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EFFECTS WITH A TAPE RECORDER

The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS

VOLUME 9 NUMBER 11 JUNE 1956

A PHOTOGRAPHIC PROCESS TIMER

by J. W. BAGNALL

Also in this issue

THE "CHALLENGER" F.M. TUNER UNIT
DYNAMIC MUTUAL CONDUCTANCE VALVE ANALYSER
SIMPLE ALL-WAVE RECEIVER, Part 2
IMPROVING RECORD REPRODUCTION
DESIGN CHARTS FOR CONSTRUCTORS, No. 6
and all the usual features

DATA Publications 1/6

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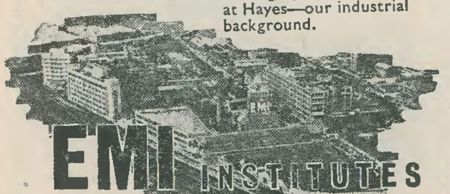

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The Radio Constructor

incorporating THE RADIO AMATEUR

CONTENTS FOR JUNE

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682 Suggested Circuits: A Dynamic Mutual Conductance Valve Analyser, *by G. A. French*
686 In Your Workshop: The "Challenger" F.M. Tuner Unit, *by J.R.D.*
691 Band III Television for the Home Constructor, Part 12, *by S. Welburn*
698 Club News
699 Simple All-Wave Receiver, Part 2, *by James S. Kent*
703 A Photographic Process Timer, *by J. W. Bagnall*
706 Can Anyone Help?
707 Improving Record Reproduction, *by O. J. Russell, B.Sc. (Hons.), G3BHJ*
711 A B7G Base for Transistors, *by C. J. Stone*
712 Effects with a Tape Recorder, Part 1, *by F. C. Judd*
716 Technical Forum
718 Radio Miscellany, *by Centre Tap*
720 Right—from the Start, Part 6, Receiving, *by A. P. Blackburn*
725 Design Charts for Constructors: No. 6, Inductance-Capacity-Wavelength Chart, *by Hugh Guy*

NOTICES

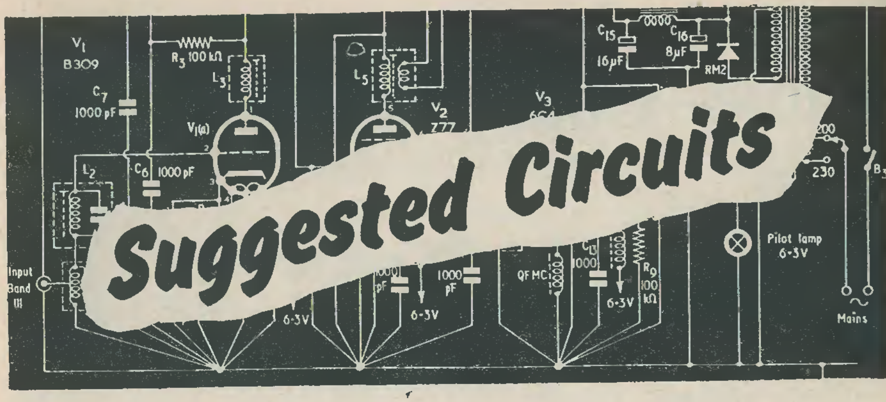
THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should preferably be typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw in most cases, but all relevant information should be included.

All MSS must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

TRADE NEWS. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

QUERIES. We regret that we are unable to answer queries, other than those arising from articles appearing in this magazine; nor can we advise on modifications to the equipment described in these articles.

ALL CORRESPONDENCE should be addressed to THE RADIO CONSTRUCTOR 57 Maida Vale London W9



The circuits presented in this series have been designed by G. A. FRENCH, *specially for the enthusiast who needs only the circuit and essential relevant data*

No. 67: A DYNAMIC MUTUAL CONDUCTANCE VALVE ANALYSER

ALTHOUGH TOO MUCH RELIANCE SHOULD not always be placed on such instruments, it cannot be denied that valve testers and analysers are extremely useful items of equipment to have, both in the amateur and in the professional workshop. Unfortunately, commercially made valve testers tend to be rather expensive, the more elaborate models, in particular, incurring quite heavy outlays. Cheaper valve testers frequently check emission only, whereupon the information they provide concerning the valve being tested is not of great practical value.

The process of constructing a valve analyser, instead of purchasing a commercially made instrument, is quite a feasible proposition if carried out with a reasonable amount of care. A simplification is provided by the fact that a multiplicity of different valveholders is not nowadays as necessary as it was before the war. Similarly, the provision of a large number of filament or heater voltages does not raise as many difficulties as have been apparent in the past. This is due to the fact that most modern valves which do not employ 6.3 volt heaters or 1.4 volt filaments are intended for connection in a series heater string. Such valves may then be accommodated by feeding them, from a suitably isolated a.c. supply of some 200 volts or so, via series dropper resistors; the latter being switched to feed 0.15, 0.2 or 0.3 amp heaters as desired.

The more difficult problems, so far as home constructed valve analysers are concerned, consist of working out a suitable type of test and of calibrating the instrument after it has been completed.

Mutual Conductance Test

Probably the most realistic check of the "goodness" of a valve is given by measuring its mutual conductance. The mutual conductance, or g_m of a valve, defines its change in anode current given by a change in grid voltage, the potentials of all other electrodes, other than the grid, remaining constant. In this country mutual conductance is expressed in terms of "mA per volt." In American literature mutual conductance is expressed in "micromhos," the mho being a unit of conductance. (A mho is the reciprocal of an ohm: a circuit having a resistance of 5 ohms would have a conductance of $\frac{1}{5}$mho). A g_m of 1,000 micromhos is equivalent to one of 1mA per volt.

This month's circuit illustrates a very simple means of measuring the mutual conductance of a valve under dynamic (i.e. non-static) conditions, and has the advantage of requiring no complicated or expensive gear for calibration. There are the incidental factors that the instrument can also provide checks for microphony and emission.

Principle of Operation

The analyser functions by applying an a.c. voltage to the grid of the valve under test and of converting the resultant a.c. current at the anode to a voltage; the voltages at grid and anode being then applied to a bridge in order to determine their ratio. The conversion of anode current to voltage is carried out by feeding the anode through a resistor, the value of this being kept very low.

To understand the functioning of the device more clearly, it might be worth while to commence by examining the simplified circuit shown in Fig. 1. In this diagram the series anode resistor has a value of 1,000 ohms; with the result that a change in anode current of 1mA causes a change of 1 volt to appear across this resistor. In consequence of this fact, if the valve under test has a g_m of X mA per volt, we can assume for the moment that a change in grid voltage of 1 volt will cause a change in anode current of X mA, together with a change of X volts across the anode series resistor. These voltages are depicted in the diagram. Since the grid and anode voltages are 180° out of phase it then becomes a very simple matter to apply them to a bridge potentiometer, as is done in Fig. 1, whereupon the arm of the latter can be adjusted for minimum output. The mutual conductance, in mA per volt will then be equal to the ratio $\frac{R_9}{R_{10}}$ It may now be seen, incidentally, that there is no real necessity to apply an input a.c. having a precise voltage to the grid of the valve, since the ratio $\frac{R_9}{R_{10}}$ will hold good for any reasonable input voltage. If Y volts a.c. were applied to the grid, XY volts would appear across the anode resistor. In practice, however, it would be preferable to use as low an input voltage as could be detected by the indicating device coupled to the bridge, since this would prevent the possibility of swinging the grid over any non-linear part of the I_aV_g characteristic of the valve under test.

There is one disadvantage with the circuit of Fig. 1, this being the fact that the 1,000 ohm series anode resistor has too high a value. If the circuit were used for testing a power valve with a high g_m, the a.c. voltage appearing across the anode resistor would be excessive and would not allow the requirement that g_m be measured with constant anode potential to be met.

This trouble can be obviated by making the series anode resistor small in value, say 25 ohms. The a.c. voltage appearing across a resistor of this value would then be one-fortieth part of the voltage appearing across the original 1,000 ohm resistor. If we next applied to the lower arm of the potentiometer R_9, R_{10} one-fortieth part of the input a.c. applied to the grid of the valve under test, we would once more be able to balance the bridge, and the expression $\frac{R_9}{R_{10}}$ would once again define the g_m of the valve in mA per volt. This is what has been done in the circuit which is discussed this month, and it is assumed that the error introduced by the presence of the 25 ohm anode resistor is negligible for all valves normally encountered in radio and television receivers.

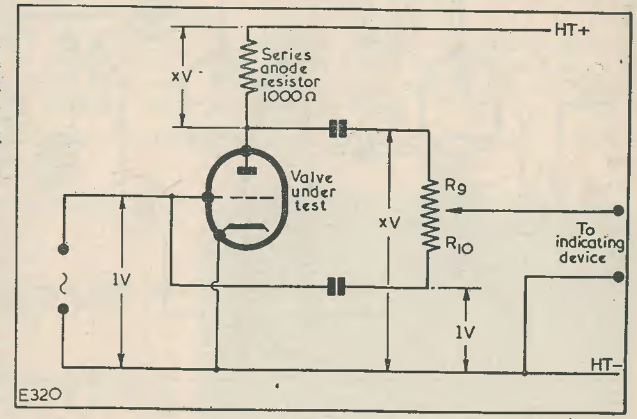


Fig. 1.

The Analyser

The full circuit of the valve analyser is given in Fig. 2. In this diagram the a.c. voltage is obtained from an audio oscillator or similar device which functions at a frequency around 4 kc/s. (The reason for this rather high frequency will be explained shortly). The 4 kc/s tone is applied to the volume control R_1 and, thence, to the cathode follower V_1. V_1 may be any low-mu triode. The cathode load of V_1 is 1,000 ohms, and one-fortieth part of the voltage built up across this load is applied, via C_6, to the lower end of the potentiometer R_9, R_{10}. (R_9, R_{10} is a single component, of course, two circuit references being quoted in order to simplify explanation). The total output of the cathode follower is applied to the grid of the valve under test, V_2, via C_3. The anode of V_2 is connected to the h.t. supply via R_6, this being the 25 ohm series anode resistor already discussed. The upper end of R_6 is decoupled to chassis by C_4. C_4 is an important component in the bridge circuit and must have a low reactance. At 4 kc/s a 50µF condenser (the value specified for C_4) has a reactance of 0.8 ohm, and this should be sufficiently low for our purposes here. The necessity for ensuring that C_4 has a low reactance is, incidentally, the reason for employing an operating frequency around 4 kc/s.

The voltage appearing at the anode of the valve under test is applied to the upper arm of the potentiometer R_9, R_{10} via C_5. R_9, R_{10} is kept at chassis potential via the resistors R_7 and R_8, these being included to prevent noise as the potentiometer is adjusted. As will be seen, both ends of R_9, R_{10} are connected to chassis via almost identical impedances.

The slider of R_9, R_{10} is coupled to the grid of V_3, this being a standard high-gain a.f. pentode. The voltage appearing at the anode of V_3 is next applied to a conventional output valve and loudspeaker. The output circuit can follow normal practice and is not, in consequence, shown in the diagram.

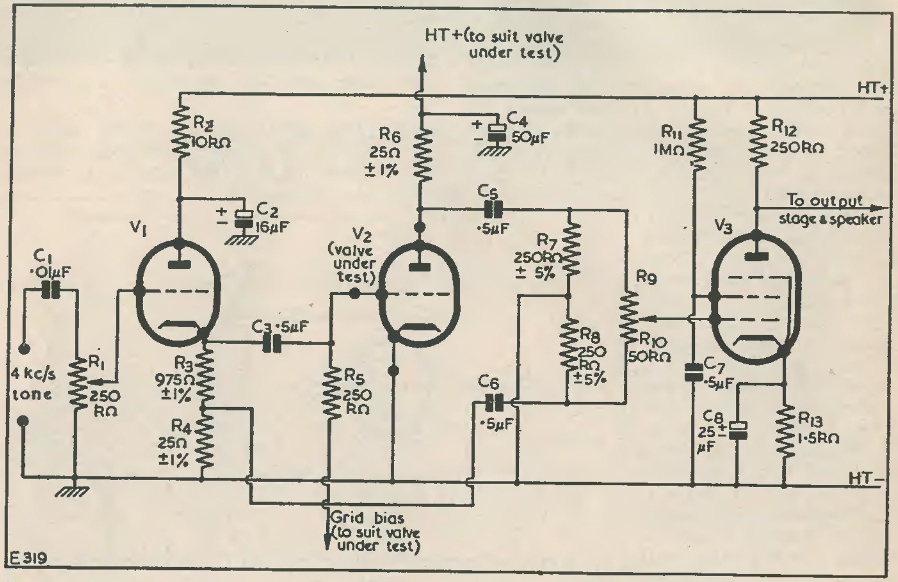


Fig. 2.

Calibration and Use

The analyser is initially set up by fitting the potentiometer R_9, R_{10} with a scale, and calibrating this directly in terms of the ratio $\frac{R_9}{R_{10}}$. The latter may be determined with the aid of an ohmmeter. When used, the valve to be tested is plugged into the V_2 position, the correct h.t. and grid bias potentials applied, and R_9, R_{10} adjusted for minimum tone in the speaker. The volume control R_1 should be adjusted during this process to as low a position as is consistent with an accurate determination of the null point. Mutual conductance can then be read directly, in mA per volt, from the scale of the potentiometer.

Tests for microphony may be carried out by switching off the 4 kc/s tone, setting R_9, R_{10} to the top end of its track and tapping the valve under test. An emission test can be carried out by inserting a meter between R_6 and the anode of the valve. This meter should be short-circuited whilst measuring g_m.

It will be apparent that it would not be possible, with this circuit, to supply the filaments of battery valves under test from a 50 c/s a.c. supply; this being due to the consequent introduction of hum. The simplest method of heating such valves would be by the use of a battery, all other voltages being provided, of course, from the mains power pack of the unit.

Little else concerning the practical aspect of the circuit needs to be emphasised, apart from the fact that the null point on the bridge will be masked if stray capacities exist between the bridge circuit and amplifier, and the circuit to the grid of the valve under test. However, it should be possible to keep stray capacities to a low value by employing normal sensible layout techniques.

Calculated Errors

Before concluding, it would be of interest to calculate the errors inherent in the circuit design. The main possible causes of error are the presence of C_4 and of R_6.

The condenser C_4 has a reactance of 0.8 ohms at the operating frequency of 4 kc/s. Thus the impedance between the anode of V_2 and chassis is equal to $\sqrt{25^2+0.8^2}=$ 25.03 ohms; and the phase shift at V_2 anode is approximately 2°. The resultant unbalance introduced into the bridge should be negligible; and could be further reduced, if desired, by increasing the value of C_4.

Inserting R_4 in the anode circuit of V_2 causes the dynamic mutual conductance of the valve to be

$$\frac{g_m}{1+\frac{R}{r_a}}$$

instead of being purely g_m. Under the worst conditions, such as could be given by, say, a triode-connected 6F6 with an r_a of 2,600 ohms, the dynamic mutual conductance becomes

$$\frac{g_m}{1+\frac{25}{2600}}$$

$$\simeq \frac{g_m}{1+\frac{1}{100}}$$

$$= g_m + \frac{1}{1.01}$$

In this case, the error in reading given by the analyser would be approximately 1%. With most valves, the error would be far less than this figure.

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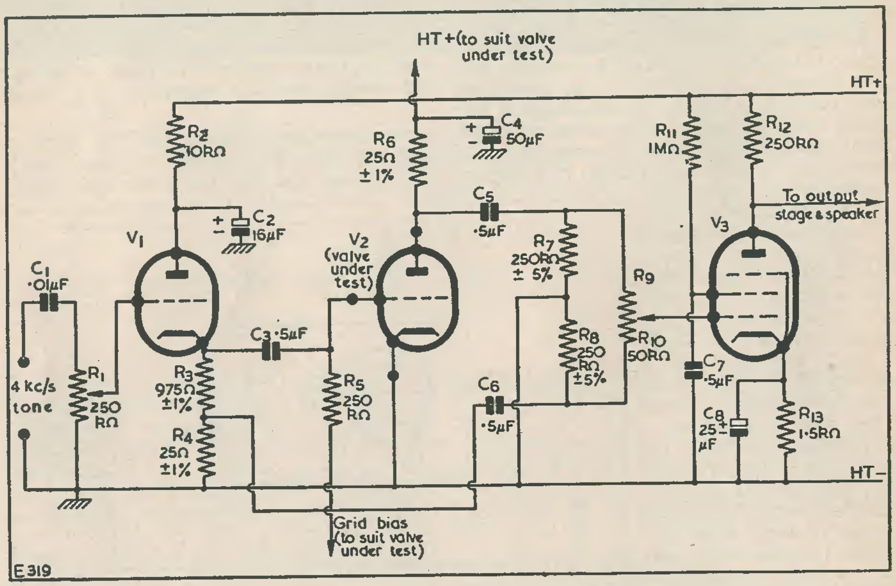

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In which J.R.D. discusses problems and points of interest based on letters from readers and his own experience. This month he introduces a new high-performance f.m. tuner unit: "The Challenger"

READERS MAY RECALL THAT DURING THE last two months "Smithy the Serviceman" took charge of the Workshop for an experimental period. I don't know whether Smithy will return in the future—this rather depends upon readers' reactions. At any rate, I do hope that he was able to pass on some hints and tips that would prove to be of use.

Home-Construction

The Radio Constructor is devoted very largely to the publication of constructional articles, and this probably provides the clue to its continually increasing popularity. This constructional angle has often been brought home to me by readers who have asked me to give practical details of some of the particular circuits which have appeared in these columns. It has been pointed out that theoretical descriptions, especially of more complex gear, are not always sufficient in themselves to enable the equipment discussed to be built.

Some correspondents have also mentioned the fact that, on several occasions in the past, I have referred to the performance of my home-built f.m. tuner unit. They have asked if this has a design suited for home-constructional use and, if this is so, whether I would be devoting any space to it in the future.

Both these points appear to be somewhat complementary in the present context. This is because the f.m. tuner is definitely applicable to construction at home; and because it offers an excellent opportunity for me to describe it with full practical details. The tuner is rather a "de-luxe" affair, but not excessively so. It is a unit with which I have endeavoured to obtain the best possible results commensurate with a reasonable number of valves, and it incorporates one or two novel features. So far as the discriminator is concerned, I have taken care to provide good a.m. rejection as well as a really linear discriminator characteristic. The circuit used has proved to be particularly efficacious against impulse noise.

I have decided to call this set the "Challenger," and I shall waste no time before carrying on to a description of its circuit.

Theoretical Details

The circuit of the Challenger f.m. tuner unit is given in Fig. 1. It would probably be best to commence by discussing this from the aerial stage onwards.

The aerial input connection is taken to the coupling winding of the aerial coil, L_1. The secondary of this coil is the tuned winding and this is pre-set, by its iron-dust core, to the centre of the band of frequencies to be received. Due to the low input impedance of the r.f. amplifier valve, V_1, the damping on this coil is sufficient to enable it to tune flatly over the whole of Band II, only slight losses occurring at the outermost edges of the range. A small-value condenser, C_3, iscon ected across the tuned winding, it being found empirically that this gives slightly better results than are obtained by relying on tuning by circuit strays only. An automatic gain control voltage is applied to the r.f. stage via the resistor R_4, and is decoupled by the condenser C_2.

The anode of V_1 is shunt-fed to the tuned circuit provided by L_2 and C_6 and C_7 in series. The connection into L_2 is made by means of a tap since, were the anode connected directly to the outside end of the coil, the subsequent damping would be too high to allow the coil to be tuned sharply. The frequency at which L_2 resonates is adjusted both by its own dust core and by the series trimmer C_6; the settings of both being somewhat critical. The *process* of trimming the coil is, however, quite simple. (The reason for employing a series trimmer is discussed later.)

From the tap in L_2 a connection is taken, via C_9, to the grid of the additive triode mixer $V_{2\text{-}(a)}$. This triode is half of a 12AT7, the other half being employed as the oscillator.

Oscillator Circuit

The oscillator circuit is of some interest, and it contains several points which may require explanation.

Essentially, it is the Colpitts oscillator which has now become so familiar to Band III enthusiasts. The coil is connected effectively between anode and grid of $V_{2(b)}$, the anode connection being made via C_{12}, and the grid connection via C_{13}. Both condensers have low impedance at v.h.f., and C_{13} serves also as the grid condenser of a conventional grid-leak oscillator arrangement. The "earthy" tap into the coil is made capacitively, it occurring at the junction, at chassis potential, of C_{17} with C_{14} and C_{15} in parallel. C_{15} is, of course, the tuning condenser and it is applied across the coil in series with C_{17}. Because of this, and on account also of the parallel capacity given by C_{14}, the effective tuning range of C_{15} is less than would occur if it were connected directly across the coil. In practice the tuning range is approximately 83 to 105 Mc/s, and so the Band II frequency range (88 to 100 Mc/s) is covered very comfortably.

Due to the restricted tuning range of C_{15}, it becomes necessary for that of C_7 to be restricted similarly, if the receiver is to track accurately. This restriction is achieved by means of the series trimmer, C_6, mentioned earlier. To ensure perfect tracking it would, in theory, be best to parallel C_7 with a condenser similar in value to C_{14} and to replace C_6 by a condenser similar in value to C_{17}. Nevertheless, the simpler arrangement shown in Fig. 1 gives excellent tracking in practice over the range required without introducing additional components.

The oscillator operates above the signal frequency, and its output is applied, via C_{10}, to the grid of $V_{2(a)}$. The low value required for C_{10} (2pF) is not critical and it is possible to use a "twisted pair" instead of a conventional component, should this be desired. This point is dealt with later, when the constructional details are discussed.

An unconventional feature is the fact that negative grid bias for the i.f. stages is obtained from part of the oscillator grid leak. This voltage is that appearing across R_9 and it is applied, after decoupling by R_7–C_{16}, R_{11}–C_{22}, to the appropriate i.f. transformer windings. The negative voltage provided by this arrangement varies between approximately 0.8 and 1.2 volts over the tuning range, and is sufficient to enable the cathodes of both i.f. valves to be connected directly to chassis.

A single heater choke is connected in series with the heaters of both V_1 and V_2. This was found, in practice, to be more than adequate for good heater decoupling. In addition, 1,000pF decoupling condensers are connected directly across the heaters of both V_1 and V_2, as well as across the heaters of the other valves in the tuner.

The I.F. Stages

It is most important, in f.m. tuners, to ensure that the i.f. stages provide a response which is as flat as possible over the band of frequencies being covered. For this reason, especial care has been taken with this section of the circuit.

Experience has shown that a prevalent source of non-linearity is i.f. degeneration, at frequencies within the pass-band, due to inadequate cathode decoupling. Normally, this tendency may only be cleared by using very large-value cathode decoupling condensers, these being connected to the appropriate valve pins by leads which are extremely short. In the "Challenger" this trouble is cleared up completely by connecting the cathodes *directly* to chassis. In consequence, this possible source of non-linearity is removed. Also, construction and wiring is made significantly easier.

Another, but not necessarily so troublesome, source of non-linearity, is inadequate screen-grid decoupling. In this tuner unit, miniature paper 0.02μF condensers are employed for screen-grid decoupling, such condensers having negligible inductance around 10.7 Mc/s. Further, the relatively large bulk of the paper condensers enables them to be laid across the valveholders, providing additional screening between anode and grid circuits. Attention has been paid to stability in all other parts of the design and, despite its high gain at a single frequency, the i.f. strip is very stable indeed.

As was just mentioned, grid bias, instead of cathode bias, is employed for the i.f. amplifying valves. An objection which could be

THE "CHALLENGER"
Components List

Resistors (all ± 20% unless otherwise stated)

R_1	150Ω ¼ or ⅛ watt
R_2	10kΩ ¼ watt
R_3	5kΩ ¼ or ⅛ watt
R_4	10kΩ ¼ or ⅛ watt
R_5	2MΩ ¼ or ⅛ watt
R_6	6.8kΩ ¼ watt
R_7	10kΩ ¼ or ⅛ watt
R_8	22kΩ ¼ or ⅛ watt
R_9	10kΩ ¼ or ⅛ watt
R_{10}	47kΩ ¼ watt
R_{11}	2.2kΩ ¼ or ⅛ watt
R_{12}, R_{13}	5kΩ ¼ or ⅛ watt
R_{14}	100kΩ ¼ or ⅛ watt
R_{15}	22kΩ ¼ watt
R_{16}	5kΩ ¼ or ⅛ watt
R_{17}	47Ω ¼ or ⅛ watt
R_{18}	47kΩ ¼ or ⅛ watt
R_{19}, R_{20}	1kΩ ¼ or ⅛ watt (see text)
R_{21}, R_{22}	6.8kΩ 10% ¼ or ⅛ watt
R_{23}	120kΩ ¼ or ⅛ watt
R_{24}	56kΩ ¼ or ⅛ watt

Condensers (all 20%, where applicable, or unless otherwise stated)

C_1, C_2	1,000pF, ceramic, T.C.C. type CTH310
C_3	5–10pF, ceramic, T.C.C. type SCD1 or SCD2
C_4, C_5	1,000pF, ceramic, T.C.C. type CTH310
C_6	Trimmer (see text)
C_8	50pF, ceramic, T.C.C. type SCT1
C_9	25pF, ceramic, T.C.C. type SCT1
C_{10}	2pF (see text)
C_{11}	1,000pF, ceramic, T.C.C. type CTH310
C_{12}	100pF, ceramic, T.C.C. type SCT2, or silver-mica, T.C.C. type SMP101
C_{13}	25pF, ceramic, T.C.C. type SCT1
C_{14}	25pF 10%, ceramic, T.C.C. type SCT1
C_{16}	1,000pF, ceramic, T.C.C. type CTH310
C_{17}	40pF 10%, ceramic, T.C.C. type SCT1
C_{18}	1,000pF, ceramic, T.C.C. type CTH310
C_{19}, C_{20}	Supplied with i.f. transformer
C_{21}	1,000pF, ceramic, T.C.C. type CTH310
C_{22}, C_{23}	0.02μF, miniature paper tubular, T.C.C. type 346
C_{24}	1,000pF, ceramic, T.C.C. type CTH310
C_{25}	Supplied with i.f. transformer
C_{26}	1,000pF, ceramic, T.C.C. type CTH310
C_{27}	Supplied with i.f. transformer
C_{28}, C_{29}	0.02μF, miniature paper tubular, T.C.C. type 346
C_{30}	1,000pF, ceramic, T.C.C. type CTH310
C_{31}, C_{32}	Supplied with discriminator coil
C_{33}, C_{34}	330pF, silver-mica, T.C.C. type SMP501
C_{35}	200pF, silver-mica, T.C.C. type SMP401
C_{36}	0.05μF, miniature paper tubular, T.C.C. type 346
C_{37}	1,000pF, miniature paper, tubular, T.C.C. type 383 (or silver-mica, or ceramic)
C_{38}	0.02μF, miniature paper tubular, T.C.C. type 346
C_{39}	8μF, electrolytic, 200VDC working, T.C.C. "micro-pack" type CE18G

Tuning Condenser and Drive

C_7, C_{15} 25pF + 25pF, Jackson Bros., type U101

Tuning Drive—Jackson Bros., type 2154, fitted with scale type 4838

Valves

V_1, V_3	6AM6
V_2	12AT7
V_4	6AU6

Valveholders

3—B7G, screened. McMurdo, type BM7/UD1, with screening can type 4/45

1—B9A, screened. McMurdo, type BM9/VD1, with screening can type 8/75

Inductors

L_1	FMC 156, Allen Components Ltd.
L_2	FMC 157, Allen Components Ltd.
L_3	FMC 158, Allen Components Ltd.
L_4	Heater Choke, Allen Components Ltd.
L_5, L_6	FMC101, Allen Components; QIFM, Osmor; IFT11, Denco (Clacton) Ltd.; IFM, Teletron.
L_7	FMC151, Allen Components, QICD, Osmor; RFM, Teletron

Tag-Strips

6—Five-way, centre earthed.

Sockets

1—Aerial input socket (Coaxial or two-way)
1—A.F. output socket (Coaxial or two-way)

Sundries

Chassis
3-way power lead
¼-in knob

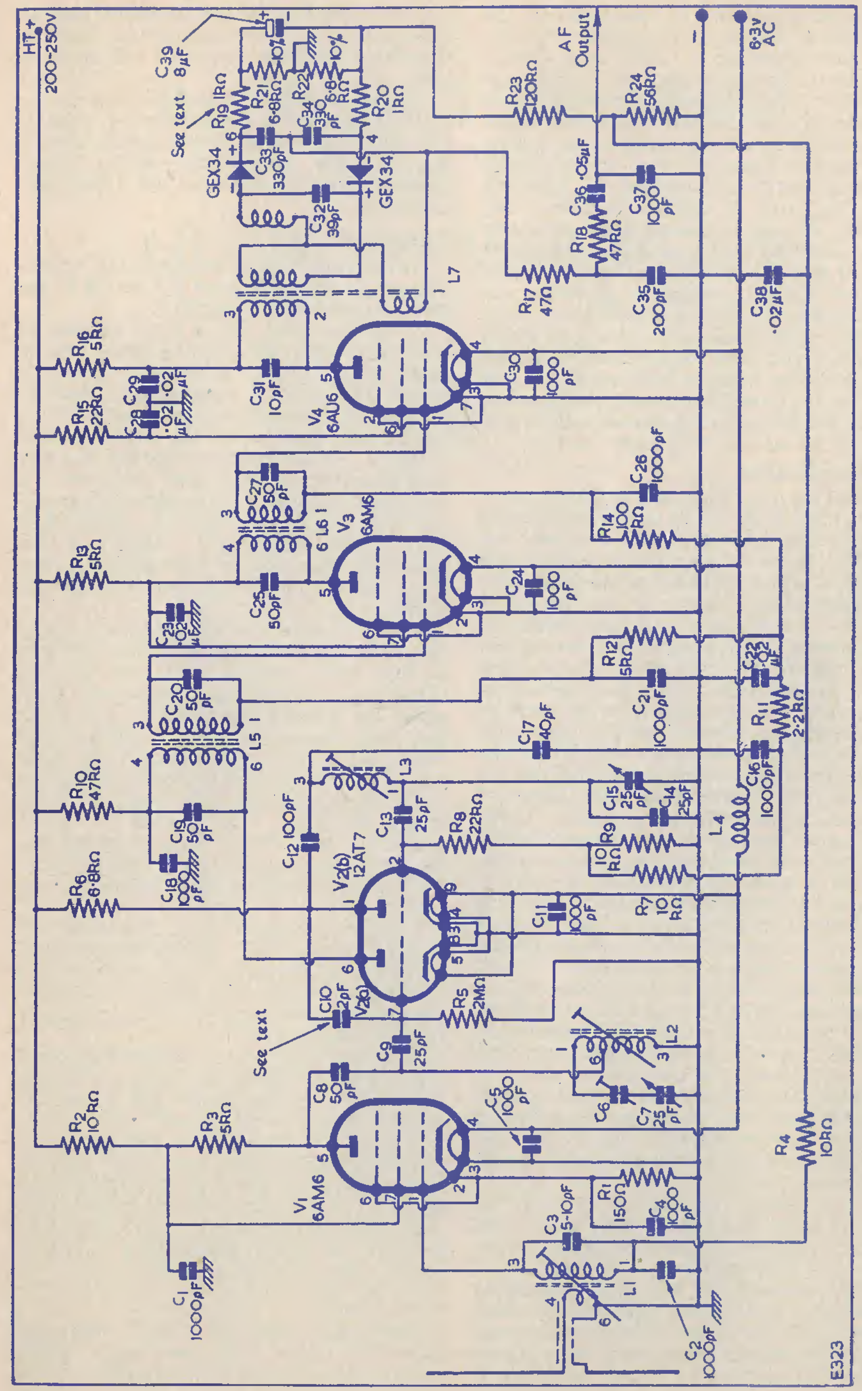


Fig. 1. The complete circuit of the "Challenger" f.m. tuner unit

raised against this form of bias is that, on the reception of heavy pulse interference (the form most prevalent at v.h.f.), such circuits are liable to be biased back by normal grid leak action, after which the receiver takes an appreciable time to return to normal again. In this receiver, care has been taken to keep the resistive value of the grid-to-chassis circuit of the first i.f. amplifier, V_3, to a low value (R_{12}, R_{11}, R_7 and R_9 in series); and recovery time is, in consequence, extremely short. On the other hand, a relatively high value of grid leak is employed for the second amplifier, V_4, thus enabling it to function as a partial limiter. Limiting is only given, however, for signal potentials at the grid which exceed the grid bias voltage built up across R_9. Back-bias voltages built up at the grid of V_4 are not passed back along the bias line, due to the low resistive return path of the latter to chassis and the presence of C_{22}.

The Discriminator

One of the most important design points of an f.m. tuner is the circuit layout employed at the discriminator stage. This is mainly due to the fact that an i.f. signal of large amplitude is injected into the primary of the discriminator transformer, and that this signal is rectified at a similarly high amplitude. In consequence, it is possible for strong i.f. harmonics to be generated, these being radiated at sufficient strength to be picked up by the r.f. circuits of the tuner or even by neighbouring receivers. In this particular receiver the i.f. amplitude reaching the discriminator is kept within reasonable bounds for most conditions of reception by reason of the a.g.c. circuit. Also, the germanium diode rectifiers are enclosed in the same can as the coil itself, with the result that a considerable measure of screening is achieved. Nevertheless, it is still of importance to take care with the wiring of the discriminator stage, and this point will be given further prominence when constructional details are published.

It will be noted that a balanced discriminator circuit is employed, a.g.c. being taken from a fixed potentiometer connected between the negative end of the stabilising condenser, C_{39}, and chassis. It is advisable to use a potentiometer here, as the negative voltage available at the stabilising condenser would normally be too high for a.g.c. purposes. The control obtained is adequate for all conditions of reception.

As it stands, the circuit around the discriminator stage will give good a.m. rejection using the component values shown. If a very high degree of a.m. rejection is needed, however, it will be necessary to replace R_{19} by a resistor whose value causes almost perfect balance in the discriminator load. The value of resistor required can only be found experimentally, since it will vary for different discriminator coil assemblies and, to a less extent, for different receivers. Instructions for finding the best value will be given later.

Finally, as may be seen from Fig. 1, the audio output of the discriminator stage is passed through the usual de-emphasis circuit, R_{18} and C_{37}, and thence to the output terminals for connection to the subsequent amplifier.

Components List

A component list accompanies this article. As may be seen, this gives full details of the principal components required.

It will be noted that a large number of resistors are specified as ¼ or ⅛ watt. In such cases, the constructor is strongly advised to obtain the ⅛ watt components wherever possible, as these will fit into the layout more comfortably than would the larger, ¼ watt, versions. As was mentioned earlier, R_{19} may need alteration in value after the tuner unit has been completed if the maximum degree of a.m. rejection is to be obtained. However, it will still be necessary to employ a 1kΩ resistor in this position during construction if the unit is to be initially put into working order.

There are one or two condensers which also deserve a few words of explanation concerning their choice. For instance, the condenser C_3 is given a recommended value which lies between 5 and 10pF. This range has been chosen because the value of the condenser is not very critical, and some constructors may prefer to employ condensers which they have on hand and which fall within this range. The trimmer C_6 should, preferably, be a Philips trimmer of the type having three concentric sets of circular vanes. Its final adjusted value will lie between 25 and 40pF.

Another condenser, C_{10}, has a recommended value of 2pF. As was stated above, it is possible to replace this condenser by a "twister pair," if desired, and instructions are given in the constructional articles for carrying out this process.

It will be noted that six five-way tag-strips are employed. These tag-strips are of conventional type, the centre tag being that which is bolted to the chassis.

It should be pointed out also that aerial input and audio output sockets are included in the parts list, but that no references are given. These parts are not of great importance, and the constructor may prefer to use whatever particular components he has on hand, or may wish to purchase.

Next Month

So much for the circuit of the "Challenger." Next month I shall commence to give constructional details of this receiver.

BAND III TELEVISION for the HOME CONSTRUCTOR

PART 12. by **S. WELBURN**

This month S. Welburn continues his popular series of articles by dealing with the procedure for correcting frequency drift in Band III oscillator circuits. He also deals with the function and use of r.f. "test points" in turret tuners.

Readers may recall that, several issues ago, the writer dealt with the problem of frequency drift in Band III oscillators. On that occasion he wrote that the easiest method of keeping oscillator drift low in a home-constructed Band III convertor consisted of ensuring that the oscillator components were kept as cool as possible. He also stated that he did not think it was worth the amateur's time attempting to reduce oscillator drift with the aid of negative temperature coefficient condensers, as the process of selecting the correct condenser could be long and tedious, especially without the aid of special equipment.

Readers' Reactions

Quite a few letters debating this point have been received since the article appeared, and their contents could roughly be divided into two categories. The first contains letters from readers who suffer from an annoying and persistent oscillator drift on Band III, even after they have taken the precautions of using good quality components in the oscillator circuit and of keeping these cool. The second classification contains letters from readers who feel that the process of selecting the requisite n.t.c. condenser for the oscillator circuit is not at all outside the capabilities of the amateur, even though it may take up some of his time. The writer definitely agrees with the opinion of this second category, but still contends that correcting frequency drift may be quite a long-winded affair. However, as readers appear to be in trouble with this fault, and as there is a feeling that it can be tackled quite comfortably, he would now like to discuss the subject in greater detail this month.

Oscillator Drift

Frequency drift in an oscillator of the type employed in a Band III converter is caused almost entirely by temperature rise in the valve, components and wiring which constitute the oscillator circuit. In the absence of any negative temperature coefficient components, this drift almost always tends to cause a reduction in frequency; such a tendency being shown both by condensers and inductors. H.T. voltage variations could also cause frequency drift, but in districts with reasonably steady mains voltages drift due to this cause does not appear to be very prevalent. The main offender is the rise in temperature.

It would be a reasonably simple job to correct the drift caused by heat if the temperature of all the oscillator components rose by similar amounts at the same rate. Unfortunately, this does not happen in practice, and very wide discrepancies can appear between the temperatures of different parts of the circuit during the first hour or so after switching on. It is these discrepancies which make the process of correction for drift lengthy and time-consuming.

Fig. 1 shows a Band III converter oscillator, and Fig. 2 a typical practical application of this circuit. In Fig. 2 the valveholder is mounted on a conventional chassis, and the oscillator components are mounted below.

At the moment of switching on, all the parts forming the oscillator circuit of Figs. 1 and 2 have the same temperature, this being that of the room in which the equipment is used. After switching on, the first thing to heat up is, of course, the valve. Some drift will at once occur due to the temperature rise in the valve itself, this drift being caused by changes in interelectrode capacity. Normally, however, such shifts are kept as low as possible by the manufacturers of the valve. Most Band III oscillator valves run fairly hot and probably take some ten to twenty minutes to settle down to a reasonably steady temperature. Capacity changes in the valve can be described, in consequence, as being of a short-term variety.

to the valveholder contacts and, thence, to the components soldered directly to those contacts. This simple fact probably causes more trouble than any other, so far as drift in Band III oscillators is concerned.

The rise in temperature of the valveholder contacts results in a similar temperature rise in the insulating material of which the valveholder is made. Most B7G and B9A

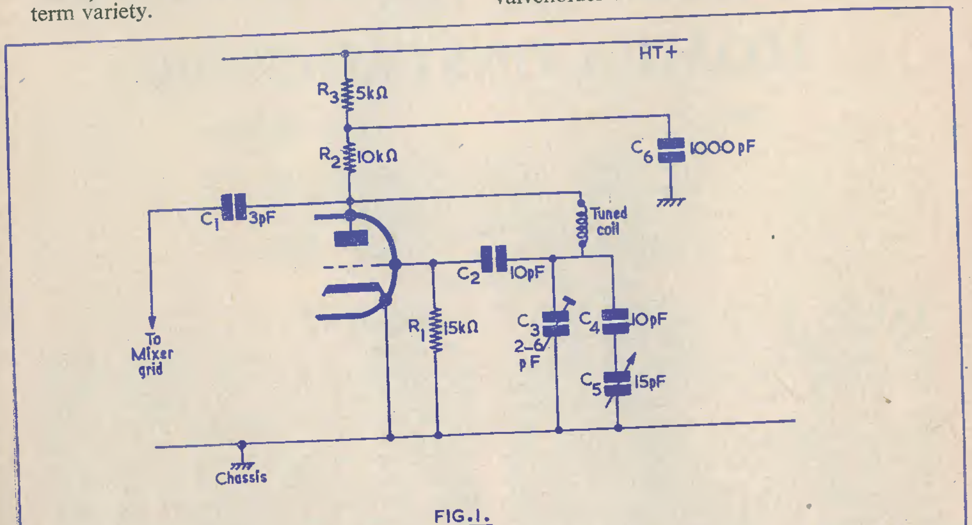


FIG.1.

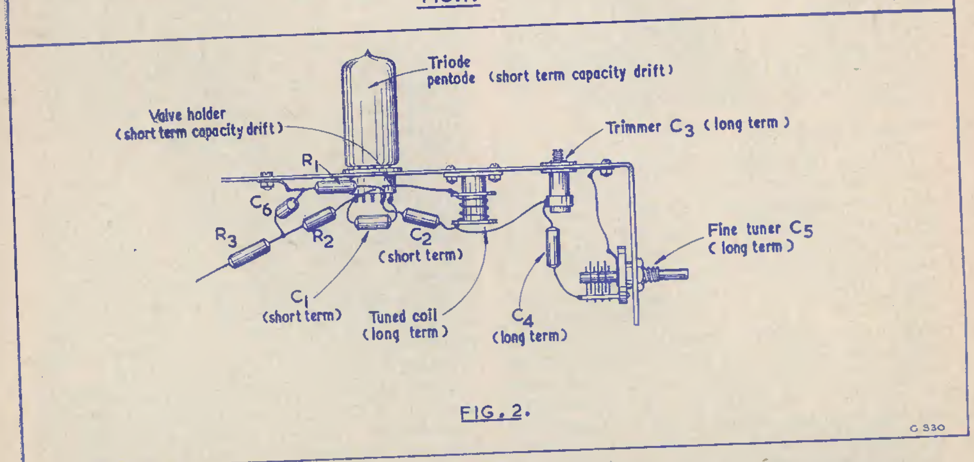


FIG. 2.

Fig. 1. The circuit of a typical Band III oscillator. Fig. 2. A practical application of the circuit of Fig. 1, illustrating the components in which short-term and long-term frequency drift may occur

Some of the heat generated inside the valve is radiated away through the glass of its envelope. At the same time, a considerable amount of heat is *conducted* away, this travelling through the pins of the valve

valveholders contribute a significant amount of tuning capacity to a Band III oscillator tuned circuit. The capacity dielectric is provided, in the case of "moulded" valveholders (the type preferred for Band III

work), by the insulating material in which the contacts are fitted; and different types of material here can cause very widely differing drifts in oscillator frequency. The best valveholder insulant material is ceramic, since this has a very low temperature coefficient. A possible, and cheaper, alternative is phenol formaldehyde, the black mould material used in many popular valveholders. (Phenol formaldehyde is employed in the McMurdo BM7 and BM9 series of valveholders). The writer's experience has been that this seems to have quite a low temperature coefficient. Some "low-loss" moulded valveholder materials, which are obviously not ceramics, seem to have rather high temperature coefficient figures, and they should be treated with some circumspection if they are intended for use at the oscillator position.

these Unfortunately, the rise in temperature of these particular components is slightly slower than that of the valve and valveholder contacts with the result that their detuning effect can sometimes be a little difficult to ascertain and to correct.

Long-term oscillator drift is that given by the temperature changes in all components in the oscillator circuit which are not coupled by a short metallic path to the valve (or any other heat-generating component). These components warm up slowly over a period of an hour or so due to heat radiation, convection currents (especially if these are "trapped" below the chasis), the conduction through the chassis and wiring.

Measuring Drift

Without extensive equipment, the only way of measuring oscillator drift consists of

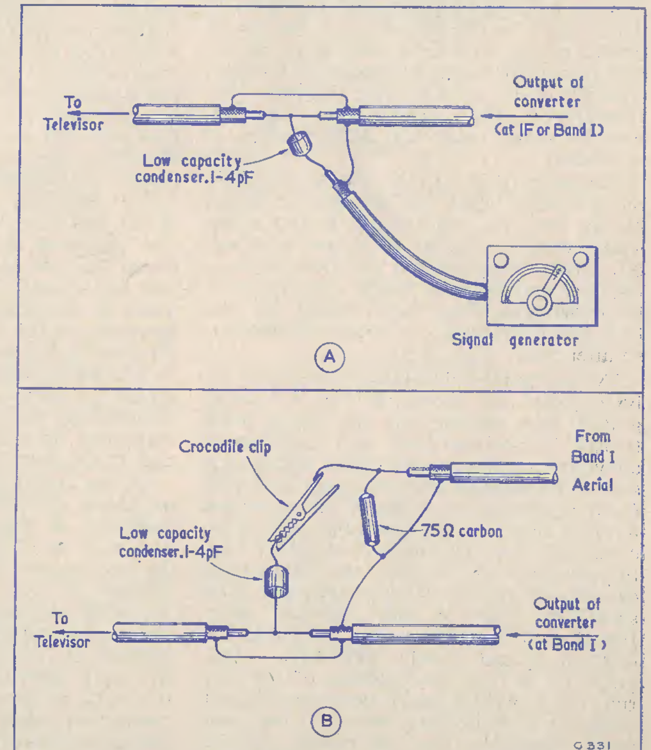


Fig. 3. Two possible methods of obtaining oscillator calibration checks when testing a Band III oscillator for drift

The change in capacity in the oscillator valveholder will normally be of the short-term variety, since the temperature of the contacts rises quickly after switching on. Other components subjected to a short-term rise in temperature are those which are soldered directly to the valveholder tags. Fig. 2 designates the more important of

checking the tuning of the converter oscillator at regular intervals during a period of time. This check may be carried out by ascertaining the correct tuning position of the fine tuning condenser, or oscillator coil slug, at regular intervals; and of plotting the results on a graph. For accurate results it is necessary to employ some means of indication to show when the oscillator is *exactly* on tune, as the usual procedure of "adjusting for maximum volume" is too inaccurate with most wide-band TV sound i.f. strips. A good method of checking exact frequency is shown in Fig. 3 (*a*), in which the output of a signal generator, set to the sound i.f. of the television receiver, is injected via a low-value condenser (1 to 4 pF or so) into the i.f. output of the converter. The correct setting of the converter oscillator is then that which causes the sound i.f. output to beat with the signal generator in the receiver. If a signal generator is not available, and the converter output is at the Band I frequency of the televisor, a check frequency may be given alternatively by the sound carrier of the Band I signal itself, this being injected as shown in Fig. 3 (*b*). A crocodile clip is shown in this diagram as it is important to connect the Band I aerial into the circuit only for the short period needed to take a calibration check. The reason for a quick, temporary connection is due to the fact that radiation and interference with neighbouring receivers may be caused when the Band I aerial is connected.

Frequency drift "runs" should be commenced only when the converter is completely cool, i.e., following a period of at least several hours after it has been switched off. From the moment of the signal appearing after switching on, tuning checks should be undertaken every five minutes for the first half-hour, and every ten minutes or so after that.

Typical graphs illustrating the result to be expected are shown in Fig. 4. These graphs were obtained by the writer from typical home-constructed and commercial converters, and represent quite clearly the sort of readings which are usually obtained in work of this sort. Fig. 4 (*a*) shows an instance in which the fine tuner has to be continually decreased in capacity all the time the converter is running, the changes in capacity decreasing as time goes on. The short-term drift is quite marked here. Fig. 4 (*b*) illustrates a case in which the drift is almost purely short-term. This graph is, in fact, the outcome of the first run on a well-designed home-constructed oscillator in which long-term drift has been made negligible due to careful layout. Only the almost inevitable short-term drift (to be anticipated in the first trial run) is in evidence, and this is fairly simple to clear.

Fig. 4 (*c*) illustrates an instance in which the short-term drift is in one direction, and the long-term drift in another. It is necessary to increase tuning capacity during the first part of the period and to decrease it during the second part. This particular curve was given by a commercial converter, and shows badly planned compensation. The oscillator is over-compensated during the short-term period and under-compensated during the second period.

Fig. 4 (*d*), taken from another commercial unit, indicates the reverse state of affairs. This time the converter is under-compensated during the short-term period and over-compensated during the long-term period. However, the total effect in this case is not too severe due to the relatively low overall frequency shift.

It will be noted that the vertical co-ordinates of the graphs of Fig. 4 are graduated in terms of fine tuning condenser rotation, or in terms of slug rotation. Both these methods of checking tuning accuracy are rough and ready, but they are adequate enough for the immediate purpose without making too much of a meal of the job. A more accurate method of measuring the drift, if the arrangement of Fig. 3 (*a*) were used, could be obtained by recording the signal generator frequencies needed to beat with the sound i.f. output of the converter. However, this method incurs complications whenever the sound i.f. output travels outside the passband of the receiver.

The frequency shift between the limits of the fine tuner and slug adjustments are also illustrated in Fig. 4, these having been taken with the aid of the signal generator just mentioned. Defining drift in concrete terms of frequency is not really necessary, however, as the more important thing to discover is the direction in which the drift is occurring, together with a reasonable idea of its severity. There is no guarantee, incidentally, that the relationship between condenser or slug rotation and frequency drift in the graphs of Fig. 4 is linear.

Curing the drifts given in Fig. 4 consists of fitting n.t.c. condensers of the correct coefficient at the appropriate parts of the oscillator tuned circuit. In Fig. 1 any of the condensers, C_1, C_2 and C_4, may be changed to n.t.c. types, and will have the necessary detuning effect on the tuned circuit as they warm up. According to their position in the circuit similar condensers will have differing detuning effects, but as this fact is dependent entirely upon the particular oscillator circuit employed it cannot be discussed in the space available here.

After having obtained one's graph, the next problem consists of finding the best physical position for the appropriate n.t.c. condenser. If the short-term drift is high, the condenser should be soldered close to the valveholder tags. When long-term drift has to be cleared up, the condenser should be isolated from any thermal connection with

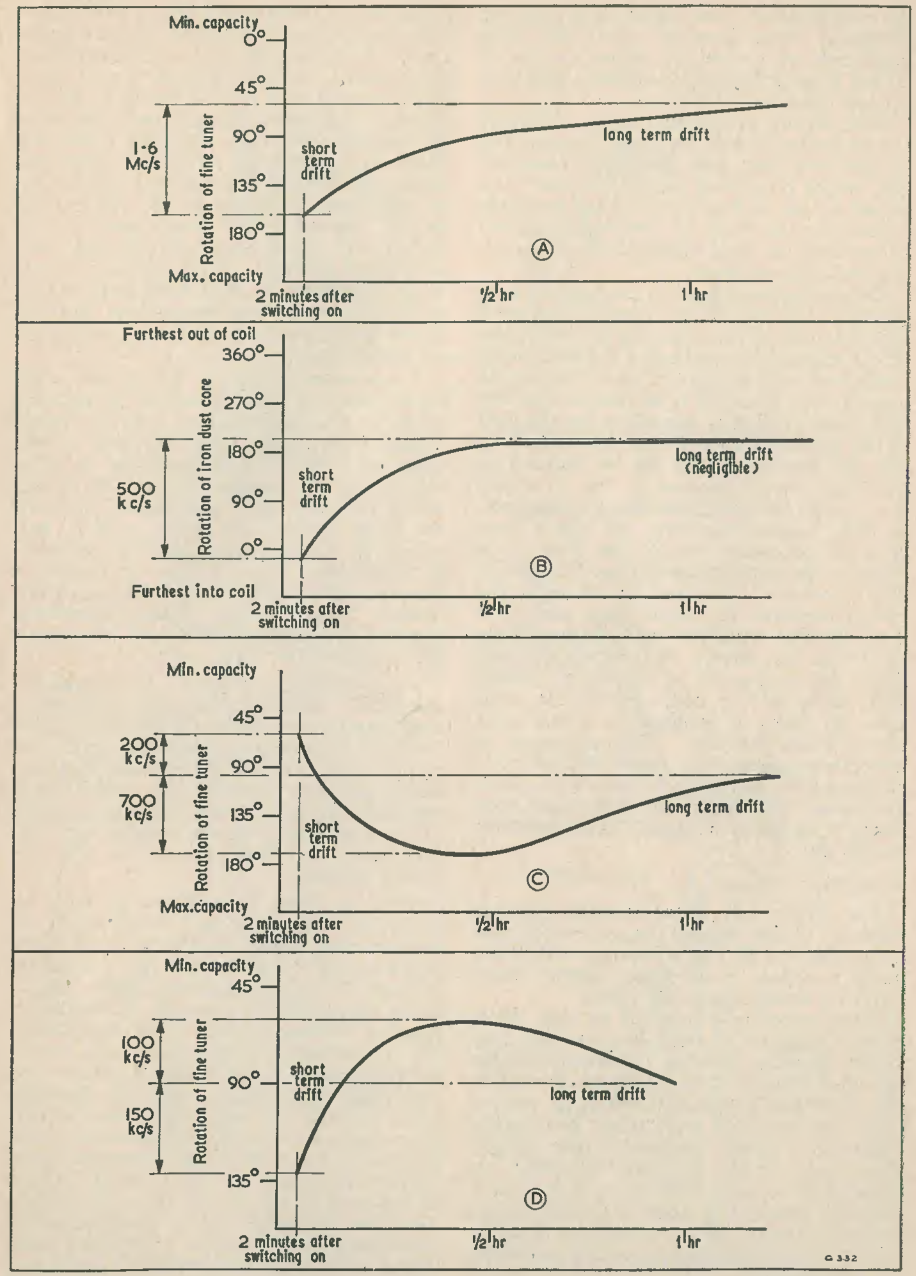


Fig. 4. Four curves obtained by the writer from typical home-constructed and commercial Band III converters. They are discussed in the text

the valveholder. The graph of Fig. 4 (*c*) illustrates what happens when an n.t.c. condenser, whose real job should be that of curing long-term drift, is allowed to warm up too quickly.

After fitting a particular n.t.c. condenser the converter should be given another run to see how the drift has been modified. The whole process of finding the best condenser to use is empiric, and may probably involve up to three or four experimental runs before a final low-drift combination can be finally achieved.

Before concluding on this subject, it is possible that one or two readers may be a little hazy as to the direction of drift when this is checked by rotation of the fine tuning condenser or of a slug in a coil. The way to visualise the situation is to assume that the fine tuner or slug is cancelling out the drift in the circuit. If, some time after switching on, the fine tuner has to be reduced in capacity, this is because it has to cancel out a rise in tuning capacity, inductance, or both, caused elsewhere. To give a cure, an n.t.c. condenser would then have to be fitted at the appropriate part of the circuit. This condenser, reducing in value as the circuit warmed up, would then take over from the fine tuner the task of keeping the circuit at its correct frequency. An iron dust slug coming out of a coil, or a brass slug going into a coil, defines the same state of affairs as is given by a fine tuner reducing in capacity. If a converter is over-compensated, this means that an n.t.c. condenser is having too great an effect. To cancel this effect, the fine tuner then has to be *increased* in capacity as the oscillator warms up.

One Every Minute

The writer has heard several rumours recently of an alleged racket which has been operated in the Midlands, and which could re-appear at any other district where Band III signals are in the offing.

What apparently happens is that door-to-door "salesmen" visit houses with television aerials, offering "converters" for sale at £4 to £5. The housewife is told of the marvellous pictures she will receive when the Band III transmitter commences operation. When, eventually, the station does come on the air, the "converter" is revealed to be quite ineffective; if, indeed, it was ever intended to work in the first place. By that time, of course, the vendor is safely out of the district, and is looking elsewhere for fresh victims.

The moral is obvious.

Turret Tuners

In last month's article, the writer stated that he hoped to be able to discuss the alignment of turret tuners with a wobbulator and oscilloscope if sufficient practical information were available to him. Unfortunately, the material he required is not yet to hand. Also, he has had second thoughts on the subject. The second thoughts were prompted by the fact that nearly all turret tuners are fitted to commercial receivers, whereupon alignment instructions are (or *should* be, at any rate) available in the appropriate service manual. The usefulness of full details of turret alignment in the constructional press is, in consequence, somewhat problematic; and the writer would prefer to seek guidance from readers' letters before proceeding at any great length on this subject.

Nevertheless, there is one point about turret tuners which appears to be puzzling quite a few constructors, and it would definitely be worth while devoting a little space to it now. This particular point is the reason and function of the "bit of wire which sticks up out of the chassis" in nearly all turret tuners. As many readers will, of course, already know, this "bit of wire" is a test point, and is used to provide a measure of the response of the signal frequency tuned circuits which are fitted between the aerial terminals and the control grid of the turret mixer valve.

Fig. 5 (*a*) shows a typical mixer circuit of the PCF80 class. The cathode of the valve is at chassis potential, and the input signal is applied between cathode and grid. The cathode and grid can thereby function as a diode detector, rectified r.f. appearing at the grid. This rectified r.f. is then available at the test point, via the resistor R_1. The test point wire may, indeed, be the free end of R_1 itself.

When a turret tuner is set up with the aid of a wobbulator and oscilloscope, the arrangement shown in Fig. 5 (*b*) is used. What happens here is that the wobbulator sweeps across the frequency range of the turret r.f. circuits, in step with the horizontal scan of the oscilloscope. The response of the r.f. circuits is then displayed by the oscilloscope in conventional fashion. An important point which has to be borne in mind is that the frequency sweep usually occurs at a repetition frequency which happens to be in the audio spectrum. Thus, during the sweep, an a.f. voltage appears at the grid of the mixer. This a.f. voltage can then be applied to the oscilloscope by connecting its Y amplifier to the test point and chassis of the turret tuner. The resistor R_1 (Fig. 5 (*a*)) then serves merely as a decoupling resistor. (Actually, in conjunction with the capacity in the screened lead to the oscilloscope it forms part of a low-pass filter).

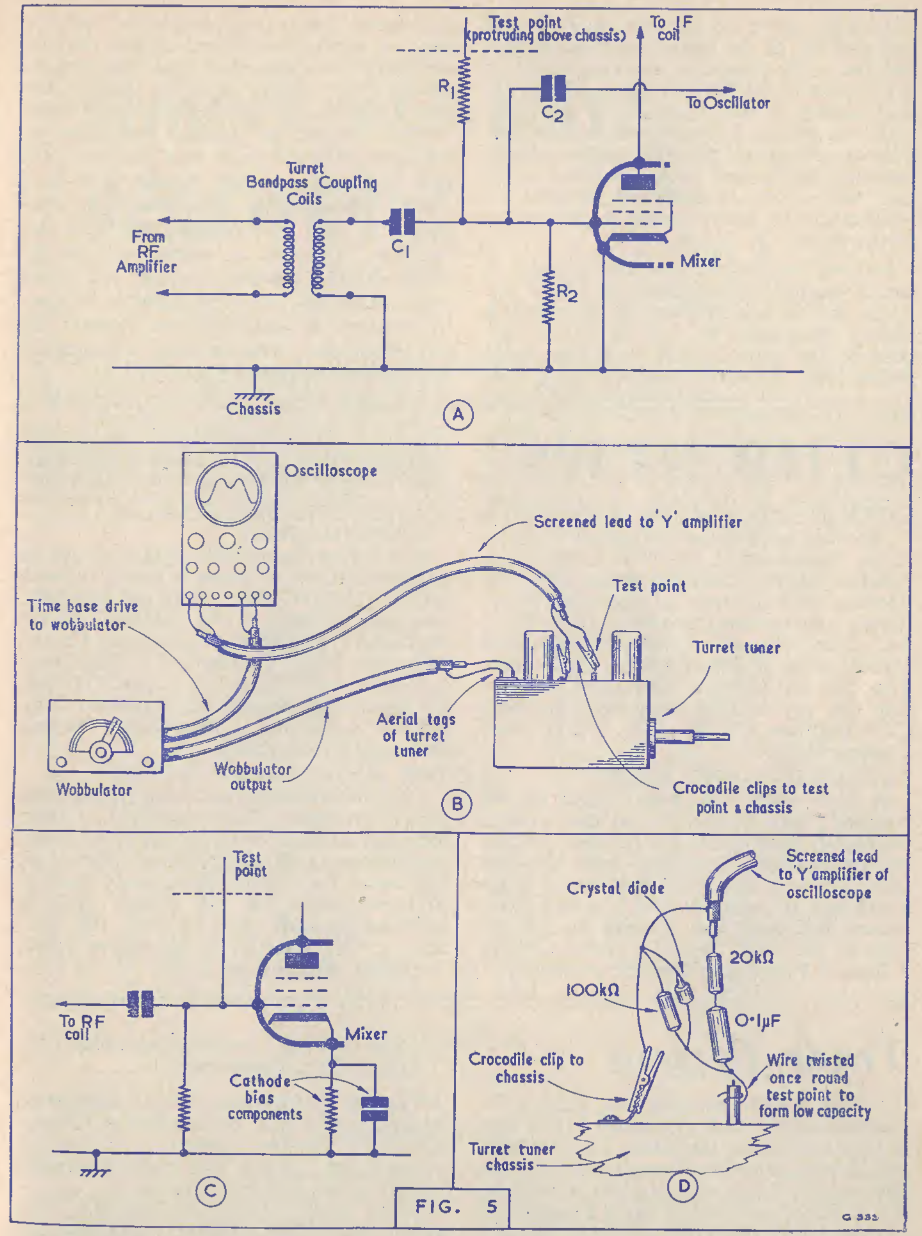


Fig. 5 (a). The mixer circuit of a typical turret tuner, illustrating the method of connection of the test point. (b). Connecting a wobbulator and oscilloscope to a turret tuner to check its r.f. response. (c). An alternative type of mixer circuit. (d). How the Y amplifier of an oscilloscope may be coupled to the test point of (c)

To infer, as we did just now, that the grid and cathode of the mixer rectify in normal fashion is not quite true, since the situation is complicated by the fact that a high oscillater voltage is also injected into the mixer grid, this biasing it negative with respect to cathode. However, the grid reaches cathode potential during part of the oscillator cycle, and this allows a sufficient amount of rectification to occur during a proportion of the time.

Several commercial turrets employ a circuit similar to that shown in Fig. 5 (*c*). From the theoretical point of view this is slightly preferable to that of Fig. 5 (*a*), because the cathode bias now introduced makes the conversion conductance less dependent upon the amplitude of the injected oscillator voltage. It has the disadvantage that the mixer grid and cathode cannot now rectify and the simple test circuit of Figs. 5 (*a*) and (*b*) cannot be used.

This trouble is usually overcome by connecting the test point wire directly to the grid itself. A separate rectifier such as a crystal diode is then connected by a condenser of very low capacity (or very low "puffage," to quote an expressive term the writer heard recently!) to the test point wire. Normally, sufficient capacity is given by twisting an insulated wire around the test point wire. The complete arrangement is illustrated in full in Fig. 5 (*d*).

CLUB NEWS

Details for insertion in this section should reach us not later than 7th of the month of publication. Insertions are subject to space being available.

CLIFTON AMATEUR RADIO SOCIETY

Meetings are held every Friday at 7.30 p.m. at the clubrooms at 225 New Cross Road, London, S.E.14. The club station, G3GHN, operates on 160 metres on alternate Fridays during constructional evenings. June diary: 1st, Quiz; 8th and 22nd, Constructional evening and Ragchew; 15th, Junk Sale; 17th, 2nd DF Contest. Details of membership can be obtained from the Hon. Sec., C. H. Bullivant, G3DIC, 25 St. Fillans Road, Catford, S.E.6.

PLYMOUTH RADIO CLUB

A club room has been found at the Virginia House Settlement, Barbican, where fortnightly meetings will be held at 7.30 p.m. on the following Tuesdays: June 12th and 26th, July 10th and 24th. It is hoped to get a club station going for SWL's as well as for transmitting members. Details on application to the Hon. Sec., C. Teale, G3JYB, 3 Berrow Park Road, Peverell, Plymouth.

AMATEUR RADIO CLUB OF NOTTINGHAM

It is hoped that suitable equipment can be acquired in the near future to enable the club station, G3EKW, to be "on the air" regularly. Meetings are held at the clubroom at the Sherwood (Nottingham) Community Centre, Mansfield Road, Nottingham. Hon. Secs., J. Rayner, G3KTQ, and R. I. Sills, G3IQM, c/o Amateur Radio Section, Sherwood Community Association, Woodthorpe House, Sherwood, Nottingham.

THE SLADE RADIO SOCIETY

The club station at the Church House, High Street, Erdington, Birmingham 23, is open every day of the week for the use of members. Instructional and constructional classes are held every Tuesday and Wednesday evening. Full particulars of the society and its activities may be obtained from the Hon. Sec., C. N. Smart, 110 Woolmore Road, Erdington, Birmingham 23.

Trade Review

T. V. RECEIVER FILTERS by LABGEAR (Cambridge) LTD. (Willow Place, Cambridge)

TYPE E5031 (low-pass—for Band I TV reception only). This eliminates interference of frequency higher than Band I (i.e. 70 Mc/s and above). Such interference may originate from radar, f.m., taxis, police, ambulance, fire, airfield or other v.h.f. radio transmitters.

TYPE E5037 (high-pass). For eliminating interference of frequency lower than TV Band I (i.e. 40 Mc/s and below). This filter, which uses the latest printed circuit technique, eliminates i.f. interference very effectively, rejecting completely all incoming signals around 35 Mc/s. It passes, without appreciable loss, both Band I and Band III TV signals. Interference which is suppressed by this model may be classified as follows: broadcast, shipping, diathermy, r.f. heating, amateur, etc. (N.B.—This model supersedes models E5027 and E5028.)

TYPE E5038 (dual band-pass). This printed circuit filter, which is of very advanced and complex design, passes *all* TV signals without serious loss but rejects all interference below 40 Mc/s *and* between 70 and 170 Mc/s. It therefore provides, in one unit, all the advantages of both the E5031 and E5037 filters, and is suitable for both Band I and Band III.

SIMPLE ALL-WAVE RECEIVER

Part 2

by JAMES S. KENT

AT THE CONCLUSION OF PART 1, PUBLISHED last month, reference was made to the fact that a comparable design, but using the modern miniature valves, was to be featured in Part 2. This is presented herewith, and it will be noted that the power supply also uses a miniature rectifier.

The circuit about to be described is very similar to that featured in the last issue, except that the 6SL7 detector stage has been superseded by a 12AT7, and the 6V6GT output stage by a 6BW6—the octal variety, therefore, being replaced in the design by the B9A (Noval) types.

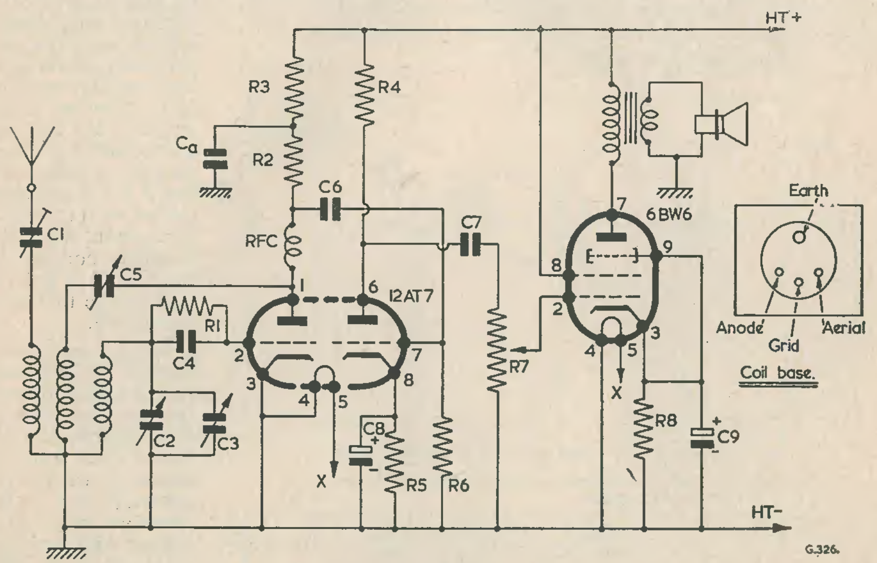


Fig. 1. Circuit of receiver.

Although the receiver described last month was recommended as a design for the beginner, there is no reason why that offered herewith should not also be constructed by the learner. The main constructional difference lies in the fact that with these smaller based valves, there is far less physical room around the actual valve-holder in which to mount the various components. The use of a miniature soldering iron is advised in order to avoid heat damage to the surrounding components.

As in Part 1, the power supply is separate from the receiver, the 5Y3GT being replaced by the Mullard EZ41 miniature B8A rectifier.

The receiver front panel layout is exactly the same as in Part 1—the chassis, of course, being somewhat different to accommodate the smaller type valves.

Circuit

This is shown in Fig. 1, where it will be seen that a 12AT7, a high slope double triode, is used. The first half is functioning as a leaky grid detector, with the output of this being fed into the second half which is operating as the first audio stage. From here the resultant audio signal is taken into the output stage, a 6BW6 beam tetrode.

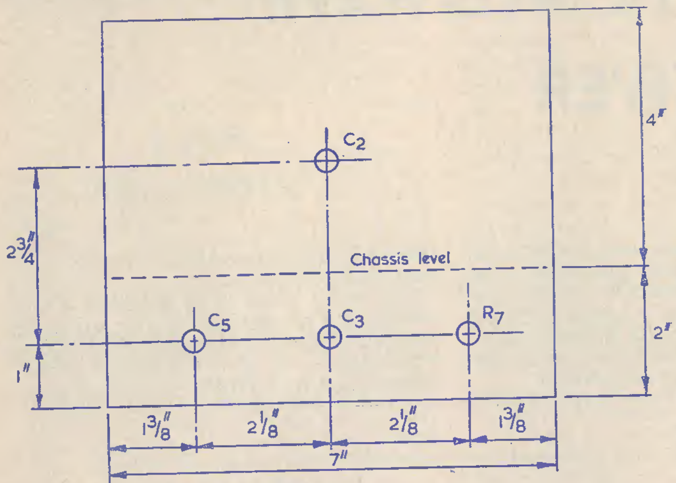
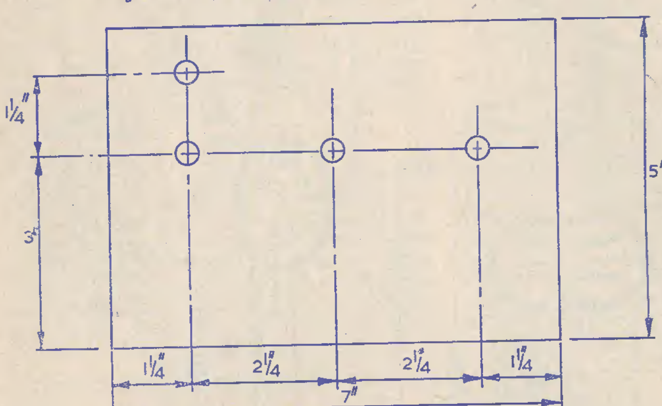
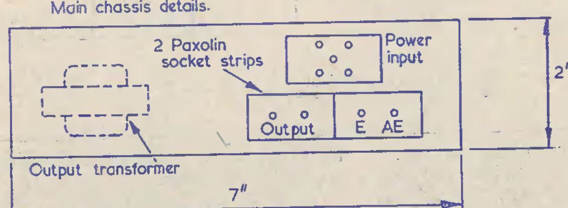


Fig. 2. Front panel details.



Main chassis details.



Chassis backdrop details.
Fig. 3.

The aerial is taken to the primary coil winding via a chassis mounted 25pF variable condenser, this being of the type that is isolated from the chassis itself, and fixed into position by means of two bolts being screwed into two metal shoulders supported at one end by the ceramic body of the component. The coils used are the Eddystone plug-in type, base details of which are given as part of Fig. 1. The variable condensers C_2 and C_3 act as the bandset and bandspread controls respectively, while C_5 is the reaction control (See following paragraph.) R_2 and R_3 are the detector anode resistors which, with the R.F.C., complete the anode h.t. circuit. The output from the detector portion of the 12AT7 is fed via C_6 into the following triode grid.

Before continuing further, mention must be made here of the reaction control C_5. As this is connected direct from the anode, it carries r.f. potential and must, therefore, not be in contact with the chassis at any time. The method of mounting used in the prototype was to insulate the condenser bush and fixing nuts by means of two paxolin washers and a short length of paxolin tubing—the latter being placed over the condenser bush before mounting on the panel. Other methods of achieving the same object are: (*a*) mounting the condenser further back from the panel on a stand-off insulator, or (*b*) cut a larger hole in the panel and fix a small square of paxolin, through the centre of which the condenser may be mounted.

Cathode bias for the second half of the valve is supplied via R_5 and C_8. R_4 is the anode load with C_7 as the coupling condenser into the volume control R_7.

The output stage is conventional, but mention must be made here of the beam forming plates. These are connected to pin 9 of the valve, and it follows, therefore, that tag 9 of the valveholder must be connected to the cathode externally. The output transformer is of the miniature type, the speaker being plugged into the receiver output via a paxolin socket strip mounted on the chassis backdrop.

The numbers shown in Fig. 1 around the various valve connections refer to the appropriate valveholder tags. An alternative valve to the 12AT7 detector is the 12AU7 which may be inserted directly into the valveholder without any alterations to the wiring or components. Using this latter valve type, a low-mu double triode, will result in considerably less gain than that provided by the former type.

drilled in that order. The main components should then be mounted; when wiring of the circuit may proceed.

The bandspread condenser was originally of the same value as that of the reaction control, the rotor and static vanes being removed and then replaced double-spaced, two rotor and three static vanes remaining as the modified condenser.

The chassis backdrop (Fig. 3) contains the separate paxolin socket strips for the speaker output, the power input and the aerial/earth connections. Also to the backdrop must be affixed the output transformer.

Each valveholder should be mounted together with its own earthed tag to which, dealing with V_1 first, should be wired tag numbers 3 and 4 together with the central metal spigot. With V_2, tag number 4 and the central spigot should be so treated. The metal casing of the volume control should also be wired to earth.

Once the receiver has been completed, the front panel, which as supplied is plain aluminium, should be painted, allowed to dry and the dial, etc., affixed. The full vision dial is that supplied with Panel-Signs Set No. 2, of which there are two such dials in every packet. Fixing instructions for this and the bandspread dial are contained on the rear of the envelope. In this instance, as there is little generated heat, there is no need to use varnish in order to mount the transfers on the panel, the gum being sufficient for the purpose.

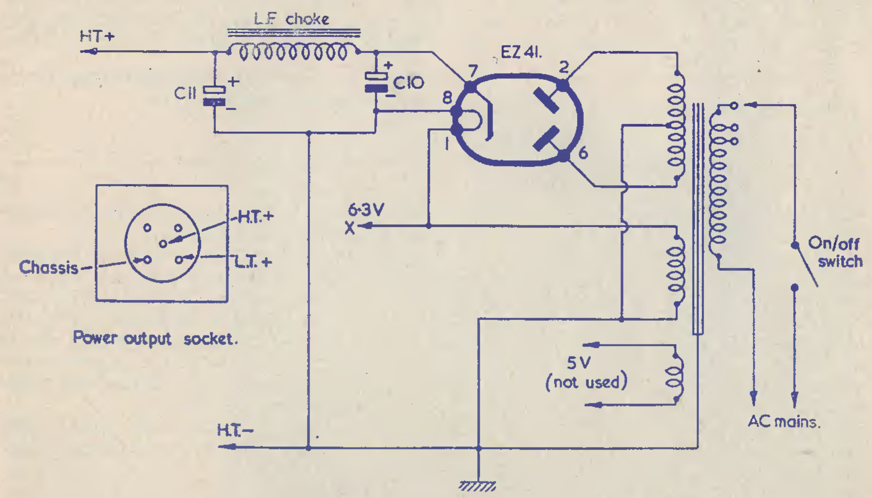


Fig.4. Circuit of power supply.

Constructional Details

Figs. 2 and 3 respectively give the dimensions and details of the front panel, chassis and backdrop.

The front panel should be drilled in the first instance, this then being used as a template for the chassis front drop. The chassis deck, followed by the chassis backdrop, are next

Component List

Valves
12AT7 Bimar
6BW6 Brimar
EZ41 Mullard

Chassis
H. L. Smith & Co. Ltd.

Mains Transformer
Ellison type MT162

LF Choke
10H, 60mA

Output Transformer
Miniature type, H. L. Smith & Co. Ltd.

RF Choke
Teletron Co.

Resistors

R_1	$1M\Omega$ ½ watt
R_2	$100k\Omega$ ½ watt
R_3	$33k\Omega$ ½ watt
R_4	$33k\Omega$ ½ watt
R_5	$1k\Omega$ ½ watt
R_6	$470k\Omega$ ½ watt
R_7	$500k\Omega$ pot
R_8	270Ω ½ watt

Valveholders
McMurdo

Knobs
H. L. Smith & Co. Ltd.

Paxolin Strips, etc.
H. L. Smith & Co. Ltd.

Capacitors

C_1	25pF variable (see text)
C_2	100pF variable Eddystone 586
C_3	25pF variable (see text)
C_4	100pF mica
C_5	75pF variable
C_6	0.02μF T.C.C. type CP33N
C_7	0.01μF T.C.C. type CP45W
C_8	25μF, 25V wkg, Electrolytic
C_9	25μF, 25V wkg, Electrolytic
C_{10}	8μF, 350V wkg, Electrolytic
C_{11}	16μF, 350V wkg, Electrolytic
C_a	0.01μF T.C.C. type CP45W

Coils
Eddystone types 706/LB, 706/Y, 706/R, 706/W and 706/P.
Coil base type 707, Southern Radio & Electrical Supplies, Salisbury

The cursor was made out of a small piece of clear plastic sheet; this being cut and filed into shape, and mounted on the knob by means of three small Parker-Kalon self-threading screws. A scriber was used to mark the "hair line" down the centre of the cursor—this afterwards being filled in with Indian ink. It is recommended that the type of knobs specified for the reaction and volume controls should be obtained. These knobs have a large skirt and, apart from looking attractive, in the case of the reaction control this reduces the possibility of hand capacity effects when adjusting the reaction control.

Power Supply

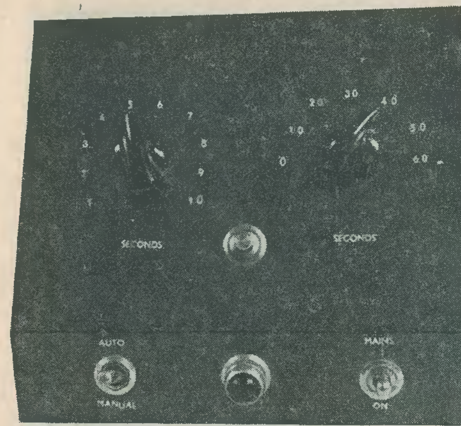
The circuit for this is shown in Fig. 4. The chassis has exactly the same dimensions as that of the receiver chassis. It is not important how the main components are mounted and if the smoothing choke will not fit under an old existing chassis, where one is to be employed, it could just as well be mounted above the chassis deck; it should be at right angles to the mains transformer, of course. An on/off switch has been mounted on one of the chassis sides.

The chassis backdrop is used for the mains input, via a rubber grommet, and the power output to the receiver—for the latter a multi-pin plug and socket is employed. (See inset to Fig. 4.) A similar arrangement for the power supplies exists on the actual receiver backdrop. Alternatively, two old valve bases and holders would suffice.

The power supply unit will supply adequate smoothed h.t. to the receiver.

Alternatives

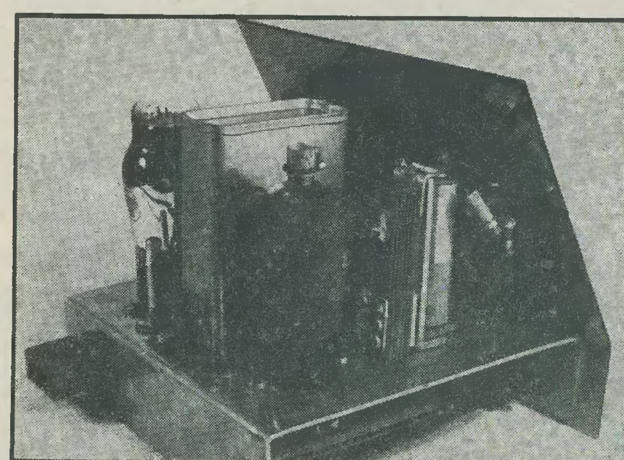
A possible alternative to the physical layout shown herewith, apart from constructing both the receiver and the power unit on the one chassis—a larger one, of course—would be to obtain a larger front panel sufficient in size to accommodate both the receiver and power unit chassis placed end to end. This would be an ideal arrangement for the beginner, for, at a later stage in the hobby, the power unit could be easily detached for use with other equipment.



A Photographic Process Timer

by **J. W. BAGNALL**

THIS INSTRUMENT WAS DEVELOPED FOR USE with a photographic enlarger, its purpose being to switch the enlarger lamp off after a pre-determined length of time. The action is started by depressing a push button which is mounted on the front panel. The basic requirements call for a definite on–off action, a reasonable accuracy in the timing and, above all, trouble-free operation with simplicity in use.

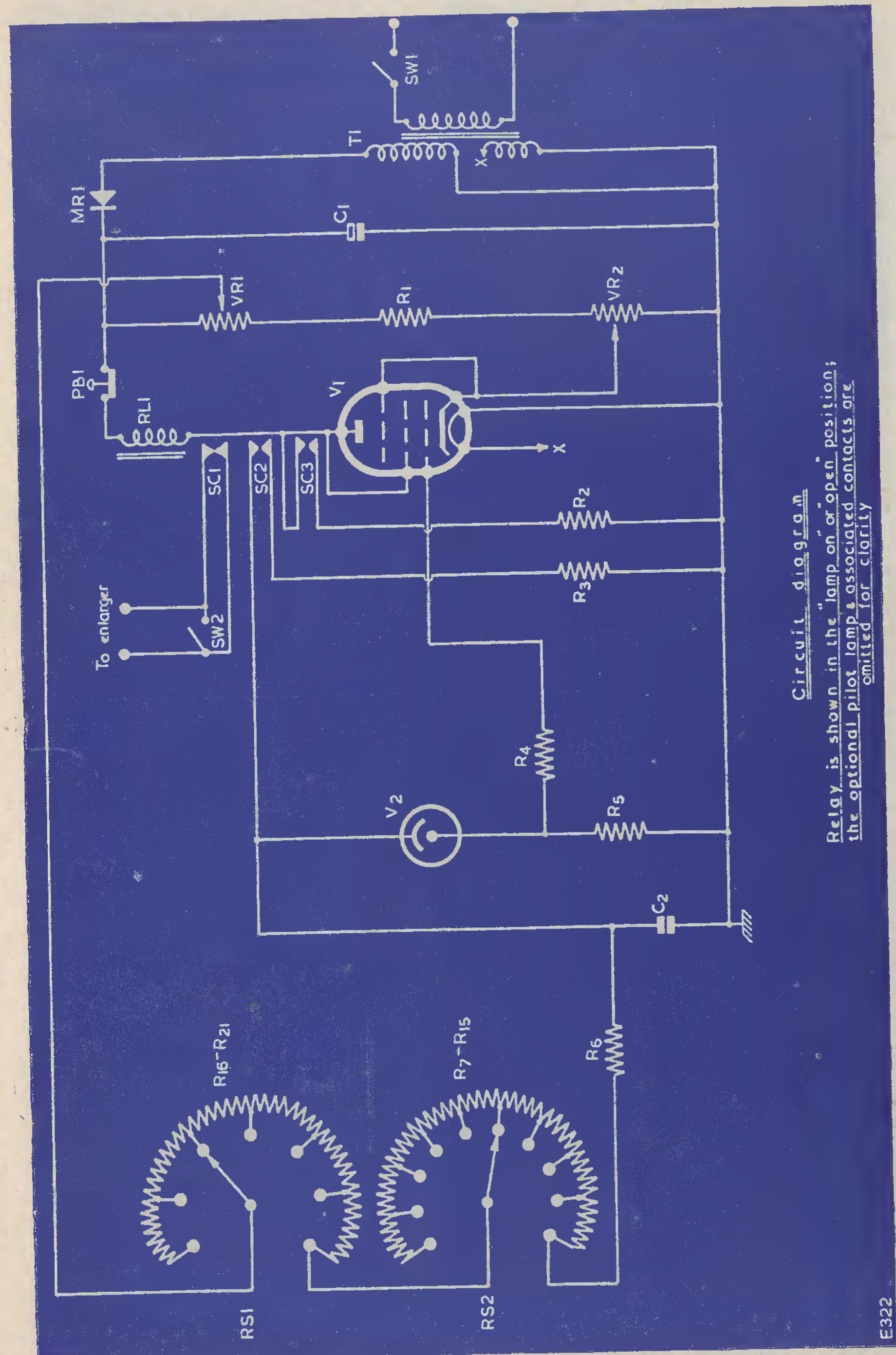


Above-chassis view of the Photographic Timer

The final design fulfils these requirements, and has proved in use to be a most reliable device. The range covered is from one to seventy seconds, in one second intervals. The need for longer periods of time was considered, but to save complication of the circuit, and also with an eye to cost, the instrument was completed in its present form. Should an exposure of, say, 84 seconds be required, the timer could be set to 42 seconds and on the cycle being completed the start button could be depressed again, thus giving the required length of time in two periods.

Circuit Operation

It will be seen from the circuit diagram that the valve V_1 is held at a point near cut-off by virtue of its cathode being returned to a point more positive than its control grid. The relay is held closed by the current flow through the contacts SC_3 and the resistance



Circuit diagram

Relay is shown in the "lamp on" or "open" position; the optional pilot lamp & associated contacts are omitted for clarity

R_2, while another pair of contacts SC_2 short out the condenser C_2 through the resistance R_3. The purpose of the latter is to limit the current flow, as the contacts make when the condenser is fully charged.

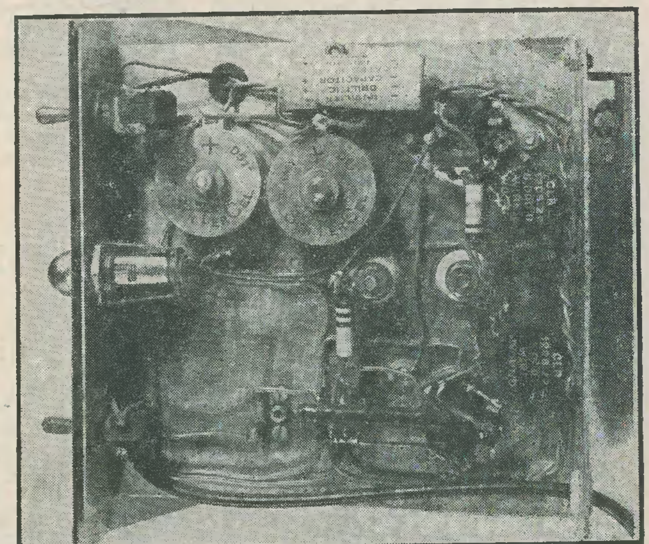
When the push button PB_1 is pressed, the relay opens and remains open as the circuit through the contacts SC_3 is now broken. The contacts SC_1 are made and the enlarger lamp is lit. As the contacts SC_2 are also open, the condenser C_2 commences to charge through the chain of resistors which comprise the switching circuit RS_1 and RS_2. The rate of charge is governed by the amount of resistance in circuit. When the voltage across C_2 reaches the striking voltage of the neon, which in this case is 135, the neon is struck and current flows through the resistor R_5 to h.t.— (chassis). This produces a positive pulse which is applied to the control grid of V_1, the resistor R_4 being in circuit to limit the flow of grid current.

On arrival of the positive pulse, V_1 is "turned on," and the current flowing through the valve closes the relay, which is once again held closed by the current flow through R_2. The contacts SC_2 close and discharge the condenser C_2, while the contacts SC_1 open and switch the enlarger lamp off. The circuit now remains stable until the push button is opened again.

Component List

R_1	33kΩ 5W
R_2	47kΩ 5W
R_3	1kΩ $\frac{1}{2}$W
R_4	10kΩ $\frac{1}{2}$W
R_5	100kΩ $\frac{1}{2}$W
R_{6-15}	330kΩ $\frac{1}{4}$W ± 2%
R_{16-21}	3.3MΩ $\frac{1}{4}$W ± 2%
VR_1	5kΩ 1W preset
VR_2	5kΩ 1W preset
C_1	4μF 350V electrolytic
C_2	4μF 600V paper (see text)
V_1	SP61
V_2	VR105
RS_1	7-way single pole rotary switch
RS_2	10-way single pole rotary switch
SW_1, SW_2	toggle switches
PB_1	Bulgin S359 biased push button switch, normally "on"
RL_1	Relay, coil 4.2kΩ, contacts 2 break, 2 make
MR_1	250V 30mA metal rectifier
T_1	Half-wave transformer, secondaries 230V at 30mA, 6.3V at 1A

then switched on, and with the relay open the control VR_2 is adjusted until the current flow through V_1 is 1mA. As the relay closes the current should be in the region of 10mA,



Underneath layout of timer

Setting Up the Timer

When the wiring has been completed and checked, a meter reading 10mA FSD should be placed in series with the relay. The unit is but the exact current flow in this position is not important.

VR_1 is a calibration control which enables the timer to be set to correspond with the time marked on the front panel. Once set, it should not need further adjustment. If the unit is checked with a stop-watch on one of the longest times, providing the resistors are within their tolerance value the shorter times must be correct. The use of a reliable component for C_2 is, of course, essential. The writer has used an American 600V oil-filled condenser which was obtained very cheaply on the surplus market. An electrolytic type condenser in this position is out of the question.

The switch marked "Auto-Manual" is provided to enable the enlarger to be switched on for adjustments without the timing circuit being in action. One point to note is that the push button is of the press-to-break-circuit type. Also it should be noted that the power supply is obtained from a double wound transformer; the use of an a.c./d.c. type of supply is extremely dangerous where the operator has not only damp hands but also well-earthed objects such as water taps within easy reach.

Should any difficulty be experienced in obtaining the specified relay, any high resistance type relay around the quoted figure should prove satisfactory. In the original unit the pilot lamp was wired on to an additional pair of contacts so that it was alight only when the enlarger was on, but this is an optional refinement which is left to the discretion of the constructor.

There is nothing tricky about construction, and variation in the placing of components need cause no concern.

Can Anyone Help?

Requests for information are inserted in this section free of charge; subject to space being available

C. Jackson, 54 New Street, Mold, Flintshire, requires the circuit and any useful information on the Murphy D.C. set D24C, and is willing to pay for same.

R. T. Trull, 1 Approach Road, Broadstairs, Kent, wishes to obtain the circuit and/or information on the Marconi B28 or CR100 receiver.

H. L. Rowlett, 92 The Vista, Eltham, London, S.E.9, requires on loan or for purchase the circuit or any other data on the Ferranti TV set model T1246.

S. Matthews, 140 Ramshead Drive, Seacroft, Leeds 14, wants to hire or borrow the service sheet or any data on the Zenith radio model 7G.605.

F. Eddison, 119 Turf Hill Road, Rochdale, Lancs, would like to buy or borrow the September and December 1954 issues of *The Radio Constructor*.

F. J. O'Dell, 13 Proscelly Place, Edgware, Middx, wishes to purchase theoretical circuit with values, intermediate frequency, etc., of the PCR2 Communications receiver.

B. H. Tooke, 26 Lyndhurst Avenue, Norbury, London, S.W.16, wonders if anyone can oblige with the circuit of the Ferguson model 992T, serial No. 48968.

G. Daniels, 27 Gloucester Avenue, Sidcup, Kent, needs details and circuit of power unit and adaptor plug (mains/battery switching) for a Romac portable battery/mains radio, or would be willing to purchase plug from anyone who has one.

W. S. Metcalfe, 22 Essex Park, London, N.3, requires information on the 62A Unit, with particular reference to conversion to a 'scope.

G. Jackson, 61 Nottingham Road, Ilkeston, Derbyshire, wishes to borrow the handbook and circuit of the R107 in order to fit an "S" meter, or would be glad of details for doing this.

L/FX893877 T. M. Kneale, R. Mess, H.M.S. *Ariel*, Winchester, Hants, and 2601923 Sgt. Sedman, R.T., W.O.'s and Sgt.'s Mess, 2 Wireless Regt., Royal Signals, B.F.P.O.53, require the circuit and/or technical data on the MCR1 receiver, on loan or for purchase.

S. Kendall, 25 Hillside Road, Saltash, Cornwall, has purchased an ex-Admiralty B34 receiver (made by Eddystone) less coil packs, and would like to purchase the latter with circuit information.

H. Lawson, BM/NEASO, London, W.C.1, needs data on the Signal Corps U.S. Army Radio Receiver BC–603–D (20–28 Mc/s f.m.), particularly gen. on conversion for use on Band II and on the i.f.'s.

W. A. W. Lankshear, "Felbrigge," 36 Down's Side, Belmont, Surrey, wonders if any reader can supply details of circuit, valve line-up, Jones plug connections, etc., for the type 78 receiver.

R. W. Sharp, 18 Sangley Road, South Norwood, London, S.E.25, would like to purchase the circuit and data on the transmitter type T.1154.N.

L. A. Thomas, 21 Coley Hill, Reading, Berks, wishes to buy or borrow the service manual for the Philips 1800A projection T.V.

R.E.A.2 G. Whiting, C.P.O.'s Mess, R.N.A.S., Abbotsinch, Paisley, Yorks, wishes to buy or borrow any information on the American Chevrolet model 985794 car radio; alternatively, can anyone advise him from where he might obtain data.

Improving Record Reproduction

by **O. J. RUSSELL, B.Sc. (Hons.) G3BHJ**

Many enthusiasts will be considering rejuvenating their record-playing equipment in readiness for the winter evenings. Many indeed will be making the changeover to LP records with their thrilling high fidelity, and purchasing pick-ups to extract the Hi–Fi from the recordings in its entirety. As has been previously explained, in other articles, this is not enough to ensure faithful and pleasing reproduction. Due to the recording processes, it is necessary to record with attenuated base, and almost invariably with deliberately boosted treble; these stratagems being employed in order to crowd the grooves closely for long playing time, and also to give the optimum reduction of surface noise. In order to reproduce the music with correct treble and bass balance, suitable equalising circuits, as have been given in this journal, must be employed to give satisfactory reproduction. Commercially, of course, this correction is usually dispensed with except in high priced specialist "high fidelity" equipment. The home enthusiast can obtain this correction by the relatively simple circuits previously given.

However, there is an important point to notice. Almost all recording companies are changing over, and most have already done so, to the "new" N.A.R.T.B. recording characteristic for LP records, and also for 78 recordings. The two chief discrepancies to be noted are that presumably the H.M.V. and the Decca FFRR characteristics for 78 r.p.m. records will remain unaltered. However, *all* LP recordings may be reproduced satisfactorily with the new characteristic, so that the circuit previously given for crystal pick-up correction may be used. However, for those wishing to add an inter-valve correction network to deal with the new characteristic, Figs. 1 and 2 give details. Figure 1 is the circuit to use when feeding the network from the anode of a triode pre-amplifier. Fig. 2 is the circuit to use when feeding the circuit from the anode of a pentode pre-amp.

Talking of pre-amps, it might be as well to mention a useful low noise high gain pre-amplifier tube, specifically designed for optimum performance as a low signal level amplifier. This is the EF86, which, if correctly used, gives an almost perfect performance as a low noise input pre-amplifier for high fidelity work. It is especially valuable for use with high fidelity pick-ups of the ribbon and moving coil type

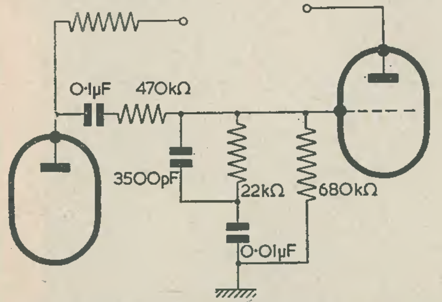


Fig.1. "Universal" correction circuit to couple a triode pre-amplifier to a grid circuit. G.306.

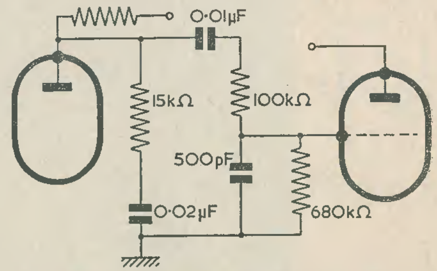


Fig.2 "Universal" equalising circuit for coupling a pentode pre-amplifier to the following grid input. G.307

where signals are at a low level, and it is imperative to keep hum and noise to a very low level. This valve is also ideal for use with microphones of the high fidelity class giving only small voltage outputs.

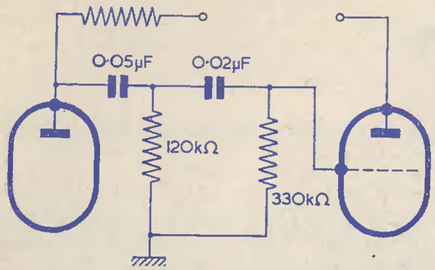


Fig.3. Two stage rumble filter eliminates low pitched turntable noise without noticeably reducing the bass register.

One aspect of the present popularity of crystal pick-ups of the high fidelity type, is that in some cases rumble has become a problem. Rumble is an annoying effect, consisting of a low-pitched noise usually grinding away at record revolution speed. This is only evident when high fidelity equipment capable of a good bass response is used, as the noise is actually an amplification of very low frequency irregularities in the turntable rotation. A good quality turntable, of course, contributes very little rumble, but in many low-priced three-speed playing desks rumble is a problem the moment bass correction is employed, and one uses a decent amplifier with a good speaker system capable of good bass reproduction. Naturally, when these desks are used without equalisation, played into the usual domestic radio with its inadequate baffle area and its speaker having a sharp bass cut-off, rumble is not noticed. Neither, of course, is any high fidelity! Even with the use of the usual tone control circuit, rumble can only be attenuated by wiping out also the rich juicy full bass response.

It will be noted that a bass correction circuit may give some 20 db or more of bass lift in the lowest register, so that while the bass corrector merely lifts the recorded bass back to correct amplitude, the rumble level is boosted by 20 db. Also, as rumble is of very low frequency, many bass boost circuits may actually boost it even more. Further, the crystal pick-up is inherently capable of reproducing very low frequencies, although some types, such as the Acos, are made to

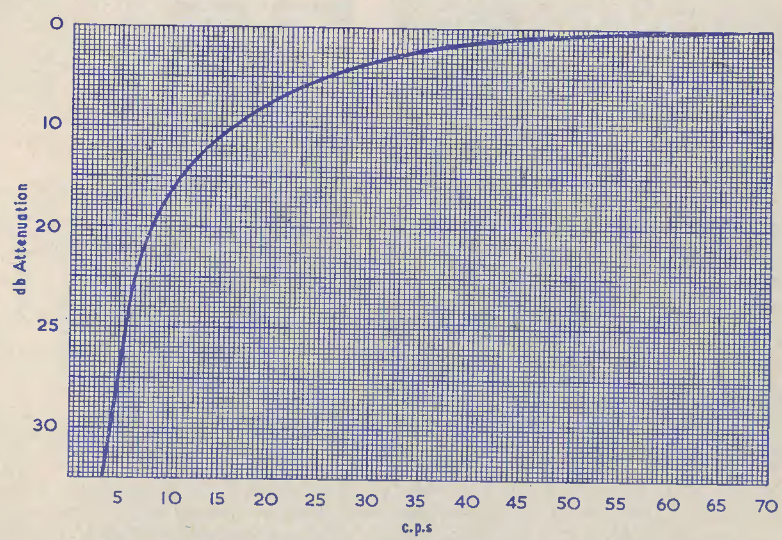


FIG.4. APPROXIMATE ATTENUATION CURVE OF THE RUMBLE FILTER SHOWN IN FIG.3

The extremely low pitched rumble frequencies are removed, with practically no loss of even the lowest record bass frequencies which extend to 30 cycles approximately

G 318A

attenuate rumble frequencies without attenuating the musical bass register. To attenuate rumble, and thus allow full bass boost to be used without annoying noises, a simple RC filter can be used. A two-stage filter, arranged to attenuate frequencies below about 30 cycles, will not noticeably affect the musical register, but will reduce rumble to vanishing point. Some rumble filtering is essential when high fidelity is attempted (Williamson used an ingenious feedback rumble attenuator) otherwise ridiculous things such as the speaker coil moving in and out at turntable rotation frequency may occur. Fig. 3 shows a simple rumble filter for interstage coupling, while Fig. 4 shows the approximate attenuation characteristic given. Like all tone correction networks (with the exception of feedback types specifically designed as such), the network must be included in the pre-amplifier, and not as a coupling in the main amplifier where it is within the feedback loop. If included in a feedback loop, the feedback merely nullifies the attenuation, and instability may be introduced.

Finally, that question of needle scratch upon old favourite 78 r.p.m. records. Most recording if the scratch is attenuated appreciably. Here again a steep cutting filter slicing away all frequencies above a given level is needed. This enables as much top as possible to be preserved, while still cutting hiss effectively. A final clean-up can be effected by a moderate application of the usual top tone control. Depending on the age of the record, and its condition, a choice of top cut frequencies is desirable, together with a "slope" control giving a control of the steepness of the cutting. Here again, an RC filter of three stages offers a means of effecting this. The RC filter does not need a crucial selection of close tolerance components, and can be constructed cheaply. To give adequate steepness three sections are used, with a slope control. A four-position switch gives a choice of three cut-off frequencies, or straight through action. Thus modern records may be reproduced with no top attenuation, and old records may be reproduced with optimum cut to compromise between loss of top and reduction of hiss for comfortable listening. Resistors may be ¼ watt or even ⅛ watt rating, so that a very compact unit is possible if a suitable switch is available.

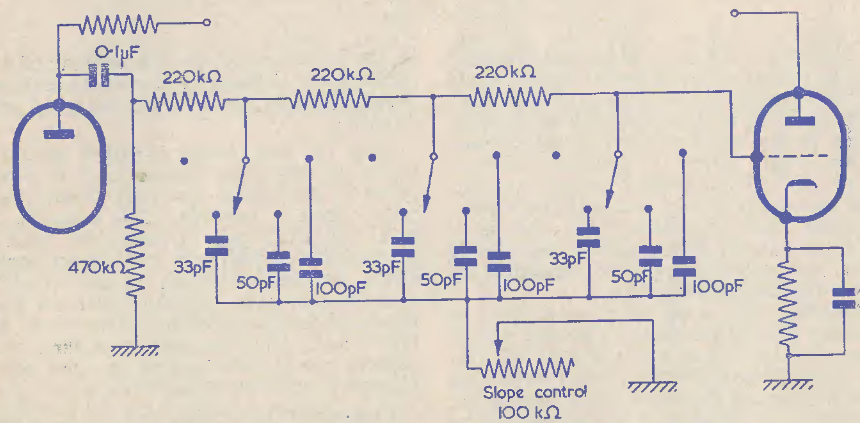


Fig.5. A steep cutting hiss filter for attenuating surface noise on old recordings without undue loss of treble.

of us have many 78 r.p.m. records, now completely unobtainable, and these have often developed severe surface noise over the years. A good cleaning with the advertised record cleaners often works wonders, but on most 78 pre-war recordings a strong hiss is inevitable when reproduced with anything approaching high fidelity in the high frequency region. The usual top tone control removes much of the treble from the

The home constructor should have no difficulty in applying these simple measures to home-built equipment in order to improve record reproduction. To recapitulate, equalisation circuits, as previously given, are essential to "equalise" the deliberately built-in 40 db unbalance of bass to treble necessitated by modern recording procedures. Unless "equalising" is employed, a most unbalanced result is obtained, with accentuated treble and almost non-existent bass. Naturally the benefit of equalising is most noticeable when adequate amplifiers and speaker systems are used. While mandatory upon the specialist hi–fi equipments sold, it is only in the most expensive commercial radiograms that any equalising is used. Naturally this omission of bass equalising helps to mask rumble, and the home constructor then needs to add a suitable rumble filter such as the one described if he restores the bass level on his own equipment. However, rumble filters and sharp-cutting scratch suppressors are *not* fitted to commercial radiograms except in the super-luxury high-priced class. The lesson is obvious, for it is clear that the home constructor can provide a good measure of high fidelity reproduction at negligible cost. The value of "do-it-yourself" is also concretely expressed in monetary form, as specialist hi–fi equipment can be very expensive. Without attaining the utmost peaks of hi–fi, the constructor can achieve very fine reproduction by the exercise of ingenuity applied to a few components. It is hoped to further develop some "low-cost high fidelity" ideas in this journal in due course.

Hints on

Hum Reduction

By J.S.K.

Often the hum level in a high gain amplifier can be reduced if the potential of the heaters is made positive to the cathodes of the valves. This can often be done by taking the earthing point of the heater winding to the cathode of the output valve. An alternative method is to join a 1MΩ resistor between the h.t. line and earthing point and a 10kΩ between earthing point and earth. The effect is to stop any emission between heater and cathode that may exist through the insulation by removing the conditions for it.

Another source of hum when using a pick-up is screened cable. The best type is that with two wires and a screen; the two wires should be connected to the two pick-up connections and the screen to the metal work. If one side of the pick-up is "earthed" to the metalwork of the player the earthing should be removed. The reason for the reduction of hum here is that when the two leads and separate screen are used the hum is fed equally to chassis and to the amplifier valve and thus cancels out. If, however, the screen is joined to the "earthy" conductor on the pick-up unit, then the hum in one lead only is cancelled out, allowing the hum in the other lead to be amplified. This is an essential point where bass compensation is used.

Twisting heater wires is also an advantage, especially if they are closely twisted. The running of the heater wires in screened wire is also an advantage, but the earthing of the centre point is better as it ensures that the hum fields from the two wires are equal and opposite.

Since the grid circuits of valves are normally of very high resistance, it is often better to use a fairly low gain double stage rather than a pentode. For example, a 6J7G will give a gain of about 100, but has to be followed with grid resistors of about 1MΩ. On the other hand, the 6SN7GT will give the sam gain, and the maximum grid resistance for the following valve would be only 70kΩ. However, larger coupling condensers would be required for the same frequency response in the latter case.

Excessively high value grid resistors can cause quite an amount of trouble. If these are higher than the manufacturer's maximum value they can cause the anode current to rise, thus causing the total current through the smoothing circuit to increase and thus cause saturation of the choke.

Smoothing chokes should be amply rated thus ensuring that saturation will not be reached because of a small increase of current caused by condenser leakage or bias trouble. Badly stored or outdated condensers often have a high leakage factor and a bad phase angle, which will also reduce the efficiency of the smoothing circuit.

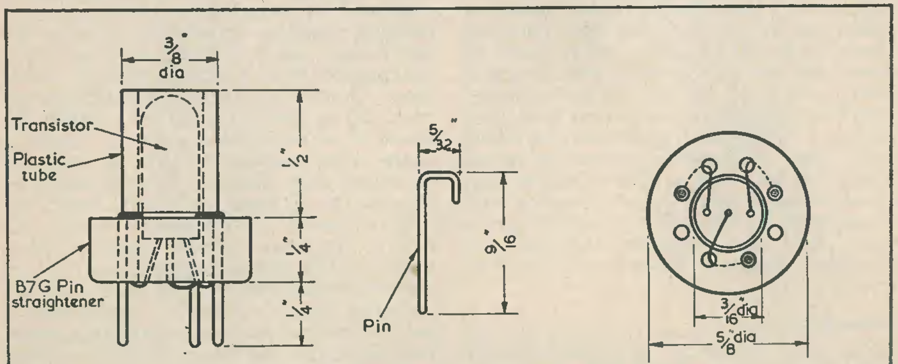
A B7G BASE FOR TRANSISTORS

by C. J. STONE

NOW THAT TRANSISTORS HAVE BECOME readily available for the home constructor, no doubt many experimenters have come up against the same trouble as the writer. This was that only one or two transistors were available for the rather obvious reasons of economy.

Therefore it was necessary that these should serve in a number of applications and experiments, but due to the fact that these transistors had wire-ends and are easily damaged both by heat in soldering and fracture due to wire bending, it will be seen that they do not lend themselves to constant re-connection in different circuits, so that damage to the all-too-valuable transistor may result.

The writer, therefore, considered the fitting of a simple base of small dimensions to the transistor, and has found what appears to be an easy solution to the problem. This is passed on in the hope that it may be of use to those experimenters in a similar position.



A B7G Base for transistors

E321

To-day many B7G valves are fitted, when bought, with a small moulded plastic pin straightener, so that it should not be difficult to obtain these. No doubt a visit to a local radio dealer would suffice in obtaining one for a few coppers. A small hole of approximately $\frac{3}{16}$in diameter is drilled in the centre of this moulding; this will, however, depend upon the size of the transistor, which should be arranged to fit tightly into the hole with the wire ends protruding through.

The three pins for collector, emitter and base are next inserted into the moulding. These can conveniently be made from the common type of wire paper clip. The pin is cut to size, pushed through the hole and bent over so that it can be secured in one of the other spare holes. After noting carefully the actual transistor connections, the wires which protrude from the centre hole in the base are bent back through the holes and soldered to the top of the pins. As emphasized by the manufacturers, great care must be taken in soldering so that minimum heat reaches the transistor to avoid damage. This should not be difficult if the part of the pin to be soldered is clean.

Finally a small piece of plastic tube, which is large enough to push over the top of the transistor and large enough in outsize diameter to partly cover the soldered top of the pins is placed in position. This provides additional protection for the transistor and prevents the pins moving upwards. The whole assembly is given a coat of cellulose cement and left to harden.

The writer has found that a transistor mounted in this manner can quite happily be plugged in and out of various circuits without the least risk of damage, and still retains its small physical size even when mounted.

EFFECTS WITH A TAPE RECORDER

PART 1. by **F. C. JUDD**

General effects and sounds. Echo effects. Splicing and editing. Multiple recording.

WITH THE AID OF SMALL MODIFICATIONS and an additional recording head, numerous effects and simple multiple recording may be achieved. The increased versatility will, of course, depend on the design and construction of the equipment available, and the number of modifications that can be made. In view of this, the writer's own recording equipment will be described, with emphasis on how and where special facilities might be incorporated in other recorders. Most owners of a tape recorder will no doubt have discovered that numerous effects can be obtained even with relatively simple decks and amplifiers, and it should be mentioned here that the writer's equipment is based on a Lane Mk. 2 deck to which has been fitted an additional recording head, tape guides, a three-speed pulley on the drive motor, and a separate free-running spool-holder. A two-stage auxiliary amplifier and a multi-vibrator controlled amplifier are used in conjunction with multiple recording facilities. The block diagram indicates the switching involved between the various units (Fig. 1).

Sound Effects

Producing "noises off" is a field for much experiment and a good deal of fun, but keep the gain down on playback—particularly whilst experimenting. Early attempts at "noises off" produced remarkably accurate sounds of gun-fire, swooping planes, and bombs falling and exploding. In fact, a most realistic "battle" was produced with no more than a microphone and a little adjustment to the recorder. Other sounds such as rocket ships taking off and other "Journey into Space" noises provide much amusement, especially for the younger members of the family. All these sounds were made with the tape running at high speed. To get the effects the tape is run at re-wind speed with the erase bias preferably off and controlled bias on the recording head. Rocket ships and similar noises are obtained by running the tape at nearly full re-wind speed to begin with, and then gradually slowing it down to a stop—at the same time blowing into the microphone with the gain control at fairly high level. Some distortion may be necessary in order to get the exact sound, and this can be produced by reducing the recording bias. Slowing the tape is done by touching the *un-winding spool.* Result of suddenly braking the wind-up spool is yards of spilled tape. Gunfire and sounds of explosions are produced by similar tactics; for example, the sound of an explosion is made by making a sharp noise, such as hitting a tin box, and recording that sound at re-wind speed as above. On playback, at normal speed, the original sound is "stretched," because its natural frequency is very much reduced. Sharp sounds such as machine gun fire are made the same way except that a slower recording speed is required; approximately half the re-wind speed is a good starting point. Remember that the tape must be in contact with the recording head as at normal recording speed and it may be necessary to hold the pressure pads "on" as they are generally released on most decks. Varying the re-wind speeds, by allowing them to slow down and then speed up again, plus various kinds of noises made at the microphone, can result in a great variety of most unearthly sounds which in turn may be used in conjunction with multiple recording methods and the production of home-made programmes. Many other effects will suggest themselves in the course of experiment. A very simple double recording system can be made to work with the aid of the erase head which must be separate, and a two-stage auxiliary amplifier (see circuit Fig. 2). It may be desirable to make a recording and then dub additional sounds on to it; for example, speech on music. The erase head is used as a monitor and connected to a small amplifier such as in Fig. 2. Voltage gain only is required and listening can be done with headphones. The tape is run through and the additional recording made with *reduced bias* to the recording head. Naturally no bias is used on the erase head. The required reduction of recording bias must be determined by experiment; it should not be low enough to cause distortion on the new recording nor yet high enough to erase, or partly erase the existing recording. It is helpful to use a little higher bias than usual for the first recording. Artificial echos on speech and music may be made by using the

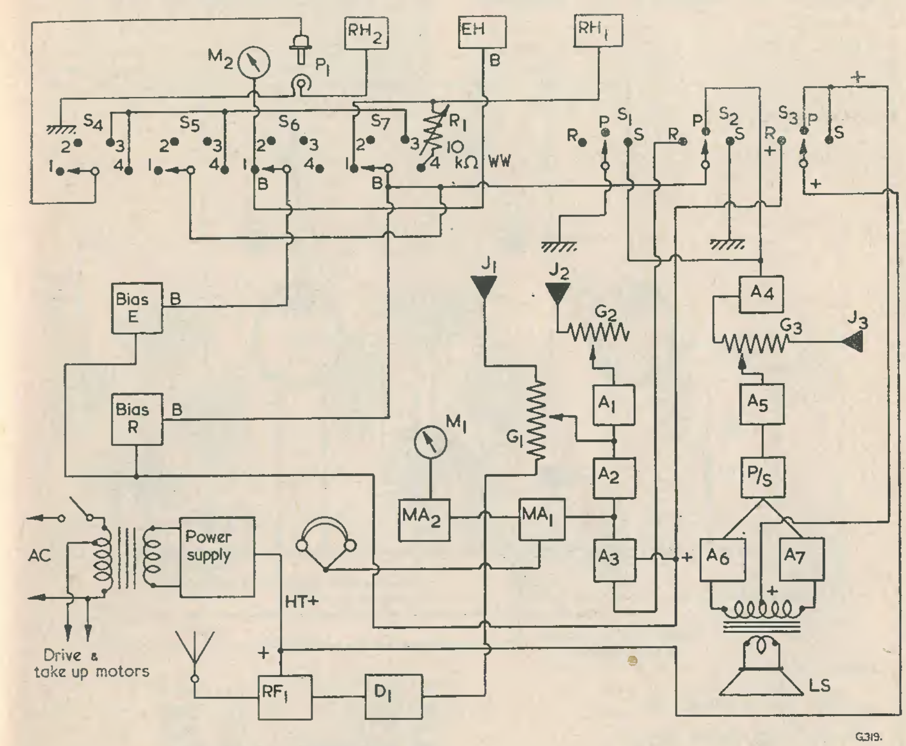


Fig.1. Block diagram. (see text)

RH2—Recording head 2.
EH—Erase head.
RH1—Main recording head
P1—Link for auxiliary amplifier
M1—Erase bias level meter
M2—Recording and bias level meter
E & R—Bias units
R1—Bias limiting resistor
J1, J2, J3—Input jacks
S4, 5, 6, 7—Head switching
S1, 2, 3—Record/playback switching
G1, 2, 3—Gain controls
A1, 2, 3—Recording amplifier
MA1 and MA2—Monitor circuit amplifiers
A4, A5—Playback pre-amplifier
P/S—Phase splitter
A6, 7—Push-pull output stage

SWITCH POSITIONS

S1, 2, 3

R—record
P—playback
S—spare

S4, 5, 6, 7

1. Normal recording
2. Double recording monitoring
3. Head 2 record. Erase off
4. Head 1 and 2 recording. Erase off

erase head for recording. The incoming signal is fed to both heads simultaneously, but preferably through separate amplifiers so that the strength of the echo may be controlled. The time delay of the echo is determined by the distance between heads and the recording speed. It must be appreciated, however, that the quality from a recording made by an erase head will not be particularly good.

So far a few tricks with a simple recorder, plus, perhaps, an auxiliary amplifier, have been described. The use of separate playback and recording amplifiers, an additional modify an existing recorder.

The writer has used a Lane Mk. 2 deck as the basis for a complete equipment and was prepared to carry out the following modifications to the deck itself:

1. An additional recording head of good quality.
2. Additional tape guides.
3. A new tape release mechanism (not entirely essential).
4. A free-running spool-holder.
5. A three-way drive pulley for speeds of 6, $7\frac{1}{2}$ and 12in per second.

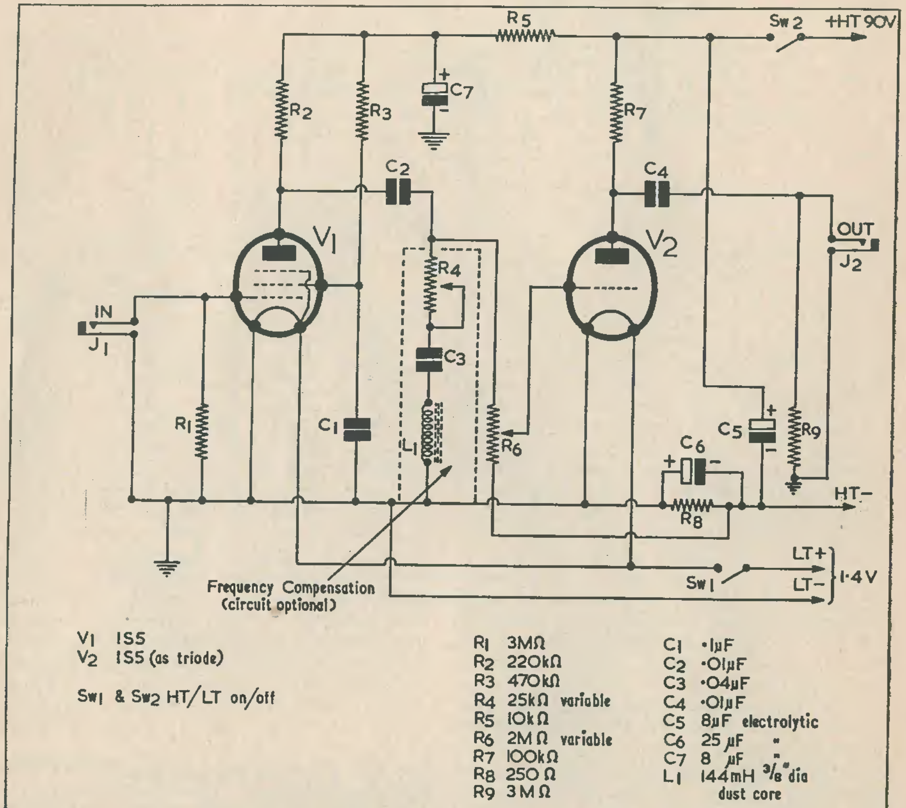


FIG. 2. 2-STAGE AUXILLIARY BATTERY OPERATED AMPLIFIER

recording head and three or four speeds for recording, re-recording and playback make for a very versatile set-up. If the reader has in mind a system capable of catering for some of the effects described later, then it is better to construct the equipment around a suitable deck, or be prepared to rather drastically

Block diagrams of the amplifier circuits along with details of the switching employed for the record and erase heads are shown in Fig. 1. In addition to the complete equipment, an auxiliary amplifier was constructed to the circuit of Fig. 2. The layout of the deck is shown in Fig. 3.

An explanation of the unusual speeds might be of interest, but unless the reader has the same requirements as the writer, standard speeds might well be used; 7.5in per second is the standard recording and play-back speed. Those of 6 and 12in per second are used for multiple recording. With the aid of three electric guitars, the writer has successfully produced recordings in which all three are used in the same way as those of the famous American guitarist Les Paul. As a point of interest, Les Paul is a radio amateur who eventually used his very good knowledge of electronics to produce the multiple guitar recordings which, as most people know, are made with equipment built by himself. He is, of course, a professional musician and one of the world's best guitarists. The writer makes no claim on this score. To continue, the speeds of 6 and 12in per second are used, so that a recording made at, say, 12in per second, will be in pitch with one made at 7.5 or 6in per second and vice versa. For example, an accompaniment recorded at 6in per second in the key of C major, will be exactly in pitch with the instrument used for the first recording, when played back at 7.5in per second. Because of the higher speed,

Key at 6-in per sec.	*Key at 7.5-in per sec.*	*Key at 12-in per sec.*
C	F	B flat
D flat	F sharp	B maj.
E flat	A flat	D flat
F	B flat	E flat
G	C	F
A flat	D flat	F sharp
B flat	E flat	A flat
C	F	B flat
F sharp	B maj.	E maj.
B maj.	E maj.	A maj.

however, the accompaniment will be in the key of F major. The usefulness of this may not be clear to anyone without knowledge of music, but readers who play musical instruments themselves will at once appreciate the potentiality of a recorder with these facilities. To the non-musical reader it means this: a background chording or accompaniment may be recorded at, say 6in per second; if this is played back at 7.5in per second it will naturally be faster than the original, and because of the higher playback speed, the frequency of all the notes will be raised. Therefore if the

(*continued on page 727*

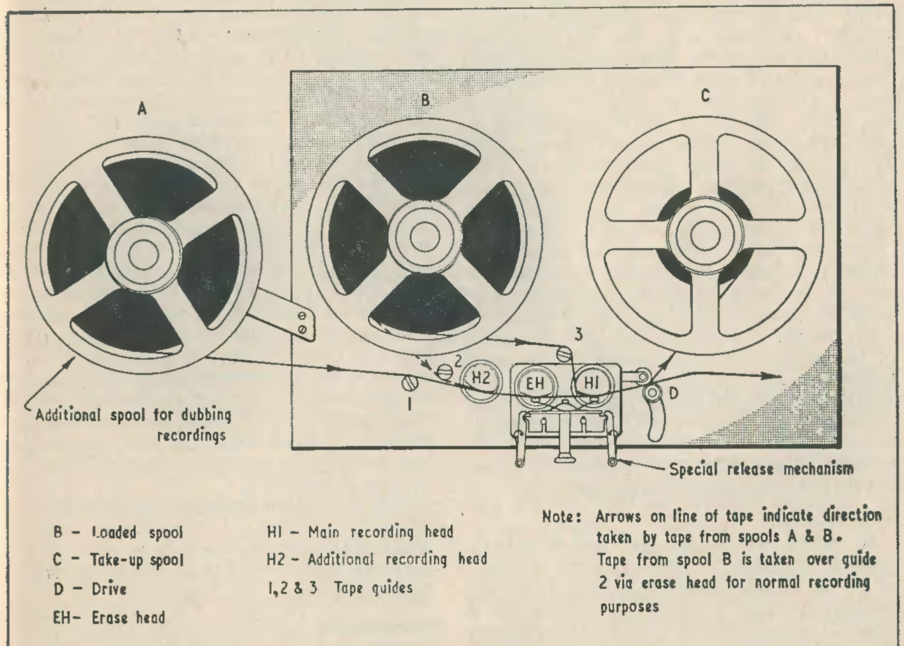


FIG. 3. DECK LAYOUT

Technical Forum

Gram-Modulated Oscillator

The little unit which we are describing this month will appeal to many experimenters, partly because of its novelty value and partly because it may meet a definite requirement. The latter arises where a gramophone pick-up has to be fed into a radio receiver which is not equipped with P.U. terminals, or where the gain of the audio side of the set is inadequate to provide good gramophone reproduction. There must be many instances where these difficulties have been encountered, and where a simple unit such as the one about to be described would come in useful. It consists of a modulated oscillator, the output of which is lightly coupled into the aerial circuit of the receiver. When modulation is supplied from a gramophone pick-up or microphone, a signal is fed into the input of the receiver which is tuned to the same frequency as that of the oscillator. The signal therefore passes through the receiver in the normal manner and the modulation is reproduced at the speaker, the power and quality being similar to that obtained when the set is tuned to a broadcast station.

The Circuit

A single valve of the triode-heptode class is employed. The Mullard ECH81, or one of its equivalents, is most satisfactory; and in this respect it is worth noting that a valve in which there is a connection between the two sections is not suitable. The heptode section of the valve is arranged as an electron coupled oscillator, the screen grids being used as the oscillator anode and the first grid as the coupling grid. To obtain the best possible oscillator waveform, and keep the valve on the optimum part of its characteristic, grid current biasing has been adopted, and the grid circuit is that which is tuned. The coil is a standard long wave component of the type normally found in the aerial circuits of simple superhets; for example, the Wearite type PA1 is ideal for the job. It is strongly recommended that a L.W. coil is used and that the tuning is set to the low frequency end of the band, i.e., the end at which the vanes of the tuning capacitor are fully meshed. By so doing, the probability of the oscillator causing interference with a neighbouring radio receiver will be minimised. The oscillator anode is parallel fed at a voltage of around 75V. The fifth grid of the valve serves to isolate the anode circuit from the oscillator and assists in preserving the frequency stability.

The triode section of the valve serves as the audio amplifier. This section is required because the signal voltage obtained from a pick-up or microphone is not sufficient to modulate the oscillator section. The triode provides a gain of about 18 times and thus, with an input of 0.5 volt, a signal of 9V is available at the third grid of the heptode for modulation. This is not sufficient to permit overmodulation, and it is unlikely that distortion can occur because of this. The output from the triode is coupled into the third grid of the heptode by the conventional C–R combination. Note that the whole of the cathode bias is used for the modulating electrode, whilst only a proportion of it serves the triode amplifier.

A 0.5 megohm volume control is used to adjust the depth of modulation; and if required the usual filters may be connected in the audio input circuit to correct for recording characteristics.

Construction

The unit is best housed in a small metal box to prevent unwanted radiation. The input is supplied via a miniature jack socket, and the power supplies through a four-way cable from the receiver with which the unit is to be employed. Alternatively, a self-contained power pack may be incorporated in the box to render the oscillator entirely independent of the set; and in this case, the use of a double-wound mains transformer is strongly recommended. It must be mentioned that if the unit is made A.C./D.C., or if it obtains its supplies from a Universal receiver, a wooden or plastic box must be used to house it. In this case the inside of the box should be lined with tinfoil to avoid the radiation already mentioned.

Operation

The unit should be positioned near the receiver, and the supplies connected and switched on. The tuning control on the unit is then set so that the vanes of the capacitor are nearly fully in mesh and the receiver tuned to the top end of the long wave band, around 2,000 metres. When the valves have warmed up, a signal should be fed into the unit from a pick-up and the volume control turned towards maximum; the tuning of the receiver should then be adjusted until the signal is heard. The best results are usually obtained with the gain control on the unit set at a high level and the one on the receiver adjusted for optimum volume level. If the radiation from the unit is insufficient to give a good signal, a short length of wire should be taken from its output socket and twisted around the aerial lead to the receiver.

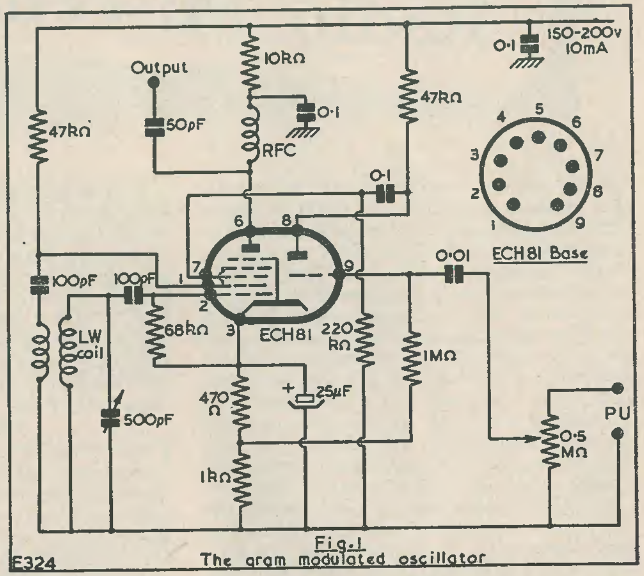


Fig. 1 The gram modulated oscillator

The circuit of the modulated oscillator shown in Fig. 1 is suitable for use with all types of crystal pick-up and all those armature types having high impedance coils, that is, coils of impedance in the region of 1,500 ohms. If a low impedance pick-up is used, a matching transformer will be required, and the same applies to all those of the moving coil type.

Constructors who use a record player which is contained in a cabinet apart from the radio receiver may find it convenient to house the oscillator with the player. It will, however, still be necessary to fully screen the oscillator to avoid an excessively high radiation field.

NEW CERAMIC PICK-UP FOR ALL RECORD PLAYING SPEEDS

A new ceramic pick-up cartridge for high fidelity reproduction of standard and long-playing gramophone records is being manufactured by Technical Ceramics Limited, for Towcester, Northants.

Known as "Sonotone," the cartridge differs from conventional pick-up cartridges in that it is constructed from a high-grade ceramic material which gives vivid sound reproduction over a very wide frequency range. The response curve has been plotted and follows almost exactly the curve specified by leading record manufacturers as ideal for the optimum reproduction of high-fidelity long-playing records. Ceramic cartridges are claimed to be completely impervious to moisture and humidity and unaffected by temperature; they can thus be used in all seasons and climates and still reproduce the exact tones recorded on the disc.

Each jewel tip is accurately polished to ensure an exact fit in the appropriate groove, thereby providing perfect coupling to the record. This improved tracking ability not only reduces record wear to an absolute minimum but also permits the stylus to track even the lowest frequencies at all speeds. The conventional turnover stylus as supplied is normally fitted with sapphire tips. Diamond tips can also be fitted, but it is not envisaged that these will be generally available in the immediate future.

Sonotone pick-up cartridges are made in Great Britain by Technical Ceramics Limited under an agreement with the Sonotone Corporation of New York, U.S.A.

Radio Miscellany

LAST MONTH I PROMISED TO GET EXPERT opinion regarding some of the problems arising from the unsuccessful efforts of a number of readers in using spray-guns. Without giving the matter prolonged thought I should have hardly imagined there were so many things that could go wrong. Possibly the advertisements for small paint spraying-guns (for model or small domestic uses) are somewhat misleading. If one did not know better, the advertisements would imply that the gun merely has to be charged, then pointed at an object and *voila*—it is coated with a beautiful gleaming, lustrous gloss. Of course, we all know that it isn't as simple as that, but even after making allowance for the advertisers' enthusiasm, the impression that first-class results are obtainable with but little trouble can be easily formed. No advertisement stresses the *work* side. The bicycle advertisements do not tell you that pedalling the darn thing along makes you hot and sticky, breathless and leg weary. The sweet young thing in the advert simply sits on and free-wheels everywhere looking just as glamorous as if emerging from a half-day session in a beauty salon. They don't show her with flat, bedraggled hair, puffing and panting uphill against a cold wind and driving drizzle. Just as the reality of cycling requires considerable effort, although much of it may be pleasurable, paint spraying, too, requires more than just the fun of squirting paint out of a gun.

Pitfalls

If by the foregoing paragraph I have gone to the other extreme, and instead of making paint spraying look absurdly easy I have implied that it is both a tricky and tiresome business, let me hasten to correct that impression. My own early attempts at spraying were reasonably successful, as I started with the advantage of having witnessed the work in its various stages in professional spraying shops, and had some experience with spraying (metallising and tropicalising) in the radio industry.

It is unfortunate that, as far as I know, there is no book dealing with the subject of small-scale spraying for amateurs. It has to be more or less a matter of trial and error, or learning by the experience of one's friends—one of the many advantages of a radio club! If you have a background of the principles and, as with soldering, have a natural knack, you begin to get a professional-looking finish after the first two or three tries—provided you dodge the pitfalls.

Points to Watch

Analysing the correspondence, my expert advises me that most of the faults were due to failure to observe the following points.

1. Attempting to spray on bare metal. A primer should always be used. It is usually easier to apply the primer by brush, as any brush marks will be covered by the final coat, and it saves the cleaning of the gun. Few amateurs, too, will have spare paint chambers. No priming is needed when repainting sound work which has been rubbed down lightly.
2. Impatience to get on with the spraying after priming. Allow to stand overnight if possible.
3. Shaking the paint container to get a good mix. This introduces a lot of air bubbles in the paint, which may cause a splutter in the spray jet.
4. Holding the gun at an angle. It should at all times be parallel to the work and never be swung in an arc.
5. Holding the gun at the wrong distance. Too near results in "runs." Too far results in "orange peel" due to the volatile drying out and thus losing the "wetness" which helps in the marrying on to the surface.
6. Mixing "wrong" paints. Not all cellulose paints are suitable for spraying; some are for brushing only. One brand may not necessarily mix with another, even if they are both good singly.
7. Attempting to stir in any skin which has formed on the top of a partly used tin. It should be drawn off and thrown away, or the paint may be strained through an old piece of stocking as you charge the gun.
   Apparently the stirring in of the dried skin is a common fault in brush enamelling as well!
8. Make sure the surface is completely free from grease, and don't spray under damp conditions.
9. Another common fault is attempting to cover the area the first time. Keep the gun moving over the work and thus build up with thin coatings.
10. If a coachwork finish is required, don't expect to get it with the gun. It might by itself have a good gloss, but lustre is obtained by burnishing.
    Burnishing simply means polishing in a straight (not circular) movement with a burnishing paste on a slightly damp cloth. It is done 24 hours after the final coat of thinners. The surplus paste is removed, and a wax polishing should produce a mirror-like lustre.

Getting Your Money's Worth

Once you have equipped yourself with a spray-gun—and many of those costing well under a pound are capable of excellent work—and you have finished spraying instrument cases, test-gear and the like—you may look round for other worlds to conquer. No doubt you will find many other jobs for it in the workshop or the den. Metallic finishes are very popular nowadays, and there is no need to buy special paints for it. The effect can be readily obtained by mixing polychromatic silver to the colour in approximately a 1 to 3 proportion. Gun gloss can be used for a super finish.

Another popular use for the more elaborate gun is flock-spraying. Surfaces are painted with an adhesive and a spray of finely cut fibre (which looks like powder) is blown on. A suede-like finish is obtainable on almost any material (wood, metal and even glass or flexible cardboard). One possible use readily springs to the radio minded—its use for the damping of speaker resonances in radio cabinets. If any reader has already tried out the idea, perhaps he will bear in mind that there are plenty of others who would like to hear of his experiences.

One-forty-eight—One-forty-nine—One-fifty!

J.R.D.'s description of the Douglas wave-winder last month was brought to my notice by a very old friend—as if I would have missed it! As keen youngsters some time about 1924, this particular friend and I designed a wave-winder of our own. Perhaps I should more truthfully say that he let me help him to build it. At that period all the best receivers used 2-pin plug-in coils, the reaction coil being coupled to the tuning coil by a swinging arm. Coils wound honeycomb fashion on an inch length of 2 in former were then considered the last word in efficiency. Amateurs often wound their own by hand, using a solid wooden centre around which were fitted thick metal pins. Cotton-covered wire was then wound in and out the pins, tracing a honeycomb layer. The completed winding was given a coating of shellac to make it "stop put" and the pins withdrawn. It was then mounted on the plug and a little binding added for strengthening.

Our honeycomb winder turned them out almost as quickly as one could make them by hand—but it was a lot more fun. Made largely from Meccano parts, a description of it, with photos, appeared later in one of the many radio journals of that period. No doubt designs for other winders were also published. One would have needed a very deep pocket to have subscribed to all the radio periodicals of that age!

Naturally our rather crude winder would deal with comparatively thick wire only. Anything finer than 36 would have most certainly broken. Still, as 22 or 24 were the popular gauges for the coils of those days, that didn't worry us. The former was, of course, cranked (and you counted the turns as you did it) keeping a constant speed. If you slowed down there was a danger of the whole lot coming undone, unless you put in a little smart braking with your left hand, which was normally used to help out the guide arm.

Our most difficult problem was not the lateral movement, but the gradual withdrawal of the guide arm from the winding as the diameter increased. And increase it did! The older generation will remember by how much, but the younger must pause to imagine the depth of such a coil when wound to cover "long-wave" reception.

(*continued on page 724*)

CENTRE TAP *talks about* **SPRAY PAINTING — AN OLD COIL WINDER — THE BEST DAYS**

RIGHT—*From the Start*

PART 6. RECEIVING

by A. P. BLACKBURN

We have spent some time with audio amplifiers in previous articles, and arrived at the stage where further progress would entail a discussion of the deeper aspects of their operation and design. No introduction has yet been made to the "receiver" part of the radio system. By "receiver" is meant that part of the set which receives the broadcast signal, the tuning mechanism and so on.

This month, then, we will follow a signal from the transmitter to the input of the audio amplifier.

Modulation

The key to radio transmission lies, obviously, in how to get the signal from the studio to the receiving set. The early pioneers found that high frequency energy could be easily radiated through space to a distant point. The frequencies involved are, however, beyond the audible range, and some system had to be found which would enable the audible sounds to be superimposed on these high frequency "carriers." The process of superimposing one upon the other is called "modulation."

The carrier frequency is chosen to be many times higher than the highest modulating frequency. For example, the long wave B.B.C. Light Programme has a carrier frequency of 200 kc/s, and the highest audio frequency is probably 8 kc/s or so. The latter, of course, represents the highest musical note to be transmitted.

One of the methods of modulation is to cause the amplitude of the carrier to vary in sympathy with the loudness of the audio signal at a rate dependent upon the frequency of the audio signal. That may sound a little alarming, but Fig. 1 illustrates it. The audio modulating signal is represented by (a), and (b) stands for the carrier signal. After modulation of (b) by (a) the complete modulated signal (c) appears. This is fed to the aerial of the transmitter, and the carrier "transports" it to the receiving aerial.

So far, so good. But apart from the problem of reconverting the modulated signal into audible sounds, there are dozens of signals being transmitted at once. How is the receiver to pick out any particular one? Every one knows, of course, that the process of selecting one particular station is called "tuning." The real mechanism of tuning is, however, not so well known.

Tuned Circuits

There is a particular type of circuit which lends itself ideally to sorting out signals from one another. The simplest type is shown in Fig. 2, which consists simply of an inductance in parallel with a capacity. Now the behaviour of this simple circuit is quite remarkable, if an a.c. voltage of a particular frequency is applied between the points A and B. What happens is that at most frequencies, the circuit appears to be quite a low impedance, but at one frequency the circuit becomes high impedance.

This means that if an aerial and earth were connected as shown in Fig. 3, at one frequency an output voltage would appear, but not at any other frequency.

The values of the inductance and capacitance determine at what frequency this will occur. The effect is virtually that all signals but the required one may be rejected if the values of L and C are chosen correctly. Fortunately, it is a simple matter to calculate these values. The expression is:

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

where f is the frequency in cycles/second,
L is the inductance in Henrys
C is the capacitance in Farads.

It is a simple matter now to make the circuit more flexible so that it may be set to any desired frequency. The most common method is to make C variable. One set of capacitor plates are moved relative to the other set and the movable ones connected to a shaft.

Having selected the required signal, we can now move on to separating carrier and modulation.

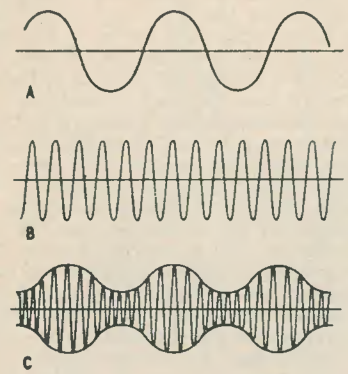


FIG. 1

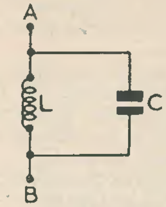


FIG. 2

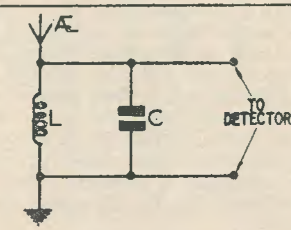


FIG. 3

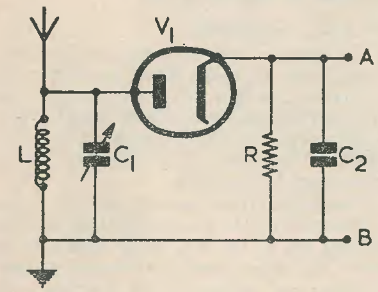


FIG. 4

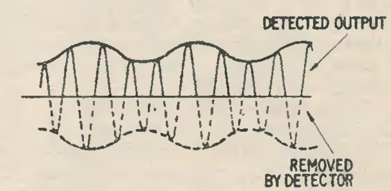


FIG. 5

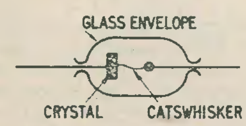


FIG. 6A

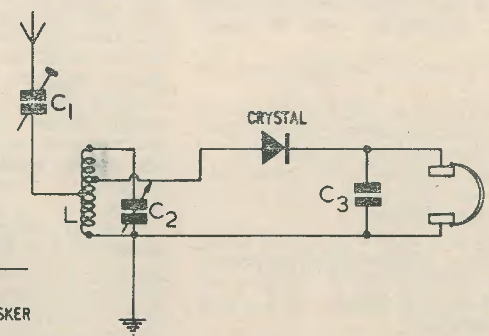


FIG. 6B

G 341

Detection

The process of separation is called "detection" or, in more highbrow circles, "demodulation."

In an earlier article, the two-electrode valve, or "diode," was mentioned. So far it has been ignored, but detection is one purpose it serves most usefully. An elementary diode detector and tuned circuit are shown in Fig. 4. With a headphone connected across A and B, this circuit is a complete, if rather inefficient, receiver.

The key to the operation of Fig. 4 is the fact that a diode will only conduct in one direction. If the anode is more positive than the cathode, current will flow through the valve, but if the cathode is more positive than the anode, no current will flow.

Now if the modulated carrier of Fig. 1C is applied to the aerial of the circuit of Fig. 4, and the tuned circuit is correctly tuned, the same waveform as Fig. 1C will appear across the capacitor C_1.

On positive half cycles of the carrier, the diode will conduct, and current will flow through the valve into the capacitor C_2. During negative half cycles, the diode will not conduct and there will be no current into C_2, which will commence discharging through R. The waveform across C_2 will look like that shown in Fig. 5; the audio signal with some carrier still present. The latter may easily be filtered out if desired.

In the simple circuits, like Fig. 4, a crystal detector is often used instead of a valve diode. The crystal detector usually consists of a small piece of germanium or silicon with a very fine wire in contact with it, as shown in Fig. 6A. The fine wire is called the "cats-whisker." These were the only efficient detectors available before valves appeared, but for a long time they were ignored. War-time radar, however, brought them back into popularity (in a very much improved form) and they are frequently used in radio nowadays.

A practical "crystal set" circuit is shown in Fig. 6B.

The aerial is fed to a tap on the coil via the capacitor C_1. The tap and the capacitor both help to relieve the tuned circuit of loading of the aerial, which would affect the selectivity, i.e. the ability of the tuned circuit to discriminate between stations.

The crystal is also tapped into the coil for the same reason. Finally the headphones take the place of R in Fig. 4. Such a set requires no batteries, of course, but has very little range or selectivity.

The Leaky Grid

The diode and crystal are not the only detectors. Another type is the "leaky grid" detector. Here the grid and cathode of a triode (or pentode) valve are used as a diode, but the valve also has properties of amplification of the audio signal. The circuit is shown in Fig. 7.

If we ignore the anode for a moment, the circuit looks like Fig. 7B. Now this is exactly the same thing as Fig. 4, but with R and C_1 and the diode swopped around. This shows how the grid and cathode of the valve in Fig. 7A take the place of the diode. The audio frequency voltage appearing on the grid will now be amplified at the anode. This makes an efficient detector from the point of view of sensitivity, but is not normally used in quality receivers because it introduces more distortion of the signal than does the diode.

There are still a number of other types; anode bend, infinite impedance and so on, which are not used extensively today.

Fig. 7C shows the leaky grid detector connected with the resistor between cathode and grid instead of across the capacitor. This is a common circuit and it amounts to very much the same thing as 7A. From the detector, of course, it is only a matter of connecting an audio amplifier, so that a loudspeaker may be driven.

The D.C. Component

This general look at detectors has shown, I hope, how the audio signal is removed from the carrier. It is worth while taking a closer look at a feature of the diode detector in particular which is of immense use in very sensitive receivers, and that is the d.c. component of detection.

If we return for a moment to Fig. 5, it will be noticed that the audio signal appears to be perched up in the air, away from the base line. This base line is a necessary line of reference and represents the average level of the total (carrier + modulation) signal. In Fig. 1C it can be seen that the area above the base line is equal to the area beneath it. The area above represents a positive signal and that below a negative signal. Because these areas are equal the average level is zero. This is why we cannot connect a pair of headphones straight across the tuned circuit. Because the carrier amplitude carries the audio signal, as the positive amplitude increases, so negative amplitude increases, and the net change is zero. It is necessary, therefore, to rid ourselves of "one side" of the signal.

If we fed an unmodulated carrier into the circuit of Fig. 4 (i.e. a constant amplitude carrier), a d.c. voltage would appear across the terminals A and B. This is because the diode, conducting on positive half-cycles, would charge up C_2 to a steady value. When modulation occurs it represents a change in the d.c. voltage; in other words the d.c. would start to vary, following the modulating waveform, as already seen in Fig. 5. The modulation is now swinging about another

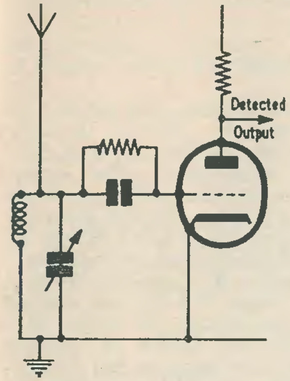


FIG. 7A

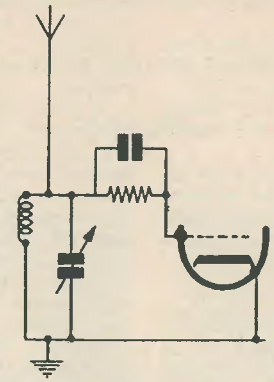


FIG. 7B

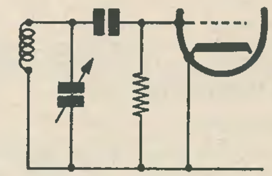


FIG. 7C

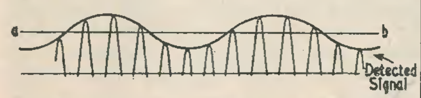


FIG. 8

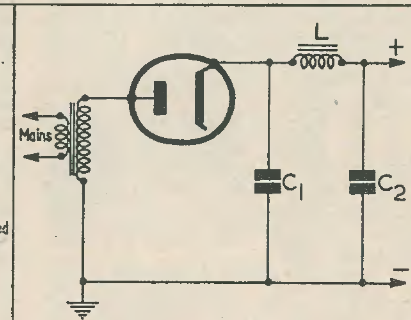


FIG. 9

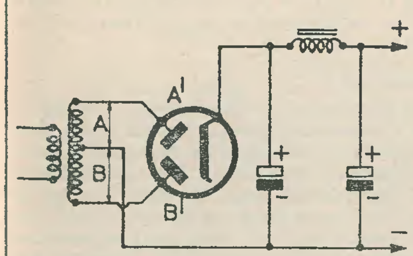


FIG. 10A

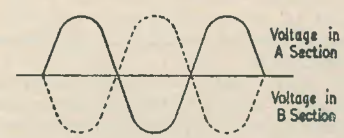


FIG. 10B

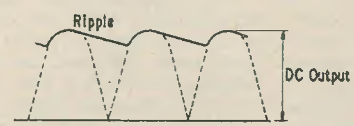


FIG. 10C

G 342

line *ab* some way from the base line, as shown in Fig. 8. This line represents the average d.c. level from the detector.

Summarising this, it means that the diode or crystal detectors give an output composed of an audio signal superimposed on a d.c. voltage, where the value of the d.c. voltage depends upon the amplitude of the carrier only.

Although this has no application to the simple sets we are dealing with at the moment, it is of immense use for providing automatic volume control in more complex receivers, as we shall see later.

Rectification

Another name for the process of detection is "rectification." The latter name is not so commonly applied to the process of separating modulation from carriers, but it is used for another application of the same process. That is, changing a.c. voltages to d.c. voltages. In this series, valves have always been shown with batteries for the h.t. supplies. In mains receivers, some method has to be used to convert the mains 50 c/s a.c. supply to d.c. to replace the batteries.

This is done by using diodes very much in the same way as for detection, except that this time it is the d.c. component only that we are interested in. Even after rectification a considerable amount of a.c. is still present on the d.c. output voltage, and therefore a filter has to be used.

Fig. 9 shows a simple half-wave power rectifier circuit. The capacitor C_1 is the reservoir capacitor. It is charged by the rectifier and retains its charge until the next conducting half-cycle. The remaining ripple is smoothed by the choke L and the smoothing capacitor C_2. Excessive amounts of ripple can be the cause of hum at the output of the receiver.

A system that produces less ripple is the "full-wave" rectifier. This is shown in Fig. 10A. Here two rectifiers are used, and a centre-tapped transformer. The voltages appearing at the secondary of the transformer are shown in Fig. 10B. The full line represents the voltage in the section A in Fig. 10A, and the dotted line the voltage in section B. Now when section A is positive, diode A' will conduct. Diode B' will not be conducting because the voltage in section B is negative. However, when B becomes positive, A becomes negative and diode A' ceases conducting, when B' commences.

Now we have rectification taking place over the whole cycle instead of only half the cycle as in Fig. 9. The output waveform is shown in Fig. 10C. It can be seen that the ripple frequency is twice the mains frequency, i.e. 100 c/s for 50 c/s mains. This has the advantage that smoothing is easier and less ripple can result.

The two rectifier circuits Figs. 9 and 10 give a positive output voltage. The diodes could be reversed, i.e. the output taken from the anode and the cathode connected to the transformer, and the output would become negative.

For most ordinary radio work, of course, a positive voltage is required, so the figures are as usually found in radio circuits.

RADIO MISCELLANY—*continued from page* 719.

We then fell to talking of those good old days, which period he was inclined to regard as the Hey-day of our hobby. Certainly the mid-twenties were exciting times with a host of bright ideas (mostly erroneous) and new developments, eagerly followed by a vast number of constructors since receiver construction was well within the capabilities of any handyman.

Ten years later saw another stage in the evolution, a period which will be considered by many others as the more memorable era. Components at give-away prices! There was a wide scale over-production of manufacturers' type components due to market instability and rapidly changing designs. With receiver construction advancing well beyond the handyman's skill, the market for surplus components was limited and hence the prices were often absurdly cheap. The knowledgeable amateur by shrewd buying could build a commercial style quality set for less than a quarter of the price of the manufacturer's equivalent.

Perhaps a still greater "era" was one of more recent experience when, just after the war, ex-W.D. gear was, for a long time, available at knock-out prices.

I suppose everyone has his own ideas which were the "best days" for the radio minded, differing just as much as my friend and I. We then fell to wondering what will be the next milestone in the history of our hobby.

Growing Up

Some months ago I wrote of an Experimenters' Club which was being formed by 18-years-old Bryan Smith of 9 St. Margaret's Road, Westgate-on-Sea, Kent. He now writes to tell me that the club has been successfully launched, and they are starting their own magazine which, in addition to club news and experiment, also covers S.W. Broadcast and Amateur DX reception. He will be pleased, on receipt of an S.A.E., to supply details of membership (I believe it is only 3s. a year membership, magazine 13s.), and the availability of the magazine (at a higher price) to non-members.

DESIGN CHARTS FOR CONSTRUCTORS

No. 6 INDUCTANCE-CAPACITY-WAVELENGTH CHART—SHORT WAVES

by HUGH GUY

THE PRACTICAL FORMULA RELATING THE frequency of oscillation of a tuned circuit with the values of inductance and capacity comprising the circuit is given as:

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

where f is the frequency in cycles per second, L is the inductance in Henrys, and C the capacity in Farads.

These units are of course unmanageably large if the circuit is to oscillate at a radio frequency, and some simplification is necessary to reduce the Henrys and Farads to practical values: e.g. microhenrys (μH) and picofarads (pF) respectively. At the same time the frequency is generally more conveniently expressed in megacycles. Using these new units the above formula now becomes:

$$f=\frac{1000}{2\pi\sqrt{LC}}=\frac{159.2}{\sqrt{LC}}$$

One further step makes things even easier; the frequency of oscillation of a tuned circuit is related to the wavelength in metres by the formula:

$$\lambda=\frac{300}{f}$$

where λ is the wavelength and f the frequency in megacycles. We can therefore express the wavelength in metres directly in terms of the inductance L in microhenrys and the capacitance C in picofarads:

$$\lambda=\frac{300\sqrt{LC}}{159.2}=1.885\sqrt{LC}$$

It is upon this formula that this month's chart is based, enabling wavelengths to be interpreted from values of inductance and capacity or vice versa. Should the frequency rather than the wavelength be known then last month's chart giving wavelength-to-frequency conversion must be used initially.

To obtain reasonable accuracy, it has been necessary to split the wavelength up into bands covering the short, medium, long and intermediate wavelengths, one chart being devoted monthly to each band. This month's chart, therefore, covers the short waves from one metre to two hundred metres, in two steps. Successive issues will complete the series.

How the Chart Works

Each chart consists of two sets of superimposed data. The first set enables the wavelength λ, as indicated by the right-hand vertical scale, to be expressed as a product of L and C. Since this is an intermediate step, however, no scale appears for this product. Instead the LC product is transferred from one reference line on the chart to a second reference line which facilitates specific values of L and C to be chosen to give the required product. This latter step, therefore, uses the second set of data.

Examination of the chart shows where the various units involved are found. The short wave chart, as mentioned above, is split into two bands, covering 1 to 20 metres on the inner scales, and 10 to 200 metres on the outer scales. The wavelengths are read horizontally from the vertical right-hand scale. Values of capacity are read vertically from the horizontal scale, and values of inductance read horizontally from the vertical left-hand scale. Information on any inner scale must be read in conjunction with that on the other inner scales; the same rule applies to the outer scales.

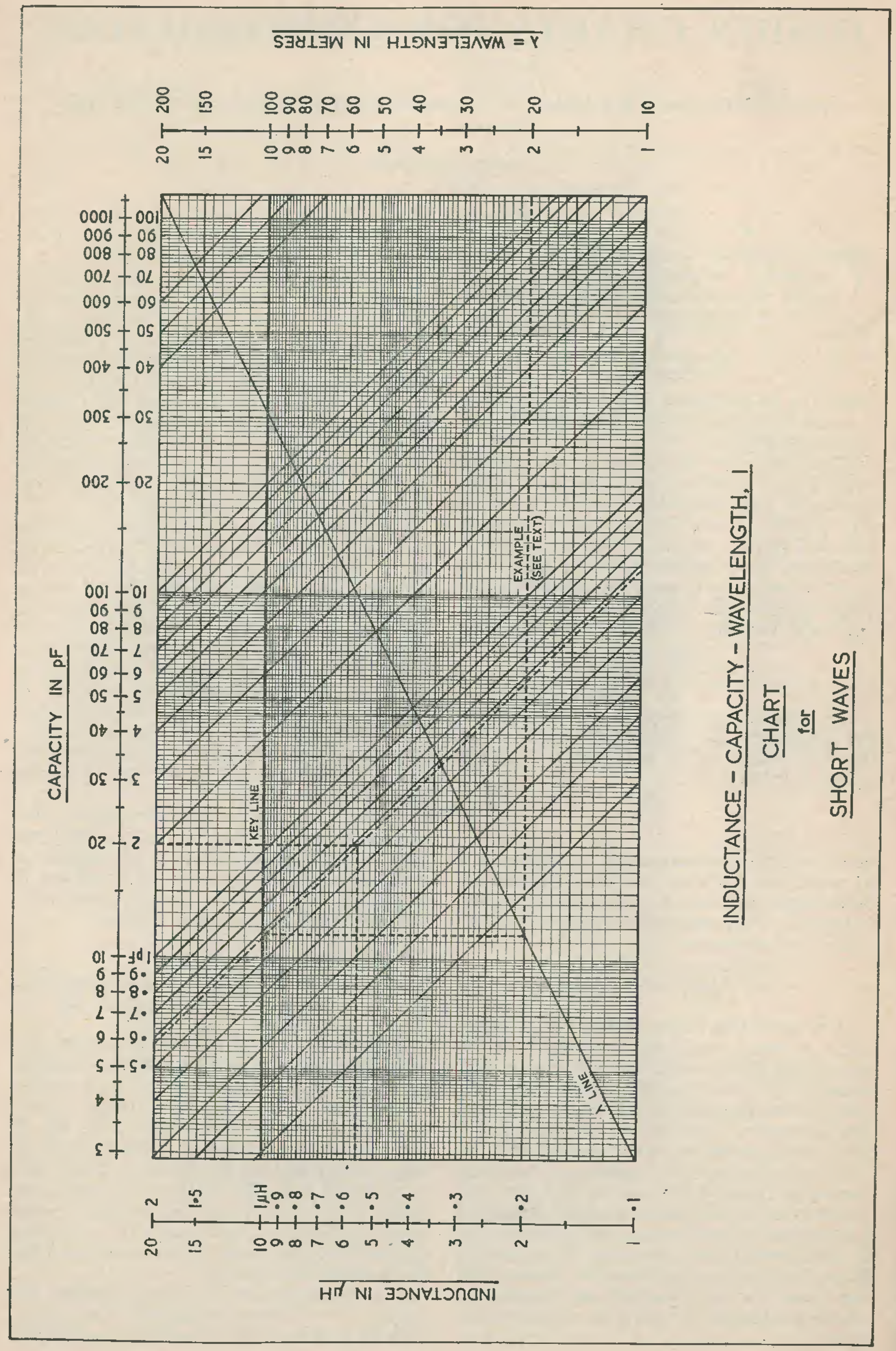
The reference lines mentioned above are clearly marked on the chart as "λ Line" and "Key Line" respectively, and an example is worked out below to show the operation of the chart. On the chart itself a step-by-step analysis is shown in dotted outline.

Example

What values of inductance and capacitance are required for a tuned circuit for the 20 metre band?

20 metres is located on the outer "λ" scale of the chart and its intersection with the "λ Line" is produced vertically to cut the "Key Line." On the chart this is shown actually drawn in as a dotted line, but in normal use the drawing of a line is unnecessary, the guide lines on the chart being used as a visual aid. To continue, however, the "Key Line" is seen to be cut at a point corresponding to 10μH (seen on the outer inductance scale) and 10.15pF (seen on the outer capacitance scale).

If a diagonal line is traced through the point of intersection with the "Key Line," parallel to the other diagonal lines, then any



values of inductance and capacitance intersecting on this line will give the required LC product.

For example, if a 20pF trimmer were being used as the capacitance in the tuned circuit, then the diagonal, shown dotted, gives the required value of inductance as 5.7μH.

Here again, although the diagonal lines relating to the principal values of capacitance are already drawn in, in most cases the required inductance and capacitance values do not intersect on an existing diagonal line. Our example was deliberately chosen to exemplify this point. It is easy enough to interpolate visually the intersection back at the "Key Line" however, though the more cautious reader is advised to use a straight edge for the purpose.

LC to Wavelength

To determine the wavelength to which known values of inductance and capacitance will tune merely involves reversing the above procedure. Working backwards through the dotted example best demonstrates this.

The point of intersection of the known values of inductance and capacitance, in this case 5.7μH and 20pF, is located, and through this point a diagonal line traced, either visually or with a straight edge, back to the "Key Line." The vertical intersection of this point on the "Key Line" with the "λ Line" will give a value of wavelength which is read on the appropriate scale.

One third use of the chart remains: given a known value of inductance say, then the required value of capacitance for a predetermined wavelength can be solved. And of course the same procedure applies for solving the value of inductance if the capacitance is known.

L-λ to C, or C-λ to L

This process is almost the same as that outlined in the first example. Step one is to locate the intersection of the value of wavelength with the "λ Line." This is then referred to the "Key Line." Here, as before, the appropriate diagonal line is selected. Then the unknown component value is determined from the point of intersection of the known value with the diagonal line.

This, then, covers all the possible variations of the use of the chart in some considerable detail, a fact which probably makes the use appear rather more complicated than it is in fact.

The remaining charts to be published in subsequent issues all work on this principle, though the position of the "Key Line" will vary from one to the next.

It will also be seen that the data contained on one chart overflows to a certain extent on to the next so that, when a complete set of these charts is obtained, if no suitable component values are available for a particular wavelength as given by one chart, then more suitable values may be obtained from the preceding or next chart.

On subsequent issues, too, only abridged information on the use of the charts will be given, as the operating data given with this first chart covers all four.

Finally, two tables will be given, the first showing the relationship between microfarads and pico- or micro-microfarads, and between Henrys and microhenrys, and the second giving the coverage in both wavelength and frequency of the four charts in this series.

Next month's charts will cover the intermediate and medium wavebands.

EFFECTS WITH A TAPE RECORDER—
continued from page 715

music was pitched in middle C, it will be pitched in a higher key at the new speed. If the new speed is not related to the original speed by a determined rate, the pitch of the notes at faster, or slower, speed might fall a semi-tone above or below the original pitch, or run into awkward or non-related keys. Musicians will at once realize the advantage of having speeds with key relationship. The table herewith shows some of the key relationships at the speeds used by the writer.

It will be appreciated that more combinations of key relationships than those listed above can be obtained. The most common ones have been listed and can all be interrelated at the different speeds. The essential feature of the system is that a recording at any of these speeds is still in concert pitch at the other speeds.

(*To be continued*)

Important Announcement . . . PRICE INCREASE

We regret that, from the next issue (July) onwards, the price of this magazine will be increased to 1/9d. per copy. This step has been forced upon us due to the recent increase in printing charges, combined with continual advance in all production costs over the past few years. We have made this deci ion with the greatest reluctance, but feel sure readers will agree that this is preferable to the only ot' er alternative, that of lowering the standard of the magazine. The annual subscription will become £1 1s., post free, as from the July issue.

REPANCO

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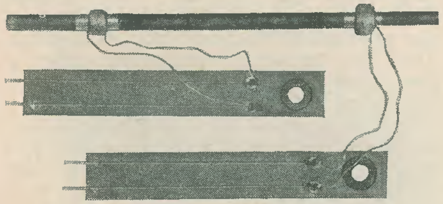

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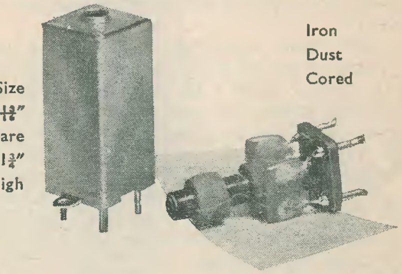

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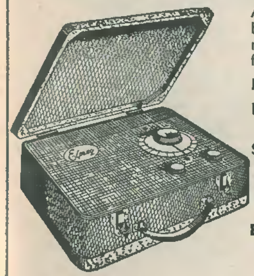

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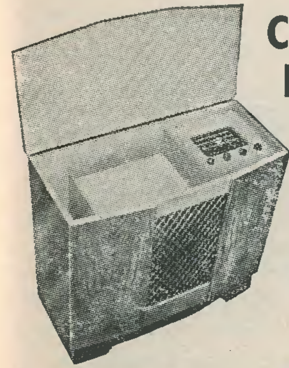
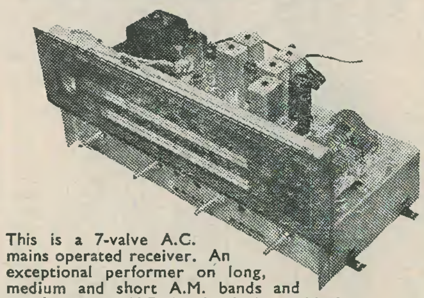


WE CARRY A VERY VARIED STOCK

PLEASE CALL

This is the "Empress," undoubtedly a beautiful piece of furniture, elegantly veneered in figured walnut and in white sycamore. The radio section is raised to convenient level but is not drilled or cut. The lower deck acts as the motor board, again is uncut. It measures 16" × 14" and has a clearance of 5" from the lid. There is a compartment for the storage of recordings. Overall dimensions of this essentially modern cabinet are 3ft wide, 2ft 8in high and 1ft $4\frac{1}{2}$in deep. Price **£14 . 14 . 0**, carriage and insurance 20/–

A.M./F.M. RADIOGRAM CHASSIS



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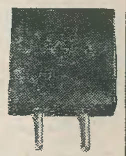

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(contiuued on page 735)

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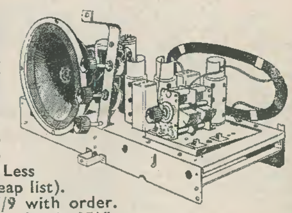

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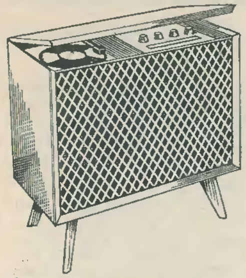

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6AT6	8/–	12A6M	7/6	ECC82	10/6	UBC41	10/6
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6BA6	8/6	12AU7	8/6	12AT6	8/–	UY41	8/6
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(continued from page 733)

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(continued on page 736)

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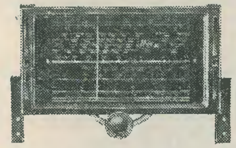

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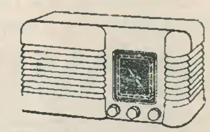

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(continued from page 735)

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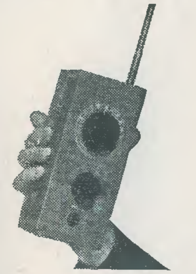

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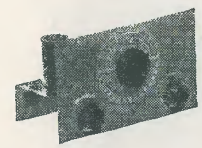

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