Tape and Wire Recording. A selection of articles reprinted from the pages of The Radio Constructor, covering both the theory and practical applications. A really useful book on this latest development of the hobby. 3/- post 3d.

Receivers, Preselectors and Converters. Practical articles, again reprinted from past issues of The Radio Constructor, which will prove of interest to many radio enthusiasts. 2/6 post 3d.

T.V. Fault Finding. Profusely illustrated with photographs taken from a television screen depicting the faults under discussion, and containing a wealth of technical information, with circuits, enabling those faults to be eradicated. 5/- post 2d.

F.M. Tuner Units for Fringe and Local Area Reception. Including optional Tuning Indicator and circuit of Osram 912 Amplifier. 2/- post 2d.

The Argonaut AM/FM MW/VHF Tuner Receiver. Describing the construction, alignment, and other details of a high quality tuner (or complete receiver), together with map of present and projected coverage areas. 2/- post 2d.

Radio Amateur Operator's Handbook. An indispensable aid to the amateur transmitter and listener, containing all details of information which are constantly required. Prefix Lists, Zone Boundaries, Call Areas, Codes and Mileage Tables, together with Maps and much other useful operating data. Latest edition. 3/- post 2d.

Inexpensive Car Radio. In which two versions, one constructed from surplus and one from new components, are described. 1/6 post 2d.


All available from your local bookseller, or from

DATA PUBLICATIONS LTD
57 MAIDA VALE LONDON W9

Telegrams Databux London Telephone CUNningham 6141 (2 lines)
THE MODERN BOOK CO

Transistor Techniques. Gernsback Library. 12s. 6d. Postage 9d.
Improve Your Reception. By J. Cura and L. Stanley. 5s. 0d. Postage 4d.
Frequency Modulation Tuner Units for Fringe and Local Area Recep-
tion. Data Publication. 2s. 6d. Postage 3d.
Electronics Made Easy. A Build-It-
Yourself Book. By L. Stern. 6s. 0d.
Postage 9d.
4s. 6d. Postage 6d.
World Radio Handbook. For List-
enors Broadcasting-Television. 1957.
12s. 6d. Postage 9d.
T.V. Fault Finding. Data Publication
No. 5. 5s. 0d. Postage 4d.

Sound Reproduction. By G. A.
Briggs. 17s. 6d. Postage 1s.
10s. 6d. Postage 9d.
Questions and Answers on Radio
and Television. By E. Molloy.
6s. 6d. Postage 6d.
18s. 6d. Postage 9d.
High Fidelity: The Why and How
for Amateurs. By G. A. Briggs
12s. 6d. Postage 9d.
Mk Buizen Handbook. 10s. 6d.
Postage 9d.
High Quality Sound Reproduction.
By Mullard Engineers. 3s. 6d.
Postage 4d.

We have the Finest Selection of British and American Radio Books in the country
Complete list on application
19-23 PRAED STREET (Dept RC) LONDON W2
Telephone PADlington 4185

DESIGNED FOR

TRANSMITTERS

WE HAVE THE FINEST SELECTION OF
BRITISH AND AMERICAN RADIO BOOKS
IN COUNTRY
COMPLETE LIST ON APPLICATION

THE TELETRON COMPANY LIMITED
266 Nightingale Road · London N9

The "AVO" Valve Characteristic Meter, Mk.III is typical of the ingenuity of design
and high standard of workmanship that exemplify all of the multi-range instruments
in the wide "AVO" range.

It is a compact and comprehensive meter that will test quickly any standard
valve or small transmitting valve on any of its normal characteristics under conditions corresponding to a wide
range of D.C. electrode voltages. The method of measuring mutual conductance ensures that the
meter can deal adequately with modern T.V. receiver valves. It does many useful jobs too numerous
to mention here, but a completely descriptive pamphlet is available on application.

List Price £75 complete with Instruction
Book and Valve Data Manual.

The AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD

AVOCET HOUSE · 92-96 VAUXHALL BRIDGE ROAD · LONDON · S.W.1.

TRADE ENQUIRIES TO S. MOZER 95 KENDAL AVE N18 TELEPHONE EDMonton 7707

505
PULLIN MULTI-RANGE TEST SETS

Get your new Test Set by return of post on the easiest of easy terms. Complete and post the coupon today, or write for descriptive literature.

SERIES 100: 21 ranges AC/DC from 100 microamps to 1,000 volts. Sensitivity 10,000 ohms per volt. £2-10-0 deposit and 9 monthly payments of £1.4-6. Cash price £17-7-6 complete.

MINIATURE: 19 ranges AC/DC from 200 microamps to 1,000 volts. Sensitivity 5,000 ohms per volt. £1-10-0 deposit and 9 monthly payments of 19½. Cash price £9-15-0 complete.

To Home Radio (Mitcham) Ltd., 187 London Road, Mitcham, Surrey. Please despatch one Pullin Test Set by return, I enclose £ for deposit and promise to pay 9 further monthly payments of £ .

Signed

Address

If over 21, Occupation from HOME RADIO OF MITCHAM

THE ACOS MIC 36

The ACOS MIC 36 crystal microphone performs as well as it looks. It is omnidirectional, highly sensitive, and has a substantially flat response from 30 to 7,000 c/s. It retails at £3.3-0 without switch or £3.8-0 with one, and is widely chosen for tape and disc recording, P.A. and amateur radio.

ACOS devices are protected by patents, patent applications and registered designs in Great Britain and abroad.

COSMOCORD LTD WALTHAM CROSS HERTS Telephone Waltham Cross 5206 (London telephone subscribers please dial WA 4 5206)
QUALITY F.M.
TUNER UNIT

SPECIAL
PRICE
£7.10.0
(p & p. 2/6)
(c.c.d. 1/6)

COMPLETELY BUILT, ALIGNED & TESTED
Circuit similar to that described in Data
Publications Ltd. Radio Reprint No. 2.
Write for details (S.A.E. please).

Built Power Pack 40/- (p. & p. 2/-) or
above in kit form £5. 12. 6 and 30/- respect-
ively (plus 2/6 b. & p.). Booklet 2/2 (free
with orders for Tuner or Kit).
Write for detailed price list
Band III Kit Set with Power Pack
with valves £9.91 and ECC81
Complete Converter £5 in Rexline (Lizard)
or walnut cabinet, 2 valves ECC81
Ditto metal cabinet, 90/-

GLADSTONE RADIO
828 HIGH STREET CAMBERLEY SURREY
Open Saturdays to 5 p.m.

ARTHURS HAVE IT!

Large Stocks of Valves and C.R.T.s
Full Range of Meters available
Avo, Taylor, Cossor, Advance, etc.
Particulars on Request
FM Kit of Parts £5, less valves
(Rel. Radio Constructor July 1954)
Amplifier/ Tape Recorder and
Loudspeakers
Jason FM Tuner Unit £17 17 0
Jason Power Pack £3 10 0
Radios and Television always in stock

VALVE MANUALS
Mullard, 10/6; Brimar No. 6, Osram, Part I,
Philco, Part II, 10/-
Postage 9d. each extra
Publications "Lodestar" Tape Recorder 3/6
Goods offered subject to price alteration and
being out of stock

Arthurs
Est. 1919
Proprietors ARTHUR GRAY LTD
OUR ONLY ADDRESS Gray House
150-52 Charing Cross Road
London WC2
TEl des 5833/34 and 4765

NEW - THE PRACTICAL WAY
of learning RADIO • TELEVISION • ELECTRONICS
AMATEUR S.W. RADIO • MECHANICS • PHOTOGRAPHY • CARPENTRY etc etc

NEW - completely up-to-date methods of giving instruction in a wide range of technical subjects specially designed and arranged for self-study at home under the strictest guidance of our teaching staff.

NEW - experimental outfits and lesson manuals are de-
patched on enrolment and remain the student's property.
A tutor is allocated to each student for personal and in-
dividual tuition throughout the course.
In the case of radio and television, specially prepared com-
ponents are supplied which teach the basic electronic circuits (amplifiers, oscillators, detectors, etc.) and lead, by easy stages, to the complete design and servicing of modern commercial radio and television receivers.

If you are studying for an examination, wanting a new hobby or interest, commencing a career in industry or running your own full-time or part-time business, these practical courses are ideal and may be yours for moderate cost. Send off the coupon today for a free brochure giving full details.

There is no obligation whatsoever.

SUBJECTS INCLUDE:-
RADIO
SHORT WAVE RADIO
TELEVISION • MECHANICS
CHEMISTRY • PHOTOGRAPHY
ELECTRICITY • WOODWORK
ELECTRICAL WIRING • DRAUGHTS-
MANSHIP • ART, etc.

PRESENTATION FREE

EMI INSTITUTES
159 Old Road
CLACTON-ON-SEA ESSEX

EMI INSTITUTES, Dept. 179, London, W.4

NAME
ADDRESS
BLOCK CAPE PLEASE

FREE present

EMI INSTITUTES, Dept. 179, London, W.4

E.M.I. STUDY COLLEGE

run by a world-wide
industrial organisation.

EMI STUDY COLLEGE

The only Home
Study College

run by a world-wide
industrial organisation.

EMI STUDY COLLEGE

-Part of "His Master's Voice", Morconiphone, etc. etc.
**REAPACO HIGH-GAIN COILS**

**DUAL-RANGE MINIATURE CRYSTAL SET COIL** with circuit. Type DRX1... 2/6

**DUAL-RANGE COIL** with Reaction. With 2 mains, 2 battery and transistor circuits. Type DRX2... 4/-

**MATCHED PAIR DUAL-RANGE T.R.F. COILS** with Reaction. With battery, mains and feeder unit circuits. Type DRM3... 8/-

**PAIR DUAL-RANGE SUPERHEAT COILS** with mains and battery circuits. Type SH4... 8/-

**FERRITE ROD AERIAL.** Long and Medium wave. Complete with fixing brackets. Type FR1... 12/6

**MINIATURE I.F. TRANSFORMER.** Pre-aligned 465 kc/s. $\frac{2}{3}$" x $\frac{2}{3}$" x $\frac{1}{3}$".

For battery or mains receivers. Type MSE... pair 12/6

**TRANSISTOR COMPONENTS**

Dual range super sensitive Ferrite Slab Aerial. Type F.S.2... 13/6

Combined Oscillators with 1st I.F. Transformer (315 kc/s). Medium and preset

Long Wave Type O.T.I... 11/6

2nd I.F. Transformer (315 kc/s) Type T.T.2... 5/-

3rd I.F. Transformer (315 kc/s) Type T.T.3... 5/-

Push-pull Interstage Transformer Type T.T.4... 8/-

Push-pull Output Transformer Type T.T.5... 8/-

FM Coil Set... 29/6

FM Tuner Unit Easy Wiring Plans... 1/6

MAIL ORDER and TRADE—

**RADIO EXPERIMENTAL PRODUCTS**

116-117 MUCH PARK STREET, COVENTRY

---

**VIDEO ELECTRONICS**

(LONDON) LTD

Head Office (Dept. RC) 22 Bacon Street London E1

Works (Dept. RG) 14/27 Bacon Street E2

Telephones Bishopsgate 0419/0410

**TV Tubes**

17" EB, 14" EB, 12" ES, etc.

Cheap, reliable high-grade seconds and reconditioned C.R.T.s, as supplied to the trade and leading Television Insurance Companies, prices from £3.

**Valves**

Send at once for our useful list of cheap valves which will save money. We are the cheapest in the trade.

Condensers

Electrolytic, bias, coupling, etc., etc., at give-away prices. All types stocked.

Resistors

A fine stock of these at very low prices.

Radio and TV Cabinets

A few radio table cabinets, new, interior sizes approx. 73" x 12" x 20" and 8" x 13" x 16", very handsome, made for export.

Send for stock list of speakers, valves, components and TV and Radio Spares. All our goods are guaranteed

---

**EMI INSTITUTES**

**POST THIS TODAY**

EMI INSTITUTES, Deps. 179, London, W.4

NAME

AGE

ADDRESS

I am interested in the following subject(s) with/without examination.

(We shall not worry you with personal visits.)

(£5 or 5s)

---

**WANTED**

**QUALIFIED MEN AND WOMEN**

Industry and Commerce offer their best posts to those with the qualifications—appointments that will bring personal satisfaction, good money, status and security. As part of a modern industrial organisation, we specialise in teaching for hobbies, new interests or part-time occupations in any of the subjects listed below. Write to us to-day for further information. There is no obligation of any kind.

**PERSONAL & INDIVIDUAL TRAINING IN—**

**OUR BACKGROUND!**

The only Home Study College operated by a world-wide manufacturing organisation

---

**FREE**

Part of "His Master's Voice," Marconi Telephone, etc.
FOUR-SIDED BLANK CHASSIS
Made in our own works from commercial quality half-hard aluminium of 16s.w.g. thickness, these chassis will carry components of considerable weight and normally require no corner strengthening.

Standard stock sizes (in inches) are as follows:

- 6 x 4 x 2
- 7 x 5 x 2
- 7 x 4 x 2
- 7 x 3 x 2
- 7 x 2 x 2
- 8 x 2 x 2

The above are sizes for which we have most demand, but we can also make other sizes to order (at a small extra charge) within the following limits: Depths 1", 1½", 2", 2½", and 3" only. Maximum length 18". Minimum width for 3" depth is 5". Minimum width for 4½" depth is 4½". Minimum width for 2½" depth is 3½". Minimum width for 1½" depth is 3". Minimum width for 1" depth is 2½". We cannot undertake to make odd shapes, extra bands, holes, etc. To arrive at the approximate cost of a special size of chassis take the nearest standard size above and add 2½. PANELS—We can also supply the aluminium for use as panels, screens, etc., cut to any size up to 3′ x 3′ at 4½ per square foot. NOTE.—A panel cannot be sent through the post if the length plus twice the width exceeds 6′. Keep this list for reference.

H. L. SMITH & CO. LTD 257/9 Edgware Road London W2 Telephone Paddington 5891

CR50 BRIDGE measures from 10pF to 100mF and from 1 ohm to 10 Megohms in fourteen ranges, having a total scale length of over 120 inches. Balance indication is given by a magic eye fed from a high gain pentode. Neon leakage test incorporated for condensers. Internal standards are "Constanza" 1% precision resistors.特別 designed for bench use with case and panel of steel, finished black crinkle and scale of anodised aluminium. Size 5½ x 8½ x 5½ high with sloping panel. Complete with all valves, full instructions and ready for use from 200/250V a.c. mains. Price £7 18. 0 plus 4½ carriage and packing.

If you are not completely satisfied with the instrument return within three days and money refunded in full and without question.

SG50 SIGNAL GENERATOR covers 100 kc/s to 80 Mc/s on fundamentals. Price £6 10. 0 plus 6½ carriage and packing.

VV50 VALVE VOLTOMETER measures up to 250 volts d.c. and a.f. and r.f. Price £7 19. 6 plus 4½ carriage and packing.

Further details sent per return of post on receipt of stamped and self-addressed envelope.

GRAYSHAW INSTRUMENTS (RC) 126 SANDGATE HIGH STREET FOLKESTONE KENT Telephone Folkestone 78618

Build for Quality

WITH THE FAMOUS JASON ARGONAUT KIT

The “Argonaut” is a super-sensitive unit to receive medium-wave AM and FM transmission. It can be built either as a tuner for feeding to a small speaker, or a complete receiver. Switching and wiring are reduced to complete simplicity without sacrificing performance and efficiency, and since its introduction the “Argonaut” is creating more and more enthusiasts for its all-round excellence.

Full building instructions are available as a Data Publication. Reprint, price 2½.

Send S.A.E. for complete list of components and prices.

JASON MOTOR AND ELECTRONIC CO 328 CRICKLEWOOD LANE LONDON NW3 Telephone SPeredwell 7050

CR50 BRIDGE measures from 10pF to 100mF and from 1 ohm to 10 Megohms in fourteen ranges, having a total scale length of over 120 inches. Balance indication is given by a magic eye fed from a high gain pentode. Neon leakage test incorporated for condensers. Internal standards are "Constanza" 1% precision resistors. Specialized designed for bench use with case and panel of steel, finished black crinkle and scale of anodised aluminium. Size 5½ x 8½ x 5½ high with sloping panel. Complete with all valves, full instructions and ready for use from 200/250V a.c. mains. Price £7 18. 0 plus 4½ carriage and packing.

If you are not completely satisfied with the instrument return within three days and money refunded in full and without question.

SG50 SIGNAL GENERATOR covers 100 kc/s to 80 Mc/s on fundamentals. Price £6 10. 0 plus 6½ carriage and packing.

VV50 VALVE VOLTOMETER measures up to 250 volts d.c. and a.f. and r.f. Price £7 19. 6 plus 4½ carriage and packing.

Further details sent per return of post on receipt of stamped and self-addressed envelope.

GRAYSHAW INSTRUMENTS (RC) 126 SANDGATE HIGH STREET FOLKESTONE KENT Telephone Folkestone 78618

RADIO CONTROL

FOR MODEL SHIPS, BOATS AND AIRCRAFT

by F. C. JUDD, G2BCX

To operate a model ship or aircraft is a most interesting hobby. But how much more fascinating it would be if one could emulate the skipper or pilot and remain in control after the model has been set off on its course. This, thanks to radio control, can now be done, and enthusiasm for it is steadily mounting. Radio Control for Model Ships, Bosts and Aircraft has become a recognised handbook in this field.

144 pages 135 diagrams and illustrations

Standard Edition, art board cover, 8s. 6d. post 5d.

Cloth bound, with gold lettering, 11s. 6d. postage 7d.

DATA PUBLICATIONS LTD 57 MAIDA VALE LONDON W9

REPANCO

"THREE DEE" TRANSISTOR RADIO FOR HOME CONSTRUCTORS

A new dual-range radio with bandpass tuning using a crystal diode and three transistors.

Amazing loudspeaker reception and low running costs from 73 volt battery supply.

Designed for local station reception, the “Three Dee” is ideal for caravan installation, bedroom, workshop or second home radio set.

Chassis size 6 x 4 x 2 (speaker extra)

SEND NOW!

1/2 POSTAL ORDER FOR EASY WIRING PLANS AND INSTRUCTIONS

Radio Experimental Products Ltd 33 MUCH PARK ST. COVENTRY

WWW.AMERICANRADIOHISTORY.COM
The NEW
I.C.S.
LEARN-AS-YOU-BUILD
PRACTICAL RADIO COURSE
as you build your
own receiver and
testing instruments

This new addition to the unrivalled I.C.S. range of technical training courses offers you a double opportunity. Here is your chance to gain a sound knowledge of basic Radio and Electronics theory—under expert tuition—whilst building your own 4-valve radio receiver, signal generator and high-quality multi-tester.

WHAT YOU GAIN
At the end of the course you will have gained not only three permanent, practical and useful pieces of equipment, you will have accumulated a personal "library" of reference material— I.C.S. Instruction Manuals, expertly edited and presented—which you can keep by you always for guidance. Furthermore, you will have gained immeasurably in knowledge, through a balanced combination of study and practical work—with the specialised help of the world's largest correspondence school.

TRAINING TO SUIT YOUR NEEDS
Whether you plan to have a business of your own, to become a service engineer, to pursue a career in the radio industry, or to take up radio as a serious hobby—this course provides the ideal way of obtaining a firm foundation of essential knowledge. If you are an intending examination candidate, I.C.S. training offers you the most thorough preparation you could have.

There are I.C.S. courses to meet your needs at every stage of your career.

POST THIS COUPON TO-DAY
for a FREE book on careers in Radio, etc., and full particulars of I.C.S. courses.

INTERNATIONAL CORRESPONDENCE SCHOOLS
Dept. 248A International Buildings Kingsway London WC2

INTERNATIONAL CORRESPONDENCE SCHOOLS

4-valve Receiver

Multi-tester (sensitivity 1,000 ohms per V)

RF/AF Signal Generator


The
Radio Constructor
incorporating THE RADIO AMATEUR

CONTENTS FOR MARCH

516 Suggested Circuits: A Simple Remote Control Employing Existing Speaker Leads, by G. A. French
519 In Your Workshop
525 Television for the Home Constructor, Part 9, by S. Welburn
534 Transistor Sets for the Beginner, Part 2, by James S. Kent
537 Technical Forum
539 The "Mini-Max," a Transistor Pocket Radio for Local Reception, Part 1, by I. F. Gregory
545 The "Versatile" Amplifier, by J. G. Ransome
547 Can Anyone Help?
548 Radio Miscellany, by Centre Tap
550 Multivibrator Design—Using C-R Curves to Simplify Calculations, by Hugh Guy
557 Field Report on the "Eavesdropper" Miniature Transistor Local Station Receiver, by W. G. Morley
559 Right—from the Start: Part 13, Measurement, by A. P. Blackburn
563 A "Three-Plus-One" Superhet Receiver, by P. L. Wingrove

THE CONTENTS of this magazine are strictly copyright and may not be reproduced without obtaining prior permission from the Editor.
Opinions expressed by contributors are not necessarily those of the Editor or proprietors.

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.

QUERYES. 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 Maid Vale London W9

514

515
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. 76. A SIMPLE REMOTE CONTROL DEVICE
EMPLOYING EXISTING SPEAKER LEADS

The writer has recently received
several letters from readers who, whilst
remaining complimentary in general,
have had a minor complaint to make. This
complaint has been that, over the past few
years, the circuits offered for the experimenter
in these columns have suffered from a
 tendency to become rather "highbrow." The
correspondents concerned have stated that
the beginner should be kept just as much in
mind as the more advanced constructor.
The writer has given some thought to this
argument and will in consequence endeavour
to present, every now and again, devices
employing fairly simple principles in future
"Suggested Circuits." (It is, of course,
possible that other readers may then complain
that the articles are becoming too elementary!) This Month's Circuit
This month's circuit is one which, it may be
safely stated, falls well within the simpler
class, insofar that no special equipment is
required for its construction and because the principles involved in its operation are easy
to visualise. No new techniques are involved
in its design, and the circuit takes advantage
of several known factors to produce a device
which should prove to be extremely useful in
its own particular application.

The circuit is that of a remote control
system which is capable of switching elec-
tronic equipment on or off from a distance
with the minimum of interconnecting wires.
In the particular circuit discussed here it is
assumed that the equipment under control is
a radio receiver or an a.f. amplifier, where-
upon the remote control facility is obtained
over the same pair of leads that feed the
remote loudspeaker. No other interconnect-
ing wires are needed. It must be pointed out
that the circuit is not recommended for use
with equipment having "live" chassis unless
some form of mains isolating transformer is
fitted. This is because such equipment can
cause the remote control wiring to attain the
same potential as that of the mains supply,
with consequent risk of shock. However, for

a.c. equipment employing a mains trans-
former, functioning should be safe and
reliable.

In order to obtain a switching facility over
the existing loudspeaker wiring, the circuit
takes advantage of the fact that it is possible
to connect a condenser of some 500µF in
series with the low impedance wiring to an
extension loudspeaker without incurring any
noticeable loss in quality of reproduction, or
undue attenuation of bass frequencies. The
insertion of such a condenser may not recom-
 mend itself in high fidelity applications
(using the term in its undebased sense). For
normal domestic reproduction, nevertheless,
the effect is negligible.

In this month's circuit, a capacity of 500µF
is inserted in series with the leads to the
extension loudspeaker in the form of two
1,000µF condensers connected in series. One
of these condensers is fitted at the equipment
end of the interconnecting wires, and the
other at the loudspeaker end. The presence
of the condensers then enables a d.c. control
voltage to be passed along the speaker lines
without upsetting a.f. operation.

The complete circuit is shown in the
diagram which accompanies this article, and
its functioning may be described as follows.
Let us assume that the controlled equipment
is switched on and that the operator is at the
remote, loudspeaker, end of the intercon-
necting lines. The operator presses the "On"
button, thereby causing the battery at the
remote station to energise the relay at the
equipment. Current from the battery does
not flow through the loudspeaker or the
secondary of the loudspeaker transformer
due to the presence of the two condensers C1
d and C2. It will be noted that the polarity of
the battery corresponds to that of the two
condensers, with the result that the latter are
not subjected to incorrect usage.

When the relay energises, its contacts
complete the power circuit to the equipment
being controlled, this becoming switched on
in consequence. After a period (dependent
on the type of rectifier employed) h.t.
becomes available in the equipment, with the
result that a voltage is applied to the relay
coil via the series limiting resistor R3. This
energising voltage has the same polarity as
that of the remote battery.
The "On" button at the remote station
may now be released, whereupon the voltage
obtained from the equipment h.t. supply
maintains the relay in the energised condi-
tion. At the same time this voltage polarises

516
THE RADIO CONSTRUCTOR
MARCH 1957
517
www.americanradiohistory.com
to the equipment. (The small-value resistor R2 prevents the flow of excessive discharge current from C1 and C2.) The "Off" button needs to be depressed only for the short time needed for the h.t. voltage in the equipment to fall to a low value, after which it may be released. The equipment is now switched off and the circuit is ready for a further switching-on cycle, as desired.

**Practical Points**

As will be realised, the whole circuit is quite simple in theory, and should give positive and reliable results in practice. A slight disadvantage is introduced by the necessity of having a battery at the receiver side, but as this is required to supply current only for the short period before h.t. appears in the controlled equipment, its useful life should be quite long. In order to make the circuit foolproof, additional contacts are added to the "Off" button, these "making" when it is released. The purpose of these contacts is to prevent the battery being short-circuited if both buttons are accidentally pressed at the same time.

It should be emphasised that care must be taken to ensure correct polarity throughout the wiring of the circuit. If, for instance, the battery is connected up with reverse polarity the circuit will work perfectly and the electrolytic condensers may suffer damage. Similar incorrect working would be given if the remote leads to the speaker became reversed. When plug and socket arrangements are used in the remote lines, these should be of the non-reversible type.

The relay employed in the circuit should have a high resistance coil, coil resistances of 2,000Ω or more being normally suitable. Such relays will usually operate with energising voltages around 9 volts or so, and can be maintained in the operated state by energising currents of several milliamperes. The voltage needed to energise the relay will, of course, dictate the working voltage required for C1 and C2. The series resistor R1 should have a value sufficiently low to enable the relay to hold on after it has been energised. This current will be lower than that needed to operate the relay and ensures minimum drain on the equipment h.t. supply. R1 also limits the current drain from the h.t. supply when the "Off" button is pressed. Suitable P.O. type relays for the circuit are available in the surplus market. Although the contacts of such relays are rather light for switching mains voltages, they appear to be quite adequate in practice. It would be advisable to mount the relay in such a manner that its yoke is isolated from the chassis of the controlled equipment. The earth connection illustrated in the diagram ensures that mains voltages may not find their way onto the remote control wiring. The relay should be employed for switching a.c. mains circuits only.

Two final points which need to be discussed concern the h.t. supply in the equipment being controlled. The first of these is that it should be ascertained, before using the circuit, whether the h.t. power supply circuits are capable of providing the few extra millamps needed by the relay after it has been energised. In practice this precaution should cause little difficulty, as the extra loading involved is so low. The second point has to do with the delay between the remote "On" button being pressed and the appearance of Dick's receiver. In the controlled equipment as will be realised, it is desirable to keep this delay to as low a figure as possible. If the equipment employed a metal h.t. rectifier, h.t. voltage will appear almost immediately after the relay has been energised; with the result that the "On" button needs to be pressed only for a very short while. When a directly-heated valve rectifier is used, a delay of some ten seconds may occur before the full h.t. voltage appears, this being not too excessive. With indirectly-heated rectifiers the delay will be longer (depending upon valve type) but, even here, it may not be longer than twenty seconds or so in some cases. It must be pointed out that, where equipment circuitry allows, the delay caused by an indirectly-heated rectifier can be reduced by replacing it with a directly-heated type.

**New Bulb Switches**

We have received a sample of three new switches now being manufactured by A. F. Bulgin & Co. Ltd., of Bye Pass Road, Barking, Essex. These are known as "Jack-stacked" switches, similar to the well-known G.P.O. Keyswitch, have a really delightful action. They are strongly constructed on a rust-proofed steel frame and have switching leaves of highest spring grade nickel silver, with pure silver contact points. The action locks securely to the switching leaves, or returns under bias, according to the model concerned. All are double-pole change-over plus double-pole change-over. Model S.700 is non-biased and locks in three positions; Model S.702, as before, has the side and centre locking; Model S.702 has both sides biased with the centre the normal position.

Working rating: 0.01–250V, 50 c/s; 5V 2A, 50W max. load. Peak test voltage, 500 c/s, dry or recovered. Retail price, 10s. each.

---

**Sound On Vision**

The workshop settled down quietly for the next ten minutes or so, the silence being broken only by the sound from Dick's receiver, as he checked its performance. After a while his face creased into a frown, this becoming fiercer and fiercer as time went on. Finally, he gave a rather self-conscious cough and walked over to Smity.

"I'm sorry, Smity," he remarked contritely, "but I'm afraid you were perfectly right when you told me to check that set in its cabinet. It has got a fault now, and I'm not quite certain what to do about it."

"Not to worry," remarked Smity soothingly, "that sort of thing happens to the best of us at times. What's the snag?"

"So far as I can see, it's sound on vision," replied Dick. "I'll show you what's wrong."

He directed Smity to follow him and examined the receiver. He noted that the set was tuned to a Band III channel, and that a musical programme was being reproduced. The louder notes of the programme caused heavy horizontal bars to run up or down the screen. Smity checked the setting of the fine tuner, then varied the volume of the receiver. The bars became more noticeable as volume increased. It seemed apparent, also, that certain notes were causing more interference than others. Smity gave the side of the cabinet a light smack with the flat of his hand and was rewarded with a momentary succession of horizontal bars on the screen.

"Well," he remarked, "there's no denying that this is a case of sound on vision. Also it's almost certainly caused by a microphonic..."

---

**Smity continues to run the Workshop, aided once more by his able assistant, Dick**
Dick pushed the set to the back of the bench, so that he could keep an eye on it as he continued with his other work.

I notice,” he remarked, “that you changed the oscillator and the tuner, and you might get away with making any comments about probable differences in self-capacities between the two valves. Isn’t it possible that the new valve might upset the pre-set turrut?”

“You’ve made rather a good point there,” replied Smithy, “but in this case the faulty valve was so very bad that it was best discarded. Perhaps if I were to digress for a minute or two and enlarge on the subject of microphony you might see what price was accepted.”

“The most prevalent source of microphony in valves is changing capacities between cathode and heater, this being followed by changing capacities between the other electrodes. The reason for this is that because of thermal expansion, it is rather difficult to make the heater of a valve fit really tightly into its cathode, whereas the other electrodes can be mounted quite rigidly. So far as the heater and cathode are concerned, a small amount of ‘stop’ is often liable to occur between these two electrodes; whereupon the capacity between them will vary if the valve is shaken. Changing capacities between cathode and heater can cause trouble if the valve is used in such applications as an electron-coupled oscillator, like this (Fig. 1). In this diagram the capacity between heater and cathode enters the tuned circuit. If an electron-coupled oscillator is employed in a mixer stage working at frequencies above 40 Mc/s or so, the risk of microphony due to catheter-heater movement can be quite high.”

Fig. 1. A typical e.c.o. oscillator, showing how the capacities between grid and cathode, and between cathode and heater, vary in tuning the coil. All possible capacities are not shown here.

“I see,” remarked Dick. “It’s just a question of using a compromise approach which still protects the set-owner. Incidentally, I was once asked to change one of the ‘standard’ triode-pentode in the mixer position, and that there are one or two more valves of the same type elsewhere on the chassis. Can you go through logic of these with that in the tuner, and save the customer the price of a valve?”

“There you are, you see,” commented Smithy, proudly. “Do I get a few bright ideas now and again? Even if I don’t quite realize why they are bright! By the way, just why should the oscillator of the mixer stage be the one chosen to have the sound? Is it something you can’t get rid of? Don’t the changing capacities in the valve cause frequency and not amplitude modulation?”

“They do, indeed,” confirmed Smithy;
“but the frequency modulation given by the microphonic oscillator causes the signal to 'ride up and down the skirts of the video i.f. response curve. The result is that the frequency, modulation causes amplitude modulation, and it is that which appears on the picture. The oscillator is the worst offender in the sound on vision field because it only needs a slight change in its self-capacities to cause a considerable change in frequency and, hence, in video amplitude. You get the same effect on the short-wave bands of sound receivers, incidentally. In these sets a changing oscillator frequency causes the i.f. signal to similarly ride up and down the skirts of the i.f. response curve. As the i.f. response skirts of this type of receiver are usually relatively steep, the conversion to amplitude modulation takes place very rapidly. A microphonic frequency-changer oscillator can then cause a feedback howl to appear on the short-wave bands whenever a station is tuned in; the feedback loop being formed through the receiver to the speaker and back again. The final link in the loop is given by the sound waves from the speaker impinging on the microphonic oscillator. I hardly need to remind you, of course, that the microphonic effect gets worse as oscillator frequency increases. In television receivers, the risk of sound on vision due to microphonic oscillator valves or components is worse on Band III than it is on Band I.”

Sound Rejection

“Well, I have added something more to my stock of knowledge,” remarked Dick. “I can now say that, if I get sound on vision, I can start looking around the oscillator stage for microphony.

“Yeah, you’ve got half the picture if you say that,” protested Smithy, “there are quite a few other things which can, and do, cause exactly the same trouble! I think the best thing I can do is to outline the routine of tracking down the cause of sound on vision for all receivers, and then you will have a more balanced idea of the subject. The first step consists of switching on the suspect receiver and seeing how it operates. If the sound on vision becomes worse as you turn the volume up, then the trouble is most probably of the type we have just discussed. In that case a few light taps — light, mind you, not heavy bashes — will help you to locate the faulty stage. If it is in the oscillator circuit, as is most likely, it may be the valve. If it is a grid valve you may have to dig around inside the turret, or mixer stage itself, to see if any particular component has become microphonic. I don’t recommend actually disconnecting any of the oscillator components, especially if a turret is used, but a very light tap on each might help to locate the trouble. You don’t want to spend too long on that sort of fault-finding, however, because it is easy to be misled by false scents. The best rule is never to change any suspect component unless it is obviously that which is causing the microphony. Fine tuner spindles occasionally work loose and cause microphony, by the way, and this should be checked. Now and again the trouble is caused by intermitter contacts in turrets and not by microphony at all. Intermittent contacts to occasionally clear what appears to be microphony by rocking the mixer valve in its holder. Here again, it pays to be reasonably gentle as with miniature valveholders rocking the mixer valve in the corresponding movement in the under-chassis components connected to the socket, whereupon these may become damaged.

The rare case where sound on vision is caused by microphony or intermitter connections. As I pointed out earlier, snags of this type can be recognised because the pitch of microphony will usually change as you turn the volume up. Unfortunately, there is another occasional cause of sound on vision which has rather similar symptoms. The trouble is that the video output stage is giving trouble. Look for unwanted couplings between the audio stages and the rest of the receiver. In most cases the trouble is due to feedback. I don’t refer to video output stage, whereupon this stage causes audio to appear on the h.t. line. In some receivers the sound output stage is decoupled from the h.t. line by its own separate electrolytic condenser, whereupon this component becomes a definite suspect. The electrolytic condenser decoupling the whole h.t. line should also be examined. Another condenser of the same value connected temporarily across a suspect condenser usually shows up any lack of capacity in the h.t. line. If this test does not establish any disconnections or unsoldering, I should point out that if the suspect electrolytic has a higher value than, say, 40-0 F or so, this value and the condenser should be added, and removed with the set switched off so that there is no necessity for sudden charges or discharges. You can get some very fat sparks from condensers having values as high as this, and they don’t do the condenser any good at all!”

“Couldn’t you differentiate this particular trouble from the microphonic snag by disconnecting the speaker?” interjected Dick. “You would then still be able to adjust the volume to see its effect on the picture and the question of microphony would be settled one way or the other with certainty.”

“It is a good idea to disconnect the speaker to identify cases of this type,” agreed Smithy, “but I would strongly advise you to load the speaker transformer secondary with a resistor having approximately the same value as the impedance of the speaker you have disconnected. If the transformer is not loaded in this manner, you can get some very high a.f. voltages appearing across the primary when the volume control is restricted to a high setting. This may easily cause sparking in the speaker transformer or between pins of the output valve base. Such sparking may cause a breakdown or may leave a ‘track’ which accelerates breakdown later.”

“Life gets complicated at times,” sighed Dick. “Still, I suppose that attention to these little points is all part of the game!”

“You’ll get used to it in time,” chuckled Smithy. “Anyway, now let us review our findings. You assumed that, when you originally examined your faulty set you found that the sound on vision occurred only in the volume control, and was evident even when it was set right back at minimum. In this case, your snag lies in the i.f. strip, and the chances are that the sound has fallen out of alignment. However, before taking any serious servicing action in this event, it might be worth while making a few checks on the fine tuned control before finally condemning the chassis. In quite a few receivers the sound rejection circuits give a very sharp dig in the video i.f. response, and may be found to be set out of alignment. In fine tuner setting will cause the sound i.f. to fall nicely into the centre of the dip, whereupon the sound on vision should clear. Indeed, assuming that the vision i.f. strip as a whole is reasonably well tuned up, the position of maximum sound rejection nearly always corresponds to optimum amplification of the video i.f. When I refer to ‘fine tuners,’ incidentally, I don’t necessarily mean the fine tuners brought out as a front panel control on 12-volt receivers. These are capable of adjustment by the set-owner who can usually be relied upon to get the hang of their operation once he has had the set in his care for a while. Instead I meant, rather, the fine tuners or oscillator trimmers fitted at the rear of earlier sets which are normally adjusted by the service engineer. It sometimes happens that these fall sufficiently out of adjustment for sound on vision to appear without the picture becoming too badly degraded.”

“I see,” remarked Dick. “I always thought, though, that if you set the fine tuner for maximum volume you automatically obtained maximum sound rejection as well. Doesn’t that make the adjustment of the fine tuner, or trimmer, a fairly simple operation?”

“Well, it does happen that maximum sound and maximum rejection occur at the same fine tuner control setting in some receivers, but this cannot always be guaranteed,” returned Smithy. “In fact, if a single coil performs the dual function of sound take-off and sound rejector, the two fine tuner settings are almost always slightly removed from each other. There is also the fact that the sound i.f. response curve is altogether sharp as the sound rejection dip, which means that tuning for maximum sound doesn’t give a sufficiently accurate indication. If the sound i.f. strip has been properly adjusted for maximum sound becomes even less well-defined. So the best plan, if you want really accurate results,
is to adjust the fine tuner for minimum sound on vision."

"That's all very well," protested Dick, "but I'm still not too happy about it. For instance, what happens if you try to tune for minimum sound on vision if the sound programme at the time is of a quiet nature?"

"You can often," replied Smithy, "intensify the effect of sound on vision by turning up the r.f. gain of the receiver and reducing brilliance. In some sets working under such conditions you can actually see the sound carrier come up on the screen as a 3.5 Mc/s 'grain.' When that occurs you tune for minimum 'grain.'"

"Well, I suppose it doesn't seem so complicated, really, when you think of it," commented Dick. "What it all boils down to is that, if the i.f. strip is properly aligned, it is best, with the average receiver, to tune the oscillator for minimum sound on vision rather than for maximum sound. In some receivers the sound rejection dip is very sharp and the oscillator tuning is, as a result, rather critical. If the serviceman has to adjust the fine tuner control himself he should make an attempt to do so as accurately as he can; if necessary using the dices you have just mentioned. When the fine tuner is at the front of the set, you rely on the set-owner to find the best position."

"Yes, I think that sums it up pretty well," commented Smithy. "Although I think I should add that, when the fine tuner is on the front panel, the set manufacturer has probably done his best to prevent too sharp a sound rejection dip."

"What happens when the i.f. strip is out of alignment?"

"In that case," said Smithy, "the only really reliable advice I would give to anyone would be to align it with the aid of the service manual and a signal generator whose frequency calibration is known to be accurate. I certainly would not recommend an inexperienced person touching the i.f. cores of any television set unless he has the manual at his side. I must admit, nevertheless, that there are one or two little dodges that can be employed if a manual isn't available and you are only worried about adjusting the sound rejector coils. One consists of tuning the receiver for optimum picture on a test card transmitted without any sound on vision that may occur. To get a steady effect from the sound channel you then connect the output of a signal generator to the aerial socket, leaving the aerial still connected, and tune it to the sound carrier of the received signal. When the generator is at the correct frequency it beats with the sound carrier, and you finally adjust it for zero-beat from the loudspeaker. If you next switch the signal generator to give a modulated output and adjust its attenuators accordingly, you get the modulation showing up nice and steady on the screen. What you finally do is adjust the sound rejector coils for minimum modulation on the test card when on the job is finished. If the signal generator range does not enable it to reach the sound carrier frequency, you will get the same result if you inject it into the i.f. strip at the sound i.f. frequency. Most sets have an i.f. test point somewhere around the mixer stage to which a signal generator can be connected. Alternatively, you may sometimes get enough i.f. injection by pushing an insulated lead between the mixer valve and its screening can, and by connecting the 'hot' side of the signal generator output to this lead. I should state, by the way, that I can only recommend this particular procedure for adjusting sound rejector coils as an idea to be carried out by the more experienced engineer. It is by no means as effective a process as that of aligning the strip according to the instructions in the manual. Also I can offer no guarantees as to its effectiveness in any particular case."

Dick chuckled. "You should have been a politician," he remarked. "I've never heard anyone make so many statements with so few guarantees!"

"One has to be careful in this business so far as statements are concerned," grinned Smithy. "Anyway, you have reminded me that, like many politicians, I seem to be in the middle of an excessively active Question Time just now. Perhaps we should get down to a bit of work for a change."

"O.K.," said Dick resignedly, turning back to his bench. "I thought the political atmosphere couldn't last for ever."

---

**TELEVISION for the HOME CONSTRUCTOR**

**PART 9**

by S. WELBURN

This month S. Welburn, our popular contributor on television topics, devotes his article to a discussion on wobbulator principles and techniques.

From time to time, the writer receives requests from readers asking that space be devoted in the present series of articles to the techniques employed in alignment with a wobbulator and oscilloscope. Amongst other things, the growing interest shown by readers on this particular subject is due not only to the fact that devices of this type are becoming more and more frequently encountered, but also because a certain number of readers have active servicing interests or hope shortly to be actively engaged in such work. There is also, of course, the point that information on wobbulator tech-

---

**FIG. 1**

Fig. 1. Simplified diagram showing the basic set-up employed with a wobbulator and oscilloscope using 50 c/s sweep.

---

with the subject of wobbulators is that it is a little difficult to avoid describing particular commercial instruments. Quite a number of commercial wobbulators are available on the market at the present date, and the writer does not wish, for various reasons, to refer to any of these specifically. As, however, their principles of operation are all inherently similar, he feels that generalised references will cover all the more important points likely to be encountered. Unfortunately, there is not sufficient space in a single article to deal with the subject of wobbulators in its entirety. This month's contribution will,
Frequency Sweep

When a series of tuned circuits are employed in radio or television equipment, there are two basic methods by means of which such circuits may be aligned and set up. First of these consists of applying one or more fixed frequencies to the equipment, and of adjusting the various tuned circuits such that they resonate at the particular frequencies recommended by the designer of the equipment. The condition of resonance in each tuned circuit is indicated by a maximum or minimum reading, as applicable, on an instrument connected to the output of the equipment. Usually the indicating device is a meter, but it may also be an oscilloscope or a loudspeaker. In the latter case they are connected and the appropriate tuned circuits are adjusted for maximum or minimum sound from the speaker.

The second method of alignment necessitates the use of test gear which is rather more complicated. For this method a frequency-modulated signal is applied to the terminals of the equipment being aligned, the output of the equipment being applied to the Y amplifier (vertical deflection) of an oscilloscope. The horizontal deflection is synchronised with the modulation of the input frequency. When correctly set up, this arrangement enables a picture of the overall response of the tuned circuits in the equipment to be displayed on the tube of the oscilloscope.

Both of the methods of alignment just detailed have inherent advantages and disadvantages. The greatest advantage of the second, frequency-modulated, method of alignment is that it enables a considerable amount of time to be saved when it is necessary to achieve a particular response curve. As was mentioned earlier, however, the question of advantages and disadvantages will be discussed more fully in next month's article.

Since the second method of alignment is of greater interest in this particular context, it would now be advantageous to consider its basic operation in more detail. This we may do with the aid of Fig. 1.

Fig. 1 illustrates a typical set-up employing a wobblator (or, to use more correct non-electronic language, a sweep generator or frequency-modulating signal generator) the equipment which is to be aligned, a detector circuit, and an oscilloscope. The frequency of the wobblator is made to alter continually, such that its output sweeps across the range of frequencies over which the response of the tuned circuits in the equipment under test is to be examined. The output of the wobblator is then applied, via an attenuator, to the input of the equipment under test. The speed at which the wobblator frequency is changed is normally kept to a relatively low figure; and at television frequencies it is becoming common practice to employ the 50 cycle mains voltage (stepped down by a transformer) to provide the required voltage.

Using the 50 c/s mains supply in this manner confers several advantages, one of the more important of these being that this is a very low frequency, so that the complication of employing a separate modulating oscillator in the wobblator. A second advantage is that a slow change in wobblator frequency (as is given at 50 c/s) prevents excessive shock-excitation of high-Q tuned circuits in the equipment under test during the period of the sweep. Additionally, there is the advantage that the sweep frequency of 50 c/s enables the oscilloscope to be equipped with sweep frequencies which are somewhat larger in value, and resistant loads which are rather smaller, than those used for conventional a.f. work. As an example, the oscilloscope X amplifier shown in Fig. 1 would employ coupling condensers having values around 0.25uF or so, rather than the more common value of 0.01uF used in normal a.f. equipment.

The frequency-modulated signal fed into the equipment under test passes through its various tuned circuits, appearing finally at its output terminals. However, whereas the amplitude of the wobblator signal applied to the input of the equipment under test was constant at all frequencies, the amplitude of the signal as it emerges from the output will vary with frequency according to the overall response of the tuned circuits in the equipment. At the output terminals of the equipment being aligned we are interested only in amplitude variations, and can forget the fact that the signal we obtain is frequency-modulated as well. To enable the amplitude variations to be handled by the oscilloscope Y amplifier, it next becomes necessary to detect them. This detection is carried out in the same manner as is used for a.m. detection in a conventional receiver; and, in Fig. 2, a crystal diode is employed for the purpose. After detection, we obtain a voltage which is varying in amplitude according to the particular relationship between the response of the equipment under test and the frequency being provided by the wobblator. The instantaneous value of the detected voltage varies, therefore, during the sweep of the wobblator; and it may be considered, in effect, as an alternating voltage having a rather complex waveform.

The lowest basic frequency of this alternating voltage is the 50 c/s modulating source which controls the wobblator sweep. Because of this, the detected signal can be treated by the oscilloscope Y amplifier almost as though it were a conventional audio frequency signal, with the result that we may employ reasonably normal a.f. techniques in this amplifier. This similarity does not hold entirely true, however, because it is usual to ensure that phase shift is kept to a minimum and that the low frequency 50 c/s component of the detected signal is not excessively attenuated in the oscilloscope Y amplifier by employing coupling condensers which are somewhat larger in value, and resistant loads which are rather smaller, than those used for conventional a.f. work. As an example, the oscilloscope X amplifier shown in Fig. 1 would employ coupling condensers having values around 0.25uF or so, rather than the more common value of 0.01uF used in normal a.f. equipment.

After detection and amplification, the voltage appearing at the output terminals of the equipment under test is finally applied to the Y plates of the oscilloscope tube. The method of connection used here is normally phased such that the spot of the oscilloscope tube is deflected upwards when the detected voltage increases in amplitude.

The 50 c/s source employed for modulating the frequency of the wobblator is next applied to the X plates, or to the X amplifier, of the oscilloscope. In consequence, the spot of the oscilloscope now travels horizontally, keeping in step with the changing frequency of the wobblator. Since, at the same time, the spot is deflected vertically according to the amplitude of the detected voltage, a trace is obtained on the tube of the oscilloscope which corresponds to the response curve of the equipment under test.

Practical Details

There are a number of minor details which have not been mentioned in the explanation just given, and which apply to the layout of Fig. 1 when used in practical form. These points will now be dealt with.

The first concerns the fact that the frequency of the wobblator oscillator is modulated by a voltage which is obtained from the 50 c/s mains supply, this supply also providing horizontal deflection in the oscilloscope. Since the 50 c/s modulating voltage is present all the time, we may then obtain the situation wherein the frequency of the wobblator is altered first in one direction, and then in the reverse direction, as successive half-cycles of a.c. are passed to the modulating circuit. At first sight there appears to be nothing wrong with this state of affairs, since the paths traced out by the oscilloscope spot in both directions should be identical, and would coincide to give a single response curve on the screen. In practice, nevertheless, difficulties can arise due to the presence of small discrepancies between the forward and the reverse traces, these sometimes resulting in the presence of two slightly different curves on the tube. When such differences become large, the trace may become fuzzy and ill-defined, or may even break up into two separate discrete lines. The reasons for the discrepancies between the two curves are mainly small phase shifts in the equipment under test, and in the various amplifiers of the oscilloscope. Phase shifts may also occur in the frequency-modulation arrangements
employed in the wobulator, these being possibly at their worst when a mechanical device, such as a mechanically driven variable condenser, is used to vary the oscillator frequency. Another possible discrepancy would be ringing in one or more of the tuned circuits in the equipment under test. If ringing at a particular frequency were present the effect would be evident in one direction for the first scanning period, and in the other direction for the reverse scanning period. Fig. 2 illustrates this effect in somewhat exaggerated form.

The simplest method of overcoming the discrepancies between the two traces consists of removing one altogether, and this can be achieved by cutting off or "blanking" the output of the wobulator during alternate half-cycles of the control voltage. During the time in which the blanked-out curve would otherwise appear, the output of the wobulator is zero. The blanking process is usually achieved in the wobulator itself, a single-valve switching circuit sufficing to remove the output during the required period. The result of this arrangement is to cause the oscilloscope tube to display a response curve of the type shown in Fig. 3. In this diagram the line ABC represents the response curve of the equipment under test, and is given during the period when the wobulator output is switched on (i.e. not blanked). At point C the direction of change of wobulator frequency and of spot movement reverses. At the same instant, however, the output of the wobulator is blanked off; whereupon the spot traces a straight line CDA before it reaches point A again, this line corresponding to zero voltage at the input terminals of the equipment under test.

At point A the movement of the spot and the direction of frequency alteration once more reverse, and the blanking circuit in the wobulator switches in the output once more. The spot on the tube now commences to retrace the curve ABC as before.

It should be noted that, although we have described the response curve as being traced by a spot moving from left to right in this particular instance, we would obtain an equally useful result if the spot had moved from right to left, the blanking period occurring during its return to the right. The direction in which the spot moves whilst tracing the response curve is unimportant so long as blanking occurs during its return journey.

It will be noticed that the curve illustrated in Fig. 3 now has a base line, this occurring during the blanking period, or "retrace," whereas that of Fig. 2 (c) did not. Amongst other things, the retrace performs a somewhat useful purpose insofar as it enables the person using the wobulator and oscilloscope to obtain an idea of what part of the trace the line can pass on the zero input to the equipment under test. Another rather useful factor is that its presence enables the average voltage passed to the line of the oscilloscope to remain more steady with relation to the response curve for changes in shape of the latter. This point will be dealt with in more detail later on.

Blanking circuits are fitted as "standard" on most wobulators intended for television alignment and using sinusoidal modulating voltages.

Linearity
As we have already mentioned, the modulating voltage applied to the wobulator oscillator, and the scanning voltage applied to the X plates of the oscilloscope, is normally obtained from the 50 c/s mains supply. Such a voltage is, of course, sinusoidal, with the result that the line of the oscilloscope will be non-linear in the horizontal direction. This fact is of some importance, for we do not require a perfect horizontal linearity on a response curve display, a reasonable degree of linearity is obviously worth aiming for. Fig. 4 illustrates a cycle (point A to point E) of the control voltage, and we may assume that we shall be employing the half-cycle which lies between points A and B for examining our response curve. (The section between B and C will then correspond to the blanking period.) If we examine the half-cycle between points A and B closely we can see that, due to its shape, its non-linearity becomes worse as we approach its ends. On the other hand, the centre part of the sine wave is reasonably linear. We would, therefore, be improving the horizontal linearity of our trace if we worked between two points on either side of the centre of the half-cycle. We could, for instance, examine the response curve between the limits D and E.

It is possible to employ a technique of this type for improving linearity by the simple process of aligning the frequency sweep in the wobulator and greater horizontal deflection in the oscilloscope than is really required for the response curve proper. A typical example is illustrated in Fig. 5. In this diagram, the horizontal deflection of the oscilloscope is widened such that the outer limits lie outside the area of the tube face. Similarly the sweep of the wobulator is increased so that the response curve now occupies a smaller part of the total overall trace. Despite these changes the response curve still appears on the face of the tube and, since it is now being displayed over the more linear part of the modulating and deflection voltage, its horizontal presentation is more linear. The dotted lines of Fig. 5 represent the two ends of the trace which lie outside the area of the tube and which are, in consequence, lost. (They would, of course, be visible if the tube area were larger.) Their loss is unimportant as they contain information which is of use to us in the present field of interest.

The amount by which the trace has to be widened to enable the response curve to appear on its more linear centre section need not necessarily be as great as that shown in Fig. 5. It should also be pointed out that physical limitations are set by the frequency sweep available from the wobulator. It is fairly safe to say that reasonable horizontal linearity will be obtained if the response curve occupies less than some two-thirds of the total overall scan. It must be borne in mind, however, that lack of linearity in the oscilloscope presentation does not present any disadvantages that are excessively serious. Even if due to, say, frequency sweep limitations, a particularly wide response curve were to occupy almost all of the scan period available, as it does in Fig. 3, the resulting heavy non-linearity would not prevent the equipment being used for purposes of alignment. The person using the gear would merely have to bear in mind that the non-linearity was greatest at the ends of the trace; these tending to be compressed in the horizontal dimension.

Phasing
A practical difficulty affecting the design of wobulators is raised by the necessity of ensuring that the frequency modulation of the wobulator oscillator, the deflection of the spot on the oscilloscope tube, and the action of the blanking circuit are all accurately phased in relationship to each other.

Fig. 6 illustrates several half-cycles of the 50 c/s supply which is used to control these three circuits. As we know from Fig. 4, we can employ the period from point A to point B to modulate the wobulator oscillator. Assuming that no phase shifts occur we may also use this period to deflect the oscilloscope spot horizontally. All being well, the frequency modulation and horizontal deflection will then both remain in step with each other.

A snag becomes apparent, unfortunately, when we consider applying this same 50 c/s...
voltage to the valve which carries out the blanking function. A typical method of blanking consists of applying a proportionately large 50 c/s sine wave to the grid of the blanking valve, using a circuit similar to that shown, in simple form, in Fig. 7. On positive half-cycles the valve of Fig. 7 conducts, whilst on negative half-cycles it cuts off. The waveform appearing at its anode is, as a result, a square wave; and this can be employed to control a second circuit which switches the wobbulator output on or off, as desired. Alternatively, the conduction, or otherwise, of the valve may itself control the wobbulator output.

The reason for discussing the circuit of Fig. 7 in some detail is to point out that the blanking circuit can only function on half-cycles which are enclosed within the points C and D of Fig. 6. However, these points are 90 degrees out of phase with the half-cycles enclosed between points A and B, with the consequence that, if the blanking period is to be kept in step with the frequency modulation and deflection periods, the 50 c/s control voltage applied to it must be 90 degrees out of phase with that applied to the other two circuits.

The requisite 90 degree shift for the blanking circuit may be obtained in the wobbulator by means of fixed phase shift networks. However, it often happens that the wobbulator is provided with a panel phasing control which enables final adjustments to be made. Setting up such a phasing control normally necessitates ensuring that blanking occurs only at the ends of the trace and does not cause any of the response curve proper to be cut off.

Although, as was mentioned above, the a.c. control voltage modulating the wobbulator oscillator may also deflect the oscilloscope spot with good synchronism, difficulties are caused in practice by phase shifts in either or both of these circuits. (See also footnote.) Because of the presence of such shifts, some wobbulators have a second phasing control (fitted normally to the deflection circuits) to enable exact synchronism to be obtained.

A.C. Voltage

We referred earlier to the fact that the use of a blanking circuit in the wobbulator enables a more steady average voltage line relative to the response curve to be obtained for changes in the shape of the latter.

Fig. 6. Several cycles of the modulating voltage, demonstrating the 90 degree phase difference needed between the modulating and blanking voltages

This particular fact may be better understood if we consider once more the fact that the detected output given in the set-up of Fig. 1 consists of an alternating voltage. We then amplify this voltage in something of the same manner as we do an a.f. voltage, using conventional a.c. couplings. As a result, the detected signal applied to the Y plates of the oscilloscope has lost its d.c. component. Because of this, the only part of the trace which will remain steady on the tube in the vertical direction will be that which corresponds to the average voltage of the signal. Fig. 8 (a) and (b) illustrate two response curves without blanking period base lines. The area enclosed by the response curve of Fig. 8 (a) is large, whereas the average voltage of the waveform will have the position shown approximately in this diagram. The area enclosed by the response curve of Fig. 8 (b) is small, and the average voltage will be lower on the curve, as shown. If, during alignment, the curve at (a) should become altered to that at (b), the whole trace would move upwards on the screen of the oscilloscope tube (the average voltage remaining constant).

Fig. 7. A simple circuit illustrating how a square wave may be obtained from the sinusoidal modulating voltage. A small-value condenser is sometimes connected across the series grid resistor to sharpen up the edges of the square wave.

Fig. 8. The position of the average voltage of a trace may be made more stable by the addition of a base line as in (c) and (d). Widening out the trace, as in (e) and (f), gives even further stabilisation.
fixed). This effect can sometimes be very irritating, especially if the movement is sufficiently large to cause the top of the curve to fall outside the tube area. Fig. 8 (c) and (d) represent the same two curves respectively, with the difference that, this time, a base line has been added by the use of a blanking circuit. Due to the presence of the base line the average voltages of each response become lower and, whilst a difference still exists between them, this is smaller than occurred in Fig. 8 (a) and (b). The final result is that there is less vertical movement of the trace on the oscilloscope tube. Even better vertical stabilisation would be given if the sweep and deflection were widened out, as they are in Fig. 8 (e) and (f). In this case the average voltages for each curve are even lower, and the vertical difference between them still less again.

The fact that smallest vertical movement of the trace on the oscilloscope tube occurs when a trace such as that shown in Fig. 8 (e) and (f) is used also covers the situation where changes in wobbulator output level are made whilst alignment proceeds.

The Detector

The set-up shown in Fig. 1 illustrated a detector following the equipment under test, its purpose being to convert the r.f. appearing at the output terminals into a form suitable for amplification by the oscilloscope Y amplifier.

It should, of course, be mentioned that many items of equipment liable to be aligned contain their own detector circuits, whereupon an external detector circuit is not required. A typical example would be given by a vision f.I. strip, wherein the oscilloscope Y amplifier could be connected to the video diode lead.

Summing Up

In order to leave a final clear picture of what occurs when a wobbulator is employed with an oscilloscope, it might be of value to examine the successive steps described in the article with the assistance of a diagram showing the various waveforms encountered. Such a diagram is given in Fig. 9. In this figure all the waveforms shown are drawn against amplitude and time.

Waveform A shows the 50 c/s voltage which controls the frequency modulation and deflection circuits. Waveform B illustrates the output obtained from the wobbulator before blanking is provided. This waveform appears as an r.f. of constant amplitude, it being assumed (ideally) that the output level is constant over all periods of the sweep. Waveform C illustrates the wobbulator output after a blanking circuit has been provided. Waveform D demonstrates what appears at the output of the equipment under test. As may be seen, this consists of an amplitude modulated carrier with blanking periods. Waveform E represents the detected signal, this consisting of a number of individual response curves, each separated by a blanking period.

Waveform F illustrates the trace displayed on the oscilloscope tube, this consisting of the response curve sections superimposed on each other, to form a single curve; and the blanking periods superimposed on each other in the reverse direction to form a single base line.

Next Month

In next month’s article, the advantages and disadvantages of wobbulator techniques will be discussed, as will also any hints which may be of advantage to the home- constructor. The question of injecting frequency markers will also be dealt with.

THE RADIO AMATEUR OPERATOR’S HANDBOOK

A NEW EDITION—THE 4th REVISED EDITION (Green Cover)

Essential to both the Transmitter and the Listener, this latest publication is chock full of such information as Amateur Prefixes (both in alphabetical and country order), Radio Zone Boundaries—1-40, Call Areas, Amateur Band Frequency Allocations, Local Time Conversion, Mileage Table, Amateur Codes and Abbreviations, the Amateur Licence, International Morse Code, QSL Bureaux of the World, Standard Frequency Transmissions, Operating Technique, Maps, and Charts on which countries, states, zones and counties heard or worked can be logged.

Price £3/postage 54.

DATA PUBLICATIONS LTD 57 MAIDA VALE LONDON W9

Telephone CU/Sheenham 6141 (2 lines)
TRANSISTOR SETS FOR THE BEGINNER

PART 2

by JAMES S. KENT

Last month two simple receivers were described, with which the beginner to transistors could construct, experiment, and have fun generally. In this instalment it is proposed to describe two more simple circuits, using much the same components as were used in the two receivers previously featured—thus ensuring that, for a minimum outlay in cash, the experimenter can gain more practical knowledge of transistors.

The first unit to be described is that shown in Fig. 1, where it will be seen that it is a simple Long and Medium Wave Feeder Unit. As such it is eminently suitable for feeding either an amplifier or a tape recorder, although the output circuit may have to be modified somewhat in order to suit the input impedance of the particular unit to which it is coupled.

The circuit is simplicity itself, and is designed around a Repanco type DRR2 coil, variable tuning capacitor, Yakley type switch, transistor and a few other small items (see Component List). The aerial coupling and band switching is effected by a 3-pole 2-way switch, which also connects an appropriate tapping on the tuned circuit to the transistor base. The transistor is operating in the earthed emitter mode (roughly analogous to the triode), the collector load resistor being of such a value as to obtain optimum voltage gain. The output is taken via a 0.1µF condenser from the collector in the customary manner. This value is suitable for the next audio stage has a high input impedance, but would be raised to several microfarads if the next stage had a low input impedance, as, for example, a further grounded emitter transistor audio amplifier.

The h.t. voltage applied will affect the output obtained, and some experiment here would be worth while. In any event, do not forget that the polarity of the h.t. supply is opposite to that of ordinary valve circuits.

A study of the accompanying photograph will show the actual method of construction used. A small piece of aluminium, 3in. by 4in., 1/2 in. thick was cut and bent so that the base is 21/2 in. wide, and the various components are then mounted. The drilling locations, which are not critical, can be seen from the illustrations and, in any event, depend on the actual size of the individual compo-
A 3-way tag strip, of the type having the centre tag earthed, is used for external connections such as the aerial input and the feeder unit output, etc. The whole unit is reasonably compact and simple, and should take only a short time to construct.

Bandpass Feeder Unit
This is shown in Fig. 5, and from the circuit it will be seen that, in this case, two type DRR2 coils are used, each being tuned by a section of a 500pF variable 2-gang condenser. The degree of inductive coupling between the two tuned circuits will be affected by the distance between each coil, in the prototype shown (see accompanying photograph) this being 1.1in. The 70pF trimmer condenser provides capacitive top coupling and, in operation, this will need some adjustment to provide optimum signal strength. Little more need be said about the circuit as it is extremely simple. The remarks made previously about h.t. voltage and output condenser value also apply here.

The method of construction is clearly visible from the photograph, from which it will be seen that the whole assembly is again mounted on a small piece of aluminium which has been bent in order to form both a front panel and base. The aluminium size is 6in by 4in; this being bent upwards some 2in from one end, leaving the base 3in by 4in.

Component Lists

**Long and Medium Wave Feeder Unit**
- Coil—Type DRR2 (Repacon)
- 500pF variable condenser (solid dielectric) J.B.
- 100kΩ resistor 1 watt
- 0.1μF condenser
- Transistor—Red Spot or Blue Spot
- 3-pole 2-way Yaxley switch
- Panel and base—Repacon
- 5-way Tag Strip, centre earthed

**Band Pass Feeder Unit**
- Coils (2)—Type DRR2 (Repacon)
- 500pF variable condenser (2-gang) J.B.
- 100kΩ resistor 1 watt
- 0.1μF condenser
- Transistor—Red Spot or Blue Spot
- 4-70pF trimmer
- 5-pole 2-way Yaxley switch
- Panel and base (Repacon)
- 5-way Tag Strip, centre earthed

The 100kΩ resistor, together with the output coupling condenser, is mounted and wired on to the 5-way tag strip shown belted to the base of the unit. The transistor, of course, being suspended with its own wiring as shown. Once constructed, and properly adjusted for best results, the unit should prove to be a useful radio tuner for either a valve amplifier or even a transistor a.f. stage or stages.

It is to be hoped that this short series of articles on transistors, both the theoretical and practical, has not only proved to be of some value to the transistor beginner but also of some interest to those about to take the plunge in transistorising equipment. The whole subject is fascinating, to say the least; and, although the transistor is now in its infancy, there is no doubt at all that it will, in the future, come to be used more and more by the radio enthusiast.

**Technical Forum**

**Intermittent Faults**

A reader recently wrote to us describing a defect which had developed in his television receiver. It appears that each time the set was switched on nothing happened for about 15 minutes, when a judicious tap or two on the side of the cabinet suddenly corrected the trouble, and the receiver operated normally. Being a busy individual he was too busy to investigate the fault for nearly a year, but during the whole of this time a carefully placed tap on the cabinet after the set had warmed up always brought results. Defects of this nature develop occasionally in electronic equipment, and from the writer's experience may usually be traced to either a valve or a resistor.

Intermittent faults are always a headache to the service engineer because they so often behave in a manner similar to toothache: they are most troublesome when the remedy is far away, but tend to disappear when repair action is about to be taken. We have known service engineers to run sets for hours waiting for an intermittent defect to appear, in some cases to find that it disappears again when the receiver is being moved to the bench. However, some knowledge of the causes of these troubles can frequently save much valuable time.

**Resistors**

In the case of the television receiver mentioned above, it was found that a carbon resistor used in the.h.t. decoupling circuit had overheated and become intermittent. This is not a fault which is inherent in these components, but it does sometimes occur, and when it does its location may cause some trouble. The best approach is to first determine the most probable part of the receiver to house the defective resistor, and then examine in turn each unit in that section. For example, if a television set developed intermittent collapsing of the frame time-base, leaving a thin horizontal line across the picture tube, those resistors in the frame timebase would first be examined, in particular any which may show signs of overheating. Overheating may not necessarily be the prime cause of failure, but may well be the result of it. Should the carbon crack, the resistance may increase appreciably, and thus the IR drop (wattage) across the fracture can be high. Whether or not overheating is present largely depends upon whether the resistor is in such a position in the circuit to permit it to pass sufficient current. A quick check for a fracture is obtained by applying a gentle but firm side or end pressure on the resistor. The direction is shown by the arrows in Fig. 1, which also indicates a typical hair-line break in the carbon body of the resistor. A gentle pull on the lead out wires will also show whether they are firmly anchored to the main element of the resistor. These tests will usually reveal a faulty resistor, but should they fail recourse must be made to resistance measurement.

![Fig. 1. A fracture in a carbon resistor may be detected by gentle pressure](www.americanradiohistory.com)
As a precaution against this happening, it is generally recommended if valves have to be mounted horizontally that they are rotated to such a position that the major axis of the grids is vertical. This is shown in Fig. 2.

Yet another reason for the intermittent operation of a valve is a broken weld which probably only makes contact after the valve has warmed up, and allows the metal to expand and remake the connection. Valve defects of the type mentioned are usually susceptible to vibration and the offending component can usually be located by gently tapping each in turn.

![Diagram of a tetrode valve](image)

**Fig. 2.** Cross-section of a tetrode valve indicating the plane in which the assembly should be mounted.

There is a particular fault which is peculiar to superhet receivers and causes them to become silent at certain times, usually when the mains voltage is low. This is due to the temporary stopping of the local oscillator, usually because the oscillator valve emission is low so that it will only oscillate when the supply voltage is fairly high. The obvious cure is to test and renew the oscillator valve (usually the frequency changer), but before doing so, check I.t. and h.t. voltages, and compare them with the valve maker's recommended figures. The I.t. is the most critical and should be within ±1 1/2 of the correct value.

This type of fault is particularly troublesome in the battery portable class of receiver where premature failure is often taken as an indication that the batteries require renewing. The battery voltage will fall gradually during life, and if all is well in the receiver the frequency changer should continue to function until the I.t. has fallen from 1.5V to about 1V. However, if oscillation ceases before this value is reached, the valve should be tested. Another contributory factor of this trouble is insufficiently tight coupling between the turns of the two windings comprising the oscillator coil. Coils made specially for use in battery receivers have the maximum possible coupling which is obtained by placing the windings one above the other.

**Fuses**

Intermittent faults are often blamed for the sudden, and on the face of it, inexplicable blowing of fuses from time to time. Whilst in many cases this is so, and some of the faults mentioned may well blow a fuse, there are instances when a fuse will open without any overload current. This may be expected to occur when a standard fuse is employed to carry a steady current near its rated value. It is usual to employ a fuse with a rated current value which is at least twice that which it is normally expected to carry. If this gives inadequate protection to the equipment, then one of the special thermal cut-outs as made by Belling & Lee should be employed.

In this short resume of the major cause of intermittent operation, no mention has been made of capacitors or transformers. Capacitors may be checked for mechanical connection in the same way as resistors, although they seldom exhibit this type of fault. Transformers rarely go intermittent; usually turns become permanently shorted or the wire parts and they become open circuit. In the writer's opinion the defects listed are those which are most likely to give trouble, and to be aware of them goes a long way towards their speedy rectification.

The article on the Collaro tape deck has had to be unavoidably held over.

---

**Radio and Electronic Component Show**

**TICKET ARRANGEMENTS**

The R.E.C.M.F. has discontinued the label badge system of admission for visitors to the 1957 Radio and Electronic Component Show, to be held in London from 8th to 11th April. This year double tear-off tickets will be issued which will admit to both sections of the show, at Grosvenor House and at Park Lane House. These tickets will be issued from the R.E.C.M.F. offices and at all prospective bona fide visitors should apply in writing direct to The Secretary, Radio and Electronic Component Manufacturers' Federation, 21 Tothill Street, Westminster, S.W.1.

---

**TRANSISTOR POCKET RADIO for Local Station Reception**

**PART 1**

by I. F. GREGORY

---

**S**ince last year's National Radio Show there has been an increasing interest shown in transistors; though unfortunately, apart from the Red and Blue Spot types, r.f. junctions are only now slowly becoming available to the constructor. The Red and Blue Spot junctions are capable of a good performance on the medium waveband, but despite this the construction of a pocket superhet is a matter of considerable difficulty. At the time of writing a small 2-gang conventional, the J.B. type "O," and a range of small i.f. transformers and oscillator coil to suit, are obtainable; but these are not really in the sub-miniature class, and there are no indications of any such items comparable to those available in the States being on the way—though there have been one or two rumours.

The Pocket Radio described here has been designed to produce a really small-sized receiver, and yet one capable of giving a reasonable volume of sound despite its physical dimensions—and this on a "speaker." The quality is, naturally, not in the Hi-Fi class; however, if the receiver is to be small and not too expensive to build, this is unavoidable.

**The Circuit**

Fig. 1 shows the circuit diagram of the receiver, the r.f. section of which consists of a single tuned circuit consisting of a ferrite frame aerial tuned by a variable condenser, feeding a germanium diode detector. This is followed by a step-down transformer to match the output of the detector into the base of the first transistor audio stage. Then follow a further four stages of audio amplification, using Mullard OC71 transistors or their equivalents.

The power supply consists of three Mallory (obtainable from Boots the Chemists) mercury hearing-aid cells, giving a total of some 4V. The "speaker" used is an ex-W.D. balanced armature earphone, which is easily obtainable.

The receiver will give an output of about 40mW in areas of good signal strength.

---

**MARCH 1957**
The Case
After a very extensive search for a suitable plastic case in which to build the receiver, the writer finally decided to use a cheap sandwich box, sold generally under the name “Elevenes Pack” and illustrated here. It should be stressed that the set has been designed to fit this particular box, after the latter has been modified, and construction would be greatly facilitated by its use.

Preparation of Box
The plastic box when bought is nearly 21-in deep, and as a final depth of 11-in only is required it can be cut horizontally as shown in Fig. 2. Great care should be exercised during this operation, as this type of plastic fractures very easily. It is, therefore, suggested that a very fine-toothed saw of the Dovetail type be used, and that the cut be kept wet whilst sawing.

On completion of this stage it may be found that the lid is now a little too tight; this is, however, all to the good as a very tight final fit is essential. The lip on the lid may be lightly filed until the desired fit is obtained. The box will require still further modification, but this is dealt with later in the article.

The Chassis
Paxolin sheeting of approximately one-sixteenth inch thickness provides a very suit-

able material for the chassis, as it can be easily cut and offers sufficient strength. A sheet measuring 6-in by 6-in will be needed as a second piece is required for the front of the box, described later in the article.

The chassis should be cut to fit closely into the box, with all four corners rounded to conform with the shape and give it maximum size.

Figs. 3 and 4 show respectively the underneath and top layouts with the main components identified.

The Transformer
Mounting the transformer presents some problems, and the following observations may be of assistance. Mounting directly on to the chassis was found to result in a howl owing to vibrations from the speaker being picked up. This trouble can, however, be completely eliminated (except when the gain control is fully advanced) by insulating the transformer by means of a rubber seating. A hole should be cut in the chassis of a size somewhat larger than the transformer (a 1-in clearance each way should be sufficient). Now place the transformer, leads downwards, upon a piece of rubber strap, and sink the laminations and leads into the strip. Cut the latter considerably oversize, and secure this assembly to the
chassis by means of two small screws and nuts. It is suggested that a small quantity of 12-BA screws and nuts be purchased from a model shop, as these are required as anchorages elsewhere, and can also be used for mounting the transformer.

![Diagram of chassis with 12-BA screws and nuts](image)

### FIG. 5 MOUNTING OF TRIMMER- SHOWING MODIFICATIONS

Tuning Condenser
The 700pf trimmer is mounted as shown in Fig. 5. The adjusting screw must be replaced by one of similar thread and having a length of 3-in, to enable a tuning disc (knob) to be fitted and also to allow sufficient space for locking nuts for this disc and the mounting nuts for the whole assembly. It may be found necessary to shorten the threaded mounting sleeve on the trimmer to give more room for these modifications.

**(to be continued)**

**Components used in Prototype**

- TR1, TR2, TR3, TR4, TR5: Mullard OC71 (or Henry’s Red Spot)
- C1: 700pF ceramic trimmer Henry’s Radio
- C2, C3, C4, C5, C6: 6pF 1.5V T.C.C.
- C7: 32pF 1.5V T.C.C.
- R1, R3, R7: 220kΩ 1/2W
- R4, R6, R8: 4.7kΩ 1/2W
- R9: 50kΩ 1/2W
- R10: 8.2kΩ 5/8W/V/ with switch, Arden V.C.1126

Crystal Diode, Mullard OA71 or similar
L1: Teletron ferrite frame type FRM/SP
Solder tags, Sub-miniature, G. W. Smith, Lisle Street
Speaker, Balanced Armature Earpiece, ex-W.D.
Batteries, 3 Malory Cells R.M.1 (Boots the Chemist).
12-BA Screws and Nuts, Bonds o’ Euston Road, 357 Euston Road, N.W.1

---

**The Television Society Exhibition, 1957**

**Place:** The Royal Hotel, Woburn Place, London, W.C.1.

**Dates:** Tuesday, 5th March, 11.30 a.m.-8 p.m. (members only); Wednesday, 6th March and Thursday, 7th March, 12.0 a.m.-8 p.m. (ticket holders only).

**Tickets:** are available, free, from the Television Society, 164 Shaftesbury Avenue, London, W.C.2.

**Exhibitors:** At the time of the issue of this press notice the following exhibitors will be taking part:
- Automatic Coil Winder & Electrical Equipment Co. Ltd.
- C. H. Banthorpe Esq.
- Belling & Lee Ltd.
- B.R.E.M.
- British Broadcasting Corporation
- Bush Radio Ltd.
- A. C. Cosson Ltd.
- Cinema-Tele-Ton Ltd.
- Edison Swan Ltd.
- E.M.I. Electronics Ltd.
- The Ever-Ready Co. (Gr. Britain) Ltd.
- J. S. Fielden
- General Electric Co. Ltd.

**Hallam, Sleigh & Cheston Ltd.**
**Leyland Instruments Ltd.**
**Livingston Laboratories Ltd.**
**Marcon’s Wireless Telegraph Co. Ltd.**
**Mullard Ltd.**
**Murphy Radio Ltd.**
**Philco Ltd.**
**Standard Telephone & Cables Ltd.**
**Telegraph Construction & Maintenance Co. Ltd.**
**Thorn Electrical Industries Ltd.**
**20th Century Electronics Ltd.**
**W. Vinton Ltd.**

**Exhibition:** The outstanding exhibit this year will be the first demonstration at an exhibition of colour television to N.T.S.C. standards. Colour signals will be generated from a flying-spot colour slide scanner, encoded and monitored on various colour receivers.

Many examples of new transistorised equipment will be shown with particular reference to television applications.

**Test gear, new components, cathode ray tubes, studio monitors, studio apparatus, colour burst generators and many other items will be demonstrated.**

---

**THE "VERSATILE" AMPLIFIER**

**by J. G. RANSOME**

**THE "VERSATILE" was designed for use in conjunction with various radio tuner units, each having its own self-contained power supply. It may, however, be argued that many of the tuner units now on the market do not possess such a feature, and that provision for their supplies must be made in the amplifier. To take care of this point, an alternative power supply is given which will, in addition to the supplies for the amplifier, give 250V at 30mA and 6.3V at 1.5A for the tuner unit. The alternative power pack also has the advantage of being isolated from the mains, and the chassis may therefore be directly earthed.**

**With the supply shown in Fig. 1, the chassis is "live" and the usual safety precautions should be taken.**

**With the valves specified, some 3-4 watts of good audio can be obtained, and this is sufficient to load an 8-in speaker. Distortion is of a low degree. Negative feedback was considered, and tried, but it gave so little improvement that, in this case at any rate, it was decided that the additional complication and expense was not justified.**

**The first stage uses a Mullard EF40 low microphony pentode, and provided that reasonable precautions are taken there should be no trouble with instability. The input lead to the pentode should be screened as should the case of the pentodimeter itself. The lead from the control to the grid of V1 could also be screened, but if this is thought to be impracticable then it should be kept as short as possible and well away from the heater leads.**

**The gain of the first stage is about 100, with the valve specified. This may be too great a gain for some tuners, which is why the volume control has been incorporated in the grid of V1 and not, as more usual, in the grid of V2.**

**The EF40 is a miniature 8BA-based equivalent of the well-known EF37A, and there is no reason why the latter valve should not, if it is more convenient, be used instead. No alterations to the circuit are required other than, of course, the replacement of the 8BA holder by an octal holder, and the appropriate wiring-up of the latter.**

**The overall gain of the amplifier is such that it is adequate for use as a gramophone, baby alarm, intercom amplifier, etc.**

**The output stage is quite straightforward, and only one comment is needed.**

**It was suggested that it might prove more versatile if, by choosing a suitable value for the bias resistor, R6, the user could obtain the choice of employing, without alteration, an EL42 for normal use or an EL91 for occasions where higher power was required. This is not practicable, however. The EL42 needs a bias resistor of 360Ω, and this is fairly critical. If a value such as this was used for the EL91 its output would be no greater than that of the EL42, if as much.**

**It should be noted that the "Versatile" has a high impedance input. Some tuner units (and some microphones and other apparatus which might be fed into the amplifier) have low impedance outputs. In this case a suitable matching transformer will be required, and this should preferably have a mu-metal case— it should be screened, in any event, and the screening taken to chassis.**

**Warning:** If the power supply shown in Fig. 1 is used, then the chassis will be "live" and, therefore, dangerous under certain conditions. Readers building this version are advised to read the comments on safety precautions which appeared in "Television for the Home Constructor" in the last issue of this magazine.

**It should not be forgotten, in this connection, that the chassis of a tuner unit or any other apparatus used with the amplifier will also become "live." This may be avoided by coupling the two items via a 1 : 1 isolating transformer; or in the case where the matching input transformer is employed, it will be achieved automatically provided it is a true transformer—and not an auto-transformer—and also provided that neither side of the
primary winding is connected to the amplifier chassis. The amplifier should be housed in a wood cabinet, with all screws covered over so that no contact can be made, even accidentally, with the chassis.

All the above complications may be avoided by employing the power supply given in Fig. 2 at very little extra cost, but even here the trouble can occur, should the amplifier be used (without an isolating transformer) with a unit which itself happens to be fitted with a self-contained power supply which renders its own chassis "live."

Life can be tedious—but it's still better to be alive!

Component List

Resistors

- R1 250kΩ pot.
- R2 220kΩ
- R3 100kΩ
- R4 1.5kΩ
- R5 500kΩ
- R6 220Ω 1 watt
- R7 25kΩ pot.

Condensers

- C1 25µF 25V
- C2 0.1µF 350V
- C3 25µF 25V
- C4, C5 16 and 8µF 350V
- C6 0.005µF 350V
- C7 0.1µF 750V

Miscellaneous

- V1 EF40
- V2 EL91
- M.R. any metal rectifier capable of handling 60mA at 250V
- L1 Smoothing Choke, 10H, 60mA
- T1 30 : 1 for 312; 30 : 1 for 811; 22 : 1 for 150, 2 : 1 for 250V
- T2 Secondary 6.3V at 1.5A

Alternative Power Supply

- C1, C2 16 and 8µF 350V
- L1 10H, 90mA
- T3 Secs: 250-0-250V at 80mA, 6.3V at 1.5A, 6.3V at 1.5A, 5V at 2A
- V1 EZ40 or similar

Can Anyone Help?

E. D. Farnsworth, 65 High Street, Carville, Durham City, wishes to buy or borrow the Manual or circuit diagram of the ex-Admiralty AVO Valve Tester pattern 59046, serial no. 10374–646. This instrument is basically the pre-war AVO design with separate valve panel.

W. Campbell, 22 Burnmouth Road, Barlanark, Glasgow, E3, is in need of and is willing to purchase a Manual, circuit diagram or any other data on the Eddystone B34 (358X) receiver. All letters will be answered.

J. J. G. Clayton, Crookham Lodge, Church Crookham, Hants, wishes to buy or borrow the handbook on, or details for converting, the U.S. Army Signal Corps receiver type BC-683-A (28–39 Mc/s). It is required to convert to Band 2.

Philip Goh, 721 Gyeng Road, Singapore 14, Malaya, wishes to buy, borrow or hire a circuit diagram for the "Erre" model KY750 receiver.

W. Stephens, 48 St. Marys Road, Oatlands Park, Weybridge, Surrey, would like to borrow or purchase the circuit diagram of the Philips radiogram type 539A.

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

J. Bromley, 333 Bolton Road, Westhoughton, near Bolton, is in need of information on the valve line-up in the driver and final stages of a Marconi C.N.Y.2. Can any reader assist?

R. McLeod, 50 Oakleigh Road North, London, N.20, wishes to buy or borrow a manual or handbook on the Pilot 85 receiver AC4810, and particularly wishes to know the wiring of the wavechange switch S1, 2, 3.

R. E. G. Coppe, G2DUV, 14 Carolina Road, Thornton Heath, Surrey, wishes to borrow or purchase the service sheet or circuit diagram of the Murphy V204 television receiver with converter type C2.

A. Mayhew, 1 Windsor Gardens, Hayes, Middlesex, wishes to purchase coils or winding data of the G.E.C. V.H.F. Unit BCS 1350.

P. G. Martin, 4 Beech Road, Princes Risborough, Aylesbury, Bucks, wonders if anyone has a service sheet for the Murphy V/14 television receiver for sale; or would exchange for "Handbook of Wireless Telegraphy," Admiralty, Vol. II, 1944 reprint.
Radio Miscellany

A number of interesting letters covering quite a range of topics have come to hand this month, and once again I have no time to answer them all individually. Nonetheless they are greatly appreciated, and where necessary have been passed on to the suitable quarter for either noting or action.

F.W.D. of Southfields, S.W.18, writes, "You recently took up the question of the difficulties encountered by readers living in rural parts in getting components—especially the small items. Believe me, it’s not only rural readers who have this trouble. Even the London shops stock only the easy-selling lines. Try to get a small item and you find that unless it shows a high margin of profit or sells without the bother of cutting or counting, etc., there is no interest in getting it for you. Recently I wanted some self-tapping screws, which are, of course, widely used by radio manufacturers, etc. I tried nearly a dozen different shops, and even my local Tool Shop. I am still looking for them! Not one offered to get them."

Oddly enough, about eighteen months ago I was in need of a self-cutting screws myself, and needing them quickly found very much the same difficulty. Eventually I found a branch of a well-known motor accessories firm (Branches Everywhere) carried a small stock of a limited number of sizes—mostly countersunk, which I didn’t want. I had to make do with the nearest size available.

These screws are also widely used in the motor trade, but by far the best plan is to stock up whenever you get the opportunity. They are useful for all sorts of jobs. Experience teaches that they work out just about as clear buying nuts and screws, but they are invaluable for jobs where it is awkward, or impossible, to get a nut on the back (Mens. K. R. Whiston, New Mills, Stockport, Cheshire, have huge stocks of almost any screw or nut likely to be wanted, and will send a list on request.—Ed.)

The Wide World

Another interesting letter comes from Mr. V. Savage of Christchurch, New Zealand, who mentions that his copies of R.C. are eagerly awaited each month. I hope the journal you have reached you safely, old man, and if you write again don’t forget we always welcome news of the activities of our overseas constructors and like to hear something of their experiences. The only thing that most home readers know about radio in New Zealand is that prices are somewhat dearer than they are in Gt. Britain, and that you see more of American gear than we do. What about it, you readers in other parts of the world?

Protection

The next comes from G.E.S. of Reading, who writes: "A couple of years ago you gave some tips on avoiding weatherproofing dual aerial elements. I tried it, but do not consider even this gives sufficient protection. What about the fancy dressing motorists have recently taken to using to protect the exposed chromium parts of their cars?"

A very good question, and I feel that G.E.S. may have got something there. Who can have failed to have seen the colourful lacquers so generously daubed over all the bright parts of so many cars. Incidentally, I have tried some myself and found it easily obtainable in the transparent form. It is really weatherproof, too, but just how the "remover" is going to work when the sun returns has yet to be seen.

When one comes to think of it, it is rather incongruous that chromium plating, which at first was intended to protect bare metals, should itself come to be in need of protection. But there it is. These lacquers, which are simply painted on with a brush, certainly give full protection from rain. Presumably dual aerial rods would be equally well protected against moisture, but whether it would retard chemical deterioration as well is a question some of our readers more versed in chemistry than I am might answer.

Round the Workshops

While on the subject of ideas, I recently saw some excellent examples of metal renovation carried out by none other than old timers. He had several ex-W.D. receiver and instrument cases which had stood empty and idle since the first R.S.G.B. Disposal Scheme. They were sadly battered, and at least one corner had completely rusted away. Needing to have his parts, I set about restoring them. After all the old paint was scratched off with a wire brush, the dents were beaten out as well as possible. With the aid of a filling marketed under the name of "Bondafiller" made up into a putty-like mixture, the dents and holes were filled in. Bondafiller is made of glass fibre, resin and a powder. It dries hard in about an hour or two, when it can be sanded or filed to give a good painting surface. Primarily made for the home repairing of splits and dents in car wings, it is also ideally suited to such jobs as that undertaken by our friend. While I have not yet had occasion to try this preparation out for myself, judging by the result achieved, I should imagine any handyman ought to be able to get a near-professional finish with the minimum of practice.

Bill tells me that a Mr. Dawson of Stoke-on-Trent was first in the field with an offer of help. I hope many others have followed his example.

Where There’s a Will

He also pays tribute to the grand work put in by their local reps. I know many of them perform their good services in face of physical difficulties. But what of Bill himself? I have not had the good fortune to meet him, as he has been bedridden for a good many years; and last June he had the misfortune to lose the sight of his one good eye—the other has long since been virtually useless. Yet he underwent training in order to use a special typewriter, so he could carry on with his secretarialship.

CENTRE TAP talks about Items of General Interest

Self-Help

With this month’s correspondence also comes an appreciative letter from Bill Harris, Hon. Sec. of the Radio Amateurs Invalid and Bedfast Club, reasonably good to look at when it can be sanded or filed to give a good painting surface. Primarily made for the home repairing of splits and dents in car wings, it is also ideally suited to such jobs as that undertaken by our friend. While I have not yet had occasion to try this preparation out for myself, judging by the result achieved, I should imagine any handyman ought to be able to get a near-professional finish with the minimum of practice.

We who are blessed with good sight, health and a full complement of limbs, are only too apt to take these things for granted. My own consciousness of incapacity was of a temporary nature during the war. For a while I was "one-armed," and if you have not yet appreciated just what effect this has on the thousands of young men of daily life, try cutting up the meat on your plate with one hand. Of course, you could try drilling a chassis, assembling components and soldering connections. You have carried on a long time, you remain unconvinced. You may well then wonder whether you have the character and fortitude, not only to remain cheerful in overcoming such a difficulty, but in getting round to helping someone whose plight is perhaps worse than your own.

It is heartbreaking to feel that in these days when there is a deplorable tendency for people to expect the Welfare State to do everything for them, that those who have a better right than most to look for help from others, should have the spirit to do so much for one another. By the way, any reader who has no modern gear he could send can still show his sympathy in a practical form. What about a supply of duplicating paper for their excellent monthly news-letter, Radial, or a book of stamps to help with its circulation?

It is hoped that a regular 40-metre "Net" can be planned by their members holding transmitting licences in the early future. Full details are obtainable from Bill Harris, 25 Playford Lane, Rushmere, Ipswich.

Lament

So the long-threatened extra hour of T.V. (between six and seven in the evenings) is at last upon us. Not only is it a backward step regretted by many (amateurs, parents, teachers, most thoughtful viewers and those who would enjoy it), but it is to be feared that a threat of round-the-clock T.V. may well lurk behind it. Remember steam radio started off with two hours a day and gradually grew to the present din which haunts us all day—and most of the night.

(continued on page 562)
MULTIVIBRATOR DESIGN
Using C-R Curves to Simplify Calculations

by HUGH GUY

Coupling Circuits
Video and pulse techniques differ from audio and radio frequency techniques principally in the types of waveform encountered. Whereas those of r.f. and a.f. circuits are nearly always sine waves, video and pulse waveforms are usually anything but. As a result, simple circuit elements need more careful consideration and are sometimes more involved when they occur in circuits required to handle pulses and square waves. A good case in point concerns resistance-capacitance coupling.

A bad choice of components in a resistance-capacitance coupling usually results in nothing more serious than an attenuation in signal and undue phase-shift, if such components comprise a.f. or r.f. couplings. A similar unfortunate choice in components used, say, in a video coupling, however, can make a square-wave recognisable. Unwanted phase-shift in a.f. and r.f. circuits is, of course, not permissible if negative feedback is to be applied, otherwise distortion may occur; but except for this case, incorrect components in such circuits cannot produce distortion of sine waveshape. This is not true in the case of square waves, or in fact of any waveshape other than the sine wave.

The fact that simple R-C circuits are capable of altering waveshapes is often utilised in pulse techniques; for example, a circuit which differentiates the output (i.e. one which produces an output which varies at the rate of change of the input) consists of exactly the same arrangement of condenser and resistor as does the coupling circuit. It will be helpful here if we consider what happens in a simple voltage divider circuit consisting of the usual R-C coupling; that is, a condenser and resistor in series. The circuit is shown in Fig. 1a. Here, a d.c. supply in the form of a battery E is connected in series with a two-positioned switch S to the condenser and resistor. In position "a," the battery supplies current to the divider, while in position "b" the divider is short-circuited.

If the operation of this elementary circuit is followed in detail, the approach to the design of R-C couplings will be readily understood.

For such a circuit Ohm's law still applies, despite the fact that a condenser is involved. If the switch is suddenly closed then electrons start to flow from the upper plate of the condenser, being attracted by the "positiveness" of the battery. These electrons constitute the charging current of the condenser C; and at the initial instant, there is no voltage across the condenser. The total voltage, therefore, appears across the resistor R, and the initial charging current i equals E/R. In Fig. 1b

With the continued flow of current in the circuit the condenser starts to charge. The formula Q = CV shows us that the voltage across the condenser increases directly with the charge and hence the voltage across the condenser commences to rise. The total voltage E remains fixed, of course, and thus the voltage drop across the resistor will correspondingly fall. This voltage drop will nevertheless be produced by the product iR and, since R is fixed, i must decrease and the condenser charge less rapidly.

This process will reach a climax when the condenser is fully charged and the voltage E appears across its terminals. By this argument, therefore, the voltage across the resistor will be zero at this time (which theoretically occurs only after infinite time), and no current will flow. This is shown in Fig. 1c.

If S is now switched to position b, the condenser will now start to discharge. This time, however, the discharge current i will flow in the opposite direction resulting in a voltage drop or the opposite polarity to the charging voltage. The amplitude and shape of the waveform will be as before, however.

C-R Curves
There is a formula by means of which it is possible to determine the voltage appearing across the resistor or condenser at any given instant during the charge or discharge of the condenser. When, for example, the con-
denser is charging, the current at any instant is given by:

\[ i_c = \frac{E}{R} - \frac{t}{t/CR} \]

When the condenser is discharging through \( R \), the discharge current at any instant is:

\[ i_d = -\frac{E}{R} - \frac{t}{t/CR} \]

Now although the charge and discharge currents are the same, apart from the minus sign, which in the latter expression indicates that the current flows out of, and not into, the condenser, the voltage appearing across the two components is not the same in the two cases because the circuit is different in each case.

\[ R-C \text{ charging:} \]

\[ e_c = i_c R = E (1 - e^{-t/CR}) \]

\[ e_c = E - e_c = E (1 - e^{-t/CR}) \]

\[ R-C \text{ discharging:} \]

\[ e_c = i_c R = -E e^{-t/CR} \]

Of these formulas, those dealing with the voltage across the condenser at any time \( t \) are the ones concerning us most.

None of these formulas is easy to deal with as they stand since they involve the use of exponential quantities, and the information is more readily available in graphical form, and therefore a more convenient version of them is plotted in the graphs of Fig. 2.

These graphs have common axes, the horizontal scales being graduated in the ratio \( t/CR \), where \( t \) is the time in seconds after the transient has occurred in the circuit, and \( CR \) is the time constant.

The vertical scale is graduated in the value of the condenser voltage after \( t \) seconds, as a fraction of the total possible change of voltage.

When designing a circuit involving the knowledge of the formula from which these graphs were drawn, one or other of the two ratios is known enabling the unknown to be solved.

Using the \( C-R \) Curves

The use of these curves is shown in a simple example.

Consider the fundamental timebase circuit of Fig. 3a. This shows a neon lamp in parallel with a condenser, the combination being in series with a resistor. Across this circuit there is an h.t. voltage of 250V. When the h.t. is initially switched on the condenser will commence to charge. When the voltage across the condenser reaches the striking potential of the neon lamp, the latter will fire, discharging the condenser very rapidly to within a few volts of zero, after which the process will be repeated.

The waveform produced by the circuit is shown in Fig. 3b, where it is seen to be repetitive. If this waveform were fed to the X plate of an oscilloscope, a trace would be produced across the face of the tube corresponding to the charging time of the condenser. The rapid discharge of the condenser through the low resistance of the now-conducting neon lamp would produce a flyback of the trace or 'fly-off' of the screen for the recommencement of the trace.

In practice, if such a circuit were used for producing a scan in this manner, the resulting trace would not be linear due to the curvature of the charging characteristic. However, the simple charging of a condenser through a resistor is the common basis of a great variety of scan generating circuits, many ingenious refinements having been devised to correct for the non-linearity of the characteristic.

How, then, do we proceed to calculate the values of condenser and resistor?

First we must know the duration of the scan, or scan time. Let us say that, for this example, we require 100 scans per second. If we assume that the flyback time is very much less than the scan time, then we can assume that the latter is 1/100 of the scan time. This is the value of the symbol \( t \) in the ratio \( t/CR \) on the graph.

We next need to know the characteristics of the neon. Let these be: striking voltage, 100V; extinguishing voltage, 15V. Average conducting resistance 100 ohms.

In Fig. 3b we see the limits marked on the waveform. The condenser starts charging from 15V, this being the level at which recharging starts after the completion of the previous scan and flyback. The charge rises exponentially towards 250V, but ceases abruptly at 100V when the neon fires. The voltage \( e_c \) is, therefore, (100-15)V, i.e. 85V, and the voltage \( E \) is (250-15)V, i.e. 235V. Thus the ratio \( e_c/E \) is 85/235 or 0.362, and from the Charge curve this is seen to correspond to a \( t/CR \) ratio of 0.44.

From a practical point of view it pays to keep the value of condenser down, both from a size and from a financial consideration, and the value of resistor is therefore best found in the Megohm region. A second point which endorses this view concerns the flyback time. If the condenser is large, when the neon conducts the discharge path consists of a parallel path through the neon resistance and through \( R \). The latter being much greater than the former means that the discharge resistance is virtually only the neon resistance. The larger the value of resistor \( R \), the truer this is, and the calculation for the discharge time is made correspondingly simpler.

This, then, is a point in favour of a large value for \( R \).

A second point is the desirability for a small value of condenser so that the time taken to discharge it through the neon resistance is negligible compared with the scan time. Now we know that the discharge resistance is the conducting resistance of the neon—about 100 ohms, we said. Let this be \( R_e \). Then we know the discharge time constant \( CR_e \) once we have fixed the value of \( C \). Looking at the waveform again, we see that the condenser discharges from 100V to 15V, and this decay finally gives us a value of 15V across the condenser for \( t \). The voltage \( E \) is, of course, 100V, being the amount the condenser could discharge if it were permitted. Thus the ratio \( e_c/E \) on the discharge curve is 15/100 or 0.15, which in turn gives a \( t/CR \) value of 1.88.

That is, \( t/CR \) must be 1.88.

From the two cases we have first, \( CR_e \) was 0.0227, and second, that \( t/CR \) equals 1.88, where \( t \) is the discharge time and \( R_e \) is 100 ohms. The discharge time is, therefore, 188 \( \times C \), showing that for a short flyback C

---

**THE RADIO CONSTRUCTOR**

---

**MARCH 1957**
must be small. If we make the value of C, say, 0.015 μF, then by the first relationship R must be 1.5 Megohms. Also the discharge time is 1.88 × 0.015 μsec; that is 2.82 μsec.

**Differentiation**

At the beginning of this article it was mentioned that an R-C coupling can be used to produce an output proportional to the rate of change of input. The significance of this is best appreciated from Fig. 5. The waveforms before and after differentiation are shown one under the other, in Figs. 5a and 5b respectively, drawn to the same scale of time. The rate of change of the leading and trailing edges of the square-wave input is very high—indefinite, in fact, in positive and negative directions, and hence the amplitude of the output waveform at these times is also high. At the flat peak and trough of the waveform however, the rate of change is zero, and theoretically the output should also be zero. Electrically the net effect of differentiation is produced, and the circuit is used to produce pulses for triggering other circuits at the leading and/or trailing edge of the square-wave.

![Waveform](image)

**Time of Rise**

No electrically-produced square-wave has absolutely vertical leading and trailing edges. If a square wave is produced at the anode of a particular valve, then the steepness of the wavefront is determined by the value of the load resistor and the stray capacitances shunting it. These "strays" must be charged and discharged each time transitions of the waveform take place, and therefore, if examined closely, every square-wave will be seen to consist of an exponential leading edge, and a similar trailing edge. Of the current provided to produce such an edge, therefore, the more that is diverted to the condenser, the more exponential will be the characteristic of the waveform. It obviously pays to keep the stray capacitances to a minimum by careful wiring and to use a low value of anode load, since the current flowing in the latter will be inversely proportional to its size.

Since the rate of rise or time of a wavefront determines its shape, it is necessary to be able to predict what the rise time \( T_r \) will be in a design. The C-R charge curve shows that the time taken to reach the full value of applied voltage is very long, and so the rise time quoted in design practice is conveniently defined as being the time taken for the stray capacitances across the load to charge from 10\% to 90\% of their full value. This is seen to correspond to a t/C% value of nearly 2.2, and therefore, \( T_r = 2.2C_0R \).

It is well worth taking the trouble to absorb what might seem to be a lengthy discourse on the mechanism of charging and discharging a condenser since it is the study of this type of transient phenomena which is basic to pulse techniques as the behaviour of sine waves is to a.f. practice.

The design of a simple multivibrator will illustrate this fact very well.

**The Multivibrator**

The simplest way of describing the multivibrator is to call it a two-stage R-C coupled amplifier whose output is fed back to the input. No frequency-conscious components are present in this positive feedback path, with the result that the output is not sinewave but square-wave.

The circuit is shown in Fig. 4.

On switching on, one or other of the two valves will start to conduct heavily due to the zero bias on its grid. Assume that \( V_2 \) is the valve in this case. Then the precipitate drop in anode voltage due to the heavy conduction through the anode load will be conveyed immediately to \( V_1 \) grid via the coupling condenser \( C_1 \), which, remember, no instantaneous change of potential can occur.

\( V_1 \) is thus well and truly cut off, but as the coupling condenser \( C_2 \) discharges so \( V_1 \) grid rises exponentially, as shown in Fig. 6, where anode and grid waveforms are given on the same time scale. When the grid potential has risen to within the cut-off bias (or grid base) of \( V_1 \), the latter starts to conduct with a consequential fall in anode potential. This drop like that just described is undergone by \( V_2 \).

The time intervals of the waveform are then dictated by the time taken to charge the coupling condensers through the series circuits comprising anode loads and following grid leaks. The number of square-waves produced per second and their mark-to-space ratio can be set by a knowledge of the valve characteristics and amplitudes of the pulses.

One minor refinement usually added in a practical design consists of returning the grid leak not to earth but to the h.t. line. This is done to prevent "jitter" or uneven timing of the waveforms which results when a valve is cut-on near the limit of charge of the condenser when the voltage is changing only slowly across the grid leak. The cut-on or cut-off potential of a valve is rather ill-defined, varying slightly from one moment to the next. It is, therefore, important to make the transition from cut-off to cut-on rapid, and as the C-R charge shows, this is achieved best at a low C-E voltage. Hence \( E \), the potential to which the condenser could finally charge, is made large. It is for this reason that the mode of connection in Fig. 7 is shown, this circuit being the one considered in the design example.

**Design Procedure**

The output required from the multivibrator should be specified in the following form:

(a) Rise time of leading edge (\( T_r \)) secs.
(b) Amplitude (A) volts
(c) Pulse recurrence frequency (p.f)
(d) Mark-to-space ratio of waveform (M/S)

Using this information, the design then proceeds in the order set out below.

(1) The estimated stray capacities (\( C_s \)) in conjunction with (a) above fix the value of \( R_s \), since \( R_s = 2.2 \times C_sR \).

(2) The current swing through the valve is determined from (b) above, since \( \alpha = I_sR_s \). This current is obtained at \( V_g = 0 \) and examination of the \( I_s/V_g \) characteristic of the chosen valve will show the anode-to-cathode voltage (\( V_a \)) of the valve to produce this current at \( V_g = 0 \). To this \( V_a \) is added the load voltage drop, and this gives the value of the necessary h.t. voltage.

(3) Voltage \( A \) will be conveyed to the opposite grid as a switch-off pulse. The rise of voltage across the associated grid leak will be controlled by the appropriate \( C \) and \( R \). \( C \) should be small and \( R \) large so that the discharge time of \( C \) is short, and so that the value of \( R_s \) is negligible in comparison with \( R \).

(4) The grid waveform is sketched and the potentials marked on as in Fig. 8a and from this a value for \( E \) is found. The grid voltage will rise exponentially towards the h.t. volt-
Field Report on the "EAVESDROPPER"

Miniature Transistor Local Station Receiver

by W. G. MORLEY

In the December and January issues last of The Radio Constructor, full details were given of the "Eavesdropper," this being a miniature transistor receiver intended for local station reception. A number of "Eavesdroppers" have been successfully built by readers, and it is now possible to evaluate the performance of this receiver under the varying conditions in which it has been used.

In some cases, somewhat poor results have been obtained, and it is believed that this may be due—amongst other things—to spread in the characteristics of the transistors employed. Since the prototype was completed, performance figures have been taken with a number of different transistors of the type specified, with the result that a change in value of two resistors brings the design centre more accurately in line with the transistors available.

Several readers have asked for details of aerial input circuits capable of allowing large aerials to be employed without loss of selectivity. The question of output level and choice of reproducer has also been raised. So far as these last two points are concerned, experiments have been carried out with reproducers alternative to the crystal microphone insert employed in the prototype, thereby enabling fuller tonal response to be obtained. All these points are dealt with in this report.

It should be mentioned, at this stage, that a component which plays an important part in the successful functioning of the receiver is the diode D1. This should be a Mullard OA71, as specified.

Modifications

Due to the spread in transistor characteristics just mentioned, it has been found that improved results will be given by the "Eavesdropper" if R1 is changed to 220kΩ and R3 to 2.2kΩ.

When additional power output, plus some increase in gain, is desired, this may be achieved by replacing R6 with an a.f. choke.

A suitable miniature component is provided by a 250:1 transformer type OL130 (available from Henry's Radio and other stockists). This transformer has its primary winding only connected into circuit, the secondary being ignored. The use of this choke incurs an increase in h.t. consumption of approximately 0.5mA.

An increase in tonal range can be obtained by employing a 1,000Ω deaf-aid insert in place of the crystal insert. The deaf-aid insert should be connected as follows: one terminal to the h.t. + line and the other, via a series 25V w.kg. electrolytic capacitor having a value between 4µF and 8µF, to the collector of TR1.

TABLE OF TEST READINGS OBTAINED ON THE

<table>
<thead>
<tr>
<th>Prototype</th>
<th>Supply Voltage</th>
<th>Total Current</th>
<th>Voltage on TR2 side of R6</th>
<th>h.t.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR1</td>
<td>14V on load</td>
<td>2.9mA</td>
<td>-0.1V</td>
<td>-2.4V</td>
</tr>
<tr>
<td>TR2</td>
<td>Base Voltage</td>
<td>-0.15V</td>
<td>Base Current, meter</td>
<td>-1.5V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>between R4 and R6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Collector Voltage</td>
<td>-1.75V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Collector Current, meter</td>
<td>-4.9V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>between trans. and R6</td>
<td>-1.8mA</td>
</tr>
</tbody>
</table>

A suitable miniature component is provided by a 250:1 transformer type OL130 (available from Henry's Radio and other stockists). This transformer has its primary winding only connected into circuit, the secondary being ignored. The use of this choke incurs an increase in h.t. consumption of approximately 0.5mA.

An increase in tonal range can be obtained by employing a 1,000Ω deaf-aid insert in place of the crystal insert. The deaf-aid insert should be connected as follows: one terminal to the h.t. + line and the other, via a series 25V w.kg. electrolytic capacitor having a value between 4µF and 8µF, to the collector of TR1.

March 1957
The negative side of the electrolytic condenser should be that which connects to TR3 collector.

Good results were also obtained by employing an ex-WD balanced armature insert in the same circuit as that just specified for the deaf-aid component.

An aerial input circuit suitable for large and small aerials

The input circuit accompanies this article. As may be seen, a capacitive tap into the tuned circuit is made by means of the 0.001 µF condenser C9. To maintain the d.c. circuit to the diode, this condenser is shunted by the 10kΩ resistor R10. The presence of C9 may necessitate slight re-tuning of the station selector trimmers when the pre-set version of the receiver has been constructed.

The value of the aerial series condenser C7 is experimental. If a short aerial is used, say, 3 or 4 feet long, this condenser may be omitted, the aerial connecting directly to the junction of C9 and L1. For large aerials, C7 should have a value which permits adequate sensitivity without loss of selectivity. Normally, the value of C7 should lie between 25 and 250pF. An earth connection is desirable, especially when large aerials are employed, but is not essential.

Test Readings

Test readings obtained on the prototype after the modification to values of R1, R3 (i.e. with R5 and not the a.f. choke as the collector load of TR3) are given in the table which accompanies this report. These readings were taken with an AVO model R, all voltage figures being with reference to the h.t. + line. It must be emphasised that these readings are given for guidance only and may vary over quite large limits for individual transistors. This point applies especially to collector voltage readings, and it is preferable, if possible, to place reliance on collector currents instead.

Aerial Input Circuits

Whilst the “Eavesdropper” should give adequate local station reception on its ferrite frame aerial in localities of reasonable signal strength, an improvement can obviously be effected by the use of an aerial. An aerial input circuit has now been developed which meets this need, this having the advantage that it may accept both large and small aerials.

New Edition of Mullard Pocket Data Book

This new edition includes details of entertainment valves, television picture tubes and germanium devices introduced since the previous edition published in 1954.

An improved format has been devised which presents the information in a simplified form. For example, base connections, type numbers, descriptions and characteristics are now given in a single line, thus enabling all the information about any particular valve to be obtained by reference to only one page.

A new section has been added which deals with Mullard Varley Thermistors, and there is a list of communications and industrial valves and tubes.

Comprehensive equivalents lists for entertainment valves and picture tubes are also included.

MEASUREMENT

by A. P. BLACKBURN

Other Types

A type which is certainly very robust, but usually less accurate than the moving coil, is the moving iron movement. Once again this has a coil through which the current to be measured is passed, and the field produced moves a piece of soft iron which is attached to the needle. The scale is not linear, being cramped at both ends, but it may be used for a.c. or d.c. measurements. Note that in this type the coil is fixed.

The hot wire ammeter is sometimes used where high frequency currents are to be measured, but it may also be used for d.c. The instrument consists simply of a piece of resistance wire which becomes heated by the passage of the current. A spring attached to the centre of the wire pulls it downward as it expands, and the resulting movement at the centre of the wire is transferred to the needle.

Neither of these types are as sensitive as the moving coil, particularly the hot wire type, which is normally only suitable for measuring 1 amp or above.

After that brief digression we will return to the moving coil meter.

Heavy Currents

As mentioned already, the moving coil meter is very suitable for small currents. It
If \( I_m \) is small compared to \( I_f \),

\[
R_s = \frac{I_m}{I_f} R_m \quad \text{(1)}
\]

Continuing the example of Fig. 2, if the meter resistance was 100\( \Omega \), what is the required value of \( R_s \)?

From (1) above

\[
R_s = \frac{1 \times 100}{10 - 1} = 11.1 \Omega
\]

If the meter were required to have a full scale deflection of 100mA, \( R_s \) would be

\[
R_s = \frac{1 \times 100}{100 - 1} = 1 \Omega \text{ approx.}
\]

Briefly, the principle is to divert some of the current from the meter. For example, if the current to be measured is 10mA and the meter has a full scale deflection of 1mA, 9mA has to be diverted as shown in Fig. 2. The diverting resistor \( R_s \) is called the shunt. By suitably switching this resistor, any number of ranges may be obtained.

The formula for calculating this resistor is easily obtained. The voltage across the meter is the meter resistance times the current, \( I_m \), flowing through it. This voltage is also equal to the voltage across the shunt resistor, which is given by the shunt resistance \( R_s \) times the current \( I_s \) through it.

It can be seen in this latter case that the denominator is scarcely affected by \( I_m \), so formula (2) could have been used.

Where to Measure

When making a measurement of current it is important to take certain precautions. For example, when measuring the anode current of the valve in Fig. 3, the circuit could be broken as shown and the meter placed in series with the anode load. Now as we are only considering moving coil meters, we have to watch the polarity. The direction of deflection of the needle in this type of instrument depends upon the direction of the flow of current in the coil. In order to get the correct deflection it is necessary to connect the meter correctly as shown in Fig. 3— in this case with the positive terminal to h.t. +. Now the current flowing through the meter will cause a voltage drop across it, perhaps of the order of a volt or so. In the circuit shown this would obviously be unimportant. The meter resistance is so low compared to the anode load, 22k\( \Omega \), that it can be ignored. If, however, we wished to measure the filament current in a battery receiver using 2-volt valves, and 1 volt were dropped across the meter, only 1 volt would reach the valves. The resultant current as indicated on the meter would not be the same as when the meter were not in circuit.

For example, let us say that the filaments take 1 amp at 2 volts, and the meter had 1\% resistance. The circuit would be like Fig. 4; the resistance of all the heaters in parallel would be 2\( \Omega \) (1 amp at 2 volts) and the meter resistance when added to this makes 3\% in all. The current flowing would, therefore, be:

\[
I = \frac{E}{R} = \frac{2V}{3\Omega} = 0.6 \text{ amps,}
\]

and the meter would indicate this. When the meter was removed, only 2\% would remain in circuit and the current would be 1 amp.

So the meter has only indicated to an accuracy of 66\%, which is hardly acceptable in the roughest measurement. Often the voltage drop is less than 1v, but this extreme value was taken to make the example clear.

Voltage

To measure voltage the same movement is normally used. We have already seen, however, that a meter with a full scale deflection of 1mA may have a resistance of 100\( \Omega \). The required voltage to produce full scale deflection is therefore:

\[
E = IR = 0.001 \times 100 = 0.1 \text{ volts}
\]

So basically such a movement will only measure up to 0.1 volts. This could be overcome by decreasing the sensitivity, i.e. increasing the full scale current. This is undesirable because a large current drain into the meter might upset the circuit under test. For example, in Fig. 5 a voltmeter which takes 10mA at the reading obtained is measuring the anode voltage of a valve. This

10mA must flow through the 10k\( \Omega \) resistor, therefore a voltage drop of \( 0.01 \times 10,000 = 100 \) volts will occur across it. So if the true anode voltage were 200 volts, the meter would only indicate 100 volts; an error of 50\%.

Returning to our meter, then, the other thing to do if increasing the f.s.d. current is of no help, is to increase the resistance. This fortunately is very simple, as shown in Fig. 6. A resistor, \( R_m \), called the multiplier is placed in series with the meter.

The calculation of this resistor is very simple. If we required to make our 1mA movement into a voltmeter with f.s.d. of 10V and 100V, we merely calculate the resistor from Ohm's Law.

\[
R_m = \frac{10}{0.001} = 10k\Omega
\]

and for 100 volts \( R_m = \frac{100}{0.001} = 100k\Omega
\]
This ignores the voltage drop across the meter, which in this case was 0.1 volt, giving 1½% error on 10V and 0.1½% error on 100 volts. The meter resistance would be important if we wished to make a 1 volt range. However, all that is necessary is to calculate as above?

\[
R_m = \frac{V}{I} = 1 \text{ k}\Omega
\]

and then subtract the meter resistance, in this case 100. The result is, therefore, 900\Ω for 1 volt f.s.d.

**Alternating Current**

The moving coil movement is only useful for d.c. measurements. The effect of applying a.c. is very little deflection. As the movement deflects in a direction according to the polarity of the applied current, an a.c. wave will tend to deflect it positively and negatively by equal amounts. If the frequency is too high to allow sufficient time for the coil to move, there will be no deflection of the needle.

The only solution is to rectify the a.c. before applying it to the meter. When measuring a.c. voltage a circuit like Fig. 7 is used. A bridge rectifier is used and the multiplying resistor is placed before the rectifier. By this means, a low voltage rectifier can be used for all voltage ranges.

An important point is that the meter will indicate the mean a.c. voltage, and not r.m.s., although most a.c. meters are calibrated in r.m.s. This is not important if the waveform is purely sinusoidal, but if a distorted waveform is being measured an error in the reading will result.

Unfortunately resistance and frequency, the last of the four quantities, has not been mentioned before and does not permit it. They will, therefore, have to be held over until next month.

---

**Radio Miscellany**

(continued from page 549)

Yet even this gloomy news contained a solitary laugh. One magazine proudly claimed that the dubious blessing of the extra hour came about as the result of its single criticism of the B.B.C. Which reminded me of the fly seated on the chariot inviting the world to behold what a dust he raised.

The final insult will come when the B.B.C. demands a further increase in the licence fee to pay for additional "service." Even the fact that the percentage of viewers deserting B.B.C. for I.T.V. still grows is hardly likely to shame them out of this for much longer.

Fortunately, an increasing number of intelligent viewers are beginning to realise that what is really wanted is fewer hours and better programmes. Many of the present programmes could very well do without the vision altogether. With the excessive number of hours of so-called light programmes, an even greater army of "entertainers" with no talent, but lots of self-assurance, are likely to smirk and posture their way on to our T.V. screens.

Critical faculties must be becoming seriously blunted when comedians who make you squirm with embarrassment for them, and plunging-necklined, brazen-voiced, hugging waggling fake crooners can so easily masquerade as entertainers for adult audiences. Few wish to see I.T.V. become a sort of evening-class-at-home, but I am beginning to wonder if even that wouldn't be preferable to a surfeit of non-stop programmes seemingly aimed at backward adolescents.

P.S. I find it so depressing that I am quite unable to think of a funny Tailpiece this month.

---

**A "THREE-PLUS-ONE" SUPERHET RECEIVER**

by P. L. WINGROVE

Details of a receiver which represents an interesting departure from conventional practice

---

**THE RADIO CONSTRUCTOR**

---

**March 1957**

---

The photo shows the shack of D. W. Robinson, G2BTJ, of Liverpool 15. G2BTJ started with an AA licence in 1939, and reopened in 1946. The present Tx runs an 829B in the final, taking 150 watts input on (mainly) 7 and 14 Mc/s. The receiver is a Hallcrafters S.20, and the station is also equipped for CW/phone operation on Top Band. The photograph was taken by R. B. Swift, G3GYT, of Liverpool 18.
Component List—set out for easy reference to Fig. 1

- **Indicators**
  - LM3 silver mica, 300V, wkg.
  - 1/2W, silver mica, 250V, wkg.

- **Transformers**
  - 47k, 15k, 10k, 7.8k, 5k, 2.5k, 600, 300.

- **Mains**
  - 26k, 13k, 6.5k, 5k, 2.5k, 1.25k, 0.75k, 0.375k, 0.25k, 0.125k, 0.0625k, 0.03125k.

- **Valves**
  - 6BQ6GT, 6AQ5GT, 6BA6GT, 6L6GT, 6BQ5GT, 6L6GTR, 6BQ5GT, 6L6GTR.

- **Capacitors**
  - 1µF, silver mica, 300V, wkg.
  - 100µF, silver mica, 250V, wkg.
  - 1µF, silver mica, 100V, wkg.

- **Resistors**
  - 68kΩ, 1 watt.
  - 33kΩ, 1 watt.
  - 10kΩ, 1 watt.
  - 22kΩ, 1 watt.
  - 22Ω, 1 watt.
  - 10Ω, 1 watt.
  - 1.5Ω, 1 watt.
  - 1Ω, 1 watt.
  - 56Ω, 1 watt.

problems of layout and construction very noticeably.

The I.F. and A.F. Stages

The valve V1 functions as a frequency-changer, the intermediate frequency which appears at its anode being applied to the primary of the i.f. transformer. Only a single transformer is employed in this receiver, and it was found that it afforded a surprisingly high degree of selectivity.

The secondary of the i.f. transformer is connected to the leaky-grid detector V2(a). The grid components (C8 and R5) used in the detector circuit have values such that the transformer secondary is not excessively damped. Due to the fact that only one i.f. transformer is employed, little risk of regenerative feedback at intermediate frequencies exists, and there is no necessity to provide filtering in the detector a.f. circuits. The detected a.f. appearing at the anode of V2(a) is applied, via C12, direct to the grid of V2(b), where further amplification takes place.

The h.t. supplies to both V2(a) and V2(b) are decoupled; this being carried out by the components R4 and C4 in the case of V2(a), and by R5 and C11 in the case of V2(b). Despite the high degree of gain given by the a.f. circuits a large amount of decoupling is not really necessary, provided here being quite adequate.

A notable feature of the circuitry between V2(a) and V2(b) is that this does not include the volume control. At the volume levels handled by the two triodes there is little risk of overloading, and it becomes possible, therefore, to fit the volume control after V2(b). This particular arrangement is advantageous because it enables all components immediately connected to V2(a) and V2(b) to be wired closely around the valvholder, whilst the subsequent lead to the volume control, R12, is less liable to pick up hum or cause instability.

The output stage is provided by V3 and is quite conventional. The a.f. tapped off by R13 is applied to the grid of V3, and the anode of this valve feeds into the output transformer primary. C14 is a tone-correction condenser.

The power supply follows normal practice also. There is, indeed, little here which needs comment save that a 6X5 is employed as rectifier in order to provide an economy in the number of heater windings required in the mains transformer. If the mains transformer employed has an electrostatic screen between primary and secondaries, this should be connected to chassis.

**Setting Up**

After the receiver has been completed and the wiring checked, it is ready for alignment.
If a modulated signal generator is available, this should be set to 465 kc/s and its output connected between the top cap grid of V1 and chassis. The i.f. transformer should then be adjusted for maximum audio output, attenuating the signal generator as alignment proceeds. If a signal generator is not available, however, the i.f. transformer may still be satisfactorily aligned, the process being carried out with a received signal. This point is due to the fact that the transformer should be received from the makers aligned on factory test gear, whereupon it will still be approximately aligned to 465 kc/s after it has been connected up in the receiver. The slight discrepancies introduced by the stray capacities in the receiver should not cause any serious shift off resonance. The final alignment of the transformer without a signal generator is described later.

The next circuits to adjust are those in the oscillator section. A signal generator is not really necessary for this operation, as a reasonably good aerial will normally offer all the signal pick-up required. (In many areas a short aerial in the same room as the receiver may cope.) This aerial should be connected to the receiver; whereupon whichever oscillator trimmer is switched in by $S_1$ should be adjusted until the required signal is heard. If the signal cannot be picked up in the range of the trimmer selected, additional capacity will need to be added across it experimentally. The oscillator trimming adjustment for the stronger signals in the medium-wave band to be received quite readily. The process may result in second channel whistles appearing with some signals, but these should be ignored as they will disappear when the circuit is used in proper fashion.

After the oscillator has been set up it becomes necessary to align the signal frequency tuned circuits. The trimmers switched in by $S_2$, should be adjusted for maximum volume from the station selected by the oscillator trimmers, the aerial being connected up normally as in Fig. 1. As trimming proceeds it may be necessary to revert to a short aerial in order to reduce signal strength. This assumes that the receiver will be operated finally with such a short aerial. If a long aerial is to be used finally, the value of $C_1$ may be reduced accordingly. It should be mentioned again here that it will be necessary to add the requisite value of parallel capacity across either $V_{C1}$ or $V_{C2}$ when the required frequency is outside the range of the trimmer.

When the receiver uses the tuning arrangement shown in Fig. 2 the alignment process then becomes that used for conventional superhet. This necessitates trimming at the high frequency end of the band and padding at the low frequency end. Padding would normally be accomplished by adjusting the core of $L_2$ until the dial calibration was correct, and then adjusting the core of $L_1$ for maximum sensitivity. There should be no need to adjust the cores of either $L_1$ or $L_2$ when the pre-set arrangement of Fig. 1 is employed.

**Fig. 2.** Showing how a conventional gang condenser may be used instead of the pre-set tuning shown in Fig. 1.

The stronger signals in the medium-wave band to be received quite readily. The process may result in second channel whistles appearing with some signals, but these should be ignored as they will disappear when the circuit is used in proper fashion.

After the oscillator has been set up it becomes necessary to align the signal frequency tuned circuits. The trimmers switched in by $S_2$, should be adjusted for maximum volume from the station selected by the oscillator trimmers, the aerial being connected up normally as in Fig. 1. As trimming proceeds it may be necessary to revert to a short aerial in order to reduce signal strength. This assumes that the receiver will be operated finally with such a short aerial. If a long aerial is to be used finally, the value of $C_1$ may be reduced accordingly. It should be mentioned again here that it will be necessary to add the requisite value of parallel capacity across either $V_{C1}$ or $V_{C2}$ when the required frequency is outside the range of the trimmer.

When the receiver uses the tuning arrangement shown in Fig. 2 the alignment process then becomes that used for conventional superhet. This necessitates trimming at the high frequency end of the band and padding at the low frequency end. Padding would normally be accomplished by adjusting the core of $L_2$ until the dial calibration was correct, and then adjusting the core of $L_1$ for maximum sensitivity. There should be no need to adjust the cores of either $L_1$ or $L_2$ when the pre-set arrangement of Fig. 1 is employed.

**DATA BOOK No. 8**

**“Tape and Wire Recording”**

(Revised Edition)

**DATA PUBLICATIONS LTD. 57 MAIDA VALE LONDON W.9 CUN 6141 (2 lines)**

**SCOTTISH INSURANCE CORPORATION LTD**

62-63 Cheapside

**LONDON EC2**

**TELEVISION SETS, RECEIVERS AND TRANSMITTERS**

Television Sets, Receivers and Short Wave Transmitters are expensive to acquire and you no doubt highly prize your installation. Apart from the value of your Set, you might be held responsible should injury be caused by a fault in the Set, or injury or damage by your Aerial collapsing.

A "Scottish" special policy for Television Sets, Receivers and Short Wave Transmitters provides the following cover:

(a) Loss of damage to installation (including in the case of Television Sets the Cathode Ray Tube) by Fire, Explosion, Lightning, Theft or Accidental External Means at any private dwelling-house.

(b) (i) Legal Liability for bodily injury to Third Parties or damage to their property arising out of the breakage or collapse of the Aerial Fittings or Mast, or through any defect in the Set. Indemnity £10,000 any one accident.

(ii) Damage to your property or that of your landlord arising out of the breakage or collapse of the Aerial Fittings or Mast, but not exceeding £500.

The cost of Cover (a) is 5/- a year for Sets worth £50 or less, and for Sets valued at more than £50 the cost is in proportion. Cover (b) (i) and (ii) costs only 2/6 a year if taken with Cover (a), or 5/- if taken alone.

Why not BE PRUDENT AND INSURE your installation—it is well worth while at THE VERY LOW COST INVOLVED. If you will complete and return this form to the Corporation's Office at the above address, a proposal will be submitted for completion.

**NAME** (Block Letters)

If Lady, state Mrs. or Miss

**ADDRESS** (Block Letters)

__________________________

JTB

MARCH 1957

567
Complete Kits or Separate Parts for the
BEGINNER'S TRANSISTOR RECEIVERS

Dual range kit with chassis (less 'phones and battery), 21/-
Kit as above plus reaction, 25/-
Earphones at special price of 14/11 per pair to purchasers of above kits
Dual range feeder (w/ chassis, less battery), 22/6
Band pass feeder (w/ chassis, less battery), 22/7
* circuits included with all above
Tuning Condensers 4/2 each
DR22 Coil 4/-
TRANSISTORS 10/- EACH
(R.F. Type Blue-Spot 15/-)

Safety First!
(Page 62, February issue)
Neon, resistor and rubber covered clip
3/6 complete
Screwdriver and mains neon tester
5/6 complete

We Stock And Recommend
* The JASON FM TUNER
Kit (less valve) £5 5s. Power Pack £2 1s. 9d.
Set Valves £1 10s. 6d. Booklet 2/6-
* The ARGONAUT AM/FM TUNER RECEIVER
Kit (less valve) including receiver section £11 10s.
7 valves and magic eye for tuner. 6s 5s. Od.
Receiver output valve 10/- Booklet 2/6-
All parts available separately

THE ARGONAUT
AM—FM MW—VHF TUNER—RECEIVER

First published in the March and April 1956 issues of this magazine this high quality tuner-receiver has aroused considerable interest. In this reprint the text has been revised and enlarged, and additional diagrams, including a map of present and projected coverage areas, have been included as a result of suggestions by readers.

28 pp. plus stiff card cover
Price 2/- post-age 2d.

DATA PUBLICATIONS LTD
57 Maida Vale London W9
Telephone CUNingham 6141 (2 lines)

The Walk-around Shop

POST OFFICE BOX (right)
(Sub-standard) 10,000 ohms
Brand new condition. Price 50/-
plus 5/- p.p.

BEACON RECEIVER
BC1206A Covering 200-400 k/s. Valve line-up: 6K7, RF; 6L7, frequency changer; 6L6GT, IF; 6SQT, audio; 2D7P, D.P. This was designed to run on 24/28 V d.c. h.f./l.f. Excellent bass for car radio; size 6" x 5" x 4". Good working order. £3.50 each, plus 5/- carriage.

HEATER ELEMENTS
230 volt, 500 watts. Size 10/- long, 11" wide, 5 3/4" deep. This unit is totally enclosed and could be termed a black heater. Flanges turn up at either end and drilled for 4" clearance—makes easy fixing. Superb element for heating greenhouses, the home (preventing freezing), etc. Price 5/- each post paid.

GYRO UNIT AND INVERTER. Inverter: 12 volt d.c. input, 3 phase 190 cycle output. (These inverters can be used successfully as 12 V d.c. motors for models.) Gyro Unit: operates on 3 phase output from inverter. Peak speed 11,400 rpm. Caged, precision made equipment. These units are ideal for experimenting and demonstration purposes. Size 11 1/2" x 3" x 3"; Gyro 4" dia. inc. cage. Price, 12/6 per pair plus 3/- p.p.

G2AK THIS MONTH'S BARGAINS

AERIAL EQUIPMENT
COPPER WIRE 14 g. ft/d. £2 14/-
90' length. £2 7s. 6d.
RIBBED GLASS INSULATORS 3" £6 6d.
or 6 for £4 10/-
MOUNTING CONDENSORS. Made by
B. F. Johnson Co., U.S.A. Max. cap. 500 pF. Ceramic insulator, size 3" long x 2 1/2" wide x 2 1/2" high, excluding shell projection. Our price only 1/- post free.

AMERICAN BREAST MIKES. Swivel head, push-to-talk and lock-on switch; excellent job; 15/6, post 1/-

HEADPHONES, H.R., type, 4,000 ohms. Very sensitive, only 12/6 pair, post 1/6.

AMERICAN TWIN FEEDER. 300 ohm, twin ribbon feeder, similar K25, 66 per yard. K35B Teflon (round) 1 3/4 per yard. Post on above feeder and cable, 1/6 each

TWIN HOME CRACKLE, Black, 5/-, postage and packing included

COLLINS MODULATION TRANSFORMERS. P.P. 200V 20W. handsome job, 12/6 each each pair.

RACK MOUNTING PANELS: 19" x 5", 7", 10" or 12" black crackle finish. 9/-, 4/-, 7/-, 9/- respectively, postage and packing 2/-.

www.americanradiohistory.com
SELF-FEED SOLDERING


TV AERIALS

25/6


IDEAL RADIO OR RADIOGRAM CHASSIS

3½ band and gram., 2½et 5-valve international oetal. Ideal table gram, but still giving high quality output. 4-knob control. 8. p.m. speaker 7/9 with order. See of knobs 3½ Chassis 15" x 6½" x 7½" LESS valves, Inc. corr. 4/1.

DUKE & CO (R.C.) 621-3 ROMFORD ROAD MANOR PARK LONDON E12

Telephone GRA 667-8 2791

ELECTRIC CONVECTOR HEATER

99/6

1d, an hour cheaper than paraffin. Switched 1 or 2 kw. Illuminated grille a.c./d.c. Ideal for home, office, workshop or greenhouse. Buy while stocks last. Carr. & ins. 10/6

12 MONTHS' GUARANTEE TV TUBES

17" £7.10.0

12" £5.10.0

6 months full replacement, 6 months progressive. Possible only by the high quality of our tubes.

SPECIAL OFFER. 14", 15", 16" £5 12" TV TUBES. 46. Shortage may cause delay.

PETROL SHORTAGE—Telephone first 15/6 carriage and insurance on all tubes

TV CHASSIS

97/6

Complete chassis by famous mfrs. Easily converted to I.T.A. R.F. e.t.c. unit included. A.C., 6 tubes. 3 separate units power-circuit/ -vision/t-base inter-connected). 6. p.m. speaker free with each order, also drawings. 1.8s. 16.5-19.5 Mc/s. Carr. ins. 10/6

For a really professional finish use . . .

PANEL-SIGNS TRANSFERS

Set No. 1: Receivers and Amplifiers. Five sheets 8½; $½; containing one Large scale, twelve control panels and wording. 3s. 6d. Postage 2d.

Set No. 2: Test Instruments. Five sheets 8½; x 5½; containing two Medium scales, twelve control panels and wording. 3s. 6d. Postage 2d.

Set No. 3: Wording

Wording for Receivers, Amplifiers, Transmitters, Test Equipment and other Radio Apparatus.

4 Sheets. Approx. 400 words, 2s. 6d. Postage 2d.

Transfers fixing varnish or ultrasound, 1s. per bottle Postage 4d.

Note—all wording is in white

Published by

DATA PUBLICATIONS LTD

57 MAIDA VALE • LONDON W9

Telephone CUNingham 6141 (2 lines) Telegrams Databux London
HENRY'S
(RADIO) LTD
5 Harrow Road Edgware Road
Paddington London W2
PADDINGTON 1008/9 and 0401

OPEN MON. to SAT. 9-6, THURS. 1 p.m.
Send Stamps for New 1957 20-page Catalogue

EAVESDROPER
THREE TRANSISTOR POCKET RADIO
(No Aerial or Earth Required)
Pre-selected to receive the Light and Home Stations.
Total cost, as specified, including Transistors, Transformers, Cells, Condensers and Battery, etc., with circuit and baseboard.

77/6
(LESS INSERT)
With Aces Insert 90/-. With Minature Hearing Aid 92/6
All components sold separately

Complete sets of Teleton Coil and Ferrite Rods.
REPEANO TRANSISTOR COMPONENTS

R.F. TRANSISTORS (BLUE-SPOT)
1.6 Mc/s. 15/-

F.M. CONVERTER UNIT
88/100 Mc/s
Containing 6 valves—2 6RA6, 6B91, VR137, 2 EF54.
Two i.f. stages and separate local oscillator, vacuum driven tuning. Just plug in to your radio and obtain good listening on FM. Voltage required 250V 50mA and 6.3V 2A. £7. 19. 6

TRANSMITTER/RECEIVER
Army Type 17 Mk. II
This well-known R/T Transceiver is offered complete with valves, high resistance headphones, No. 3 hand mike and instruction book giving complete details and circuit, contained in strong cabinet. Variable tuning. Frequency range 440 to 61 Mc/s. Range approximately 3 to 8 miles. Power requirements standard 120V h.t. and 2V r.t. Ideal for Civil Defence and communications.

BRAND NEW 59/6
Calibrated Wave meter for same, 10/- extra

INDUSTRY'S
JUNCTION TYPE (Red-Spot) (P.N.P.)
10/- each (Tested and complete with data and circuits)

N.B.—These transistors may be used in place of Mullard OC71 or similar transistors.
Please note that these Red-Spot Transistors are ideal for most circuits including "W.W." Peacock Transistor Receiver and Transistor Amplifier. All transistors are British manufactured and guaranteed. Send for circuits and data.

PRE-SELECTED SEVEN TRANSISTOR PUSH-PULL PORTABLE SUPERHET
Just switch to your favourite station. No tuning, no aerial or extra. Pre-select 3 stations. Complete with all components and seven transistors. 7" x 4" elliptical speaker. Tелефон superhet coils and I.F.s. Powered by 7½V dry battery which lasts for months. 150 milliwatts output. All the above with circuits, etc. £9. 17. 6 extra paid
Or with matched Mullard OC77's (200W output) and 7" x 4" elliptical high resistance speaker, 30/- extra Suitable plastic Cabinet easy to assemble £18/6

CALL AND HEAR DEMONSTRATION MODEL WORKING

TRANSPORTER SIGNAL TRACER
Complete kit with 2 transistors, components, 'phones with circuit, 42/6

TRANSPORTER SQUARE WAVE GENERATOR
Build a complete kit with 2 transistors and components and circuit, 25/-

TRANSPORTER PUSH-PULL AUDIO AMPLIFIER
(150 milliwatts output)
Build this push-pull amplifier which is ideal for crystal or magnetic pick-up amplification, baby alarm, microphone, etc. Powered by 6V dry battery lasting for months. Complete kit of parts including 4 transistors and all components with circuit (less speaker). £4. 10. 0

SPECIAL OFFER
Set of four transistors, including one R.F. transistor, 42/6
Set of six transistors, including one R.F. transistor, 60/6

CRYSTAL MICROPHONE INSERTS
Ideal for tape recording, gramophone amplifier, etc. Varies sensitive. Guaranteed and taxed, 5/-
We have over 50,000 Valves in stock. Send for List.

SPECIAL REDUCTION FOR SETS OF VALVES
For set of 8
IAG7, IN5GT, IN5GT, IASGT (or IQ5GT or IQ5GT) 27/6
10 E580 (Ex-branch new units), 5/- each 27/6
10 E580 (Red Syphonia, ex-branch units) 6/- each 35/-
18LG6, AK7G, 627G, 627G, 153G, 254G 27/6
185, 155, 154 (or 384 or 384) 27/6
TP25, VP21, HJ2,12DD, PD6W (or 20PD6) 27/6
D96A, 965, DAF6, DL95 27/6
16MG, 6X7G, 627G, 254G, 254G 27/6 (or 257G or 227G) 37/6
12SK7GT, 12XGT, 12XGT, 352GAT, 352GAT (or 504G7T) 37/6
25AG7T, 257G7GT, 238G7GT, 352GAT (or 504G7T) 35/-

SMALL ADVERTISEMENTS
Reader's small advertisements will be accepted at 3d per word, including address, minimum charge 2/-.
Trade advertisements will be accepted at 5d per word, 25% minimum charge 6/-.
If a Box Number is required, an additional charge of 2/- will be made. Terms: Cash with order. All must be by the 8th of the month for insertion in the following month's issue.

PRIVATE

FOR SALE Radiola DC/AC Converter, type 230/100A, nearest new price £11.6.6, accept £6.10.0 Owen, 108 Prestbury Road, Macclesfield.

FOR SALE V/Master chassis—valved, converted i.f. requires tuner and tube only, £9. Tuner price components—WA, No. 1, F. Coke, Scan coils, W/Control and circuit—new £3.00. (Dobex) W.B. Focus units — new, 5/-. Each.—WA, doto.
New, 10/-. Extra e.h.t. components, 5/- set, e.h.t. rect., KB1/100, new, 7/-, MB/120, 7/-, 1212 magnifier, £1. Two console t.v. cabinets, one at 30/-, other at 50/-, 12in Mullard, slight burn, £1. 12in Mullard, 2nd VG, £3. 8in Concor, electrostat, 15/- Tube socket, Stern Radio, 10/- pass. Trans. £16. 5 volt—250V, 25A10.—One tapped 3V—30V, 3A, 10/- 1—6, 3V, 7/6, 7/6. All 200—250 in. Small W.W. Lathe and angle iron stand, £3.10.0. Heavy polishing head, 10/-. Green Arrow space heater, requires adjustment, 10/-. Please add for carriage R. F. King, 4 Bridge House, Beverley Avenue, Calthorpe, Surrey.

FOR SALE Tape recorder using Truvox deck with built-in radio, £25. Eddystone receiver, coverage 90 kcs to 30 Mc/s, with plug-in coils and power pack, 11 gns. Receiver RA-1B, with power pack, £9. 19 Set and power pack, also head set, £4. All equipment in perfect condition. Offers considered. Mr. King, 20 Kerwick Gardens, Ridlip, Middx.

FOR SALE Victaflor 12/20 speaker. VCR131 c.r.t. Offers R. Pillar, Devon Constabulary, North Tawton, Devon.

FOR SALE CR100, good condition, £15 o.n.o. GIJFU, 1 Walton Road, Leverington, nr. Wisbech, Cambs.

FOR SALES 12in BTH loudspeaker, new and unused, £6.0o. Box No. E1214.


FOR SALE R1155B, at new, with power pack and output stage, E.12 o.n.o. 33 Southport Road, Ormskirk, Lancs. Telephone Ormskirk 3309.

FOR SALE Eddystone 750, excellent condition and performance. 45 Cornwall Avenue, Peaishaven, S. Ayr.

FOR SALE Eddystone 35SX receiver, modified EF54 r.f. and 6V6 output stages, nine valves, complete covering 100—110—120—130—140, excellent condition, complete with special power pack, £11.10.0. S. Davies, 78 Thorney Street, Wathamstow, London, E.17.

continued on page 573

AMPLIFIERS
3 watt, 3 valve, complete with power pack and ready for use, 200—250 volt mains. Soundly constructed. In robust metal case with carrying handle. Ideal for parties, etc. Factory built and tested £13. 10. 0
Or in kit form, less metal case, £12. 15. 0 each. Post free. Suitable make 7/6. Suitable 8" speaker 22/6

I.T.A. PATTERN ELIMINATING COILS
Specially made to reject B.C.B. interference, tunable to cover any channel. Simple to install and complete instructions supplied. Price 5/- post free. (State B.C.B. Price)

OSCILLOSCOPE KITS
Complete kit of parts to build your own ‘scope, together with full circuit and assembly instructions, 31/1 tube, power supplies, two valves and all components. Price 65/- post free.

LAURENCE ELECTRONICS
15b Chipstead Valley Road Coulsdon Surrey Telephone UPLands 9073
Open to personal callers on Saturdays only

SPECIFIED COMPONENTS FOR THE BEGINNER’S TRANSISTOR RECEIVERS
J.B. .0005 2-gang Condenser 11/6
J.B. .0005f Variable Condensers 3/11 each
J.B. 3-pole 2-way Switch Chassis, ready wired No. 1 3/9
No. 2 1/9 No. 3 1/6 No. 4 1/9
9-way Tap Strip Junction Transformer 10/- each
Repeano Colls DR22 4/8 0.1f Condenser 1/-
100K Resistor 3d.
High Impedance Headphones 17/6
S.A.E. for free point-to-point wiring diagrams

Radio Experimental Products Ltd
33 MUCH PARK ST.
COVENTRY
SMALL ADVERTISEMENTS
continued from page 575

TRADE


COILS, COILS, COILS. We can supply coils for all frequencies, r.f. chokes, etc. Send SAE for circuits and data. The Teletron Co., 266 Nightingale Road, London, N.9.

PANL, the air-drying black crackle paint. 3/6 per 1/8th pint can. G. A. Miller, BCM/PANL, W.C.1.


MORSE CODE TRAINING. Special course for Beginners. Full details from (Dept. RC) Canders System Company, 52b Abington Road, London, W.6.

“FM TUNER UNITS
for Fringe and Local Area Reception”

This booklet, now in its Fifth Edition, includes a description of a Suitable Tuning Indicator and of The Oram 512 High Fidelity Amplifier. 92 pages with art board cover, price 2s. 6d. post paid

H.A.C. THE ORIGINAL SUPPLIERS
OF SHORT-WAVE KITS

One-valve Kit, price 25/-; Two-valve Kit, price 50/-.
Improved designs with Denico coils. All kits complete with all components, accessories and full instructions. Before ordering, call and inspect a demonstration receiver, or send stamped envelope for catalogue.

DATA PUBLICATIONS LTD
57 Maida Vale London W9
Telephone GU/Naltingham 6141 (4 lines)

HOME RADIO of MITCHAM
FM TUNER KITS

The Beginners “SHORT WAVE 3”

Never mind the weather this winter, build the Beginners Short Wave Three and bring the whole world to your own fireside. Enjoy the thrill of travelling the world on short waves, music from America, sport from Australia, news from all parts, and the fun of listening in to amateurs in the remotest corners. Join the happy band of Short Wave Listeners TODAY. Without doubt the most satisfying and interesting side of Home Constructor radio work. Full Constructional Data. 3/10.

JASON FM. Without doubt the most successful Home Constructor design ever produced. Complete kit of parts as illustrated with valves, 67, 72. Full constructional details with price list, price 2/-.

JASON ARGONAUT AM/FM tuner or receiver. All parts in stock. Full constructional data, price 2/-

ALSO ALL PARTS IN STOCK FOR THE G.E.C. JUNIOR AMPLIFIER, G.E.C. 912 AMPLIFIER, MULLARD 2J and 510 AMPLIFIERS, EAVESDROPPER PORTABLE, HIGHWAYMAN PORTABLE HOME RADIO (MITCHAM) LTD
187 LONDON ROAD MITCHAM SURREY Telephone MIT 3282

YOU CAN RELY ON US

We specialise ONLY in radio and electronic components, a comprehensive stock of which are held by us, to supply Government, educational and commercial laboratories. Can we be of some help to you, the experimenter and constructor?

QUALITY AMPLIFIER KITS

IN STOCK

MULLARD 3 WATT QUALITY AMPLIFIER INCLUDING WYNALL TRANSFORMERS
MULLARD 510, F.M. UNIT, PRE-AMP
20 WATT AMPLIFIER
OSRAM 912, PASSIVE UNIT, PRE-AMP, F.M. UNIT
TRANSFORMERS FROM STOCK— WYNALL, PARTRIDGE, GILSON, W.B., ELLISON

Detailed Price List Available on Request New Catalogue No. 14 on Request

Next to South Ealing Tube Station 65 Bus

RADIO SERVICING CO