TRANSISTOR CIRCUITS MANUAL

No. 1

by I. F. Gregory

CIRCUITS AND INSTRUCTIONS FOR BUILDING :—

1. SINGLE TRANSISTOR RECEIVER
2. 2-TRANSISTOR T.R.F. RECEIVER
3. 3-TRANSISTOR T.R.F. RECEIVER
4. 3-TRANSISTOR REGENERATIVE RECEIVER
5. LIGHT OPERATED RADIO
6. 2-TRANSISTOR SIGNAL TRACER
7. 200 MILLIWATT AMPLIFIER
8. TELEPHONE PICK-UP AMPLIFIER
9. SINGLE ENDED PUSH-PULL AMPLIFIER
10. SIMPLE TRANSISTOR TESTER
11. R-C. SINUSOIDAL OSCILLATOR

No. 156 **15p**

BERNARDS RADIO MANUALS

TRANSISTOR CIRCUITS MANUAL

Instructions For Building 10 different transistor units

LONDON
BERNARDS (Publishers) LTD

BERNARDS RADIO MANUALS No. 156

General Editor: CLIVE SINCLAIR

First Published December, 1959
Reprinted March, 1960
Reprinted June, 1960
Reprinted September, 1960
Reprinted December, 1960
Reprinted May, 1961
Reprinted September, 1961
Reprinted June, 1962
Reprinted November, 1962
Reprinted May, 1963
Reprinted October, 1964
Reprinted August, 1965
Reprinted December, 1966
Reprinted March, 1968
Reprinted June, 1969
Reprinted June, 1970
Reprinted November, 1971

Printed by V. Cooper & Partners Ltd., Flitcroft Street, W.C.2 for Bernards (Publishers) Ltd., The Grampians, Western Gate, London, W.6.

CONTENTS

PREFACE

We have had numerous requests for a low priced book which fully covers the constructional side of transistors. This is it.

Every unit described has been built and thoroughly tested so that even a complete beginner can easily handle the circuits. At the same time the more advanced constructor will find circuits here that he has not seen before. For example, the light operated receiver and the telephone pick-up amplifier. All the circuits in this book were designed by Mr. Gregory himself who has had many years of experience with transistors having been one of the first people ever to build a transistor superhet.

CLIVE SINCLAIR

A FEW HINTS ON USING TRANSISTORS

If you are just introducing yourself to Transistors, the following few tips may be of help before starting to build any of the circuits in this booklet.

The Transistor is a fairly rugged little device and will withstand quite a lot of vibration, more in fact than the thermionic valve, but it also has several weaknesses and it is these that must always be borne in mind. One small slip and a transistor is ruined.

The first of these is the matter of Polarity.

If the battery is connected in circuit with the battery polarity reversed all the Transistors in a circuit may be destroyed, the rule is that with P.N.P. Type Transistors the Collector must be negative with respect to the Emitter.

Soldering Transistors

It is suggested that soldering be avoided wherever possible and that in its place Transistor Sockets should be used. This will avoid damage through excessive heat. Very small yet rugged holders are now available from Ardente which are simple to mount and will enable quick and safe replacement of Transistors, an operation that occurs often during the testing and experimenting with this new section of Electronics.

If, however, soldering is considered vital, in certain circumstances then the following procedure should be adopted.

1. Make the joint as quickly as possible.
2. Use some form of heat shunt, i.e. a cold pair of pliers placed across the leads will help to conduct heat from the iron.
3. The joint should be made as far away from the Transistor as possible.

Connections to Transistors

Figure 2 should be studied as it gives the key to all Transistor leads now available and relates to all the circuits in this booklet.

Most manufacturers put a "Red Spot" on one side of their Transistors to denote that the lead nearest to it is the Collector, but this spot has an irritating habit of disappearing with age and excessive handling. However, should this state of things occur all is not lost as this has been anticipated. In Figure 2 it will be noticed that the leads are not evenly spaced but in fact the Collector is widely spaced in relation to the Base and Emitter. This then is the second line of defence and so often proves invaluable, and remember again that the wrong polarity will ruin your Transistor whether it is through reversing the Battery or inserting a Transistor the wrong way round, both so easily done but a costly mistake.

SIMPLE ONE TRANSISTOR RECEIVER

The first circuit (illustrated in Fig. 1) is of a very simple One Transistor Receiver, the construction of which requires little explanation. It must be stressed however, that amplification is small and that a good 50ft. outdoor aerial is essential together with an efficient earth connection.

In spite of the simplicity of this receiver it does give an introduction to the semiconductor as an Audio Amplifier and illustrates some of its attributes, i.e. the very small voltage needed (1½ volts is sufficient), the fact that only one battery is used as opposed to the two with all valves and perhaps the most interesting feature of all, the incredibly small consumption of current, usually in the region of 1 milliamp, when used in a circuit of this type.

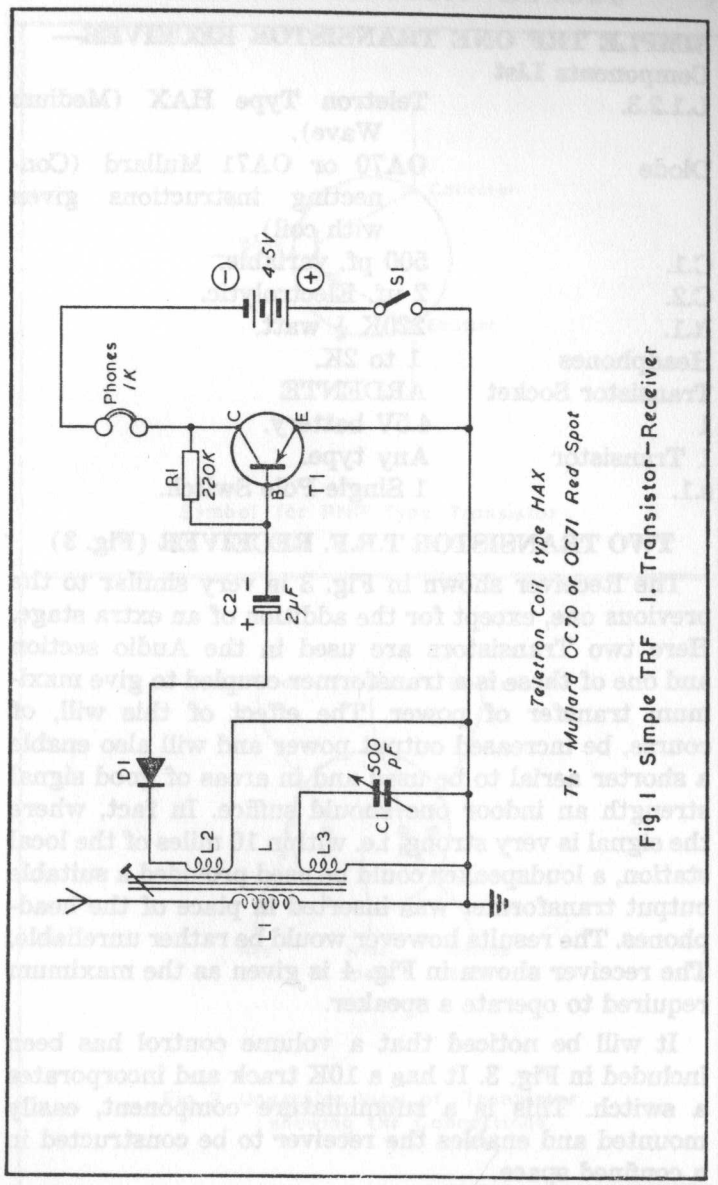


Fig. 1 Simple TRF 1. Transistor–Receiver

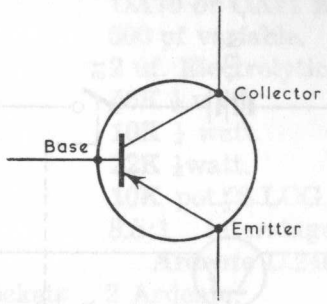
SIMPLE TRF ONE TRANSISTOR RECEIVER—
Components List

L.1.2.3.	Teletron Type HAX (Medium Wave).
Diode	OA70 or OA71 Mullard (Connecting instructions given with coil).
C.1.	500 pf. variable.
C.2.	2 uf. Electrolytic.
R.1.	220K ¼ watt.
Headphones	1 to 2K.
Transistor Socket	ARDENTE
1	4.5V battery.
1 Transistor	Any type.
S.1.	1 Single Pole Switch.

TWO TRANSISTOR T.R.F. RECEIVER (Fig. 3)

The Receiver shown in Fig. 3 is very similar to the previous one, except for the addition of an extra stage. Here two Transistors are used in the Audio section and one of these is a transformer coupled to give maximum transfer of power. The effect of this will, of course, be increased output power and will also enable a shorter aerial to be used and in areas of good signal strength an indoor one should suffice. In fact, where the signal is very strong, i.e. within 10 miles of the local station, a loudspeaker could be used provided a suitable output transformer was inserted in place of the headphones. The results however would be rather unreliable. The receiver shown in Fig. 4 is given as the maximum required to operate a speaker.

It will be noticed that a volume control has been included in Fig. 3. It has a 10K track and incorporates a switch. This is a subminiature component, easily mounted and enables the receiver to be constructed in a confined space.



Symbol for PNP Type Transistor

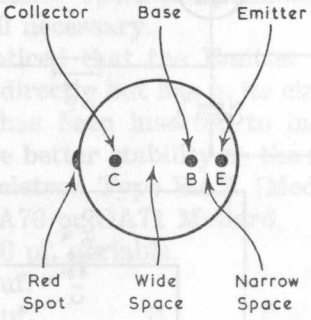


Fig. 2 Underside View of Transistor showing the Connections

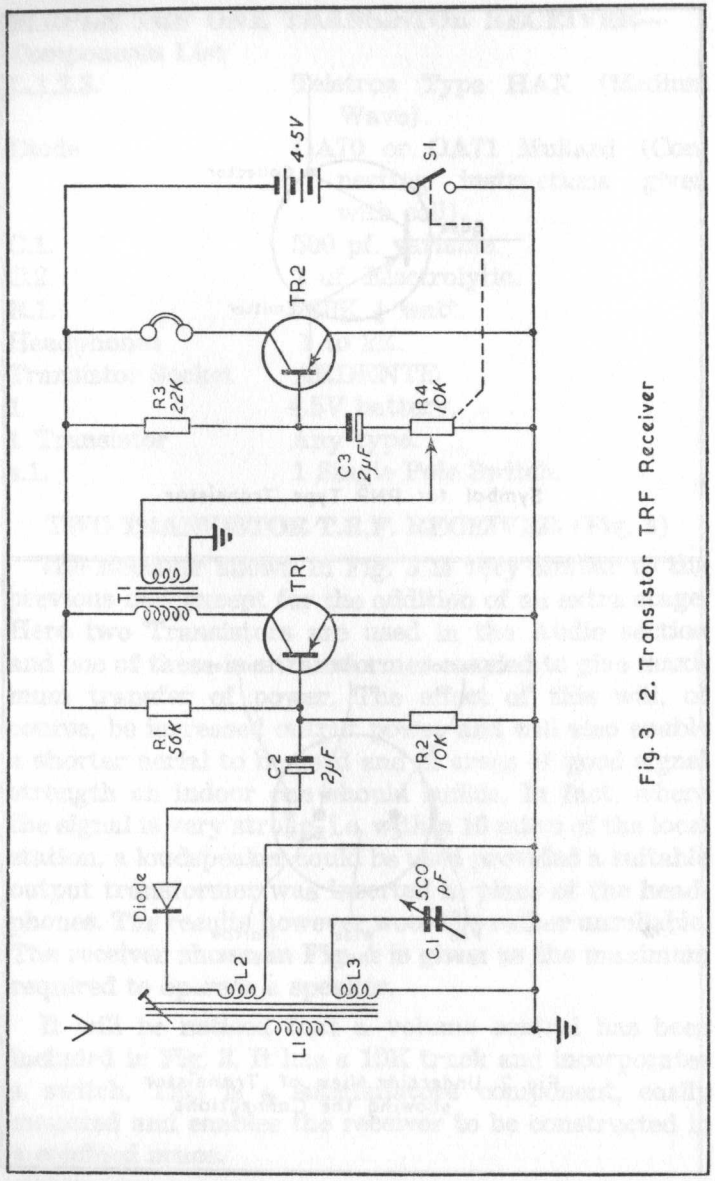


Fig. 3 2. Transistor TRF Receiver

L.1.2.3.	Teletron Type HAX (Medium Wave).
Diode	OA70 or OA71 Mullard.
C.1.	500 pf variable.
C.2.3.	2 uf. Electrolytic.
R.1.	56K ¼ watt.
R.2.	10K ¼ watt.
R.3.	22K ¼watt.
R.4.	10K pot. S.LOG. and SWITCH.
T.1.	8.5:1 interstage transformer **Ardente** D.240.
Transistor Sockets	2 Ardente.
Transistors 1 and 2	OC71 or Equivalent.
Headphones	1K.
Battery	4.5 Volts.

THREE TRANSISTOR T.R.F. RECEIVER (Figure 4)

Once again in this circuit we use the same front end but yet another Audio stage has been added making reliable loudspeaker operation possible. A good aerial however, is still necessary.

It will be noticed that the Emitter of T.R.3 is not taken to earth directly but has in its circuit a bypassed resistor. This has been inserted to increase base response and give better stability to the final stage.

L.1.2.3.	Teletron Type HAX (Medium Wave).
Diode	OA70 or OA71 Mullard.
C.1.	500 pf. variable.
C.2.4.	2 uf.
C.3.	8 uf.
C.5.	50 uf.
R.1.	100K ¼ watt.
R.2.	3.9K ¼ watt.
R.3.	56K ¼ watt.
R.4.	5K S.LOG. WITH SWITCH—ARDENTE VC.1126.

R.5. 470 ohm.
R.6. 15K.
T.1. 15:1 interstage transformer Ardente D.240.
T.2. Output transformer Ardente (when ordering state speaker voice coil impedance)
TR.1.2.3. Mullard OC71.
Sockets 3 Ardente.

THREE TRANSISTOR REGENERATIVE RECEIVER
TWO PRE-TUNED STATIONS SWITCHED STATION

We now come to a receiver that offers possibilities for miniaturisation hitherto impossible, in fact this set can be constructed entirely inside a packet of ten cigarettes. No outside aerial or earth are required as it relies quite satisfactorily on its own self contained ferrite rod (Fig. 6).

Regenerative receivers are, of course, more difficult to build and require more patience to tune, but the components for this offer far greater sensitivity and selectivity. The circuit as seen in Fig. 5 and Fig. 7 gives a suggested layout of components that will suit the plastic box mentioned in the list of parts, the outside dimensions of which are only 2″ x 3″ x ¾″.

The receivers described in previous sections require little explanation but here we may run into a few snags so the following points may be of help.

The whole receiver depends upon the correct winding and operation of the aerial coil, if this is incorrectly wired or connected regeneration will not be obtained. Similarly, if regeneration is obtained we may have too much for the very small capacitors to regulate, so that although winding instructions apply accurately to the prototype, they may not be the exact number of turns

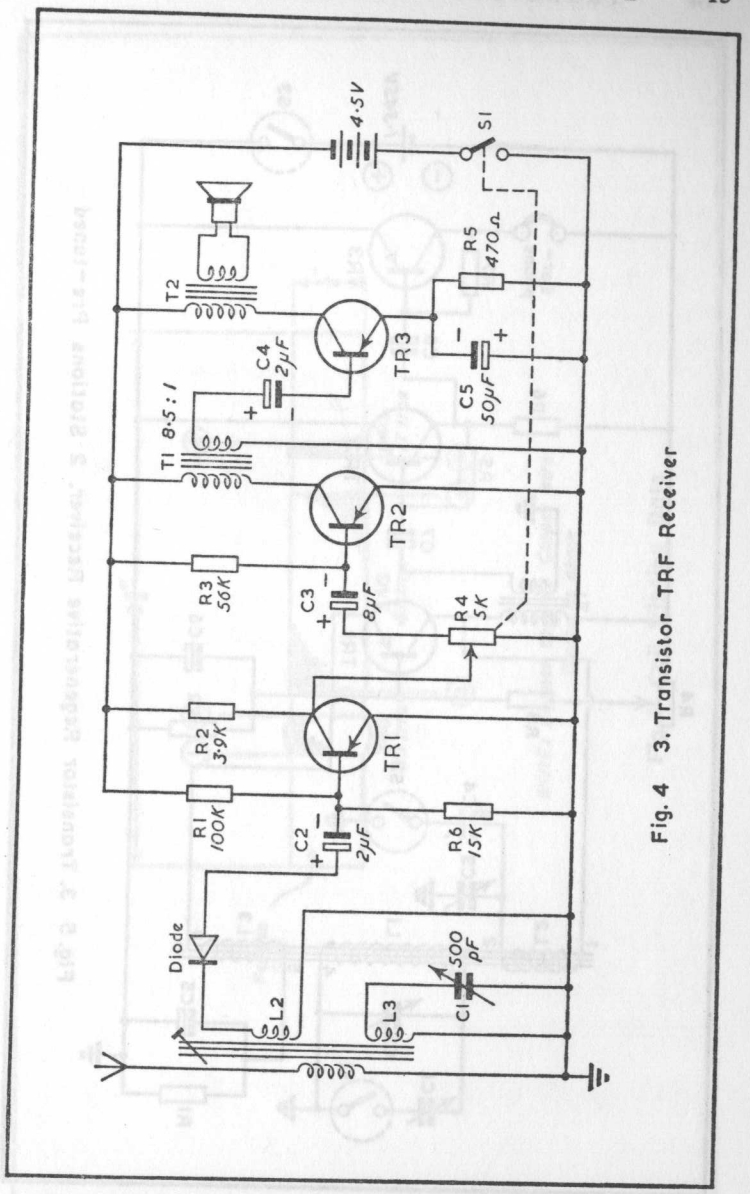


Fig. 4 3. Transistor TRF Receiver

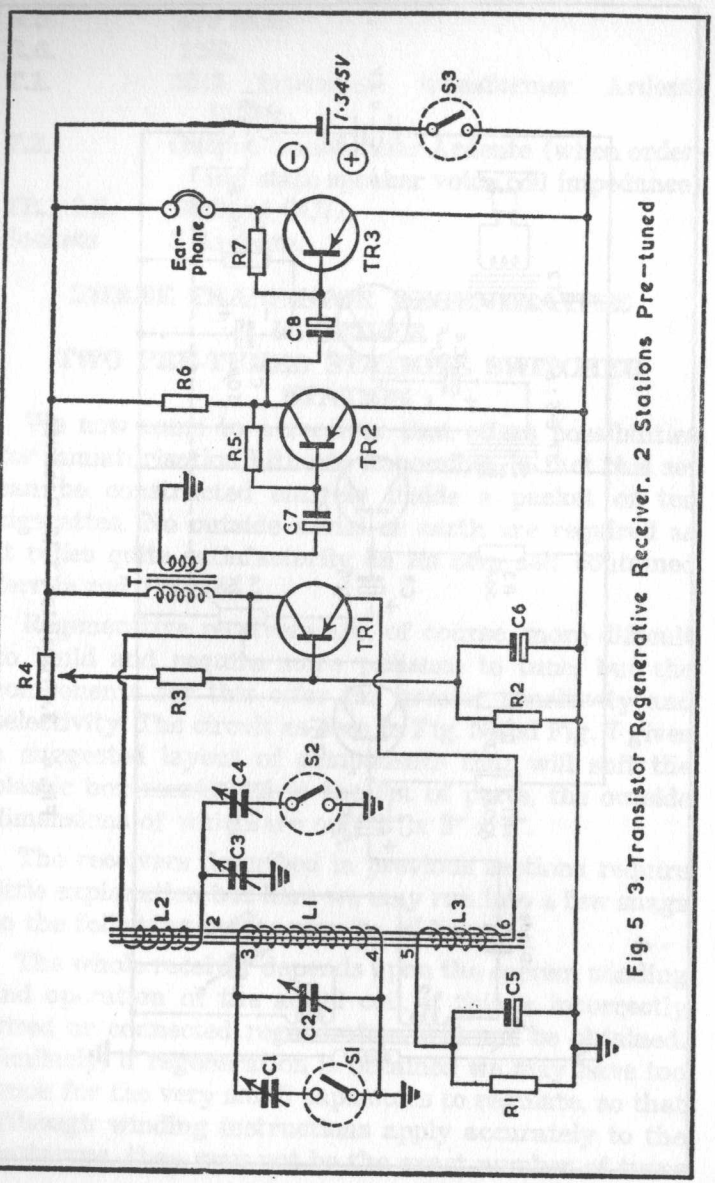
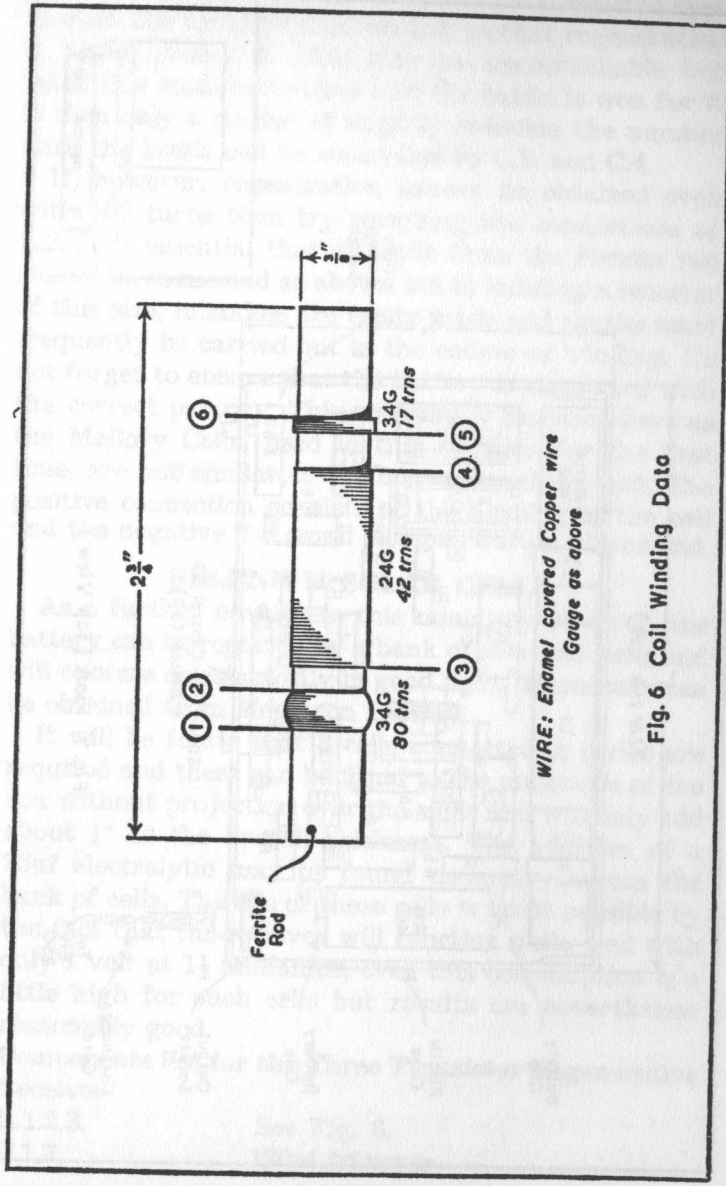


Fig. 5 3. Transistor Regenerative Receiver. 2 Stations Pre-tuned



WIRE: Enamel covered Copper wire
Gauge as above

Fig. 6 Coil Winding Data

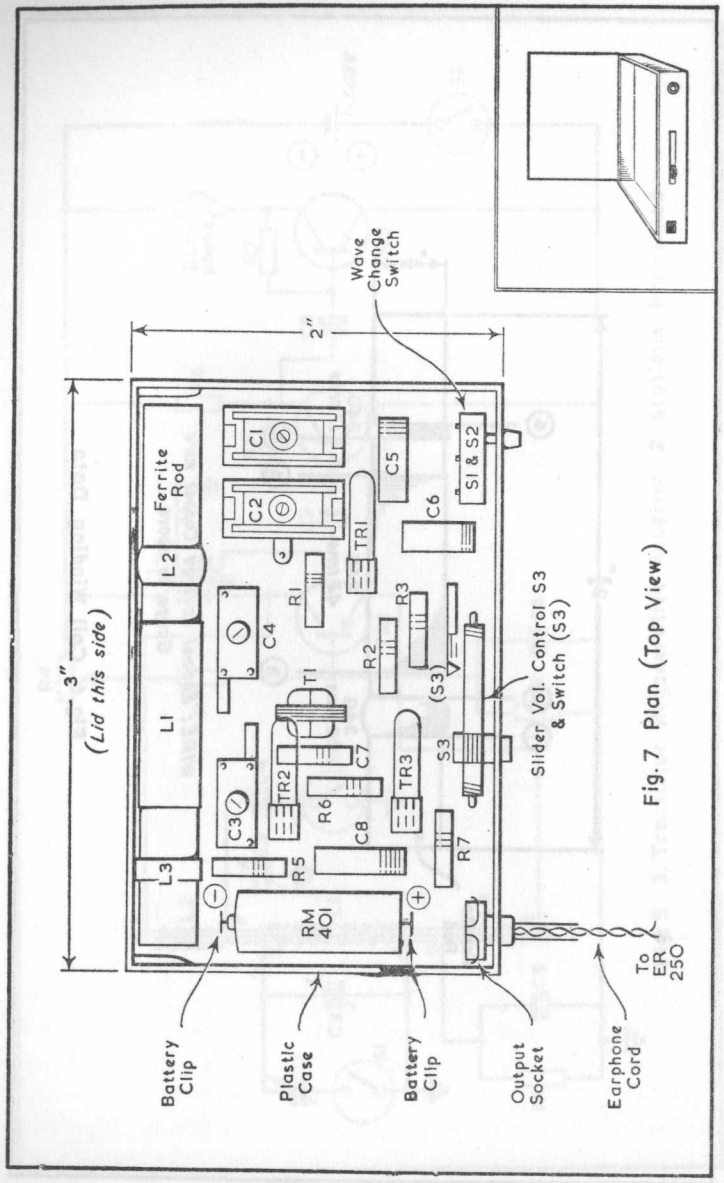


Fig. 7 Plan (Top View)

needed with other Ferrite rods, so it is suggested that at least 100 turns be tried on L.2. so that regeneration is easily produced. This may be uncontrollable but when this state is reached half the battle is won for it is then only a matter of slightly reducing the number until the howls can be controlled by C.3. and C.4.

If, however, regeneration cannot be obtained even with 100 turns then try reversing the connections of L.2. It is essential that all leads from the Ferrite rod should be connected as shown but in building a receiver of this size, mistakes are easily made and checks must frequently be carried out in the course of winding. Do not forget to ensure that the battery is connected with the correct polarity. This warning is repeated here as the Mallory Cells, used in this receiver for the first time, are not similar to the conventional dry cell. The positive connection consists of the housing of the cell and the negative the small isolated Button at one end.

SELENIUM SOLAR CELLS

As a further novelty to this miniature receiver, the battery can be replaced by a bank of selenium cells and will operate satisfactorily in good light. These cells can be obtained from Megetron Limited.

It will be found that 3 cells connected in series are required and these can be fitted to the underside of the box without projection over the sides and will only add about ¼" to the overall thickness. The addition of a 25uf electrolytic may be found necessary across the bank of cells. The use of these cells is made possible by the fact that the receiver will function quite well with only 1 volt at 1½ milliamps, even this consumption is a little high for such cells but results are nevertheless reasonably good.

Components list for the Three Transistor Regenerative Receiver

L.1.2.3. See Fig. 6.
C.1.2. 120pf trimmer

C.3.4.	20pf. trimmer (Perdio).
C.5.6.7.8.	8 uf electrolytic.
R.1.	2.2K $\frac{1}{8}$ watt.
R.2.	10K $\frac{1}{8}$ watt.
R.3.	3.3K $\frac{1}{8}$ watt.
R.4. & S.3.	Slider vol. control with switch 5K S.LOG. Ardente Type VC.1226.
R.5.	180K $\frac{1}{8}$ watt.
R.6.	4.7K $\frac{1}{8}$ watt.
R.7.	47K $\frac{1}{8}$ watt.
T.1.	Miniature 5:1 interstage. Ardente Type T.1079.
TR Sockets	3 Ardente.
TR.1.	OC45 Mullard (or preferably a Surface Barrier type transistor Semiconductors Ltd.)
TR.2 & 3.	OC71 Mullard or equivalent.
Earphone	Ardente ER250.
Output Socket & Earphone Cord	Ardente SK.1255.
S.1. & 2.	Miniature S.P. 2-way Wave Change Switch (Fortiphone).
Battery	Mallory type RM.401.
Plastic Box	3" x 2" x $\frac{3}{4}$"

TWO TRANSISTOR SIGNAL TRACER (Figure 8)

This is essentially a two stage transformer coupled transistor amplifier, a very useful piece of equipment with many uses, the main one of which is, as the name implies, to trace faults in all types of receivers. In its simple form it is used to trace faults in the Audio sections, however, by the addition of a diode it can be used to trace signals in the R.F. or I.F. circuits of a receiver.

The method of construction of this simple instrument is of no particular importance, but by using the sub-miniature components listed, the whole unit can be

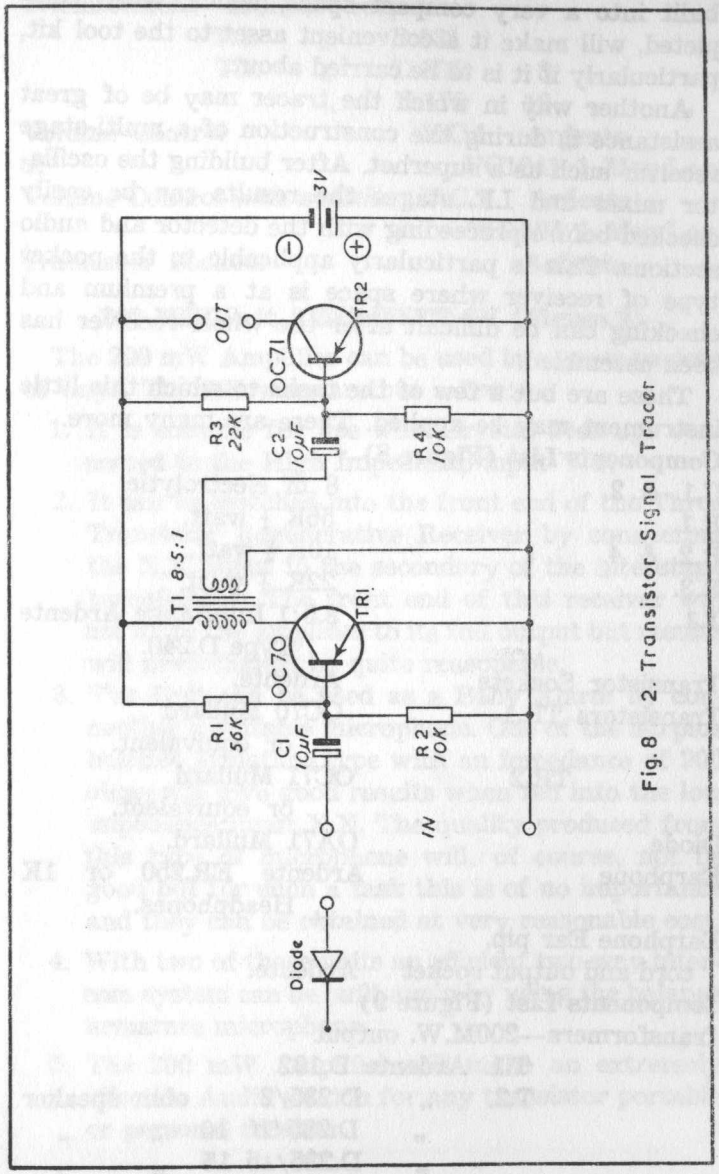


Fig. 8 2. Transistor Signal Tracer

built into a very compact space, which, when completed, will make it a convenient asset to the tool kit, particularly if it is to be carried about.

Another way in which the tracer may be of great assistance is during the construction of a multi-stage receiver such as a superhet. After building the oscillator mixer and I.F. stages the results can be easily checked before proceeding with the detector and audio sections. This is particularly applicable to the pocket type of receiver where space is at a premium and checking can be difficult after the whole receiver has been assembled.

These are but a few of the tasks to which this little instrument may be applied. There are many more.

Components List (Figure 8)

C.1. & 2.	8 uf electrolytic.
R.1.	56K ¼ watt.
R.2. & 4.	10K ¼ watt.
R.3.	22K ¼ watt.
T.1.	8.5:1 Interstage Ardente Type D.240.
Transistor Sockets	Ardente.
Transistors TR.1	OC70 Mullard or equivalent.
TR.2	OC71 Mullard or equivalent.
Diode	OA71 Mullard.
Earphone	Ardente ER.250 or 1K Headphones.
Earphone Ear pip, cord and output socket	Ardente.

Components List (Figure 9)

Transformers—200M.W. output

T.1.	Ardente	D.192	
T.2.	„	D.235/2	ohm speaker
	„	D.235/10	10 „ „
	„	D.235/15	15 „ „

Transformers—100M.W. output

T.1.	„	D.131	
T.2.	„	D.132	3 „ „
	„	D.178	10 „ „

Volume Control	V.C.1 Ardente
or	VC1041 1 Meg.Log.
Volume Control with switch	V.C.1 Ardente
	VC1126 1 Meg.Log.
Transistor Sockets	Ardente

200 MilliWatt AMPLIFIER 6V (Figure 9)

The 200 mW Amplifier can be used in a great variety of ways. The following are but a few:—

1. It is suitable for use with Crystal Pick-ups connected to the High Impedance input Y.Y.
2. It can be matched into the front end of the Three Transistor Regenerative Receiver by connecting the X.X. input to the secondary of the interstage transformer. The front end of this receiver will not drive the amplifier to its full output but results will nevertheless be quite reasonable.
3. The Unit can be used as a Baby Alarm by connecting a suitable microphone. One of the surplus balance armature type with an impedance of 200 ohms will give good results when fed into the low impedance input X.X. The quality produced from this type of microphone will, of course, not be good but for such a task this is of no importance and they can be obtained at very reasonable cost.
4. With two of these units an efficient two-way intercom system can be built again by using the balance armature microphone.
5. The 200 mW Amplifier will make an extremely effective Audio section for any transistor portable or personal receiver.

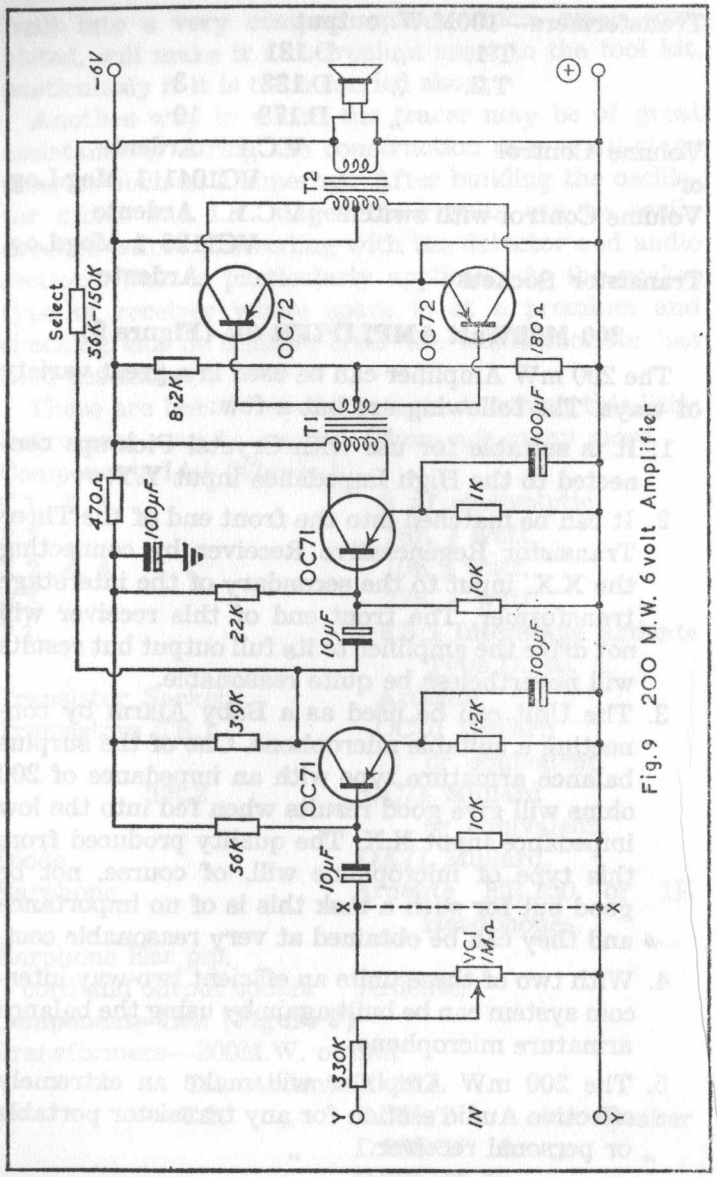


Fig. 9 200 M.W. 6 volt Amplifier

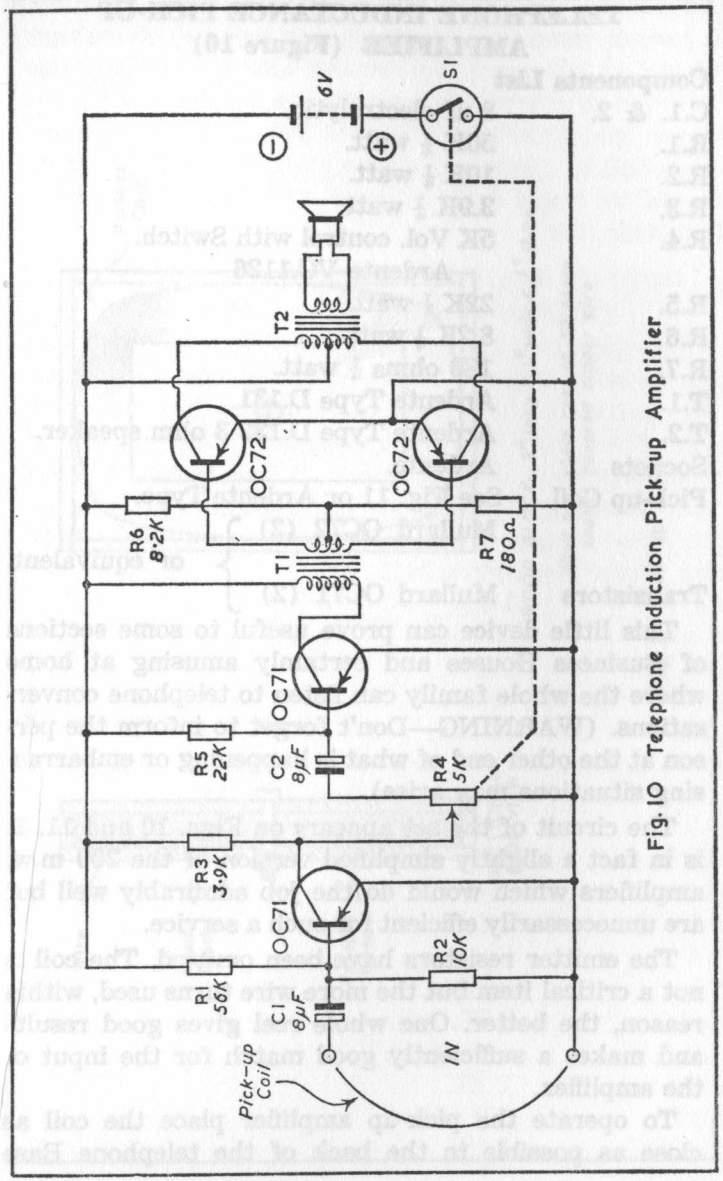


Fig. 10 Telephone Induction Pick-up Amplifier

TELEPHONE INDUCTANCE PICK-UP AMPLIFIER (Figure 10)

Components List

C.1. & 2.	8 uf electrolytic.
R.1.	56K ¼ watt.
R.2.	10K ¼ watt.
R.3.	3.9K ¼ watt.
R.4.	5K Vol. control with Switch. Ardente VC.1126.
R.5.	22K ¼ watt.
R.6.	8.2K ¼ watt.
R.7.	180 ohms ¼ watt.
T.1.	Ardente Type D.131.
T.2.	Ardente Type D.132 3 ohm speaker.
Sockets	Ardente.
Pick-up Coil	See Fig. 11 or Ardente Type.
Transistors	Mullard OC72 (2), Mullard OC71 (2) } or equivalent.

This little device can prove useful to some sections of Business Houses and certainly amusing at home where the whole family can listen to telephone conversations. (WARNING—Don't forget to inform the person at the other end of what is happening or embarrassing situations may arise).

The circuit of the set appears on Figs. 10 and 11. It is in fact a slightly simplified version of the 200 m.w. amplifiers which would do the job admirably well but are unnecessarily efficient for such a service.

The emitter resistors have been omitted. The coil is not a critical item but the more wire turns used, within reason, the better. One whole reel gives good results and makes a sufficiently good match for the input of the amplifier.

To operate the pick-up amplifier place the coil as close as possible to the back of the telephone Base

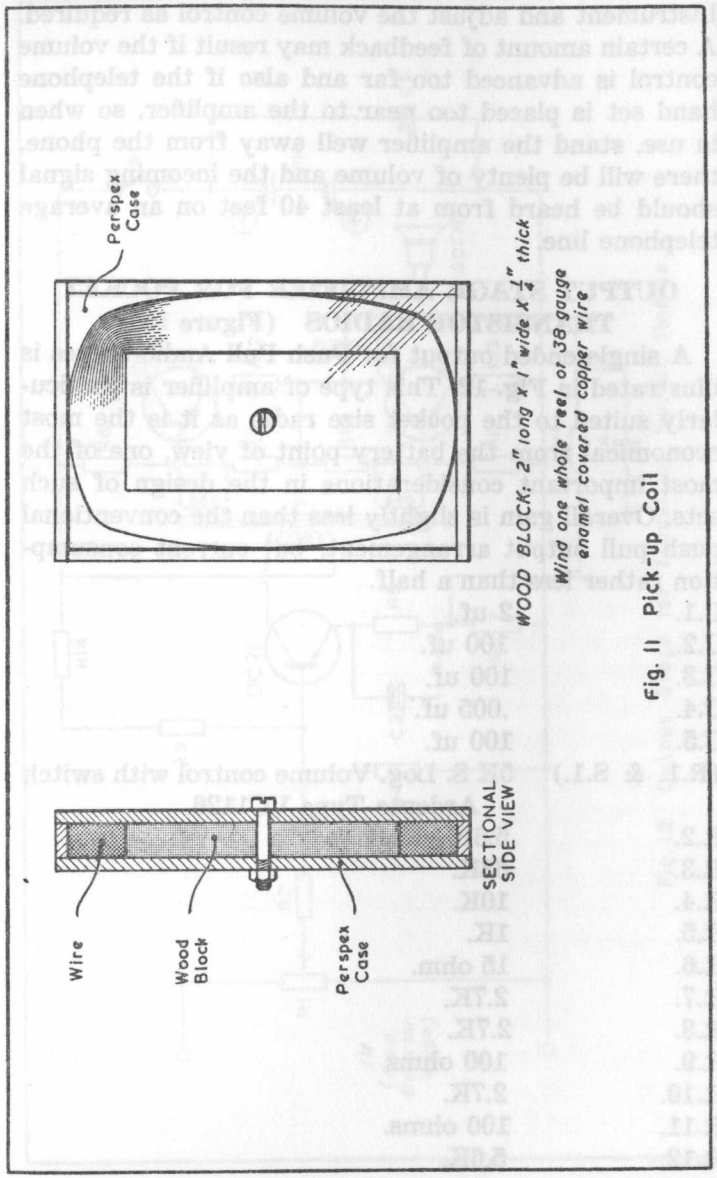


Fig. 11 Pick-up Coil

Instrument and adjust the volume control as required. A certain amount of feedback may result if the volume control is advanced too far and also if the telephone hand set is placed too near to the amplifier, so when in use, stand the amplifier well away from the phone, there will be plenty of volume and the incoming signal should be heard from at least 40 feet on an average telephone line.

OUTPUT STAGE AMPLIFIER FOR POCKET TRANSISTOR RADIOS (Figure 12)

A single ended output for Push Pull Audio stages is illustrated in Fig. 12. This type of amplifier is particularly suited to the pocket size radio as it is the most economical from the battery point of view, one of the most important considerations in the design of such sets. Overall gain is slightly less than the conventional push pull output arrangement, but current consumption rather less than a half.

C.1.	2 uf.
C.2.	100 uf.
C.3.	100 uf.
C.4.	.005 uf.
C.5.	100 uf.
(R.1. & S.1.)	5K S. Log. Volume control with switch Ardente Type VC1126.
R.2.	5.6K ¼ watt.
R.3.	68K.
R.4.	10K.
R.5.	1K.
R.6.	15 ohm.
R.7.	2.7K.
R.8.	2.7K.
R.9.	100 ohms
R.10.	2.7K.
R.11.	100 ohms.
R.12.	5.6K.

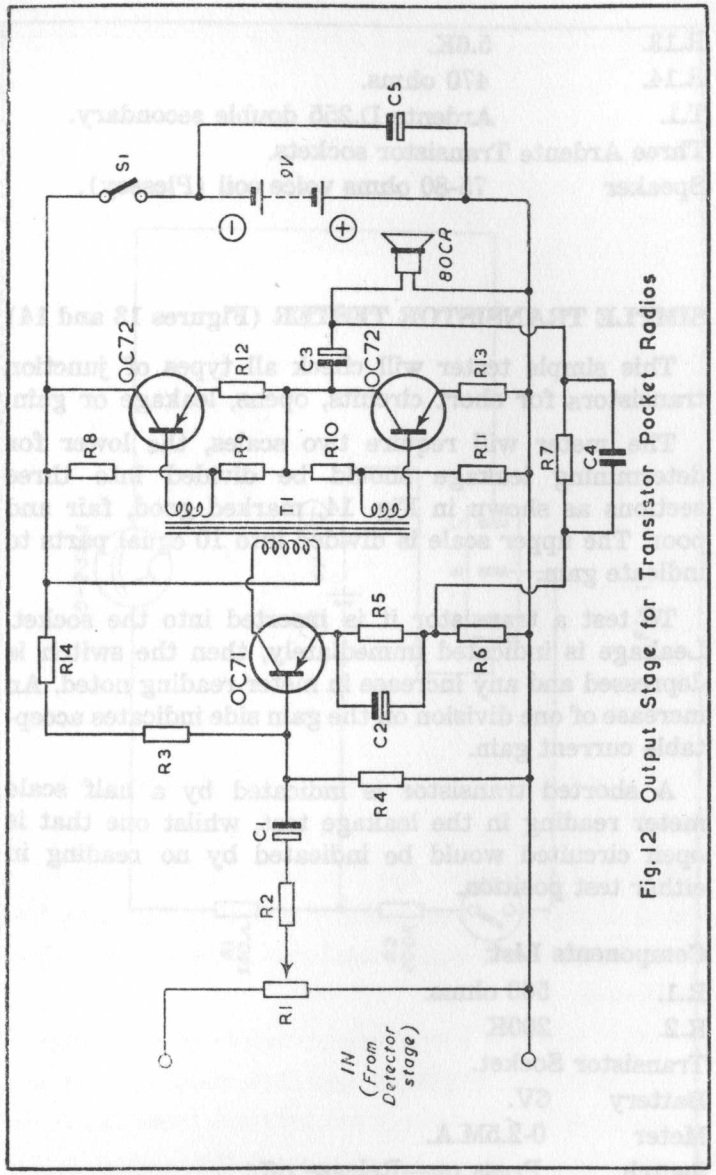


Fig. 12 Output Stage for Transistor Pocket Radios

R.13. 5.6K.
R.14. 470 ohms.
T.1. Ardente D.255 double secondary.
Three Ardente Transistor sockets.
Speaker 75-80 ohms voice coil (Plessey).

SIMPLE TRANSISTOR TESTER (Figures 13 and 14)

This simple tester will check all types of junction transistors for short circuits, opens, leakage or gain.

The meter will require two scales, the lower for determining leakage should be divided into three sections as shown in Fig. 14, marked good, fair and poor. The upper scale is divided into 10 equal parts to indicate gain.

To test a transistor it is inserted into the socket. Leakage is indicated immediately, then the switch is depressed and any increase in meter reading noted. An increase of one division on the gain side indicates acceptable current gain.

A shorted transistor is indicated by a half scale meter reading in the leakage test, whilst one that is open circuited would be indicated by no reading in either test position.

Components List

R.1. 560 ohms.
R.2. 200K
Transistor Socket.
Battery 6V.
Meter 0-2.5M.A.
Switch Press on—Release off.

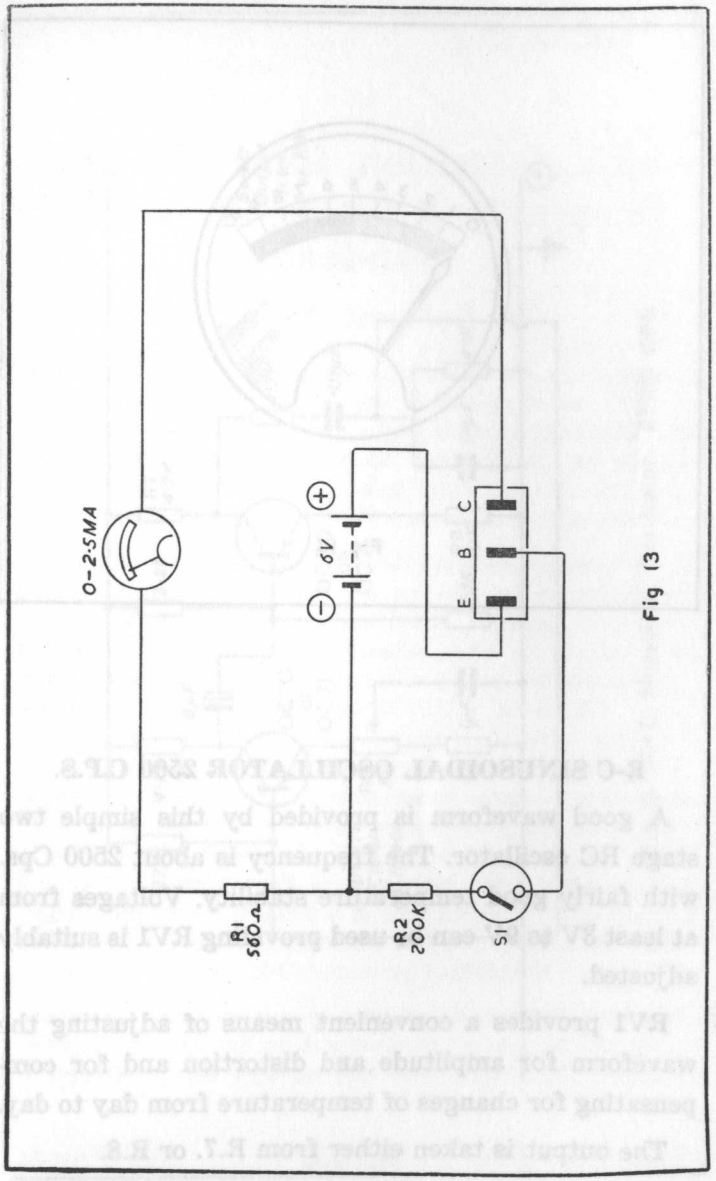


Fig 13

BERNARD'S AND BABANI PRESS RADIO BOOKS

No.		Price
56.	Radio Aerial Handbook	13p
57.	Ultra-Shortwave Handbook	13p
58.	Radio Hints Manual	13p
96.	Crystal Set Construction	8p
100.	A Comprehensive Radio Valve Guide, Book 1	30p
103.	"Radiofolder A". The Master Colour Code Index for Radio and Television	10p
104.	Three Valve Receivers	10p
121.	A Comprehensive Radio Valve Guide, Book 2	30p
123.	"Radiofolder F". The Beginners' Push-Pull Amplifier	10p
126.	Boys' Book of Crystal Sets and Simple Circuits	18p
129.	Universal Gram-Motor Speed Indicator	8p
138.	How to Make F.M. and T.V. Aerials, Bands 1, 2 and 3	18p
141.	Radio Servicing for Amateurs	20p
143.	A Comprehensive Radio Valve Guide, Book 3	30p
146.	High Fidelity Loudspeaker Enclosures	37½p
147.	Practical Tape Recording Handbook	30p
149.	Practical Stereo Handbook	20p
150.	Practical Radio Inside Out	25p
156.	Transistor Circuits Manual, No. 1	15p
157.	A Comprehensive Radio Valve Guide, Book 4	30p
160.	Coil Design and Construction Manual	30p
161.	Radio, T.V. and Electronics Data Book	25p
163.	Transistor Circuits Manual, No. 2	15p
165.	Hartley on Hi-Fi. Book 1—Radio Tuners	30p
168.	Transistor Circuits Manual. No. 4	15p
170.	Transistor Circuits for Radio Controlled Models	40p
171.	Super Sensitive Transistor Pocket Radio	20p
173.	Practical Transistor Audio Amplifiers, Book 1	20p
174.	Transistor Subminiature Receivers	32½p
175.	Transistor Test Equipment & Servicing Manual	25p
176.	Manual Transistor Audio Amplifiers	40p
177.	Modern Transistor Circuits for Beginners	40p
178.	A Comprehensive Radio Valve Guide, Book 5	30p
179.	Transistor Circuits Manual, No. 5	30p
181.	22 Tested Circuits using Micro Alloy Transistors	25p
183.	How to Receive Foreign TV Programmes on your Set by Simple Modifications	25p
184.	Tested Transistor Circuits using Professional Printed Circuit Modules. Transistor Circuits Manual No. 3	20p
185.	Tested Shortwave Receiver Circuits using MAT's	30p
186.	Tested Superhet Circuits for Shortwave and Communications Receivers using MAT's	30p
187.	The TSL Mark "4" Valved F.M. Tuner and its Construction	20p
188.	Construction of the B.H. High Fidelity "14" watt Audio Amplifier	10p
191.	Practical Car Radio Handbook	30p
501.	ABC's of Magnetism	30p
502.	ABC's of Missile Guidance	30p
	Resistor Colour Code Disc Calculator	10p
	Engineers' Reference Tables	10p
BP1	Handbook of Transistor Equivalents and Substitutes	40p
BP2	Handbook of Radio, T.V. and Industrial tube & valve Equivalents	40p