistor having a value of 18,000 to 20,000 ohms. This resistor should always be included even though the owner of the set has no intention of using an external aerial at any time.

Now for the mechanical details. The manufacturer of the loop states that if possible it should be mounted in a position that does not bring it closer than ½″ to any metal object. By placing it in a vertical position at the back of the cabinet, it is possible to approach fairly closely this requirement. One point should be noted however, in some of the portable kits the chassis is fitted with two wooden blocks designed to prevent it from sliding too far back into the cabinet. In such cases care should be taken to ensure that the leads to the loop are long enough to allow it to stand between these blocks as otherwise it will prevent the chassis from going right into the cabinet.

As has been stated earlier, the loop takes the place of the aerial coil, and the circuit comprising the secondary winding of the loop and the aerial tuning section of the condenser gang must be lined up with the oscillator circuit in exactly the same way as when the conventional aerial coil is used. Obviously the alignment procedure must be carried out before the chassis is placed in the cabinet. In this regard it should be pointed out that the only trimmer which need be touched is the one across the aerial section of the tuning gang. It is of course, presumed that this trimmer has been left in position between the fixed and moving plates of the condenser gang. The alignment follows normal procedure, one tunes the set to the high frequency end of the broadcast band, to 1400 K.C, if one is using a modulated oscillator or to some station near this frequency if one does not possess a modulated oscillator. The volume control should be turned full on and the cabinet placed in such a position that the station is heard fairly weakly. The aerial trimmer is then adjusted either way until a definite peak is noted in the strength of the station.

One important point should be noted. During alignment the loop should be located about the same distance from the chassis as when it is installed in the cabinet. If this precaution is neglected the alignment of the aerial circuit will be upset when the receiver is placed in the cabinet.

In conclusion may we repeat the warning that if the loop is being added to a set which has already been built and aligned, the adjustment of the I.F. transformers and the oscillator trimmer should under no circumstances be altered. Of course, if the loop is being incorporated in a new set the complete alignment procedure is carried out in the normal way as described in the original article in the May issue of "Service."

Readers may wonder why we have not included any circuit diagram showing the loop connections. This information has been purposely omitted because a circuit diagram is supplied by the manufacturers of the "Q Plus" loop. A copy of this circuit is enclosed with every loop.

# ELECTRONIC CAMERA TUBES

The previous article in this series commenced a discussion on electronic camera tubes. In this article we take up the story from where it was left off in the June issue.

Progressive deflection of the electron beam is produced, in all modern camera tubes, by electro-magnetic means. A transverse electro-magnetic field is produced by coils located on the outside of the tube's stem as shown in Figure 1 in the June issue of "Service." Two sets of coils are provided, one to deflect the beam from side to side to produce the necessary horizontal line scanning of the picture of the image, and one set to lower the scanning beam slightly at the end of each horizontal sweep so that the image will be progressively scanned from top to bottom as well as from side to side. The deflection impulses are provided by a special type of oscillator which will be discussed in later articles. Suffice it to say here that as the scanning beam reaches the extreme right hand side of the mosaic it is suddenly flicked back towards the left hand side whence it starts another scanning sweep over the mosaic surface. Although in theory the scanning beam should move in a perfectly horizontal direction from left to right and then be flicked suddenly back from right to left and slightly downward at the same time there are certain technical difficulties in the way of accomplishing exactly this. In practice therefore the scanning beam does not move in a perfectly horizontal manner from left to right but tends to drop slightly as it moves over the mosaic surface. However, fly-back of the spot to its starting point is virtually horizontal. Reference to Figure 2 in the article published in the April issue of "Service" will explain the process diagramatically. It is appropriate here to draw your attention to a previous statement that the scanning beam should not be unduly broad. If the scanning spot has an over-large diameter it will "shine" on several of the mosaic globules at the one time. This will reduce the detail apparent in the transmitted image because the mosaic discharge current produced by the electron beam will be a single impulse having an average value rather than a number of individual pulses representing varying degrees of light and shade. It is, of course, not possible to make the scanning beam so fine that it will scan each globule individually, the aim is to make it as small as practicable. The minimum diameter of the spot is actually governed by the number of lines per picture which the television transmitter is designed to handle. If the spot's diameter was smaller than the depth of a single line, the whole of the picture would not be scanned by the beam, some of it would be left out. The result of this would be a series of black lines across the transmitted image.

When a still picture is being transmitted that section of the mosaic which has been scanned by the moving electron beam immediately charges up again as soon as the beam has passed, and so the next time that particular portion is scanned the discharge current produced by the scanning beam will have exactly the same value as with the previous scan. If on the other hand, the picture is a moving one, subsequent scanning sweeps by the electron beam will not necessarily produce the same intensity of discharge current because the light intensity shining on individual parts of the mosaic may have changed.

The voltage pulsations which appear across the resistor connected in the camera tube's output circuit are extremely minute and require considerable amplification before they are eventually used to modulate the television transmitter. The peculiar problems involved in the design of the video amplifiers as they are called, will be discussed at some future date.

The greatest disadvantage of the iconoscope camera tube was the fact that spurious video signals were introduced by the secondary emitted electrons dropping back onto the photo-sensitive mosaic. While the effect could be greatly reduced by introducing an out of phase signal from a so-called shading generator, the original iconoscope form of camera tube was eventually discarded for more satisfactory versions. Incidentally, the shading generator received its name because it served to restore the image light and shade to their correct relative values.

The original patent taken out by P. T. Farnsworth for a television camera tube was granted in the U.S.A. in 1931. Farnsworth called this tube an image dissector. A schematic diagram of this camera tube is shown by Figure 1. The only similarity between the operation of the image dissector and the iconoscope was that in both cases an image of the scene to be televised was focussed upon a photo-sensitive surface. However, unlike the mosaic of the iconoscope the photo-sensitive cathode in the image dissector tube is uniformly coated. It has not the individual globule structure of the iconoscope mosaic. Apart from this similarity the operation of the image dissector is quite different to that of the iconoscope. As with all photo-electric substances the coating on the image dissector screen will emit electrons when illuminated by light. The number of electrons emitted from any particular part of the screen will depend upon the intensity of light affecting that portion. Electrons emitted from the photo-sensitive cathode are drawn down to the opposite end of the camera tube by virtue of the positive voltage applied to the anode shown in Figure 1. The anode is actually the outer covering of an electron

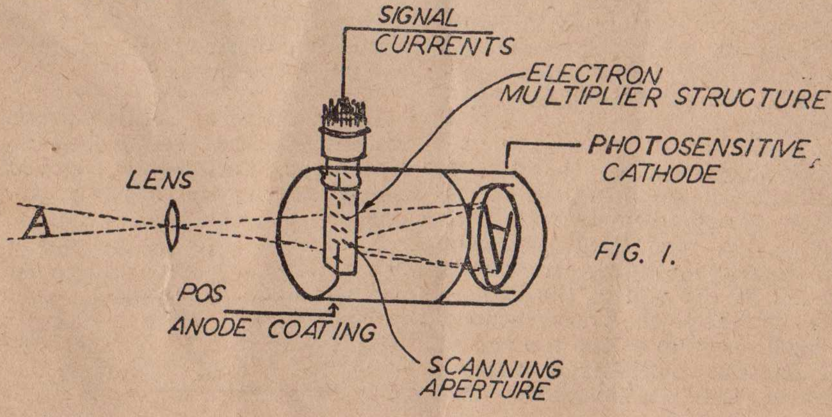



FIG. 1.

multiplier. An enlarged view of an electron multiplier is shown in Figure 2.

The operation of an electron multiplier is dependent upon the common effect known as secondary emission. The fundamental operation may be seen by examining Figure 2. It will be seen that the electron multiplier consists essentially of a number of parallel plates, each one staggered in relation to its opposite number. The electrodes numbered 1 to 4 are known as cathodes while the fifth electrode is termed the collector plate. If a stream of electrons is caused to strike cathode No. 1 a certain number of secondary electrons will be released by impact. Due to the fact that a positive potential is applied to electrode No. 2, the secondary electrons emitted from electrode No. 1 will be drawn to the second electrode. Again secondary electrons will be emitted by impact and these will be drawn to electrode No. 3 by virtue of the fact that it also has a positive potential applied to it. Once again secondary electrons will be emitted which in like manner will be drawn to electrode No. 4. Finally, all the electrons are collected by electrode No. 5. At each succeeding emission of secondary electrons the number of electrons is increased, hence the name electron multiplier. As a consequence, a useful degree of amplification is obtained.

The part played by the electron multiplier in the operation of the image dissector camera tube is as follows. As mentioned previously the electron multiplier structure is located at the end of the camera tube opposite to the photo-cathode. A small aperture at the top end of the electron multiplier is directed towards the photo-cathode. The image is scanned by causing the electrons emitted from each part of it to progressively enter the aperture of the electron multiplier. This is brought about by causing the electrons emitted from the photocathode to be swung across the electron multiplier aperture by means of deflector coils located on the outside of the tube. Both horizontal and vertical deflection coils are used so that as well as moving the beam across the aperture for line scanning, the beam is also lowered slightly at the end of each scanning sweep so that the next line may be scanned.

As the beam of electrons emitted from the photo-cathode is not of even intensity, i.e. a large number of electrons will be emitted from bright portions of the image, while a small number, or none at all will be emitted by very dark portions, the intensity of the electron beam entering the electron multiplier will vary from instant to instant. The consequent variations in the intensity of electron flow through the multiplier appear as a varying voltage drop across a resistor connected between the multiplier collector plate and its positive voltage supply. Although later versions of these early camera tubes have very greatly improved performance their fundamental principles of operation are much the same.

In an effort to achieve greater sensitivity, R.C.A. evolved the image iconoscope. Incidentally, it might be mentioned here that the icono-

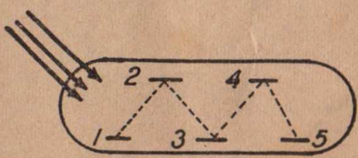



FIG 2

scope is fundamentally more sensitive than the image dissector because of the fact that it makes far greater use of the light directed upon the photo-cathode. The iconoscope operates on the so-called light storage principle whereas the dissector employs instantaneous scanning. The image iconoscope uses both a photo-electric cathode similar to the one employed in the image dissector and a mosaic structure as in the original iconoscope. The mosaic differs however in this respect, it is not treated for the production of photo-electric emission, but relies upon the secondary emission of electrons from its globules in order to achieve the necessary distribution of positive charges over the mosaic plate.

In operation the image to be televised is focussed on the back of the photo-electric cathode from which a beam of electrons is emitted just as with the image dissector. By virtue of the high potential existing between the photo-cathode and the anode coating on the walls of the camera tube a beam of electrons is projected towards the mosaic at the opposite end of the tube. This beam also like the beam emitted by the image dissector's cathode is not of constant intensity throughout. As a consequence, the secondary electrons emitted from the mosaic globules will vary in intensity at different points on its surface. This in turn will result in positive charges of varying intensity appearing on the surface of the mosaic just as with the original iconoscope. The scanning beam sweeping across the face of the mosaic will neutralise the charges and so produce pulsations across the load resistor connected between the back plate of the mosaic and the high voltage supply. This again is in line with normal iconoscope action.

As with the iconoscope the scanning beam in the image iconoscope is of high velocity and consequently with the latter type of tube it was still necessary to introduce correction signals from a shading generator to overcome the effect of secondary electrons liberated from the mosaic surface.

Early in 1939 the orthiconoscope, or orthicon for short, was developed in America by R.C.A. scientists. This camera tube removed the major disadvantage of the iconoscope in that a low velocity scanning beam was used and so no trouble resulted from secondary emission from the mosaic. What is perhaps more important, the electrons normally emitted from the photo-electric mosaic are collected completely. With the iconoscope incomplete collection of electrons allowed some of them to fall back on to the mosaic thus destroying the contrast of the picture. The lack of secondary emission and the improved collection resulted in the orthicon having a storage efficiency of practically 100%. Its sensitivity was thus much greater than any of the camera tubes produced up to that time. One of the few disadvantages of the orthicon was the fact that the low velocity scanning beam was much more subject to deflection by extraneous electro-magnetic and electro-static fields than was the case with the high velocity beams used in the iconoscope. However, careful shielding of the complete camera tube and its associate amplifiers serve to overcome trouble from this source.

(*Concluded in next month's "Service"*)

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## IF YOU'RE IN DOUBT, ASK A.R.C.

The old saying goes, "If you're in doubt, ask a policeman." That may be a very good plan for general use, such as finding streets, time of day, location of buildings, etc., but as far as radio matters are concerned, evidently the rule is becoming "Ask A.R.C."

Recently we received a letter from Eire and the only address on the envelope was "Radio Australia, Sydney." Evidently the Post Office thought that if anyone should get it, it should be the College and the letter was forwarded to the College unopened. Actually the sender was enquiring about wave lengths and times of broadcasting of Radio Australia, and we were able to give him the correct information.