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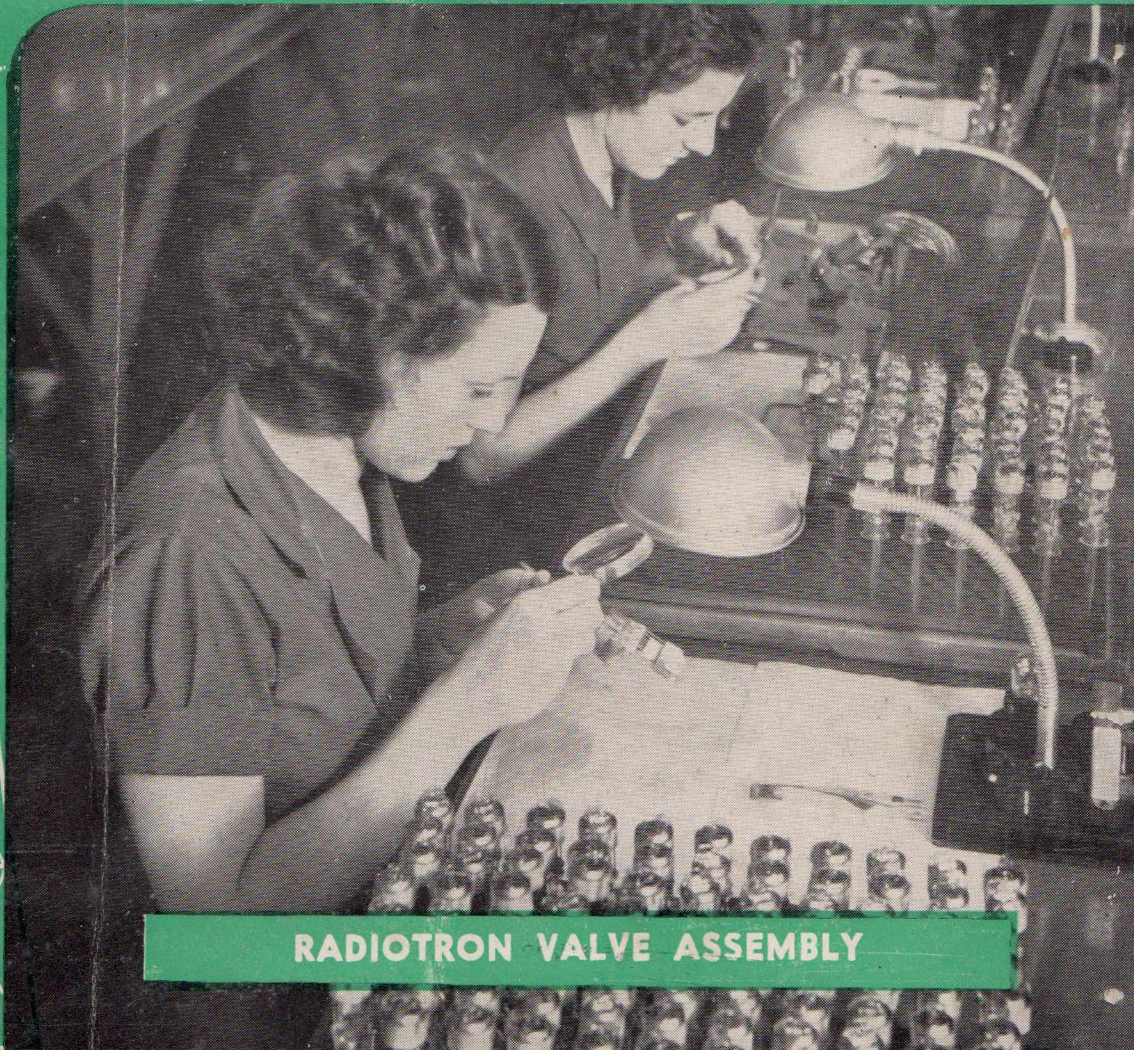

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JUNE-JULY, 1951 Registered at G.P.O., Sydney, for transmission by post as a periodical. VOL. 15, NO. 11 1'6

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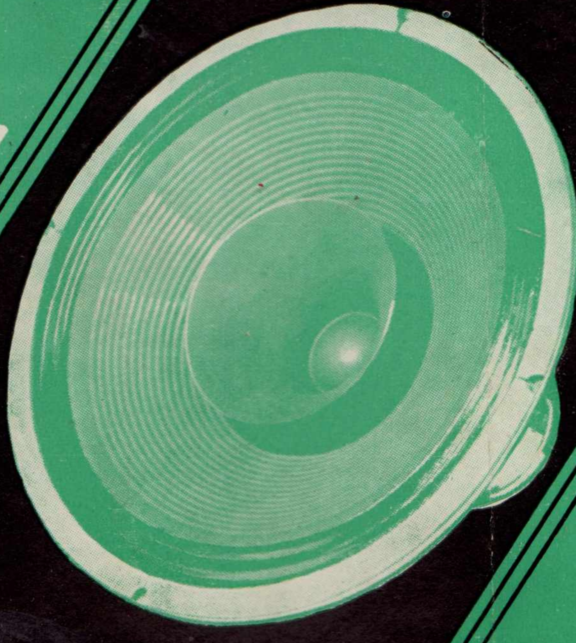

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Vol. 15 JUNE-JULY, 1951 No. 11

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OUR COVER

Mounting and inspecting Radiotron Valve Assemblies at the works of Amalgamated Wireless Valve Company, Ashfield, N.S.W.

* * *

Managing Editor:
LAY. W. CRANCH
AMIRE (Aust.) M.W.I.A.
VK2XC

★

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EDITORIAL

The expansion of a relatively new field of endeavour, such as electronics undoubtedly is, depends largely in a given place, on the number of skilled engineers and technicians that are available. The Australian radio industry, even at the present time, is short of such personnel, and possible future events can only increase the shortage, unless something is done about it. Not only is it possible that in a very few years the manufacture and maintenance of television receivers will be added to the industry's present endeavours, but the normal development of radio services generally, and the expanding use of electronic equipment in a wide variety of industries, will create a need for more men whose knowledge and attainments will have to be high, by present-day standards, if their functions are to be satisfactorily carried out.

One of the greatest difficulties in attempting to entice more young men into the industry is that there is no professional standing attaching to most technical jobs within the industry.

What other avenues of approach are available? If the boy is of greater than average ability, and is well advised, he may go to university, take a science degree in radio-physics, or one in electrical engineering, and then, after years of expensive preparation, find that the only positions available which will make use of his attainments are those in Government departments. This may not worry the young man himself, because he is usually sufficient of an enthusiast to be glad of work that is interesting, and in his own particular line, but it should worry the radio industry!

The radio industry should, for its own good, do something active to encourage university graduates of the right kind, and with the right qualifications, to join its staffs. It may think that it has no place for such men, and in some cases this may be true, because the positions that might be held by them are filled by men who have grown up with the industry almost from boyhood, and who hold their positive by virtue of long practical experience rather than by formal qualifications. These men are extremely valuable, and no one in his senses would suggest that they should not hold their positions because they do not hold degrees. But time has already marched on, and these old hands will before long have disappeared; from where are they to be replaced They should be replaced, when the time comes by young men of the kind we have been discussing. Those responsible should not make the mistake of believing that because the "old hands" were so good without formal training, then formal training is not needed. It is the time factor that counts, as ever; for a young man, suitably trained *before* engagement, can, if he is a capable youth, be brought to the required standard more surely, and in a tenth of the time than can one who has no formal background.

THIS COMBINED ISSUE—or BLACKOUT BLUES—(Part 2)

In our May issue we wrote a leader on newsprint shortage, etc., and had hopes that our supplies of paper already "on the water" would arrive in time to prevent further worry in this direction. Well, it did arrive in Sydney Harbour quite satisfactorily — but it's **still** on the water, as due to measures beyond our control, the ship containing same has not been unloaded to date. Wouldn't it?

This, of course, has thrown a large spanner into our works, with the result we have been forced to publish our June and July issues together, otherwise we would have been 30 days behind delivery date with Australian Radio & Electronics.

We, therefore, have taken this drastic step of catching up a month's lag, but can assure all concerned that there will be no loss of continuity in articles, advertisements or subscriptions, as the latter expiry date will be extended to cover an extra issue.

Many of our readers have complained that they are not receiving A.R. & E. until the month following publication date, and this has also been a prime factor in combining this issue, as it gives us the opportunity of getting a bit of time "up our sleeves" so that we can endeavour to overcome the many problems of publishing today.

Considerable reorganisation has been necessary and we intend producing a bumper August issue, to compensate for this combined one, which will start our new volume, and A.R. & E. should, according to plans, make its appearance in the first week of the month in future.

The trials and tribulations of today are enough to send a man bald-headed (as a matter of fact, your Editor is already growing a nice head full of skin), but as some wise gentleman once wrote, "It's better to be optimistic than have a misty-optic" — so here's hoping.

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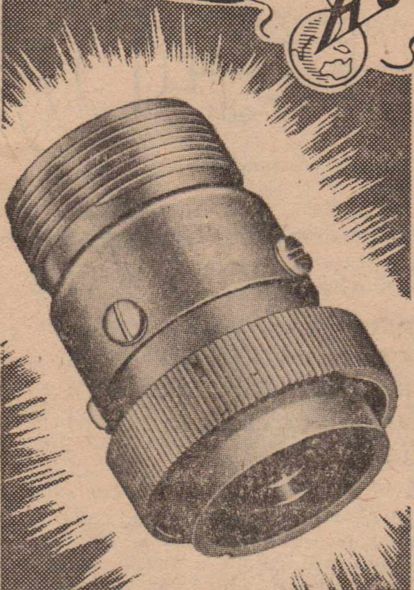

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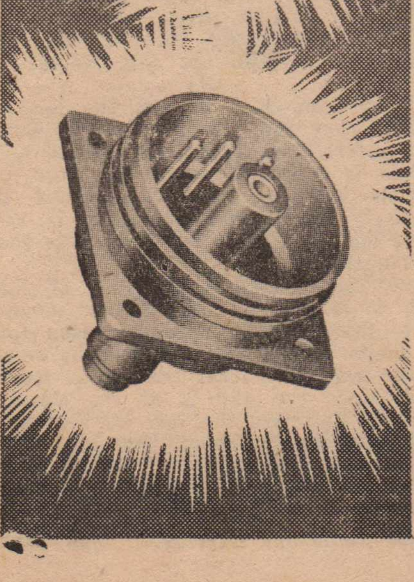

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The Tape Recording Head

* By P. D. THOMAS

In response to the deluge of enquiries made to us for design data on a Tape Recording Head, we have pleasure in presenting herewith an article covering the subject, in a very practical and straightforward manner from the able pen of Mr. P. D. Thomas. This article follows on from a previous one entitled "The Magnetic Tape," which appeared in our Composite issue (Vol. 15 No. 5), December, 1950 (limited copies of which are available from our Back Dates Dept.) and should be read in conjunction with this month's feature.

THE EDITOR.

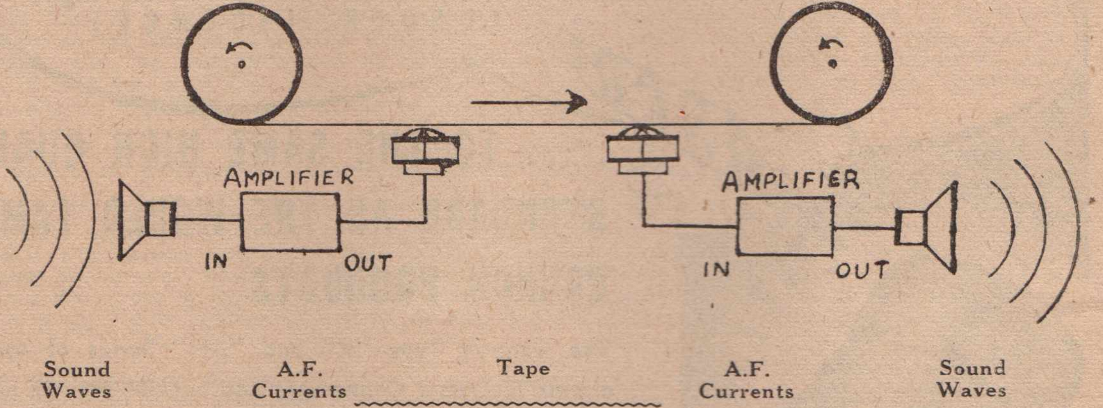

Fig. 1

A magnetic recording head has much in common with a moving coil loudspeaker. Just as the loudspeaker acts as the link between electronic circuits and the medium of air through which sound waves travel, so the recording head links electronic circuits to the tape or wire recording medium.

INTRODUCTION

Again, in the same way that a speaker can be used in reverse, so to speak, as a microphone, the recording head may be used to reverse the recording process and link the tape or wire medium to the electronic circuits of the amplifier. These functions are illustrated in Fig. 1, which shows in block form the basic principles involved in magnetic recording. Sound waves in air are converted into corresponding A.F. currents by the microphone; these are amplified to a useful level, and converted by the recording head into variations in magnetic flux on the moving tape. A few seconds (or a few days or years) later the whole process is reversed; the second, or playback, head converts the magnetic variations into A.F. currents, which are amplified as before; and the loudspeaker, the last link in the chain, converts these currents into sound waves.

The recording head, like the microphone or loudspeaker, is basically a very simple device, yet the performance of the recorder depends upon its careful design and construction.

THE CORE

Figs. 2 and 3 show a tape recording head, with typical dimensions of the core. This is ½in. square and ¼in. thick, and will record a track across the full width of a standard ¼in. tape. However, a narrower track than this is often used, as for example when two tracks are recorded on the same tape. For this purpose the core would be about 3/32in. wide.

It will be seen from Fig. 3 that the longer dimension of the front gap, measured on the face of the core, is referred to as the width and not the length. This is to avoid confusion, since it corresponds to the width of the track recorded on the tape. Similarly the shorter dimension is referred to as the length since it corresponds to the recorded wavelength.

In most commercial recorders the face of the core is curved, as in Fig. 2, and the tape moves in a tangent to this curve. The main reason for choosing this shape is that good contact between the tape and the gap, with least friction, is more easily obtained, since the gap is at the closest point to the tape. However, the face of the core may be flat, or only slightly curved, provided that the tape is kept in close contact with the business portion. Whatever the shape may be, the four corners of the core should be rounded slightly to

---

*P. D. Thomas, Esq., 11 Aver Avenue, Colonel Light Gardens, Adelaide, South Australia.
Born and educated in England, joined Eng. staff B.B.C. Served with Burma Army R.E.M.E. (Telecom Section) Recording Specialist.

avoid concentration of flux at sharp corners where it is not wanted.

The core is made in two halves, with one section of the winding on each half. It is laminated to reduce eddy current losess, the laminations being .01in. to .02in. thick.

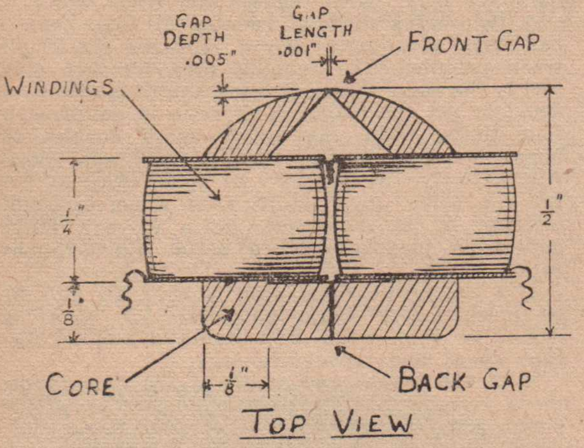

Fig. 2

For recording and playback heads, permalloy or mumetal are undoubtedly the best materials, but for a supersonic erase head stalloy or a similar material is often used as a heavier current can be fed to it before saturation occurs.

Residual magnetism in the core of a playback head causes noise, or, in extreme cases, partly or wholly erases the signal. This trouble frequently occurs with a soft iron core, but if permalloy or mumetal is used it should not be serious, particularly if the laminations are correctly annealed after shaping.

To test for noise generated by a magnetized core, run a blank or lightly modulated tape through the head so that the noise is apparent. Bring a small horseshoe permanent magnet slowly towards

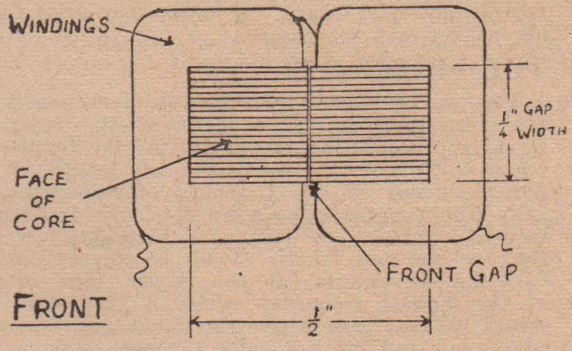

Fig. 3

TAPE RECORDERS & ACCESSORIES

Use a "NOVA" Tape-Deck to build your own Tape-Recorder or to attach to your Radio, Radiogram or Amplifier.
To help the amateur to make a first-class Tape-Recorder, "NOVA" have released moderately priced Tape-Decks, Amplifiers, Kit Sets and Accessories. Following is a brief description of some items available:—

TAPE DECK, TYPE L—Size 18" x 12". Two High-Torque Ball Bearing Motors. Precision Ground Capstan Drive for 7½ inch/sec. recording speed. Rewind 50 seconds. All switching electrically and mechanically from one switch in r.h. bottom corner giving space for chassis 12 inches long. Forward can be operated from foot-switch for Office recording. Price, without heads **£42**

AMPLIFIER, TYPE H—Chassis 12" x 8" x 2½". Six valve Hi-Fi circuit, including Supersonic Oscillator. 4 Watt output, Monitoring while recording. Jack for external speaker. Price **£39**

AMPLIFIER KIT SET, TYPE S—All the parts necessary to build a High-Fidelity 5-valve amplifier-oscillator. Three 6AU6, 1 6M5, 1 6X4. Including chassis, transformers, valves, oscillator coils, knobs, terminal, 5-inch speaker, etc., and circuit
Price **£24/17/6**

Circuit for above, 9/6.

RECORD—PLAYBACK HEAD—Astatically (balanced) high impedance winding of 135 mH on specially heat treated Mu metal. Gap .0005". Heavy cast shield, nickel-plated. Frequency limit at 7½" per sec. is 8000 c/s. Price **£5/7/6**

ERASE HEAD—Astatically wound high impedance winding on special silicon steel. £5/7/6

OSCILLATOR COIL—The quality of a magnetic recording depends on the supersonic bias. Our coils are proved and tested and give best results with every type of head. Price **19/9**

MOTOR—From a large number of motors we have selected this type as the most suitable for tape and wire recorders, owing to its power to weight ratio and the vibration free-silent running. **£5/18/6**

CAPSTAN—Complete with ground spindle, turned to within .0005". For 7½"/sec tape speed
Price **£3/14/9**

CABINETS—Leatherette covered to fit above tape-deck, 18" x 12" x 8½"
Price **£5/7/6**

RECORDING TAPE—"Pyral" French High Coercivity Tape, High Fidelity, Paper base, 1200 ft., including plastic reel **£2**

Plastic base, 1200 ft., including plastic reel **£3/3/4**

Rubber Wheels, Guide Pulleys, Take-up Drive and Clutch, Brakes, etc. Prices on application.

"NOVATAPE" MAGNETIC TAPE RECORDER—Featuring Tape L Tape-deck and Type H Amplifier with 6" Speaker, fitted in Cabinet **£107/7/6**

Above prices plus postage and exchange.

Please direct your enquiries to your dealer, or to:—

NOVA ELECTRICAL & ENGINEERING CO.

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the face of the core, to within perhaps ¼in. of it, trying both directions of polarity in turn. If there is residual magnetism in the core, the noise will drop to zero, or decrease considerably, when the field from the magnet just balances the core flux across the gap. The wrong polarity will cause an increase in noise.

If it is impossible to reduce the noise by applying an external magnetic field to the core, then the noise is probably due to dirt in the gap or a noisy tape. The former is dealt with by cleaning with carbon tetrachloride, which should be done periodically in any case. The latter may arise from an ineffective erase system.

THE FRONT GAP

The overall response of the recorder rises with frequency until the wavelength of the recorded signal approaches the gap length. At the frequency where the wavelength equals the gap length, or an exact multiple of this frequency, the response is zero. The practical upper limit of the frequency response is between half and three-quarters of this; so the gap length should be approximately half the wavelength, at the chosen tape speed, of the highest frequency which it is desired to record without loss. Above this frequency the response will fall off gradually to zero.

Thus the maximum gap length is determined by the required upper frequency limit and tape speed. Increasing the tape speed gives a proportional increase in upper limit and decrease in playing time, other factors being equal; so the designer has a choice of a low-fidelity, long-playing or a high-fidelity, short-playing recorder. Alternatively this choice may be left to the operator, by providing two or more speeds; say 7½ and 15 inches per second, which would give respectively ½ hr. and ¼ hr. running of a seven-inch reel.

In theory there is no reason why the gap should contain anything but air, but in practice it is advisable to make it solid, filling it up with some non-magnetic substance such as brass, mica, copper, etc. This excludes dirt, and magnetic dust rubbed off the tape, which would move about in the gap and cause noise. A fairly hard substance is desirable, as if it is too soft it may allow the edges of the gap to become burred over which would affect the performance of the head. Ideally the material would be of such a hardness that it would wear down at the same rate as the core itself; however, a suitable material is brass shim, say .001in. thick, which has the advantage of being of an accurately known thickness, thus automatically spacing the gap correctly.

It is essential that the gap be at exactly right angles to the core, and that the sides of the gap be parallel. The latter may be checked easily, but an angular displacement of a degree or two is not so easily noticed.

If the length, from pole to pole, of a magnet is small compared with its width, there is a tendency for the magnet to demagnetize itself, which increases as the length becomes less. A single cycle of a 750 c/s signal recorded at 7½in. per sec. occupies 7.5/750 in., or .01 in., along the tape, yet the track may be .25in. wide. This cycle may conveniently be regarded as two complete "magnets," one for each half cycle, having a ratio of width to length of 50:1. In practice an even higher ratio than this is quite permissible, since a reduction in response at higher frequencies, when the "magnets" become progressively shorter, can be compensated for in the amplifier circuits. However the ratio is improved by running the tape at a higher speed, when the wavelength for any given frequency becomes longer; or by using a narrower core which reduces the track width.

A twin track recorder running at 15in. per sec. has some advantages over a 7½in. per sec. single-track recorder. The running time for any given reel is the same since the track length is effectively doubled; yet the magnetizing ratio is improved by four times, while the higher speed doubles the upper frequency limit, with the same gap length. Alternatively, the gap may be made twice as long for the same upper limit, with a corresponding increase in its reluctance, which gives a higher output on playback and a better signal-to-noise ratio.

If a supersonic erase head is used, its gap will be much longer than that used for recording; .005in. to .01in. would be suitable, depending upon tape speed and erase frequency.

With the length and width of the gap decided, there remains the question of depth. A greater depth gives a greater area of gap face, and a lower reluctance across the gap. A high reluctance is desirable, therefore the gap should be as shallow as possible consistent with the allowance for wear, which will decrease the depth of the gap over the life of the head. Ideally the depth would be less than the length, but in practice it may be as deep as .005in.

THE BACK GAP

The back gap is a result of the method of construction, but it plays a definite part in the performance of the head, and must be considered in the design.

A fairly large gap is sometimes used to reduce residual magnetism in the core. However, increasing the length of either gap will decrease the inductance of the head, which will affect the frequency response.

The output on playback is highest when the reluctance of the front gap is many times higher than that of the back gap. This is easily achieved, even when the back gap is spaced slightly, since its cross-sectional area is far greater than that of the front gap.

Normally the back gap would be closely butt-jointed.

CONSTRUCTING THE CORE

In producing cores in quantity, stampings are used as for transformers, and to save work similar stampings may be used in making an experimental head. The method is as follows:

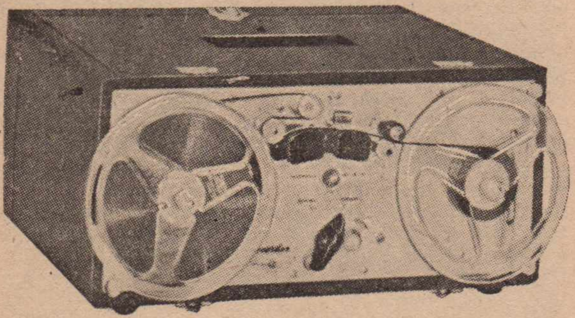
Assemble the stampings in two stacks, each as high as the required track width: for example, ¼in. in the case of a single track head. As the same operations will be performed on each stack in turn, only one will be referred to. Clamp the stack in the vice (unless it is a small type, a hand vice is most suitable), with the poles pointing downwards, taking great care to have all sides at right angles. With a hot iron, tin the edges of the laminations along the upper side and run enough solder over them to hold the stack together. Use

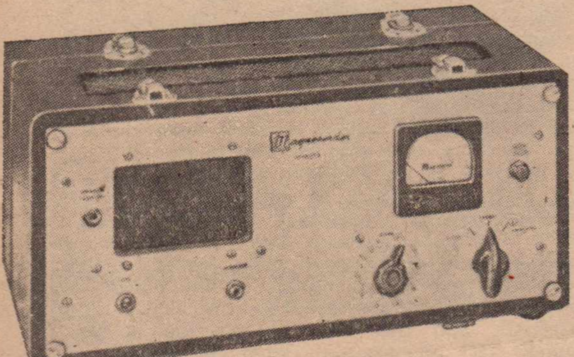
Continued on Page 10

IN TUNE WITH THE TRADE

RECORDER

In the field of sound recording, we learn that Byer Industries Pty. Ltd., of South Melbourne, who are, no doubt, well known to readers for their extensive range of "BRS" products, have completed arrangements with Magnacord Incorporated, of the United States, to manufacture exclusively the MAGNECORDER series of Tape Recorders in Australia for the sterling market. It has been reported that the equipment is used more extensively in the United States than any other recorder of its type, and promises to prove extremely popular with Australian radio and electrical engineers. It is understood that the first batch is already off the assembly line, and for the present manufacture will be concentrated around the JA series, a twin unit, dual purpose combination. The amplifier unit and tape drive mechanism are normally contained in separate carrying cases for portability, but may be extracted quickly and easily from their cases for rack mounting in studio or laboratory. A feature of the MAGNECORDER seems to be high quality combined with portability and adaptability.





A range of multi-channel mixer units are in course of production to enable two or more tape drive mechanisms to be coupled to a single amplifier for continuous programme recording.

We have received discriptive literature from the manufacturers, who, we understand, will be pleased to forward details to those interested.

Enquiries should be made to Byer Industries Pty. Ltd. or their Interstate Representatives, as listed on our back cover.

BON VOYAGE

Mr. Jim Magrath, of J. H. Magrath & Co., Melbourne, left last month by air on a business visit to the United States, Canada, and Great Britain.

We understand Mr. Magrath will study the position of Television, especially with relation to the future distribution and manufacture of Television Component Parts in Australia.

Kit Sets, for home construction, have always been this Company's speciality, and we predict that in the none too distant future, Television Kit Sets will be available in Australia, together with other high frequency apparatus.

It is expected that J. H. Magrath & Co. will add many new lines to their already comprehensive range of Radio equipment and components during and following the "Chief's" visit abroad.

NEW RECEIVER

Followers of our Short Wave Review, D.X. listeners and New Australians will be pleased to hear that Electrosound Pty. Ltd. (see advertisement elsewhere in this journal) have developed a receiver especially designed for oversea reception. One of these receivers is being installed at our short wave listening post, and will be reviewed by our Mr. Keast at a later date.

Ease of tuning, plus high sensitivity, are claimed as two of the many features, with frequency coverage in two bands extending from 13 to 120 metres, thus covering all worthwhile oversea channels.

The "R. and E." Gramophone Pre-Amplifier

PART II (Continued from the March 1951 issue)

CONSTRUCTION—continued

The wave-change switch used for S1 can be seen, in the centre of the chassis, and has its operating shaft 2½in. from the end of the chassis. This brings it in a convenient position for connecting to the circuit of V2.

It should be noted that the switch is mounted, not by the usual single-hole fixing, but by passing the long side-bolts through the chassis, and assembling the switch in position. Two of the wafers are placed above the chassis, and the remaining one below. The idea of this is to allow S1a, S1b, and S1c to be above the chassis, where they are shielded from the plate circuit of V3, which would be uncomfortably close if they were underneath. It also enables all the small parts comprising the parallel-T network to be placed above the chassis, making room below for some of the larger parts, including the cathode bypass condensers and the plate-to-grid coupling condensers.

In this connection it should be noted that the condensers and resistors of the parallel-T network are all mounted on the switch contacts themselves, and that several other small parts are also above the chassis, mounted on tag strips. These include all the parts between the grid on V3 and the output of the plate network of V2, and the parallel-T network in the plate circuit of V3 itself. Two small tag strips have been mounted behind the switch, and these carry all the parts mentioned. The exact manner in which these are disposed is not very important, because of the low overall gain of the three stages, but the work should be carried out as neatly as possible, and we would strongly recommend that lugs be provided on the tag strips so that all resistors and condensers are able to terminate on one of the lugs, or else on one of the switch lugs. In this way, all parts are properly supported, and there is no chance of accidental short-circuits through shifting of the parts, and through loose soldered joints that are able to shift their position with respect to the rest of the wiring.

CHOICE OF SMALL COMPONENTS

It will probably have been noticed that contrary to our usual practice, tolerances have been marked against certain of the condensers and resistors. The reason for this is that the performance of the low and high-pass filters is to a large extent governed by the accuracy with which the values are chosen. It is quite possible to build the unit without choosing the parts with any special care, but if this is done, it should be remembered that the cut-off frequencies of the filters may not come within quite a way of the designed values unless the tolerances specified are adhered to. However, those who have no facilities for purchasing or choosing accurate values need not think that this makes the circuit entirely unpractical, for such is not the case. Tests have shown that quite acceptable performance can be obtained by using standard-tolerance components throughout, but that the attenuation above the cut-off frequencies will not usually be quite so great. The moral is, use parts that are as accurate as can be obtained for the ones where close tolerances are specified, but do not worry unduly if these cannot be obtained.

It is advisable to make a careful check of the wiring, especially that of the switch for the low-pass filter, before the unit is put to use. It is very easy to make wiring mistakes in a circuit like this unless great care is taken, and a little time spent checking before switching on may save many hours of searching to find the cause of some unpredictable behaviour.

HUM REDUCTION

This pre-amplifier is not suitable as it stands, for pick-ups with very low output, such as the moving-coil variety, or the variable reluctance type, which have an output of only 10 millivolts or so. Rather is it intended for medium output pick-ups of 0.1 volt output or more. It may be found that for pick-ups with only 0.1 volt output, the hum output, though tolerable, is not quite low enough for high-fidelity requirements. For the latter, it should be about 50 db. or more below the maximum power output of the amplifier with which it is to be used, and with the present design, this figure can be reached by means of a little attention to detail. The circuit as originally given three months ago, does not show what earthing arrangements are to be made for the heater wiring. It was found that the hum from the unit was such as to be equivalent to a hum voltage of 0.35 mv. when the following precautions were taken. At that, a pick-up with an average output of 0.35 volt would give a signal/hum ratio of 60 db., while one of 0.175 volt would give a ratio of 54 db. These figures are worked out on the average pick-up output, so that at full signal input, the ratio would be slightly better, and at low signal levels, slightly worse than these figures.

The first thing to do is to instal two 50-ohm resistors in series across the filament pins of the EF37, and earth the junction to the nearest possible point to the valve socket. This can conveniently be a solder lug held under one of the socket's mounting screws. Note that it will have been necessary to run a two-wire heater system, and to have left the heater circuit ungrounded, so that the centre-tapping by means of the 50-ohm resistors is the only ground on the heater circuit. This gives at the outset a much lower hum level than earthing one side of the heater wiring, as can be done in an ordinary amplifier chassis. The next step is to instal at any convenient place in the chassis a low-resistance wire-wound potentiometer. Any value between 100 and 500 ohms total resistance will do. A good place for it is right at the heater winding terminals of the power transformer. The ends are wired to the heater winding terminals, and the centre connection is for the moment left unconnected. Then the screen bypass condenser in the EF37 circuit is disconnected from earth, and an insulated lug installed in a suitable position, and the earth end of the condenser taken to it. Finally, a wire is run from the moving arm of the low-resistance potentiometer to the screen bypass condenser (i.e., to the end that has just been disconnected from ground.) The preamplifier is connected up to the main amplifier, the pick-up

Continued on Page 32

HIGH QUALITY SOUND

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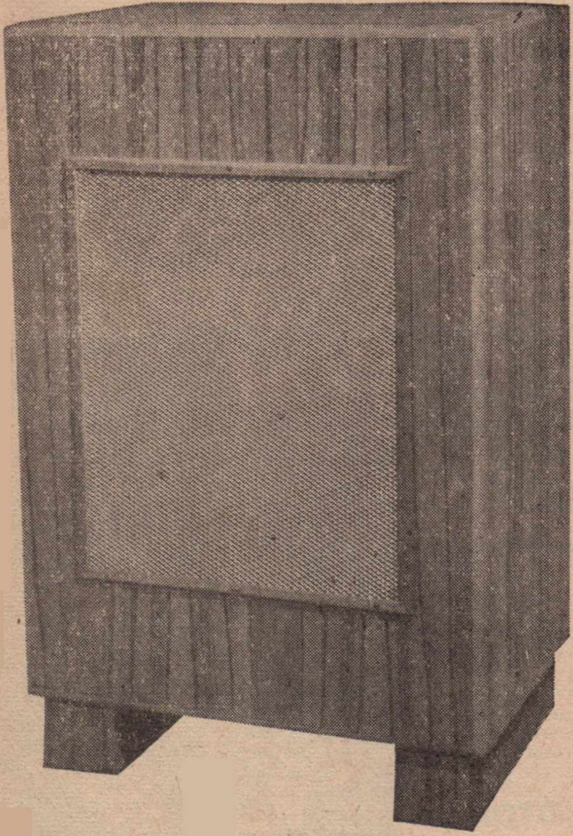
Having a fundamental Cone Resonance between 50 and 60 cycles. Each cabinet is lined with 1" felt and constructed of 1" Walnut Veneer Timber



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THE TAPE RECORDING HEAD (From P. 6)

resin as flux. If the stampings have rough edges, it may be easier to file two or three narrow channels across the stack with a fine rat-tail or triangular file, removing no more metal than is necessary to make a smooth channel, and run solder along these.

Remove the stack from the vice and check that everything is square, particularly the edges of the poles which form the gaps. Now, using the same method as before, run solder over the back edges and the inside of the front gap (see Fig. 4). The stack is now firmly joined together and may be worked as a single piece of metal.

If soft iron is being used the outer laminations may tend to peel off while it is being worked, as it does not take kindly to soldering. To avoid exasperation, a pair of dummy stampings filed out of sheet brass may be placed on each side of the stack like the covers of a book, and soldered up with the rest; they will hold the stack together firmly during subsequent operations, and may be stripped off after the core is finished.

Smooth the face of the core on a fine oilstone, removing no more metal than necessary, and taking care not to round off the front gap (Fig. 4). Now the open side must be cleaned up, and the

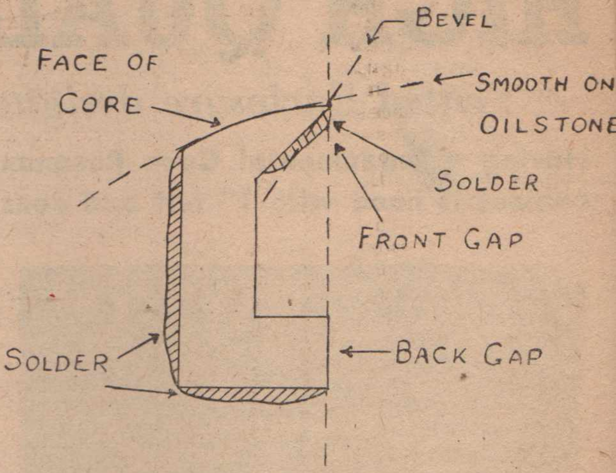

Fig. 4

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back gap face must be made flat and true with the front gap, again using the oilstone, as shown by the broken line in Fig. 4. Check progress with a powerful magnifying glass. In order to get a perfect finish on the front gap, it will almost certainly be necessary to cut the gap face back by several thousandths or even hundredths of an inch. As this would make the front gap too deep, it is necessary to bevel the underside of the gap (Fig. 4), using the finest file available, so as to reduce the depth of the gap face to about .002in., as shown in cross-section in Fig. 5. This is the most difficult part of the whole work, and too much care cannot be given to it. Tin the bevelled edge again before finishing the gap on the oilstone.

If all is well the two halves should fit together neatly with no light showing between the gaps. If the core is intended for an erase head, remove two or three thousandths of an inch, with the oilstone, from each face of the front gap, without touching the back gap. This will give approximately the correct spacing.

THE WINDINGS

Apart from the relatively small size of the core, there is nothing unusual about the windings, and the procedure is straightforward. One half of the winding (or of each winding if there are two) is placed upon each "leg" or half of the core. The general rule is to get as many turns as possible into the space available, as the thickest wire should be used which will allow the required number of turns to be squeezed on. Enamelled wire is of course essential. As a fairly high inductance is desirable for a high impedance head, calling for a large number of turns, 40 or 42 S.W.G. is about the thickest gauge which can be used for this type of head.

A low impedance head is easier to wind, since 28 to 34 S.W.G. wire may be used, with fewer turns; however, it has the disadvantage of requiring a matching transformer. This causes little difficulty when recording, but with a playback head, care is needed to prevent hum pick up by the transformer, which is followed by a high-gain amplifier.

If separate heads are to be used, a low impedance for recording, and a high impedance for playback, are recommended.

The actual number of turns depends upon the core size and the impedance, but 1,000 to 2,000 turns for a high, and 40 to 100 turns for a low impedance are fairly typical.

Sometimes a separate winding for the bias current is called for. This is usually low impedance.

Continued on Page 23

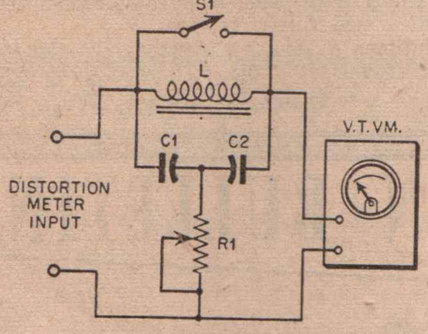
Audio Frequency Distortion Measurements

Part 2.—A Practical Distortion Analyser

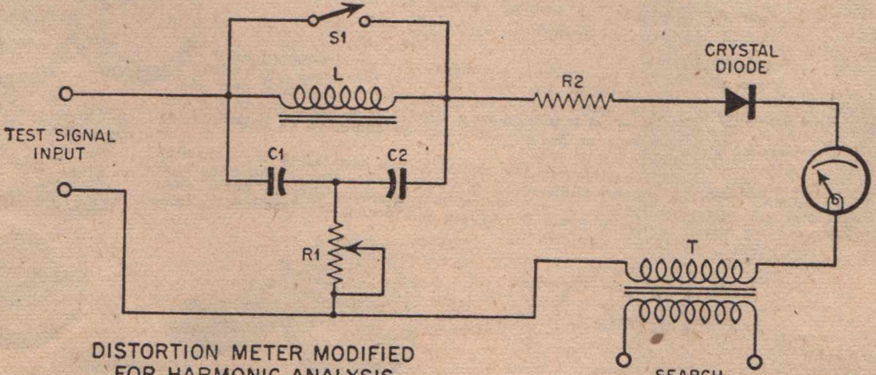
By the Engineering Department, Aerovox Corporation

Part I of this series contained a discussion of the nature of audio frequency distortion and a survey of the methods employed in making quantitative distortion measurements on audio equipment. The present article details the design and construction of a simple and practical distortion analyser which is a very useful adjunct to any amplifier service shop or audio high fidelity experimenter's bench. The instrument is compact, easy to adjust and use, and costs little to build. Yet, the results obtained are sufficiently accurate to permit evaluation of the performance of most audio equipment and observation of the results of even minor design changes.

As was pointed out in Part I, the simplest form of distortion meter employs a null bridge to suppress the fundamental test frequency being amplified under test and a vacuum tube voltmeter to read the amplitude of any signals which pass unattenuated through the null bridge. If the signal input to the amplifier is a pure sine wave of frequency equal to the null frequency of the bridge, the only signals indicated by the voltmeter will be the harmonics introduced by distortion in the amplifier being tested. If the response of the voltmeter is linear, it is easy to express the total harmonic content thus indicated as a percentage of the amplifier output.



BASIC DISTORTION METER
FIG.1



DISTORTION METER MODIFIED
FOR HARMONIC ANALYSIS
FIG. 2

THE DISTORTION ANALYSER

The major shortcoming of the null bridge type of distortion meter, as it is usually employed, lies in its inability to identify the order of the harmonic content indicated. It reads **total** percentage of distortion and thus may only be classed as a distortion **meter.** To be considered a distortion analyser, the instrument should be capable of identifying each harmonic component present and indicating their relative amplitudes. Commercial distortion analysers which accomplish this are both complicated and costly. However, a simple system is available which is not appreciably more complicated than the common null bridge distortion meter, but is capable of considerably better results. Its use is predicated upon the availability of a second audio oscillator.

The circuit of a typical null bridge distortion meter is shown in Fig. 1. The components L, C1, C2, and R1 constitute the null bridge network which suppresses the frequency at which L and the series combination of C1 and C2 are resonant, as given by:

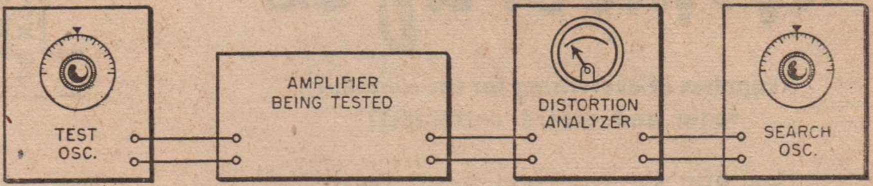
(1)

$$\text{Null frequency } (f) = \frac{1.414}{2\pi\sqrt{LC}} \text{ cycles per sec.}$$

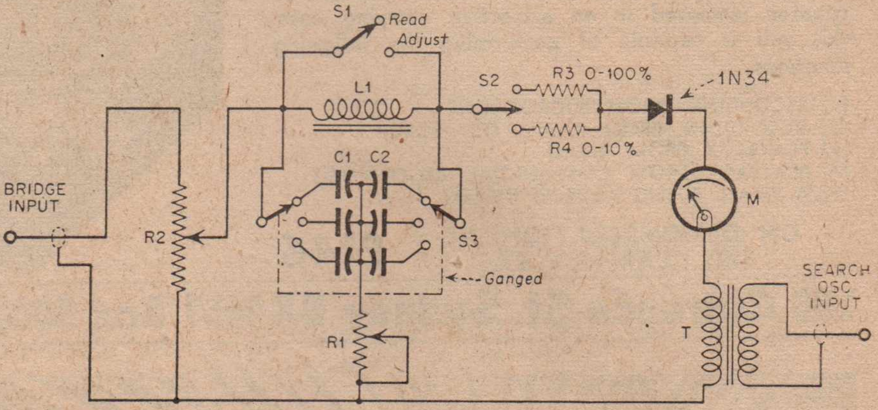
Where: L is the choke inductance in henries.
C = C1 = C2 is the capacitance of each unit in farads.

The circuit configuration will be recognized as the "bridge-T" type of network. The resistance (R1) is used to adjust the null reading to minimum. If the circuit constants are chosen properly, and distributed capacitance is minimized, virtually zero transmission will occur at the null frequency. If the null circuit "Q" is high, the null will be very sharp and nearby frequencies will be very slightly affected. The voltmeter is used to measure both total amplifier output and harmonic output by shunting out the bridge circuit with the switch (S1) during the former measurement. A vacuum tube voltmeter may be employed, or as shown by Turner*, a simple crystal diode voltmeter may be used with only a slight sacrifice in accuracy.

To convert the distortion meter of Fig. 1 to a distortion analyser, the modification shown in Fig. 2 is made. An audio transformer is added to permit the insertion of a sine wave signal from a second audio oscillator. This signal is used to identify individual harmonic components present in the bridge output by the beat method. To accomplish this, the second oscillator is swept through the frequency range containing the harmonics of the fundamental test signal. Fig. 3 of the block diagram of the complete test set up. Near the frequency of each harmonic present, a "beat" will be observed in the distortion meter reading. The amplitude of the beats are indicative of the relative magnitude of each harmonic component identified. Thus, a quantitative indication of harmonic content, as well as total harmonic percentage, is obtained.



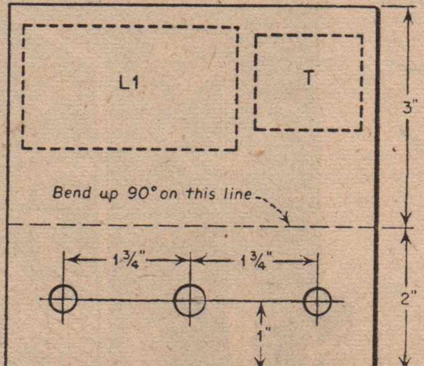
TEST SET-UP FOR DISTORTION MEASUREMENTS
FIG. 3



R1 - 1 megohm, carbon.
R2 - 1000 ohm, wire wound.
R3 - 30,000 ohms, ½ watt carbon.
R4 - 2000 ohms, ½ watt carbon. (Approx.)
S1, S2 - S.P.D.T. toggle switch. ↖See text.
S3 - 2gang, 3 position wafer switch.
L1 - 8 hy. 150 ohm choke.
T - See text. M - 0-100 microamperes.
CRYSTAL - 1N34 or equivalent.
C1, C2 - 400 C.P.S. .04 μfd (Aerovox Type 489)
- 1000 C.P.S. .006 μfd (Aerovox Type 1089)
- 5000 C.P.S. .00025 μfd (Aerovox Type 1468)

PRACTICAL DISTORTION ANALYZER
FIG. 4

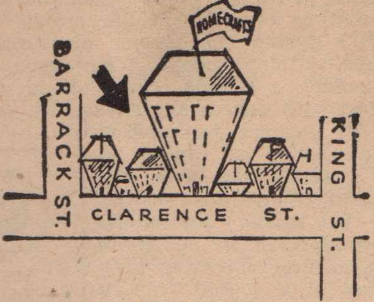
As an example, suppose that the test frequency is 400 cycles and the distortion meter indicates a total harmonic distortion of 10 per cent. before the introduction of the "search" oscillator. If there is both second and third harmonic distortion, an amplitude beat will be observed when the second oscillator is swept through 800 and 1,200 cycles. If the second harmonic predominates, the beat at 800 cycles will be greater than the one at 1,200 c.p.s. in the same proportion. Knowing the total harmonic disortion, it is easy to evaluate the percentage of each harmonic component. The search oscillator frequency should be adjusted close enough to the harmonic frequency to give nearly zero beat, so that the meter needle can follow. The oscillator used for searching should be relatively free of harmonic output.

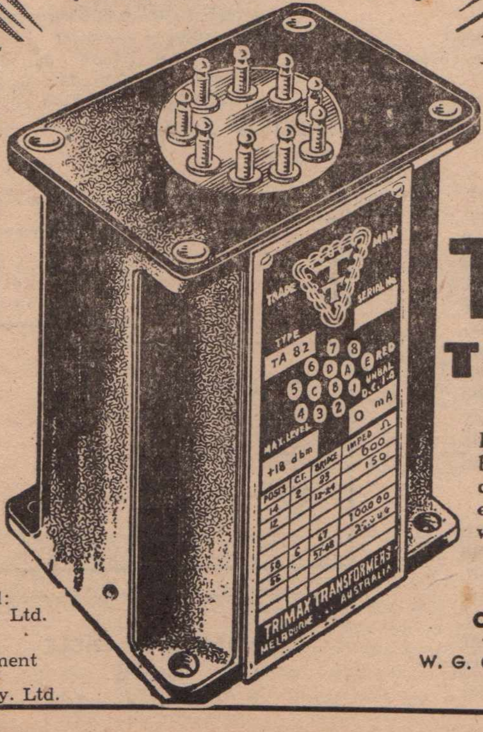


DETAILS OF SHELF
FIG. 5

CONSTRUCTION DETAILS

The practical circuit diagram of the distortion analyser is given in Fig. 4. Since no vacuum tubes or power sources are required for its operation, the unit may be assembled in very compact form. A crackle-finish metal cabinet measuring 6in. x 6in. x 6in. affords more than sufficient space to mount all components. No chassis is used; all parts are mounted on the front panel except the choke (L) and the audio transformer (T) which are supported by a sheet-metal shelf fastened to the back of the removable front panel by means of the shaft bushings of R1, R2, and S2 (Fig. 4). The dimensions of this shelf and the approximate locations of the parts mounted on it are shown in Fig. 5. The suggested front panel lay-out is shown


HOMECRAFTS
BARRACK ST.
KING ST.
CLARENCE ST.


TRADE MARK
SERIAL No.
TYPE
TA 82
MAX. LEVEL
+18 dbm
IMPED Ω
600
150
TRIMAX TRANSFORMERS
MELBOURNE AUSTRALIA

in Fig. 6.

To assure maximum verastility, three null bridge frequencies, 400, 1,000, and 5,000 cycles, are provided. These frequencies are selected by substituting the proper capacitance values for C1 and C2. Capacitor switching is done with a two-circuit, three-position water switch. If additional or alternative test frequencies are required, the necessary capacitor values may be computed from:

(2)

$$C1 = C2 = \frac{1}{158f2} \text{ farads (for 8 henry choke)}$$

Where: f is the desired null frequency.

For most routine amplifier testing, the three frequencies for which values are given in Fig. 4 will be sufficient.

For effective fundamental frequency rejection with low harmonic frequency attenuation, the "Q" of the null bridge components must be high. Best quality components should be used for the resonant circuit comprising C1, C2 and L. The choice of the choke is important since the resistance as well as the inductance of this unit is critical. The resistance of the choke will adversely affect the "Q" of the null circuit if too high.

Some selection of capacitors may be necessary to arrive at any given test frequency, although for most practical purposes it is not necessary to measure distortion at exactly the frequencies specified.

The null resistor (R1) is a variable one megohm potentiometer mounted on the front panel and provided with a small knob. This control is used to adjust the null response to minimum at each of the test frequencies. The setting of R1 usually remains fixed for any given frequency.

The crystal diode voltmeter uses a 1N34 or any of the germanium crystals as a rectifier. It gives a response that is approximately linear with input voltage if a high sensitivity meter is used. A 0-100 microampere meter is ideal, since the scale calibration can be used to indicate distortion percentage directly. Otherwise, any meter requiring less than about 250 microamperes for full scale deflection may be employed. Above this current, the average crystal diode characteristic departs markedly from linearity.

Two meter ranges are provided to allow more accurate reading of distortion percentages. These ranges, 0-100 per cent and 0-10 per cent., are selected by switching meter multiplier resistors R3 and R4 by means of a toggle switch (S2). The multiplier resistor for the 0-10 per cent. scale is selected to give full scale deflection at 1/10th the RMS input voltage required to give full scale reading on the 0-100 per cent. range.

The audio transformer (T) may be almost any unit of good quality which the experimenter might have available. The characteristics are not critical, since this transformer is used merely to introduce a small audio voltage from the search oscillator into the voltmeter circuit. A good 3:1 interstage audio transformer will usually be found satisfactory.

The audio input cable to the bridge circuit, as well as the external lead to the search oscillator, are run through holes in the left hand side of the metal cabinet and wired permanently to the circuit. These leads are of standard single-conductor shielded audio cable and are fitted with alligator clips at the input ends. The cabinet holes should be fitted with rubber grommets.

USING THE DISTORTION ANALYSER

The use of the instrument is relatively simple. After the construction has been completed, the operation of the null bridge circuit is tested at each of the test frequencies. To do this, the bridge input cable is connected directly to the output terminals of the test oscillator. With the toggle switch S1 in the "Adjust" position and the test oscillator and frequency selector switch set at the proper test frequency, the output of the test oscillator and the gain control (R2) are adjusted to give full scale deflection of the distortion meter. Then, when S1 is thrown to the "Read" position, the meter reading should drop to a very low value. To minimize the reading, the null resistor (R1) and the test oscillator frequency must be varied simultaneously. If the null bridge is functioning properly, the adjusted null at some frequency near the desired test frequency will be quite sharp and the meter reading will be very nearly zero.

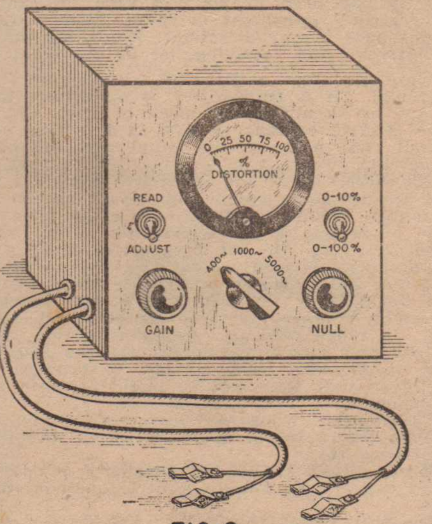


FIG. 6

If an incomplete null is obtained, the bridge components are faulty or the test oscillator has some harmonic output which is being indicated on the meter. The nature of this residual reading can be readily determined by the use of the search oscillator. With the distortion meter operating as above in the "Read" position, the search oscillator is connected to the audio transformer input leads and enough search signal is injected to about double the residual reading on the meter. The frequency range of the test signal and its harmonics is then explored by varying the frequency dial of the search oscillator slowly. If there is a large beat fluctuation of the meter pointer at the fundamental frequency and little at its multiples, the residual reading is caused by imperfect bridge balance. If the converse is true, the harmonic content of the test oscillator is to blame for the incomplete null. The harmonic output of the test oscillator should be carefully recorded so that it can be discounted when actual amplifier tests are being made.

In using the bridge to analyse the distortion

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GETTING STARTED – Part 4

RADIO WAVES

To continue our discussion from last month's chapter on "What Is Radio?" we will now deal with some elementary theory, and the use of technical terms which are used to describe the various functions in a receiver. Another way of describing Radio Waves is—electric currents which have escaped from the wires carrying them. Many of you will not know what an electric current is, but for our purposes this does not matter very much, for electricity had been known and used for centuries before its real nature was discovered. However, electric currents are very important in radio, because radio waves are simply a form of electricity which is able to travel through space in any direction. Producing the waves is the job of the transmitter, but, since we are at the moment more interested in receiving, let us see what the waves can do.

Suppose we erect a piece of wire a few feet above the ground. If a transmitter is operating, the waves sent out by it **strike** the piece of wire and cause a minute electric **current** to flow in it. This current is so small that none of the usual methods of demonstrating the presence of an electric current will tell us it is there. First and foremost, then, our radio set is an arrangement which will reveal the presence of very minute electric currents. In radio terms, the set is said to **detect** the radio currents in the **aerial** (our piece of wire) and the set **is** therefore called a **detector**. Very simple sets such as crystal sets do nothing but detect the radio currents and make them audible in a pair of headphones. In more complex sets, though, valves are used to **amplify** the radio currents collected by the aerial. In these sets, the amplifier portion is followed by a **detector** which serves exactly the same purpose as the simple set itself, namely, to change the radio currents so that they can be made to work a pair of headphones or a loud-speaker.

To summarise what we have already learned—

(1) Radio waves travel outwards in all directions from a transmitter.
(2) These waves strike the listener's receiving aerial and cause very minute electric currents to flow in it.
(3) The purpose of the radio receiver (or set) is to change these radio currents into such a form that they can operate a pair of headphones, giving rise to sounds we can hear.
(4) Valve sets often contain **amplifiers** which make the radio currents from the aerial bigger, after which a portion of the set called the **detector** performs the step described in (3) above.

WHAT AMPLIFIERS ARE FOR

The next question might easily be: "Why do we have sets with many valves, when sets can be built without valves at all?"

There are three main reasons. In the first place, crystal sets containing no valves will not operate a loud-speaker, but only a pair of headphones. Secondly, a crystal set does not amplify the radio currents before detecting them, so that only the strongest stations can be received, even with headphones. Thirdly, it is difficult to be sure that a crystal set will allow us to hear a weaker station when there is a very strong one transmitting. All these disadvantages can be overcome by using valves, because of their amplifying properties.

WHY START WITH CRYSTAL SETS?

This is not a difficult question to answer. Valve sets are too complicated for the very beginner. There are too many reasons why even a simple valve set may not work, for it to be undertaken before a simpler set. It is only by finding out at first hand the limitations of crystal sets, that the advantages of valve sets can be fully realised. Besides, many will find a valve set too expensive for a first effort. All the parts used in building various crystal sets can be put to use when we come to build our first valve set, so that as we progress, a few parts at a time can be purchased. Thus, the putting of the first valve set into operation will not be too much of a strain on the pocket when the time comes for it.

WHAT TO BUY?

For building crystal sets, and also small valve sets, the first necessity is a good pair of headphones. Notice the word "good." It is very important. The 'phones are the only expensive item you will have to buy, so it is as well not to buy a cheap pair. These are seldom worth the money paid for them, and even if a good pair costs twice as much as a poorer pair, the expensive ones will give better than twice the results of the poor pair.

There is a simple test that will enable you to be sure you are getting a good sensitive pair of 'phones. At the end of the cord are two metal tips by means of which the 'phones are connected to the set. Put the 'phones on, making sure that the ear-pieces fit snugly. Take a coin (perferably a half-crown, which has a milled edge) between the thumb and forefinger of the left hand. Then, take one of the 'phone tips and hold it between the remaining fingers of the left hand and the palm. Finally, take the second 'phone tip in the right hand and rub it gently along the milled edge of the half-crown. If the 'phones are sensitive, this will make an easily-heard sound in the 'phones.

* * *

NOTE: Should the reader have any difficulties at all in following our Beginner's Course, the Editor of this journal would be pleased to hear from you concerning your problem and thus be in a position to offer personal and individual assistance.

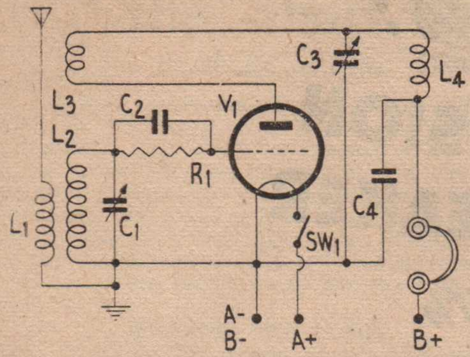
A SIMPLE 1-VALVE REGENERATIVE SET

Component List

C1 0.0003 or 0.0005 uf. variable.
C2 0.00025 or 0.0005 uf. fixed.
C3 0.00025 uf. Can be air or mica-spaced.
C4 0.0005 mfd. fixed.
V1 Any of the types in the above table.
L3, Ticker coil. 10 turns of 30 D.C.C., wound over the lower ten turns of L1.
L1, L2, same as for aerial and tuning coils of any of the crystal sets.
A Battery, to suit valve used.
B battery, 13½ to 45 volts.
L4 Broadcast R.F. choke.
SW1 On/off switch.

Note.—If the three windings are all wound in the same direction, on the former, connecting the **bottom** of the tickler to the plate will be right. If the set will not oscillate at all, try reversing the tickler connections, because the direction of winding might not be right.

A Simple I Valve Regenerative Set



This design incorporates a typical triode regenerative detector and in this particular stage lies the secret of outstanding sensitivity of the set. The regeneration is introduced by coupling from the plate circuit back to the radio frequency input. At the plate output there is a combination of rectified audio voltage and an amplified R.F. signal voltage. The effect of this type of regeneration is to increase the radio frequency voltage applied to the detector and at the same time to produce a corresponding increase in selectivity. The increase in signal voltage will reach a limit which is governed by the amount of reaction required to cause the detector to go into oscillation, and when this occurs the received signal will produce a beat-note or whistle. When regeneration is carried as far as possible without oscillation occurring, the increase in amplitude (or gain) is very great for weak signals and less, although still considerable, for strong signals. This factor explains the D.X. (long distance) capabilities of this set. The amplification (or gain) of a received signal when the detector is operating at the critical point, that is, when the detector has the maximum amount of regeneration without causing oscillation, is extremely large. Under favourable operating conditions the amplification of an incoming signal has been found to be as high as 15,000 times.

Tube Type	Fil. Voltage	Fil. Current	Type of Base
1G4-GT	1.4	0.05 amp.	Octal
1H4-G	2.0	0.06 amp.	Octal
30	2.0	0.06 amp.	4-pin

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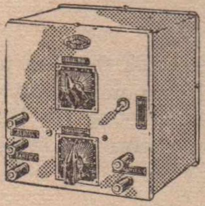

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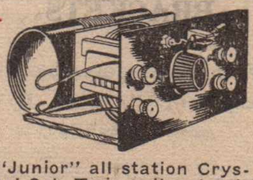

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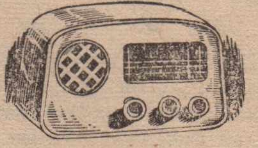

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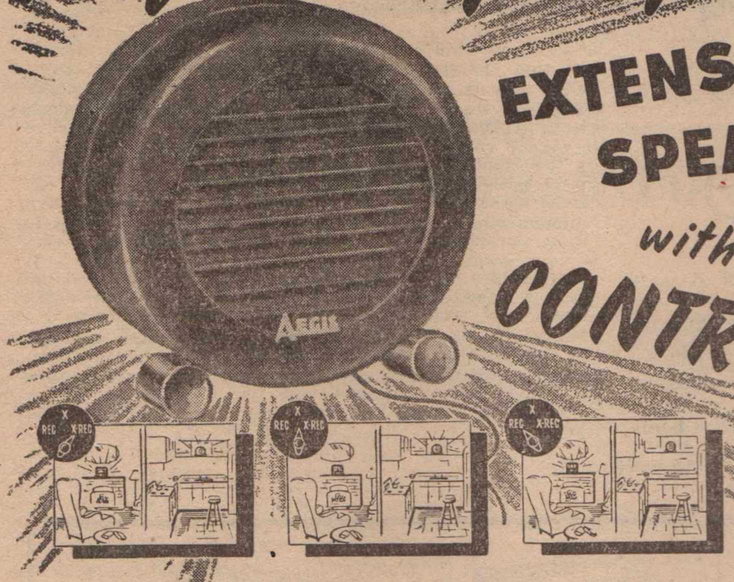

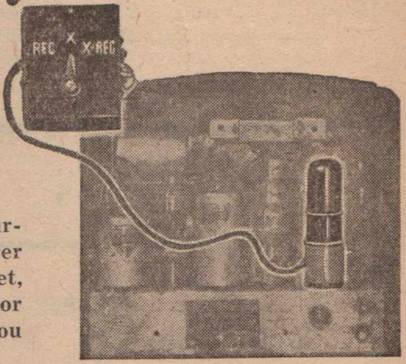

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The Short-Wave Miniature Three

PART II: MAKING THE COILS AND OPERATING THE SET

In the first instalment of this article, which appeared in the April 1951 issue of **"Radio and Electronics"**, the circuit and construction of the set was described, and photographs of the prototype were featured so that builders would be able to duplicate the original layout as closely as possible. In this, the final instalment, details of the coils are given, and this is followed by some tips on operating the set so as to get the best results out of it.

MAKING THE COILS

The set covers the whole of the normal short-wave range of 3 to 30 mc/sec. To do this, three sets of two coils per set are needed, making six coils in all. They are not difficult to make, being wound on commercially available coil formers with enamelled wire that is in all cases thick enough to be quite easy to handle. The numbers of turns on all winds are given in the table below:

	L1	L2	L3	L4	Tap on L3
RANGE A					
No. of Turns	5	26	26	3½	3½
RANGE B					
No. of Turns	4½	13	13	2½	2½
RANGE C					
No. of Turns	2½	5½	5½	2½	2½

NOTE.—L2 and L3 for Range A are wound with 30-gauge enamelled wire. For Ranges B and C, these windings are of 20-gauge. For all ranges, windings L1 and L4 are of 30-gauge wire.

All coils are wound on ribbed formers, 1¼in. in diameter. These formers are provided with bases carrying the pins with which the whole is plugged into the valve-socket holders, and which carry the electrical connections from the coils. The bases are held to the base of the former by a single screw, threaded into the bakelite, and so can be removed entirely while the windings are being put on. To hold the windings on the former, small holes are bored in it with a sharp instrument, such as scriber point, or a bradawl, with the business end filed down to a width of about one thirty-second of an inch. To commence a winding, one hole is bored in the former, close up to one of the ribs, and a short length of the wire threaded through, on to the inside of the former. It is then taken down to the bottom of the former, where there is a flange, with several small holes already provided. The wire is taken round the flange, to the outside of the former, and then passed down through the nearest hole, where it is left projecting. The wire can then be pulled taut without fear of its coming adrift. The required number of turns is now wound on, which brings the winding near the bottom of the former, and wire is held while a further hole is bored in the former. The wire is cut from the reel, leaving several inches to spare, and threaded through the newly-made hole, just as at the start of the winding. It is then brought out at the bottom of the former, as before, and anchored in a further hole in the flange. All the coils are space-wound. That is, L2 and L3 are wound with the turns spaced from each other by a distance equal to the diameter of the wire. This is easily accomplished in the following way. After the wire has been anchored for the start of the winding, a second piece of the same wire is temporarily anchored by passing it through the same hole as the main wire, but this time, taking it out through the top of the former, and simply bending it over. We now have two wires coming out of the starting hole, and these are wound on, side by side, so that the whole makes a solid winding, with the turns tightly pressed up to each other. On coming to the end of the winding, the additional wire is released, and springs away from the former, leaving the main wire wound on, very accurately spaced. Since bakelite formers are slippery, care is needed to ensure that after the spacing wire has been released, the turns of the main winding do not slip, or the spacing will be lost, and it will be necessary to start again.

ADDING THE SMALL WINDINGS

Of course, the main windings are L2 and L3, which are the tuning coils, and these should be put on first. Then the small windings can be added. In the case of L1, the following procedure will do the trick. A small hole is bored in the former, five turns up from the bottom of the main winding. It will not be possible to do this without disturbing the spacing of the lower turns of the coil a little, but as long as its ends are secure, this does not matter. L1 is then started from the bottom end, by reeving it through one of the holes provided in the flange. The turns are then wound on, in between the turns of L2, until the ending hole, which has just been made, is reached. It is then passed through this hole, and taken down and anchored, as before. Since both windings are of the same wire, the turns will bed together closely, and will automatically correct the spacing that was displaced while boring the finishing hole.

On the other coil, L4 is put on in a similar manner, but not until the tap has been added to L3. The best way to do this is to wind L3 completely for a start, and then bore a hole at the appropriate spot on the former. Just opposite the hole, the wire of L3 is carefully scraped to remove the enamel, and the bare surface is tinned with solder as quickly as possible, so that the wire will not stretch with the heat and become slack. Then a short piece of wire is anchored to one of the flange holes, and taken up inside the former, and out through the hole drilled for it. A piece of the wire is bared and tinned, and soldered to the tinned spot on the main coil, and the tapping is completed. L4 is then put on exactly as for L1, except that in this case, the finishing hole is made about ⅛in. from the hole for the tapping wire, and it is necessary to see that inside the former, the wires from the tap and from L4 do not touch. If they did, the filament of V2 would be short-circuited, and so would the A battery when connected up.

The coil for Range A will be the most difficult to make, because all windings are of the same

Continued on Page 30

An Easily Constructed Instrument for Measuring R.F. Resistance and Other Important Quantities—Part 2.

CONSTRUCTION

The instrument is very easy to construct, and, as can be seen from the photograph on page 4. of the last issue, the whole circuit is built on the steel panel, and the leads are cabled and taken off to the batteries, which are housed inside a box, 11in. x 7½in. x 6½in. The panel fits over, and forms the lid for one of the 11in. x 7½in. sides of the box.

The valve is mounted in an Amphenol socket, which is set into a circular base, of the kind used for setting such sockets into a chassis. In this case, the socket is mounted with the lugs inside the base, which is then screwed to the panel, as shown in the photograph A low-loss socket needs to be used, because the plate connection comes out through the base of the tube, and this pin is connected to the "high" side of the circuit under test. This arrangement gives a very short lead to the ceramic feed-through insulator which is used for connecting the test circuit to the dynatron, and this is of assistance at high frequencies, where short leads and low losses are essential.

The three controls are mounted in a row along the bottom edge of the chassis, and are provided with large knobs to make accurate adjustment easy. Apart from the three potentiometers, four fixed resistors, and the plate and screen bypass condensers, the only parts are the valve itself and the three meters, so that all the parts can be mounted using the terminals of the meters and the switch as tie points. The grid stopper resistor is mounted in the grid lead itself, right at the grid cap of the valve. Please note that there is only one earth on the whole instrument—at the earthed feed-through, very close to the valve socket. In the original, the whole circuit was built, completely insulated from the panels, and then a wire was soldered from the one input terminal to the panel. As was pointed out earlier, as long as the bypassing from plate and screen to the cathode is inserted with as little lead length as possible, the whole of the rest of the circuit is purely a D.C. one, so that the exact lay-out of parts, and the way in which the wiring is run, is of little or no consequence. For this reason, builders may please themselves just how they construct the instrument, as long as the two leads that carry R.F., and the bypass condenser leads, are made as short as possible.

CHOOSING A TUBE

We have not yet said anything about how to come by a valve for the dynatron. In the circuit, this has been shown as a 224, and this is quite correct. It is certainly true that new valves of this type can no longer be had, and it is equally true that if they were available, the chances are that they would not be suitable for the purpose in hand. The trouble is that only the very old screen-grid tubes show the best dynatron characteristics, because the secondary emission phenomenon which makes the dynatron oscillator possible was looked upon as a disadvantage when screen grid tubes were first produced, and steps were taken to eliminate the secondary emission. As a result, the 24A, an improved version of the 24 or 224, was produced, and this had the plate specially treated to make the secondary emission as small as possible. The 24A, therefore, is not the tube to use in this arrangement. There are still to be found, more particularly in the junk boxes of dealers and service shops, some of the old 224 tubes, which can be used, even if their emission is somewhat on the low side. The one used in the prototype was one of Arcturus manufacture, with the blue glass envelope, and proved quite satisfactory for the purpose. If one is lucky enough to acquire more than one of the right sort of tube, there then arises the problem of finding out which is the best of them to use. This can be done quite easily, in the following way. A tuned circuit—say a broadcast coil with about 200$\mu\mu$f. connected across it, is connected to the test terminals, and a voltmeter is connected between the cathode and the moving contact of the 500-ohm potentiometer. The grid bias is decreased until the circuit just oscillates, and a reading of the grid bias voltage is made on the temporarily connected meter. Then the next tube is plugged in and the process repeated. The tube with the best dynatron characteristics is the one which oscillates with the **highest** value of grid bias.

The reason for this is that the greater the negative mutual conductance, the higher can be the bias, while still allowing a given circuit to oscillate.

USING THE INSTRUMENT

The simplest use to which the instrument can be put is that of measuring the dynamc impedance of a tuned circuit. When it has been completed, some trial measurements should be made, to see that it is working satisfactorily. Apart from the meter itself, it is necessary to have some means whereby one can ascertain when the circuit starts to oscillate. In many cases this can be a sensitive radio receiver, or, if one is available, a beat frequency meter. For those who have no more elaborate equipment, the best solution is to make up a simple regenerative detector circuit, using a triode, with plug-in coils to cover the frequency range in which you are interested. This can include the usual I.F. band round about 455 kc/sec., since an old I.F. transformer can easily be modified to act as a plug-in coil for such a detector. A short piece of stiff wire, to act as an aerial, can be connected to the detector circuit, and placed within a couple of inches or so of the circuit, under test in the resistance meter. Then, the latter is turned on, and the grid bias potentiometer is turned to the position which gives minimum bias on the 224. At this, the circuit is bound to be oscillating, so a search is made in the

Continued on Page 27

The "R. and E." Amateur Television Project for Home Construction

PART V: SUCCESSFUL PRODUCTION OF PICTURES

SUMMARY OF PROGRESS

Needless to say, our own laboratory work on this Project is kept, as it were, several jumps ahead of the description presented in these pages. The business of month-by-month publication makes this state of affairs a necessity, and it is for this reason that we are able to report, here and now, that we have succeeded in producing our first satisfactory pictures. They were obtained using a VCR112 cathode ray tube as the flying spot light source, with a raster large enough to cover a 2½in. x 3½in. photographic negative, and an actual negative was used as the source of scenic material. This was viewed by the 931A electron-multiplier photo-cell, which was followed by three stages of video amplification using 6AC7 tubes. These were provided with shunt peaking coils to extend the frequency response to approximately 4 mc/sec., and the last stage was fed to the grid of the receiving tube, which was a VCR97. The time base circuits were those which have already been described, and later modified in accordance with the circuits to be presented in this instalment.

The definition obtained was approximately equivalent to that of a 200-line picture, and was good enough to show a considerable amount of detail—much more, in fact, than one would expect to be available from so small a number of lines. It is intended to go into this at a later date in more detail, since the question of just how the detail is produced is a most important one. Indeed, the observation on the actual receiving screen of the results of making certain organized changes in the equipment is of absorbing interest, and gives a better insight into the mechanics of picture reproduction than can any amount of reading. At the same time there were certain imperfections in the system that prevented a better resolution than 200 lines from being realized. We have our own ideas about this, but until further work is done, it is not possible to say whether it is due to inherent limitations in the gear being used, or to factors within our own control. It will be very interesting, for instance, to find out whether the size of the spot of the transmitting tube is the limiting factor, or whether better results could be obtained by varying the frequency response of the video stages in such a way as to compensate for the decay characteristic of the screen material on transmitting tube rather better than at present.

We mention all this, because followers of the Project will no doubt be interested to hear of our own progress, and also to point out that even if present limitations turn out to be outside our control, short of obtaining different equipment, readers who wish to duplicate our own equipment can rest assured that they will find the trouble well worth while. A 200-line picture is by no means to be sneezed at as far as reproduction of detail is concerned, and will be found of immense interest by anyone who may be keen enough to construct the gear.

ALTERNATIVE TIME-BASE CIRCUIT

In the last instalment of this series, we mentioned that the successful transmitting tube, the VCR112, has a much smaller deflection sensitivity than the VCR97 that we can use for the receiving end. Because of this, greater deflecting saw-tooth voltages are needed if the raster is to fill the screen. It might, of course, be asked why it should be desirable or necessary to fill the screen in any case, since a smaller raster merely means that a small transparency can be accommodated, but there is a very good reason for using as large a raster as possible. The present state of the prototype equipment gives a very good example of this very point. The trouble is, that the spot which scans the picture is not infinitely small. Ideally, it would beat all times smaller than the spacing between the lines of the raster. If it is not, it is highly probable that however good the rest of the equipment may be, the picture will not show as much detail as it should. It is obvious enough that no picture detail can be resolved (i.e. seen as a separate entity) unless it is larger than the size of the scanning spot itself, and this will determine the smallest detail, in a direction parallel with the lines of the raster. And since the aim should be to have approximately the same resolution both parallel to the line direction, and at right angles to it, there is no advantage in having more lines than can be separately distinguished when the raster is viewed from a very close range. Now, for a given cathode ray tube, at given operating voltages, the size of the spot can be taken to be the same, at whatever part of the screen it happens to be, so that if the raster is very small, the lines cannot be distinguished, and much detail is lost.

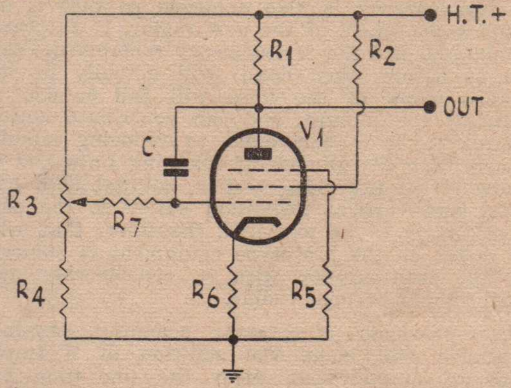


Fig. 5.—Alternative line T.B. circuit. Values are for 6AC7.

R1, R4, R5, 50k.
R2, 60k.
R3, 100k. pot.
R6, 1k.
R7, 200k.
C, 0.002.

THE "R. & E." T.V. PROJECT

Suppose, for example, that we have a spot of diameter 1/100in. This would actually be a pretty good one, but the figure will serve as illustration. Suppose further, that the raster is only one inch high. In this case, it would be of no use employing more than 100 lines, because if more were used they would overlap, and detail in the vertical direction that was smaller than 1/100 inch high could not be reproduced. But if the raster is made 3in. high, on the face of the same C.R.T., then it would be possible to resolve 300 lines vertically, and a 300-line picture could be used, and improved definition and detail would actually be realized. It is for this reason that we should make every effort to fill the screen of the transmitting tube with the raster.

In the case of the prototype equipment as it is at the moment, it is not considered that the spot is anything like as small as a hundredth of an inch in diameter, and the raster used was only about 2in. in height. Thus, by making the raster taller, and at the same time correspondingly wider, much more detail should be rendered visible, as long as the transparency is also enlarged so that it still occupies the whole of the new raster. If the raster is enlarged, and the transparency remains the same size as before, then detail will actually be lost, because many of the lines will fall outside the limits of the picture, and can contribute nothing towards it. It is equivalent to reducing simultaneously both the number of scanning lines and the bandwidth of the video system, so that both horizontal and vertical resolution suffer to the same extent. It is to be expected, therefore, that when the raster on the prototype equipment is enlarged, and the transparency with it, considerably more detail should become visible.

The provision of greater scanning saw-tooth amplitude will mean the addition of a further stage of amplification after the line time base circuit. What is wanted is not more voltage gain, but greater output capability, so that a larger undistorted output voltage can be fed to the deflecting plates. It will, in fact, be necessary to add a push-pull stage, using larger tubes, and probably the most suitable ones will be 6V6's, or similar output valves. Because of this addition to the already rather large number of valves in the scanning circuit, it has been decided to give a less complex line time-base generator circuit, that will actually do as good a job as the more complicated one using the thyratron one already described. It can readily be made to work with any of the high-mutual-conductance pentodes, such as the 6AC7, the EF50, or the EF42. Its circuit and values are given on this page. R3 is a potentiometer which enables the frequency to be varied over quite a wide range, and will be found very useful, especially after the pictures have first become a reality. The condenser C can be used to give large frequency steps, but this facility is not needed in the present application. The output is more than sufficient to swing the grid of the amplifier and phase inverter stage, and the circuit can be directly substituted for the oscillator and thyratron circuit in the original diagram of the deflection unit. The linearity is very good indeed at high frequencies, such as are used for the line time-base, so that there will be no left-to-right shading of the picture owing to variation in speed of the scanning spot as it travels from one end of the line to the other.

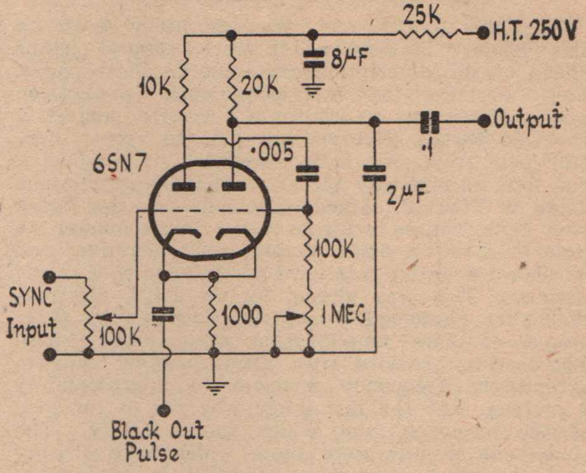


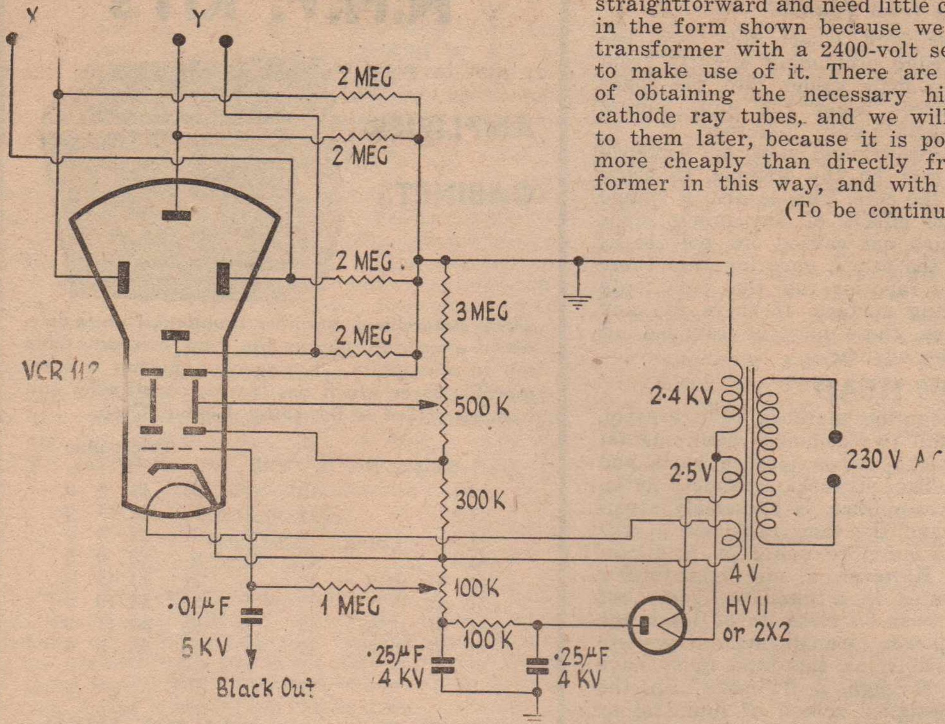
Fig. 6.—A satisfactory alternative frame T.B., giving a good pulse at the cathode for black-out purposes. It may easily be synchronized with the mains frequency by attaching the synch. input terminal to the heater winding. The circuit of Fig. 5 could also be used for the frame T.B. by changing R7 to 1 meg. and C to 0.05 uf.

Fig. 6 shows a simple circuit which can be used as the frame time-base. It has a terminal to which a synchronizing input can be applied, and this is very handy, as will be explained in a moment. It also produces quite a good blackout pulse across the cathode resistor, so that none of the advantages of the more complex original circuit are lost. The charging condenser must be large if linearity is to be good, and no less than the 2 μf. shown should be used.

THE "R. & E." TV PROJECT

Fig. 7 shows the power supply circuit, as used for the VCR112 transmitting tube. It is quite straightforward and need little comment. It was used in the form shown because we had a high voltage transformer with a 2400-volt secondary and wished to make use of it. There are several other ways of obtaining the necessary high voltage for the cathode ray tubes, and we will devote some space to them later, because it is possible to do the job more cheaply than directly from a mains transformer in this way, and with more safety, too.

(To be continued)



THE TAPE RECORDING HEAD (From P. 11)

As it only requires one or two layers of winding, not much space is lost.

If a balanced winding is to be used, for example, to feed into a push-pull amplifier, one half of each winding may be wound on each leg, with the start of each winding connected together as the centre point. In an unbalanced winding the two halves are merely connected in series. The phase relationships between the windings must be correct. If both halves are wound in the same direction, then either both inner or both outer ends may be connected together.

Thin paxolin is a suitable material for making end cheeks to contain the windings, being rigid and easily worked. It need not be thicker than about .01in. Between these a few layers of fine paper, thinly coated with shellac, can be wound over the leg of the core, and one or two additional coats of shellac will seal any cracks. The shellac should be completely hard before the winding is commenced.

ASSEMBLING THE HEAD

Fig. 5 is a cross-section of the front gap, greatly enlarged, showing how a brass filling piece is fixed in the gap.

With the halves of the core clamped very firmly together, in correct alignment, solder a ½in. x ¼in. strip of fairly thick brass along the back edge, to join the back gap. Tin the .001in. brass filler, carefully wiping off the surplus solder which would

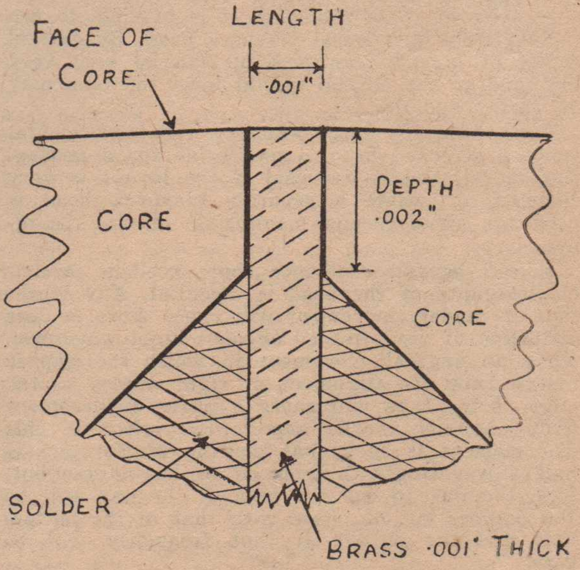


Fig. 5

Continued on Page 24

TAPE RECORDING HEAD

Continued from Page 23

add to its thickness, and insert this into the front gap with the edge protruding slightly from the core face. Run a little solder into the space between the pole pieces below the gap, joining the poles and the brass rigidly together.

The face of the core should now be flattened slightly around the gap, on the oilstone, to bring the brass flush with the core. This is also a simple means to remove the effects of any minor error in the alignment which has caused one pole to be slightly higher than the other; ensuring that there will be nothing to scrape or rub the tape, only a glass-smooth running surface. If there are any rough or sharp edges, these may be rounded off slightly, also with the oilstone.

MOUNTING THE HEAD

Details of head mounting methods vary greatly, but they must all fulfil two common requirements: freedom from hum pickup when playing back, and mechanical rigidity. The playback channel, incorporating a high-gain amplifier, is extremely sensitive to hum fields; and the hum problems of the playback head are similar to those of a microphone transformer. However a mic transformer can usually be mounted in a hum-free spot; not so the head, which must be close to at least one motor, if not a power transformer. Complete screening is not possible, as the tape must have access to the core through a "window" in the screen; but a well-designed screen of mumetal or soft iron will reduce the hum pickup very considerably.

The playback head may also pick up voltages from the bias or erase supply, or from an output transformer, either of which would cause trouble. Screening is again effective here.

In spite of these problems, it is possible to use a completely unscreened playback head. By careful choice of layout, hum pick up can be kept very low, and at the normal output level the hum may be barely audible.

But while this is satisfactory for experimental work, a screened head is preferable for a production model, and is essential if the layout is very compact, or where a separate playback head is used for simultaneous monitoring of the recording.

It will be fairly obvious that excellent mechanical rigidity of the head is essential. Any vibration or random movement will cause more or less distortion of the recorded or reproduced waveform, while an angular movement in which the gap is moved from its alignment at right angles to the edge of the tape will cause a phase displacement from one end of the gap to the other. If this displacement is such that the top of the gap is half a wavelength in front of or behind the bottom, the flux in the top half of the gap will be 180 degrees out of phase with that in the bottom half and the output at that frequency will be zero.

Remembering that in the example given earlier, the wavelength of a 750 c/s signal at 7½in. per sec. was only .01in., it will be seen that a dis-

(*Continued on Page 32*)

HAM ACTIVITIES

Things on all bands have been very poor once again—DX is becoming almost non-existent with only a handful of W's trickling through on 40 and 20 metres. The most outstanding DX signal for the month must have been I1CNE whose 20 metre 'phone signal had to be heard to be believed. So, with the DX bands yielding so little their usual habituees have temporarily migrated to 40, or in some cases, 80 metres.

FROM MY LOG

5FO is a new call making a debut on 40 recently. Jim was an enthusiastic listener before obtaining the ticket and looks like a promising DX man.—.—.

6MK has finished a T-match to the radiator of his 3 element 20 metre beam which is now considered correctly tuned up after two years work on it. This beam is atop a 40ft. tower, the final a 813 running the quota whilst a Collins 75A-1 takes care of those "40 over 59-ers".—.—.

Conducted by
J. A. HAMPEL, VK5BJ

ZL3LC is using a V-beam which probably accounts for the consistent appearance of his signal on 20 in the afternoons.—.—. Bill Wright, ex-5BW, -3AAW, -4TU, is now signing 5CN from Darwin. Bill may prove to be a decided asset to the VHF boys as he has initiated automatic MCW transmissions on 50.8 mc. besides running the 50 mc. rig in parallel with his lower frequency rig when on those bands. Bill is running 35 watts to a two element beam directed on Melbourne.—.—.

Another 6 metre enthusiast in the Territory is 5IR but as both he and Bill are on shift work no definite schedules can be announced although it is hoped to always keep a 6 metre signal on the band by their combined efforts. Ray, 5RA, is interested in 6 but so far has not put a signal on the band.—.—.

4JA has been QRL, building a new shack and moving all the gear into it, however Jim is now established but still not heard much since he took delivery of the new car. Time is now taken up with visiting the boys and their rigs.—.—.

4NC is putting up a three element beam using a Command VFO running into a 807 in the final. Charles is on shift work so for the next few months work on the beam can be done during the day and the idea is to sit back and work the DX then while the "QRM-ers" are at work.—.—.

Doubtless everyone has seen that gem of journalism which originally appeared in the "New York Times" and subsequently by reprint in our own local papers that Amateurs had been responsible for QRM'ing Korean army radio channels. Hams everywhere were highly indignant naturally and several letters were immediately despatched to W.I.A. executives with subsequent representation to the A.R.R.L. on the matter. "MARS", the U.S.'s military amateur radio system made investigations with the appropriate government departments with the result that the army announced their tank transmitters used channels adjacent to amateur channels and had wandered into those channels so that an Amateur transmission was heard on a tank receiver.

The original report appeared on 9th February so it was with relief that Amateurs read of ARRL's President George Bailey, W2KH, statement on 19th February entirely clearing Amateur Radio of the stigma so wrongly misplaced. Further more the originating paper graciously devoted space for a feature article on the achievements of Amateur Radio to clear up in the minds of laymen that we had been able to vindicate ourselves entirely.

Considering the large number of VK's who complained about insertions in their local paper it is a pity something similar to W2KH's article could not appear out here. Once again the W.I.A. has proved itself as the worthy representative of Australian Amateurs by stirring up interest in the U.S.A. .—.—.

5BC has been back on 40 of late after spending the summer months on 6 metres. Hughie's next move is to 80 where there is now a surprising number of signals in the evenings. The Adelaide end of the 6 metre sked between Hughie and his brother 5HD has been missing recently—looks like Bill is QRL with the new harmonic in the shack.—.—.

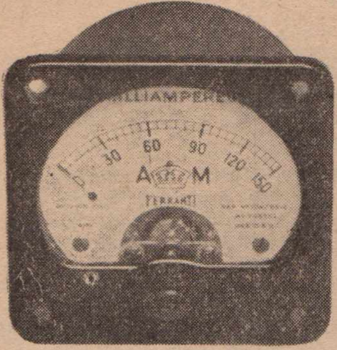
3TI sends along the latest Mildura news—ex-5SB and now back under his old call 3CI, Sid only stayed a short while at Merbein, near Mildura, before being forced to move on to Bendigo due to lack of accommodation in the district. The local boys were sorry to see his departure because of Sid's intense interest in VHF technique and they had hoped to obtain some worthwhile "gen" on the highs.—.—.

Ham activity has reached an all-time high in this River district. 3AUG has bought a windmill tower and put up a 20 metre beam on his fruit block. 3TI just wishes he had the room to swing a beam.—.—. 3GZ, the Zone officer for the district will be back on soon with a TAI2D on which he is now working. He has already bought a considerable amount of VHF gear.—.—. 3SN is still in Mildura but has lapsed into inactivity just recently. 3FC is an OT of the district who is now heard consistently at week-ends from Ouyen.—.—.

5GY and 5CE in Whyalla have had their fists in trim by running nightly C.W. skeds. Nobby, GY, is busy changing from his present hill-top QTH to the new home down close to the sea. It is expected from his recent QSO that fishing will now take some of the time previously devoted to Ham radio. He is very interested in 288mc. hoping to push through to Adelaide one day. Contact with 5JY across the Gulf at Crystal Brook was only one way but Nobby and Jim are still confident. The Adelaide boys should not be surprised to hear 5GY on 288 in July as Nobby is taking his rig with him while on leave.—.—.

4SV, the technical advisor for the VK4 division of the W.I.A. gave a very interesting lecture and practical demonstration on F.M. mobile equipment as used by the Brisbane ambulances, nice work Harold.—.—. 4RL is running 50 watts with a 834

Continued on Page 31

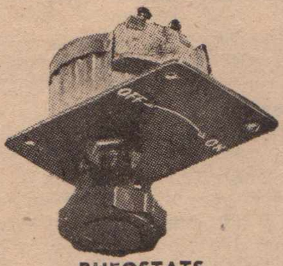


METERS

We have the following Meters in stock. They are mostly brand new, and if not they are in excellent condition:—

0-1, M.A., D.C., 2 in scale, square	32/6
0-20, 0-200 D.C. volts, 2 in scale, round	17/6
0-5 amps R.F., 2 in scale, round	22/6
0-40 volts D.C., 2 in scale, square	19/6
0-3 amps R.F., 2 in scale, round	22/6
0-2.5 amps R.F., 2 in scale, square	22/6
0-50 M.A. D.C., 2 in scale, square	22/6
0-100 volts A.C., 2 in scale, square	39/6
0-20 volts D.C., 2 in scale, square	19/6

Please note the 0-100 volt A.C. Meter is an excellent buy, as it has a 1. M.A. dry metal rectifier, valued at 35/-, built into each meter.



RHEOSTATS

Bargains in heavy duty Rheostats, I.R.C., 250 ohm, 25 watt, wound on mica and porcelain insulated, as illustrated.

Price 4/6

100 ohm Heavy Duty Rheostat, as used in English Aircraft.

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BRITISH NAVY RESISTORS

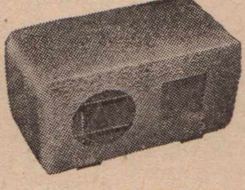
Assorted bundles, all wattages and values. Mixed ½ watt, 1 watt, 2 watt, 5 watt, from 100 ohms to ½ meg, 5 p.c. and 10 p.c. accurate. An excellent buy. Prices as follows:—

50 Assorted	15/-
100 Assorted	27/6
500 Assorted	125/-

FOUNDATION KIT

For 5 Valve Mantle Radio for either A.C. or Battery use.
Kit consists of:—Nicely figured Walnut Cabinet with chenille velvet speaker cloth.
Overall dimensions: 17in. x 10½in. x 8¼in.
Dial Glass, Dial Drive Assembly.
Specially constructed chassis to fit into cabinet, with welded front plate into which loudspeaker and dial assembly part fit.
Ideal for the home constructor. Easily worth £6/10/-.

Our Price £3/15/-



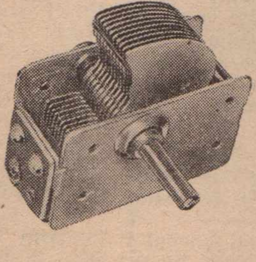
METAL CABINETS

Finished in mottled cream. Size, 14in. x 7in. x 6¾in. Usual price 30/-.

Our Price 17/6

Similar to above, but 11in. x 7in. x 7in. Usual price 27/6.

Our Price 16/6



SINGLE GANG CONDENSERS

Ideal for Crystal Sets, etc. Capacity, approximately .0005. Brand new and perfect. Easily worth 12/6.

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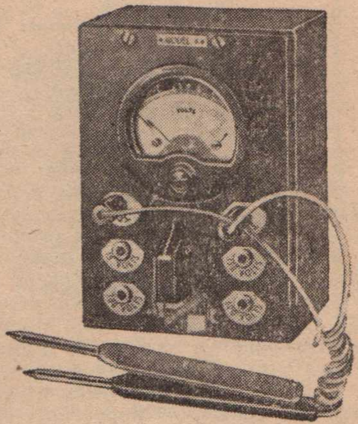
NOTE

All parcels will be sent registered post unless otherwise stated. Postage or freight must be included with all orders.



CHIEFTAIN MULTIMETER

The ideal pocket size meter for measuring voltages of electrical circuits and checking continuity of circuits, etc. Volt Scales: 0-15, 0-150, 0-300, 0-600. D.C. Ohms Scale: 0-50,000. The cheapest and smallest on the market. Complete with prods and battery. Can be carried in your coat pocket with ease.

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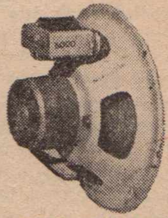
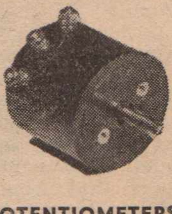


SPECIAL BARGAIN IN SPEAKERS

6in. Permag Cadet Speakers with transformer, 5000 ohms impedance, for 17/6, less transformers for 12/6. These speakers have damaged cones. New cones to suit, 1/6 each.



POTENTIOMETERS

Heavy Duty Wire Wound Potentiometers, value 270 ohms, worth 7/6.

Our Price 3/-

CARBON POTS

With short shaft, screw drive adjustment, 1500 ohms. Just the thing for adjustable bias resistors. Worth 4/6.

Our Price 1/3

MS MOTOR SPARES LTD.

547 ELIZABETH STREET, MELBOURNE

R.F. RESISTANCE METER

Continued from Page 20.

expected frequency range with the regenerative detector, until the signal is picked up. When found, the 224 bias control is backed off, and then advanced slowly until the circuit just goes into oscillation. In judging the onset of oscillation, the best plan is to set the detector so that when the dynatron is oscillating, a beat note of about 1000 c/sec. is heard. Then, when the bias control is operated, the start of oscillation will be accurately indicated by a sudden appearance of the 1000 cycle note. It will then be found a simple matter to set the dynatron bias very accurately to the point where the circuit is just hovering between the non-oscillating and oscillating conditions.

When this condition has been reached, it is necessary to measure the negative resistance. This is done as follows. The test coil is removed, and replaced by a short thick piece of wire as a shorting bar. Next, the balancing potentiometer is turned until only about one scale division of deflection is left on the 100 μamp meter. The switch is then held down, to remove the meter shunt while the additional plate voltage control is manipulated. With the switch held down, plate voltage is added by means of the potentiometer until the meter shows a drop of 10 μamps. The switch is then released, and the additional H.T. voltage is read from the voltmeter. If, as recommended, the meter is scaled to read 5 volts at full scale deflection, the resultant negative resistance can be read off as hundreds of thousands of ohms. This figure, as explained above, is the dynamic impedance of the test circuit, commonly written as Rd.

How, then, is the circuit Q found? The important formula which connects Rd with Q is as follows:

$$Rd = 2\pi fLQ$$

where f is the frequency in cycles per second.
L is the coil's inductance in Henries, and
Q is the Q of the tuned circuit.

From this simple formula, it can be seen that if Rd, f, and L are known, then Q can be found. However, for most purposes it will be unnecessary to go to all the trouble of finding Q, since the most commonly required answer is to find how well a given coil should perform in an actual circuit, and the value of Rd does this much much directly than the value of Q. For instance, if one has a batch of coils, and it is suspected that some of them are not as good as they should be, the value of Rd is all that is required, not only to sort them out in order of goodness, but in order of the actual gain to the expected use. The only assumption here is that when tested, all coils are tuned to the same frequency. This can easily be arranged by testing the coils in a tuned circuit made up of the coil itself, and a good low-loss variable condenser. The oscillation indicator—the regenerative detector whose use was described earlier—can also be used to set them to the desired frequency so that it is quite unnecessary to know the exact frequency. All that is needed is to know that this is close to the required operating frequency, and that all coils tested are tested at the same frequency.

OTHER MEASUREMENTS

Now that we have a means of measuring Rd, which is only another name for the parallel R.F. resistance at resonance, we are in a position to measure the R.F. resistance of resistors, to measure the R.F. shunt resistance of condensers, and many other things. In fact there are so many measurements that can be made with the aid of the resistance meter that a separate article will be necessary if they are all to be described in detail. However, as an interesting illustration of what can be done, let us take the case of a condenser—say a fixed tuning condenser from a permeability-tuned I.F. transformer that is subjected by being leaky. What we want to know is how leaky the condenser is, and whether it is bad enough to have an adverse effect on the gain of a transformer in which it may be used. The actual shunt resistance at R.F. represented by the leaky condenser can be measured as follows:

A suitable coil is taken, such as a winding from an I.F. transformer, and together with our low-loss variable condenser is made into a tuned circuit and connected to the dynatron. The Rd of the combination is measured in the ordinary way, and the figure noted. Then, the suspected condenser is connected across the coil, and capacity is removed from the variable until the oscillation frequency is the same as before. Then the Rd is measured once more. If the added condenser is a good one, the two figures for Rd will be the same. But if the condenser is leaky, then the Rd will be reduced, and from the two figures obtained, we can easily calculate the equivalent shunt resistance of the condenser. For example, if the original Rd was 300k., and the Rd after connecting the condenser was 250k., we proceed as follows:—

The value of two resistances, A and B, in parallel, is given by AB ÷ (A + B), so that we can write

$$250 = \frac{300x}{(300 + x)}$$

or, $300x = 250x + 75,000$
thus, $50x = 75,000$, and
$x = 1,500$

But we have worked our sum in thousands of ohms, instead of in ohms, just so as to avoid a large number of zeros in the working, so that the answer is 1500k., or 1.5 megohms.

The condenser is therefore exactly equivalent to a perfect one, shunted by a resistor of 1.5 megohms. This is not very good, as the losses in a condenser like this should be so low as to make no noticeable difference to the Rd. Incidentally, this shows how sensitive the method is, and also, that a condenser which would be perfectly good if used as a bypass condenser at low voltages, would not necessarily be good enough to use as a tuning condenser.

As can be seen, the method outlined above could not be applied to finding the actual R.F. resistance of low-value resistors, for when connected in parallel with the test circuit, they would reduce the Rd so much that the dynatron would no longer be able to make it oscillate. However, low resistances can be measured, by putting the resistance in series with the coil instead of in parallel with it,

Continued on Page 32

CRAFTSMAN-BUILT RADIOGRAMS AND SPECIALITY SETS.

Attention!

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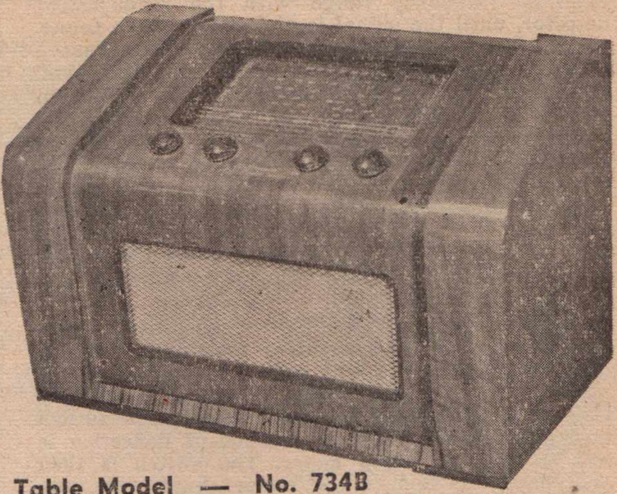

Table Model — No. 734B

FEATURES

- SEVEN power packed valves for spanning the world.
- Frequency coverage, triple wave, 500 KC - 1500 KC broadcast band; 13-42 metres and 40-120 metres on the TWO short wave bands.
- Tuned R.F. stage and push pull output.
- Large, legible console type dial.
- 8 inch heavy duty speaker.
- Large, modernistic, totally enclosed polished wooden cabinet with protective back panel and attractive aluminium speaker grille.
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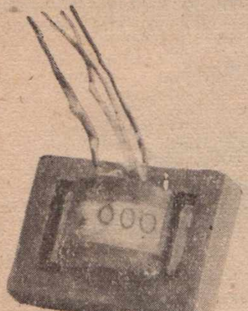
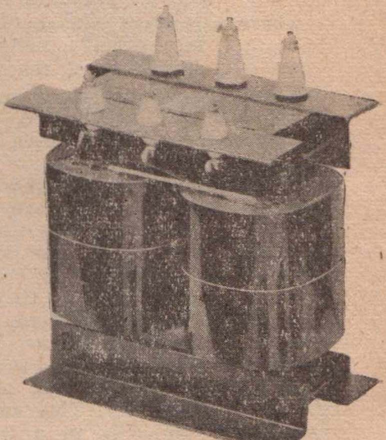
- Dimensions: 22in. across x 15in. high x 11½in. deep.





ELECTRONIC

A & R

EQUIPMENT

This month we illustrate the outer limits of our transformer range. The item on the right is a 5 KVa High Tension Transformer, and the illustration on the left represents a Microphone Transformer, Impedances 50/25,000. Four of these items fit quite comfortably in a matchbox.

The foregoing may seem irrelevant, but it serves as an indication of the large number of applications for which A & R Transformers are produced. When the job is tough and the specifications rigid, an A & R Transformer is a natural choice.

For Value and Reliability insist on A & R

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378 ST. KILDA ROAD, MELBOURNE, S.C.1 **Phones MX1159, MX1150**

SHORT WAVE REVIEW

Conducted by L. J. Keast
7 Fitzgerald Rd., Ermington, N.S.W.
Phone: WL 1101

NOTES FROM MY DIARY

AMATEURS INSPIRED

It is very pleasing to read that newcomers to the short wave have found inspiration in these pages.

Mr. Anderson, of Paddington, N.S.W., who credits this paper of having encouraged him to take up short wave DX-ing apologises for not sending in a long list of stations this month, as time has been taken up with making himself familiar with a new radio he has purchased.

With the new machine he figures he will be able to stretch out in his fields and doubtless he will as he is showing that persistancy which characterizes all good DX-ers.

He has already added another Verie to his list, the one on this occasion coming from Radio France Asie on 11.83 met.

A new correspondent is Mr. R. R. Rabe, of Yallourn, Victoria.

Mr. Rabe is only a beginner but is doing the right thing by making himself familiar with the Calibration on his dial, by logging such countries as New Zealand, U.S.A. (West Coast), India and a number of Radio Australia Transmitters.

"Keep the good work up Mr. Rabe and don't hesitate to drop me a note if there is any way in which I can assist you."

IN THE GOOD OLD WINTERTIME

In the last issue I suggested that DX-ers would find the daytime reception excellent for quite a number of overseas stations.

I am therefore printing a list which is not anything like the full number of stations to be heard, but which contains some that I think will be found most interesting.

For instance probably quite a number who have been confined to night reception have not heard the excellent programmes put over by the B.B.C. for Canada, U.S.A. and Mexico.

Also from the same source programmes intended for the West Indies and Latin America.

Then, there are the numerous programmes put over by the U.S. Those that I consider giving reasonable good or very good reception are being shown in the list referred to.

RADIO AUSTRALIA

All Australian High Frequency transmitters will use new suffixes as from June 1st. The numeral following the transmitter call sign will then indicate the megacycles band in use. The same suffix will be used in that band, e.g.:—

VLA15: Any frequency in the 15 m.c. band.
VLA9: Any frequency in the 9 m.c. band.
VLB21: Any frequency in the 21 m.c. band.

THE MONTH'S LOGGINGS

B.B.C. GENERAL OVERSEAS SERVICE TO CANADA, U.S.A. AND MEXICO

8.00-10.00 a.m.	11.80 mc.	25.42 met:
8.00- 9.00 a.m.	9.825	30.53
10.00 a.m.-2.15 p.m.	6.11	49.10

Special Programme for Western Indies and Latin America

9.15-9.45 a.m.	9.58 mc.	31.32 met:
	6.195	48.43

General Overseas Service for West Indies and Latin America

9.45 a.m.-1.00 p.m.	9.58 mc.	31.32 met:
	6.195	48.43
8.00 a.m.-1.00 p.m.	11.75	25.53
	9.51	31.55

General Overseas Service for Central America

9.00-10.00 a.m.	11.82 mc.	25.38 met:	(Span.)
9.00 a.m.-1.00 p.m.	9.41	31.88	(Span.)
10.00 a.m.-1.45 p.m.	6.05	49.59	(Span.)
8.00-11.30 a.m.	11.86	25.30	(Port.)
8.00-11.30 a.m.	9.915	30.26	(Port.)

HIER SPRICHT LONDON
.. B.B.C. TRANSMISSIONS TO GERMANY ..

4.00- 4.15 p.m.	6.05 mc.	49.59 met:	7.28 mc.	41.21 met:
5.00- 5.45 p.m.		49.59		41.21
7.00- 7.15 p.m.		49.59		41.21
			9.625	31.17
12.00-12.30 a.m.	7.32	40.98	9.625	31.17
			11.93	25.15
3.00- 4.15 a.m.		40.98		31.17
				25.15
5.15- 5.30 a.m.	6.05	49.59	7.32	40.98
6.00- 8.15 a.m.		49.59		40.98
10.00-10.15 a.m.		49.59		40.98

General Overseas to South America

8.00-9.00 a.m.	15.26 mc.	19.66 met:	(Span.)
8.00 a.m.-1.00 p.m.	11.82	25.38	(Span.)
9.00 a.m.-1.45 p.m.	9.60	31.25	(Span.)
8.00-11.30 a.m.	12.04	24.92	(Port.)
8.00-11.30 a.m.	9.915	30.26	(Port.)

General Overseas Service to Mexico

9.00-10.00 a.m.	12.095 mc.	25.80 met:	(Span.)
9.00 a.m.-1.00 p.m.	9.64	31.12	(Span.)
10.00 a.m.-1.45 p.m.	6.18	48.54	(Span.)

THE S/W MINIATURE THREE

Continued from Page 19

relatively thin wire, but with the others, there will be plenty of room between the wires of the tuning coil to bore the necessary holes, and to wind the thin wire.

CONNECTIONS TO THE COIL SOCKETS

Readers will probably have noticed that we have not shown any schedule for connecting the various coil windings to the pins of the coil formers, and so to the coil sockets on the set itself. This has been done on purpose, because there is no particular virtue in using any pins for a particular winding, and builders may please themselves what pins are used for what. The best plan, to avoid possible confusion, is to mark on the circuit diagram the socket pins that it is intended to use. The best sockets to use are of the Amphenol type, and these always have the pin connectors numbered. These numbers should be inserted in the circuit diagram in accordance with the way the underneath of the set has been wired. Then, when it comes to making the coils, the windings can be terminated on the right pins to make the circuit correct when the coils are plugged in. If the top (grid end) of L2 is connected to pin No. 4 on the socket when the coil is plugged in, then pin No. 4 must be connected to the grid of V1 and to the stator of the gang condenser when the set is wired—or vice versa. Needless to say, all corresponding coils must be made with the same pin numbers connected to corresponding ends of the windings.

PUTTING THE SET INTO OPERATION

If the wiring has been done without any mistakes, and if the coils have been made properly, according to specifications, then the set should go at first switching on. However, it is a very good plan to do some checking before connecting any of the batteries to the set. Go over the circuit carefully, and see that none of the connections have been accidentally misplaced, or omitted altogether. When satisfied that the wiring is correct, give the coils a close examination and make sure that the windings terminate on the right pins on the former. For example, if the aerial end of the aerial coil has been taken to pin No. 1 on the coil, make sure that No. 1 connection on the socket actually goes to the aerial, and so on, for all the connections. Choose one set of coils for this check, and until the set works with this set, ignore the others altogether. The best set to use for initial testing is Range A, for it will be easier to get it going on this range.

If you are satisfied that all wiring, and coil connections are correct, it is time to connect the A battery. Turn it on, and then examine the valves very carefully—preferably in the dark. If the filaments are alight, it will just be possible to see it glowing a faint red in the dark, or in subdued light. In this way we can check that all three filaments are running. If one does not light, then re-check the filament wiring, and if this is O.K., the valve would be suspected. To test it, connect one tag of the headphones to the A battery, one filament pin of the valve to the other A battery terminal, and complete the circuit by touching the remaining phone tip to the other filament pin. Needless to say, if there is continuity, a loud click will be heard in the phones. If not, the filament is open, and the valve useless. Of course, for the test, the valve is removed from its socket, and the battery disconnected from the set.

When the filaments are all alight, the negative end of the B battery can be connected, the phones plugged in, and finally, the positive terminal of the battery connected. This also should give quite a loud click in the phones, as V3 starts to pass plate current. The next thing to do is to test for oscillation. The aerial is left disconnected, and with the condenser gang set at about mid-scale, the reaction control, R4, is slowly advanced, and a sharp watch is kept for the appearance in the phones of a rushing noise, which should appear as the reaction control is rotated. **Slow** operation of the control is essential, because it is easy to go past the right point, after which the noise disappears again. If this noise is found, as it should be, then all is well, and we can proceed to see whether it is obtained, as it should be, at all possible settings of the tuning dial. The position of the reaction control will be slightly different, according to where the tuning dial is set, but if all is well, there will be little change in its setting as the tuning dial is moved from one end to the other. If it is found that at the low-frequency end of the tuning dial, no setting of R4 enables the rushing sound to be heard, it means that L4, and a few turns of L3 below the tap, should be squeezed up a little towards the rest of L3. Only a very slight adjustment in this way can produce a large effect, and such adjustment may be all that is needed to make the reaction control work properly even if no oscillation can be found at any point on the dial for a start.

With the rushing sound, which indicates that the detector is oscillating gently, it will now be possible to connect the aerial to the set. Then by turning the main dial, signals should be heard as whistles, which are tuned over in turn as the dial is rotated. Pick a loud one, ignoring the very weak ones that may be heard, and set the dial as close as possible to the spot where the whistle descends to a low growl. Then, **very carefully**, back off the reaction control until the whistle disappears. If the signal is speech or music, then this will now be heard. If the signal was morse code, then the dots and dashes would already have been heard as interruptions to the whistle. A station transmitting speech or music will be heard as a steady whistle, with perhaps just a suggestion of the music present. This is really all there is to tuning the set. The important thing to know is that the set is most sensitive when it is **just not oscillating**, and for hearing weak signals it will have to be tuned in very carefully. The best results will be had if, after backing off the reaction control to remove the whistle, the tuning is rocked very carefully to see if the signal cannot be made just a little louder. However, with this set, re-tuning in this way will only need to be very slight, if any, since the reaction control has very little effect on the tuning of the signal.

* * *

SHORT WAVE REVIEW

(Continued from Page 29)

And here are a few United States East Coast Stations that should come in during winter:

CALL	TIME	METRES
WLWO-7	2.15- 4.00 p.m.	6.06
WRUL-1	2.45- 5.00 p.m.	6.06
WRCA-3	2.45- 5.00 p.m.	6.10
TANGIER-4	1.15- 5.00 p.m.	7.20
WLWO-8	2.15- 4.00 p.m.	9.52
TANGIER-2	1.15- 4.00 p.m.	9.54
WLWO-5	2.15- 5.00 p.m.	9.56
WRCA-1	2.45- 5.00 p.m.	9.615
MUNICH-2	1.15- 5.15 p.m.	9.67
TANGIER-1	2.30- 5.00 p.m.	9.70
WABC-5	2.00- 8.45 p.m.	15.13
WRCA-6	5.00- 9.45 a.m.	15.15
WRCA-6	10.30- 1.00 p.m.	15.21
WABC-2	9.45-11.00 a.m.	15.27
WRUL-5	9.00-10.00 a.m.	15.29
WGEO-1	2.00- 8.30 a.m.	15.33
WLWO-2	11.00 a.m.-1.00 p.m.	15.35
WRUL-3	2.00- 8.30 a.m.	17.75
WGEO-3	2.15- 9.45 a.m.	17.76
WRCA-5	2.00- 8.45 a.m. 9.45-Noon.	17.78
WABC-6	2.00- 8.45 a.m.	21.50
WLWO-3	1.15- 8.30 a.m.	21.52
WABC-1	2.00- 7.45 a.m.	21.57
WGEO-2	1.15- 7.45 a.m.	21.59
WRCA-1	2.00- 8.45 a.m.	21.61
WLWO-7	2.00- 8.30 a.m.	21.65
WRCA-3	2.15- 9.45 a.m.	21.73

CANADA

CKLO	8.30-8.45 a.m.	News	0.63 mc.	31.15 met.
CKRZ	8.30-8.45 a.m.	News	6.06	49.50
CHOL	8.45-9.00 a.m.	News	11.72	25.60

And now a few miscellaneous:

CEYLON

Radio Commercial	Noon-12.15 p.m.	News	15.12 mc.	19.84 met.

ITALY

Rome Radio	6.15-6.30 p.m.	News	21.56 mc.	13.90 met.
			15.12	19.84
			11.81	25.40

POLAND

Radio Polskie	3.00-3.30 p.m.	News	9.525mc.	31.49met.

SWITZERLAND

HER-5	7.20-7.30 p.m.	News	11.865mc.	25.28 met.

TURKEY

TAP	7.00-7.45 a.m.	News	9.46mc.	31.70met.
TAS	7.00-7.45 a.m.	News	7.28	41.21

ICI LONDRES

B.B.C. TRANSMISSIONS TO FRANCE

5.30- 5.45 p.m.	6.18 mc.	48.54 met.	7.21 mc.	41.61 met.
6.00- 6.15 p.m.	6.18	48.54	7.21	41.61
7.00- 7.30 p.m.	6.18	48.54	7.21	41.61
	9.825	30.53		
10.30–10.45 p.m.	7.21	41.61	9.915	30.26
	11.77	25.49		
11.30-11.45 p.m.	7.21	41.61	9.915	30.16
	11.77	25.49		
3.00- 3.15 a.m.	7.21	41.61	9.915	30.26
	11.77	25.49		
5.30- 8.00 a.m.	6.18	48.54	7.21	41.61
	9.915	30.26		

HAM ACTIVITIES

(Continued from page 25)

final and a 3 element beam when not sorting cards under his task as QSL officer.—.—. 4JR is certainly busy—has had his call two years but only had two QSO's in that time.—.—.

VK1HV is back home under 4HV at Townsville after a spell at Heard Island.—.—. VK7AZ is knocking over the DX with his bi-square beam and push-pull 807's.—.—. 3ATN is contemplating building a 2 element beam for 10 metres—if that band ever comes good again. Why not put it up on the fire station's tower Ray,.—.—.

7RX reports there is little activity in the southern part of the Apple Isle but up further 7AB and 7KB are active specially on the UHF bands.—.—. 5DK is back on again after a bout in hospital for a month. Des is now using a.m. after not getting far with f.m. on his command type transmitter; also been able to talk the powers that be into putting up an outside Zepp in preference to the old inside "piece of wire".—.—.

After 12 years, 4DY has decided to make his comeback. Ted is another who allows the fish to take up the space time instead of radio.—.—.

Q S O es Q.V. (Qui vive)

Amateurs in this and other countries still persist in discussing subjects like the "Persian do" as one ham put it or the New Zealand situation on the air. All I can say is if you don't consider yourself then think about your fellow hams. Much more of this sort of thing will lose us our bands for good.—.—.

We fully concur with J.A.H.'s remarks, and commend all concerned to re-read and digest our "straight from the shoulder" editorial in the MAY issue on similar malpractice.—The Editor.

In assisting with news this month thanks goes to 4LM, 5CH, 3ATN, 3TI and those who have passed along news personally.

The address for news is Box 1589M, G.P.O., Adelaide—the deadline is 20th each month. Till next time, don't let sunspots get you down!

J.A.H.

A.F. DISTORTION (From P. 15)

introduced by an amplifier, the procedure followed is the same as that used above for determining the distortion content of the oscillator except that the amplifier is introduced between the test oscillator and the bridge, as shown in Fig. 3. The bridge input leads are connected directly across the speaker voice coil or other normal amplifier load. The gain of the amplifier is set to the value at which it is desired to determine the distortion. The null reading is then obtained as above and, expressed as a percentage of the full scale reading of the meter minus the residual reading, is the total distortion percentage introduced by the amplifier. The harmonic components may then be individually identified by the use of the search oscillator. Each beat noted indicated a component of that frequency (read from the search oscillator) and relative magnitude present in the output of the amplifier.

*R. F. Turner, Radio and Television News, Nov. '48, p. 69.

R.F. RESISTANCE METER

(*Continued from Page* 27)

and then using a different calculation. This, and the other things that can be done with the dynatron will have to be left for a later article, but in the meantime, those interested can rest assured that the dynatron measuring instrument is well worth having on its own account, and even more so when a little additional equipment, such as a capacity bridge, can be built or purchased, so that a very wide range of R.F. measurements become possible.

TAPE RECORDING HEAD

(Continued from Page 24.)

placement from top to bottom of only .001in. will seriously affect the frequency response.

A displacement from a true right angle, provided it is constant, will not affect the frequency response if the recording is played back by the same head, but if another head is used to reproduce such a recording the effect of the error will be apparent.

If the head mounting is arranged as shown in Fig. 6, with the channel through which the tape runs made as long as possible, angular or vertical movement of the tape is restricted by the top and bottom guides.

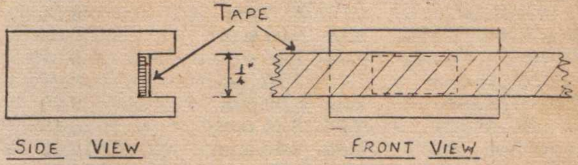

Fig. 6

In professional recording equipment, where heads which have become excessively worn after long use must be replaced, great care is taken to realign the gap correctly when a new head is fitted.

As the tape runs past the head, some device is necessary to keep its surface in close contact with the gap. The effect of poor contact is a progressive loss of high frequencies; or if the contact is intermittent, the reproduction becomes fluttery and distorted.

At the other extreme, excessive pressure causes unnecessary wear on both tape and head, and strain on the tape drive system which may affect the constancy of speed.

Unless guides are arranged close to the head to keep the tape in contact with the gap, a felt pad arranged to bear against the tape with gentle spring pressure will be required. This is very satisfactory, but it must be moved out of the way while the tape is being threaded.

PRE-AMPLIFIER (From P. 8)

connected to the input, and the potentiometer just installed is very carefully adjusted to the position that gives minimum hum output from the speaker. This will reduce the hum to a very low level indeed, and should be all that is required.

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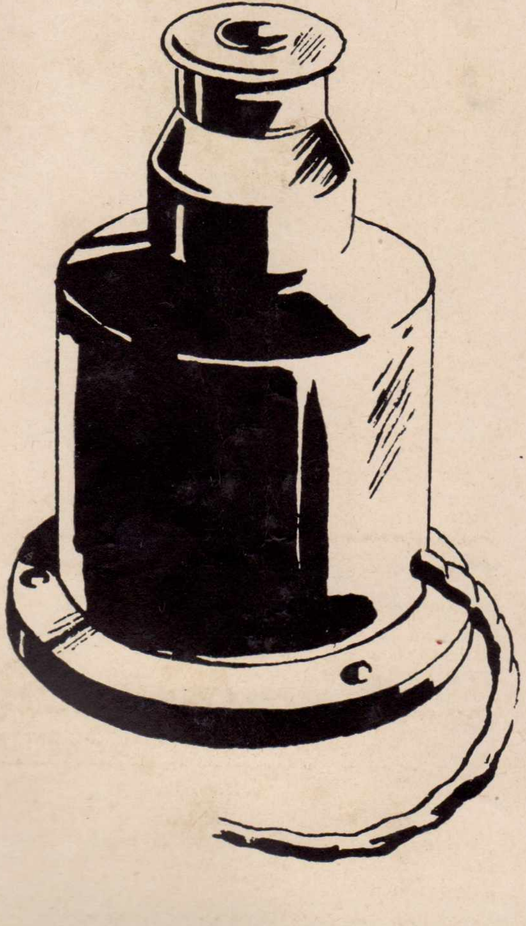

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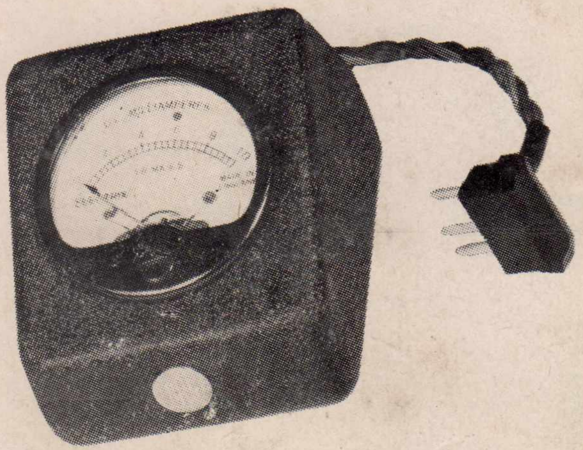

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