THE
RADIO CONSTRUCTOR

Vol. 23 No. 2 SEPTEMBER 1969 THREE SHILLINGS

Solid State D.C. Voltmeter and A.C. Millivoltmeter

Special IN THIS ISSUE

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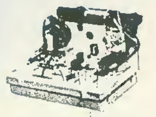

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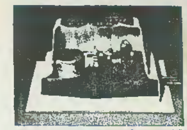

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THE **Radio Constructor**

Incorporating THE RADIO AMATEUR **SEPTEMBER 1969**

Vol. 23 No. 2

Published Monthly (1st of Month)
First Published 1947

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9

Telephone 01-286 6141
Telegrams Databux, London

Annual Subscription 42s. (U.S.A. and Canada $5) including postage. Remittances should be made payable to "Data Publications Ltd.". Overseas readers please pay by cheque or International Money Order.

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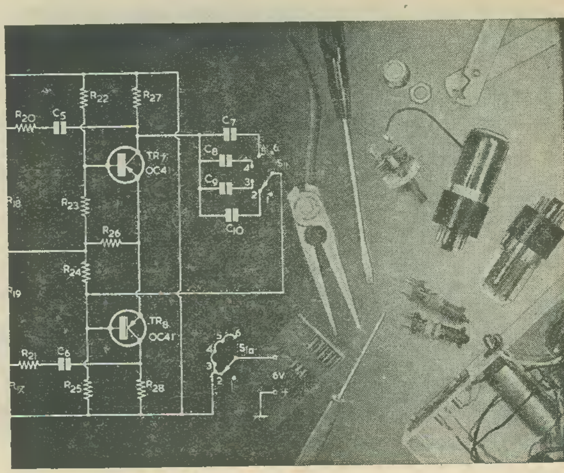
Production.—Letterpress.

CONTENTS

Published in Great Britain by the Proprietors and Publishers, Data Publications Ltd, 57 Maida Vale, London, W.9.
The *Radio Constructor* is printed by Kent Paper Company Ltd, London and Ashford, Kent.

OCTOBER ISSUE WILL BE PUBLISHED ON OCTOBER 1st



BATTERY SAVER FOR BEDSIDE RADIOS

by G. A. FRENCH

IT IS PLEASANT TO HAVE A TRANsistor radio in one's bedroom, since it is then possible to settle down to sleep against a background of radio music. How often does it happen, however, that one wakes up on the following morning to find that the transistor radio is still playing, having been left switched on all night!

This month's "Suggested Circuit" describes a simple delayed switching circuit which may be added to any standard 9-volt transistor radio. When switched in, the delay circuit allows the transistor radio to contine running for about three-quarters of an hour, after which it turns the receiver off. It is possible, in consequence, to switch off the bedroom light and drift off into sleep whilst the radio is still playing, having the comforting knowledge that it will switch itself off automatically when the delay period has elapsed.

The delay circuit has the advantage that only a few components are required, but the disadvantage that one of these is a rather bulky electrolytic capacitor. As a result, it may not be possible to fit the circuit into very small receivers having compact internal layouts. If, nevertheless, a receiver of this type were adapted to run from an external battery when it is used in the bedroom, the delay circuit could easily be incorporated in a small unit with the external battery.

As a final introductory point it should be mentioned that the delay circuit does not employ a relay. The switching action is carried out by a transistor.

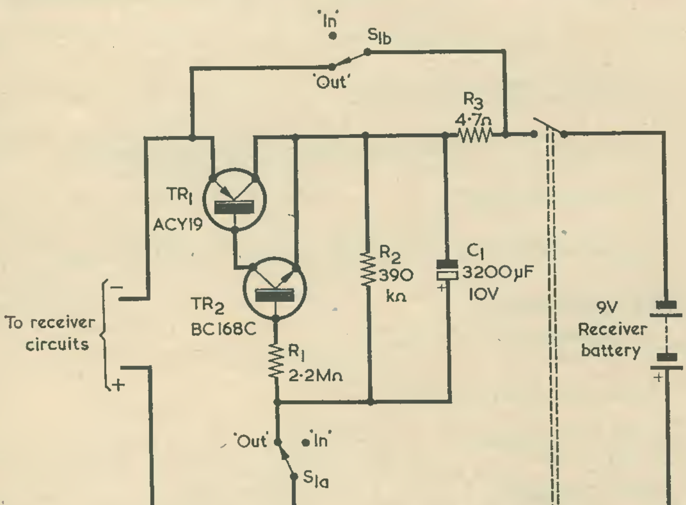


Fig. 1. The delayed switch-off circuit. This is incorporated immediately after the on-off switch of the associated receiver

SWITCHING CIRCUIT

The switch-off delay circuit appears in Fig. 1, and it is intended for installation between the on-off switch of the receiver and the remainder of the receiver circuits. Transistors TR1 and TR2 are coupled together in a manner which allows a very high level of current gain to be achieved. The writer has used the same transistor combination in an earlier "Suggested Circuit"*, in which it was similarly employed for controlling the power supply to a transistor radio. An important feature of the circuit is the choice of a BC168C for TR2, this transistor having the extremely high gain figure of 450 to 900. (The BC168C is available from Amatronix, Ltd.). In the present instance it is merely necessary to point out that TR1 is held hard on for load currents of up to 50mA flowing between its emitter and collector when a current of slightly more than 1μA flows to the base of TR2. Thus, provided that the requisite base current flows in TR2, TR1 allows full battery voltage (less a fraction of a volt dropped in the transistor) to be applied to the circuits of the transistor radio.

In Fig. 1, switch S1(a) (b) will be normally in the "Out" position S1(a) then causes the positive supply

* "Suggested Circuit No. 222 — Light Operated Radio Switch", *The Radio Constructor*, May, 1969.

line to be applied to the lower ends of R1 and R2, and to the positive terminal of C1. When the receiver is switched on C1 is, in consequence, charged to the full 9 volts provided by the battery. Also, S1(b) short-circuits TR1 and R3, thereby eliminating the small voltage drop in TR1 which occurs when it is conducting, plus that in R3. The receiver is operated in the usual fashion, and is switched on and off by its own on-off switch.

When it is desired to introduce the delayed switch-off facility the receiver on-off switch is left in the closed position and S1(a) (b) is thrown to "In". The short-circuit is taken off TR1 and R3, and the battery supply is now fed to the receiver circuits by way of these two components. A base current well in excess of 1μA flows to TR2 via R1, causing TR1 to be hard on. Since TR1 is conductive, the receiver continues to operate. At the same time the positive terminal of C1 is disconnected, by S1(a), from the positive supply rail. C1 now commences to discharge, the discharge currents flowing through R1 and the base-emitter junction of TR2, through R2, and through the internal leakage resistance of the capacitor itself. Due to the very high current gain in TR1 and TR2, the initial discharge current flowing to the base of TR2 via R1 is sufficient to maintain TR1 hard on, and the controlled receiver continues to play. After a period the voltage across C1 falls to a level at which the consequently reduced discharge current in R1 cannot maintain TR1 fully conductive, and the supply voltage applied to the receiver circuits commences to fall. When this supply voltage is insufficient to allow the receiver oscillator to function the set becomes silent. The supply voltage continues to fall until it reaches a negligibly low value. The current finally passed by TR1 is transistor leakage current only.

The receiver has therefore been initially silenced, after which the current drawn from the battery has further reduced, falling eventually to an insignificantly small level. The circuit has thus fulfilled its function and it remains in this state until S1(a) (b) is returned to the "Out" position. The set then proceeds to operate in normal manner. When desired, another delayed switch-off cycle can be initiated at any time by once more setting S1(a) (b) to the "In" position.

CAPACITOR DISCHARGE

As will have been gathered from the description of circuit operation just given, the delay circuit enables very nearly full supply voltage to be applied to the receiver circuits until the end of the delay period. The delay circuit does not then, however, turn off the supply instantaneously but allows the current passed by TR1, and hence the voltage across the receiver supply rails, to fall gradually.

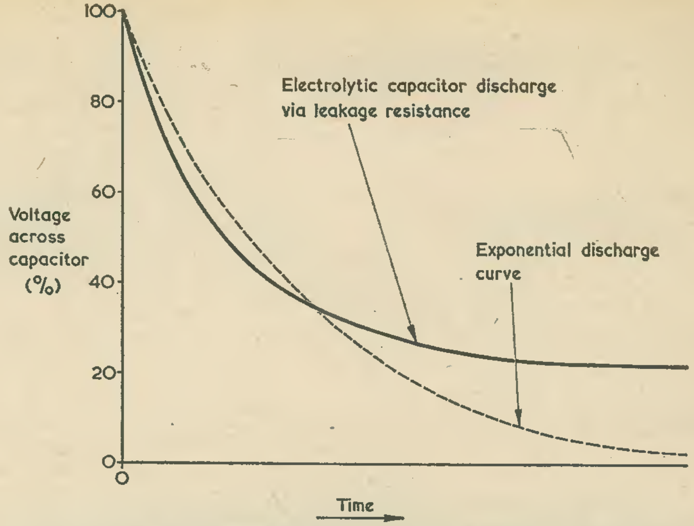


Fig. 2. The solid line shows a representative discharge curve for an electrolytic capacitor discharging into its own leakage resistance. The standard exponential discharge curve is given in dashed line

It is desirable that the time during which the current passed by TR1 is reducing gradually should be kept as short as possible, because this represents a period when battery current is wasted since it is not being used to provide an audible output from the receiver. A further factor, which has not been mentioned, is that it is preferable, in order to save cost and space, to keep the value of delay capacitor C1 as low as possible consistent with the achievement of a long delay period. These requirements are conflicting, as will next be explained.

The longest possible discharge time of which C1 is capable is provided when it is allowed to discharge through its own leakage resistance, with no external resistor connected across it. A large-value electrolytic capacitor can take a surprisingly long time to discharge completely under these conditions. Unfortunately, the leakage resistance of an electrolytic capacitor is not constant, but increases as the voltage across the plates reduces, resulting in a voltage/time discharge curve of the type shown in solid line in Fig. 2. As may be seen here, the voltage across the plates of the discharging capacitor drops relatively rapidly at first but then falls very much more slowly as, at the reduced voltage, the leakage resistance increases. Also shown in Fig. 2, in dashed line, is the normal exponential discharge curve for a capacitor and resistor in parallel. It will be seen that the electrolytic capacitor discharging through its own leakage resistance "lingers" at the lower voltages for a much longer period than does a capacitor obeying the exponential discharge law.

Returning to Fig. 1, if R2 were omitted and C1 allowed to discharge mainly through its own leakage resistance, very long switch-off delays could be achieved with quite low values in C1. However, after the voltage across C1 had dropped to the level at which TR1 ceased to be fully conductive the subsequent fall in C1 voltage would be relatively very slow and the period during which TR1 remained partly conductive very much longer. The advantage of using a small value in C1 would be completely outweighed by excessive waste of battery current after the controlled receiver had been silenced.

A compromise is reached in the present circuit by using a somewhat large value for C1, and by shunting it with the fairly high value resistor R2. C1 then discharges mainly through R2 and only partly through its own leakage resistance, thereby approaching more closely the true exponential voltage/time discharge curve.

To assess the performance given by the combinations of C1 and R2, the output of the switching circuit (i.e. the two circuit points at the left of Fig. 1) was coupled to a 300Ω resistor instead of to the circuits of a transistor receiver. A 300Ω resistor draws a current of 30mA at 9 volts and is reasonably representative of a transistor receiver playing at a fairly high output level. Fig. 3 shows the results obtained with the prototype circuit, illustrating that the voltage across

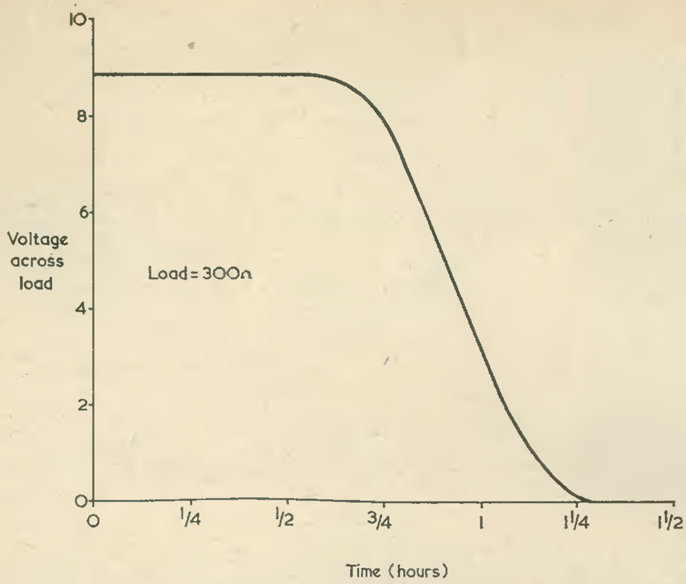


Fig. 3. The result given by the prototype switching circuit when coupled to a 300Ω load

the load remained constant at slightly less than 9 volts for nearly three-quarters of an hour after S1(a) (b) had been switched to the "In" position. The voltage then fell fairly quickly, dropping to a negligibly low value after slightly more than an hour and a quarter from the start. The current in the load resistor is, of course, proportional to the voltage across it. As may be seen from Fig. 3, the average current drawn during the half-hour after which the voltage commenced to fall is about one-half of the full current. It can be argued, in consequence, that the switching circuit has enabled full voltage and current to be applied to the load for nearly threequarters of an hour, at a cost of a further quarter of an hour of wasted full current.

This performance seems to be more than acceptable for practical purposes, bearing in mind, in particular, the considerable simplicity of the delay switching circuit. The only disadvantage is that C1 requires the fairly high value of 3,200μF.

CAPACITOR PERFORMANCE

The manufacturers of electrolytic capacitors normally only quote the maximum leakage current which is to be expected in their products, and this is usually very much higher than the leakage current the capacitors actually exhibit. In consequence, the delay capacitor, C1, is used in an application which is not covered by manufacturers' specification, since it is expected to pass a leakage current (through its leakage resistance) which is much lower than the manufacturer's maximum figure. Experience with high-value capacitors bears out, however, that the performance obtained in the writer's prototype circuit should be approximately duplicated in other circuits built up to Fig. 1, although there is no guarantee that an individual capacitor might not exhibit a higher leakage current whilst still being within manufacturer's specification. It can be anticipated that the delay offered with other capacitors may not be exactly equal to that illustrated by the curve of Fig. 3. Taking into account, also, variations in gain in TR1 and TR2 it would seem reasonable to expect that the switch-off delay in other circuits made up to Fig. 1 may range between about half-an-hour and an hour. The actual switch-off delay can only be ascertained by checking it in practice.

The capacitor employed in the prototype was a 3,200μF 10V component in the Mullard C431BR series. It has been the writer's experience that capacitors in this series offer consistently low leakage currents and are, as a result, particularly suitable for a circuit of the present type. It should be remembered that, when voltage is applied across a high value capacitor after it has been in store for a long period, quite an appreciable time is required for it to form and give its final performance. Several runs with the circuit should be undertaken before the usefulness of the capacitor is finally evaluated.

Turning to the other components in the circuit, TR1 and TR2 have already been dealt with. The three resistors, R1, R2 and R3, may be ⅛ watt 10% components. R3 is merely a limiter resistor, and it limits switch-on surge currents in TR1. Its position in the circuit is such that it also limits switch-on surge currents in C1 as well.

Switch S1(a) (b) is a double-pole single-throw component and may have a toggle, slide or rotary action. If desired, S1(b) may be omitted, whereupon the battery supply to the receiver is fed via R3 and TR1 all the time. This alternative arrangement has the slight disadvantage that the small voltage drop across these two components is always present, and the slight advantage that the only switch required is the single-pole single-throw component shown in Fig. 1 as S1(a).

PRACTICAL PERFORMANCE

When S1(a) (b) is in the "Out" position, additional current is drawn from the receiver battery via R1, R2 and the leakage resistance of C1. The current in the two resistors is very small, being about 4μA and 23μA respectively. The leakage current at nine volts in the electrolytic capacitor employed in the prototype was about 25μA. All these currents are only drawn when the receiver is switched on and are extremely small when compared with the normal receiver current.

When describing the performance illustrated by Fig. 3, it was stated that the voltage dropped to a negligibly low level slightly later than one and a quarter hours after the start of the delay period. The current in the load at that time, as measured in the test circuit, was 0.3mA. This current continued to fall until, after a further quarter of an hour, it consisted of transistor leakage current only, and was actually less than 20μA.

When feeding into the 30mA load offered by the 300Ω resistor, the voltage dropped across R3 and the conducting TR1 was slightly in excess of 0.5 volts.

As a final point, Fig. 1 assumes that the receiver in which the delay circuit is incorporated has a double-pole on-off switch. The circuit may, of course, be similarly employed with a receiver having a single-pole on-off switch. When S1(a) (b) is in the "Out" position, the receiver will take a little longer to become silent after switching off due to the presence of C1. The receiver circuits will very probably have a high value electrolytic bypass capacitor across the positive and negative supply rails, and the delay circuit of Fig. 1 must appear *between* the on-off switch and this capacitor. If such a capacitor is not fitted in the receiver circuits, limiter resistor R3 could be omitted. ■

QSX

by

FRANK A. BALDWIN

(All Times GMT)

● **TOPIC**

In a recent issue (June 1969) when writing under a pen name, I pointed out that many listeners found difficulty in obtaining information on publications providing some of the constant flow of information required by the keen Broadcast bands operator.

Very few books are published specifically for the interest of short wave listeners and it is quite an event when one appears on the bookstalls. Two such publications have, however, recently been released. The first is *How To Listen To The World*—published by World Radio-Television Handbook Co. Ltd., and available at 25/- plus 1/- postage from the Modern Book Co., 19 Praed Street, London W.2.

Between the covers of this publication is a veritable mine of information on all aspects of Dx-ing written by some of the world's foremost listener experts. Chapters on such subjects as – First Steps in Dx-ing; Selecting a Short Wave Receiver; Physics of the Ionosphere; Measuring Frequencies and Calibrating Receivers; How to Report to Stations; Tape Recording of Reports; Broadcasting in Peru and Languages in International Radio. Many other chapters – there are 45 in all – on other aspects of listening are included. Among the many well-known listeners who have contributed to this publication, the writer noted two British enthusiasts – Charles Molloy of Southport, an expert on Medium Wave Dx-ing and Alan Thompson of Neath, an experienced top-flight short wave Broadcast bands Dx operator. Much useful information is included even for the seasoned listener.

The second publication of the utmost importance to s.w. Broadcast bands listeners has recently been released – *World Radio-TV Handbook Summer Supplement*. A copy of this may be obtained from the bookshop mentioned earlier at 17/6 plus 1/- postage. This latest edition contains all the up-to-date information currently available on frequency and wavelength listings throughout the Long, Medium and Short Wave ranges and also the many TV channels.

This publication is a must for all who operate receivers over the various bands, especially where a correct record of frequency listings is maintained. All the many changes are included and, where Short Wave Operation is the main interest, this book provides all the very latest information, in handy form, easily available to the short wave listener.

Also of interest to s.w.l.'s is the *World Radio Bulletin* published by World Publications. Lindorfsalle 1, Hellerup, Denmark. Published twice monthly, it contains information on all the latest news, frequency changes, schedules, new stations, addresses and programs, etc., of stations around the world. A sample copy is available on request and an annual subscription (26 issues) costs 36/-.

● **AMATEUR BANDS**

The past few weeks have provided plenty of Dx on these frequencies provided, as always, that one was prepared to spend some time 'digging' for it under the semi-local transmissions — this particularly applying to the c.w. portions of the various bands.

On 'Top Band' the usual summer conditions applied—plenty of heavy static varying reception conditions from the tolerable to the impossible!

1.8MHz

CW: GI3SLM, GM3UYF, GW3UMB, GW3XJC, OK1AFK, OK1JKR, OK1JMF, OK2SEX, OK3YAO, OL1AFO, OL1AKG, OL1ALM, OL2AIO, OL2AKS, OL2ALS, OL5ALY, OL9ADO.

7MHz

CW: CX7BY, HC2HMC, HK1BDE/4, PY1DMF, PY2DFR, PY3CFB, PY7AWW, PY7AZQ, ZL1AH.

14MHz

CW: CR6AL, CR6KB, CP4AB, FL8MB, HC2RT, HK7BDA, HS2AAF, JA3AOI/MM, (off ZF1), JA3GZN, JA3QQO, JA7TGO, JA8ZO, KZ5HC, LU1EC, VK2AMB, VK2QU, XE1RA, ZE2KL, ZL2CC, ZL3ADF, 9J2CL, 9J2MG, 9Y4DS.

SSB: EP2CB, FG7XL, HC2PC, HC2RZ, HKØBIS, HK3AUE, HK3MT, HK3SJ, HK4DF, HP1AS, HR1KS, JA2BTV, KG4DS, KZ5JW, PJ2CC, PJ3CA, TG9VD, TI2ES, VK3VK, VK4HA, VK7AZ, VP2VV, XE1AE, XE1OE, XE1KV, YN1RTS, YN2OM, YS1O, ZF1GC, ZL1ACP, ZL2BS, ZL2LA, ZS3BP, 5N2AAF, 6Y5GB, 9Y4LP.

21Mc/s

CW: CO2BB, CO2KG, CR6BX, CR6KB, CR6LK, HC3GG/1, JAØBYS, JA2CLI, JA3CNQ, KR8EA, KX6DQ, MP4TAF, PZ1CM, TJ1AJ, 6W8BM, 8P6BU.

● **BROADCAST BANDS**

This is the 'season' for best reception of the South American low-powered stations and listed here are some of the results of recent operating sessions on the lower frequencies.

3240kHz 0358 OBX4U Lima, Peru, ending a programme of Latin American songs with the identification "Radio America".

3250kHz 0305 OCX7D Juliaca, Peru, with identification as "Radio Collasuyo" (also at 0257). Channel blotted out at 0310.

3265kHz 0247 ZFT Georgetown, Guyana, heard with identification in English and closing with their National Anthem.

3300kHz 0420 Belize, B. Honduras, with a talk in English. Tentative logging – QRM from strong unmodulated carrier on channel.

3330kHz 0350 OAX1M R. Progresso, Peru, with Andean type flute music. Signed off suddenly after announcement in Spanish at 0357, no National Anthem. Weak signal, tentative logging.

3350kHz 0254 OAX5J Ica, Peru, with a song programme. Identification as "Radio Indepencia, Ica" at 2050. Signed off with slowly rendered choral song at 0254.

3380kHz 0250 TGCH Jocatan, Guatemala, featuring light music. This station often radiates organ music. 3 chimes between commercials. Identification and 5 chimes at 0334.

5045kHz 0425 CP38 La Paz, Bolivia, with Latin American music and identification "La Voz de Altiplano".

5180kHz 0331 OAX8F Lima, Peru, with light music and identification.

6040kHz 0243 HJLB Ibague, Colombia, with a programme of Latin American music and identification "La Voz del Tolima".

6075kHz 0315 HJCT Sutatenza, Colombia, with news in Spanish and identification.

6160kHz 0259 HJKJ Bogata, Colombia, with a commentary in Spanish and identification "Emisora Nueva Granada".

6250kHz 0305 OAX7A Cuzco, Peru, with 2 chimes and identification "Radio Cuzco". Cuzco is an ancient town situated in the Andes at an altitude of 11,400ft. in the valley of the Urabamba river. Cuzco was once the capital of the Incas, has an Incan temple and fortress and was besieged and sacked by Manco Inca in 1536.

For those beginner Broadcast bands listeners who would like to try the higher frequencies and receive the more powerful stations, try these:–

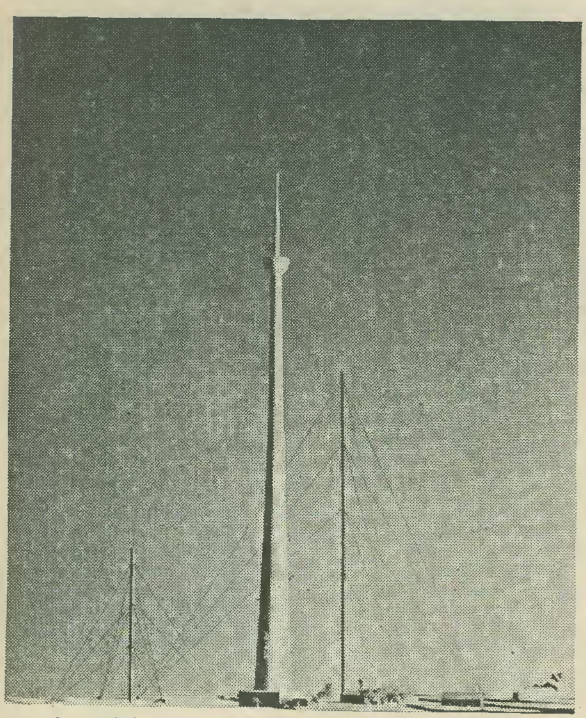
17805kHz 0500 RSA, South Africa, with news commentary in English and identification.

17820kHz 0455 R. Australia, with news in English and identification.

21500kHz 0515 Brazzaville, Congo, with news in English and identification.

21540kHz 0510 R. Australia, with news in English. ■

NEWS . . . AND .



A model of the proposed new ITA reinforced concrete television tower which, by the end of 1970, will be broadcasting from Emley Moor the programmes of Yorkshire Television, BBC–1 and BBC–2 in UHF, 625-lines. It will also transmit the present 405-line VHF services for Yorkshire Television and BBC–1. For comparison purposes, a model of the present 675ft. "Swedish" mast is shown on the right, and of the temporary BBC–2 300ft. mast on the left.

AFRICA EXPEDITION RUNS INTO TROUBLE

The radio communications expedition to North, East and South Africa, led by 25-year-old Mr. David Dunn, of Cardiff, reported in our March issue, has run into difficulty with the Moroccan police.

The main objective of the four-man expedition is to study the reliability of low power short wave radio communications. Mr. Dunn, a senior draughtsman with the Powell Duffryn Group company Hydraulic Machinery (Great Britain) Limited, of Rhymney, Monmouthshire, did not have a transmitting licence for Morocco and, in accordance with Moroccan law, the radio equipment was confiscated.

Mr. F. J. Seller, secretary of the Amateur Radio Society at the University College, Cardiff, said the party were told the equipment would be returned when the expedition left the country, but this promise was not fulfilled.

Mr. Seller said, in a recent letter from Addis Ababa Mr. Dunn told him that he was beginning to despair of ever seeing the equipment again.

"If this is so it will, of course, mean the end of any short wave communication aspect of the expedition," said Mr. Seller. "This is most unfortunate since I understand Mr. Dunn has transmitting licences for almost all the countries he has yet to visit."

Mr. Dunn hopes to rejoin the Cardiff office of Hydraulic Machinery at the end of the trip this September. His companions are Colin Such (24), and Richard White (22), both of Cardiff, and David Cocks (25) of Gloucester.

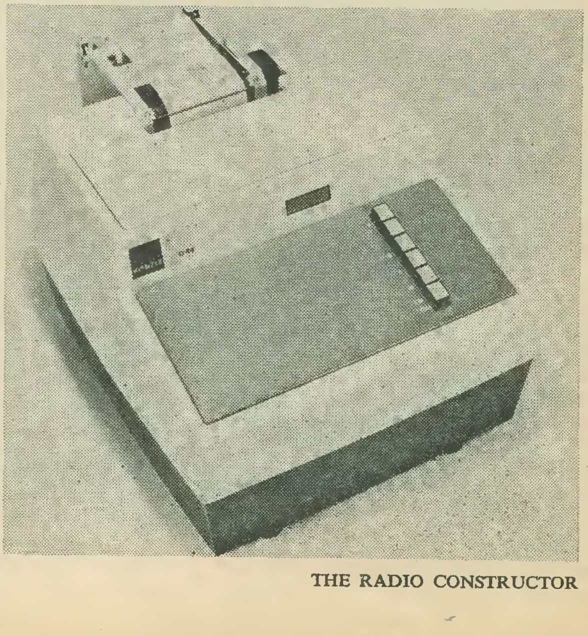
NEW DIGITAL PRINTERS FROM KIENZLE

The entire range of Kienzle parallel entry digital printers has been superseded by a redesigned range offering all round improvements and several new features.

The new range of Kienzle printers have been rehoused in unbreakable plastic cases of advanced styling, complementary to modern electronic instruments and systems.

The redesigned mechanics permit an increase in the printing speed to four lines per second except on printers fitted with adding/subtracting register, where the speed remains at three lines per second.

Several other new features are incorporated, and the new printers are expected to find many applications in data logging, automatic test equipment, weighing systems, automation projects and instrumentation in the laboratory, industry and marine environment.



Pat Otter, Divisional Manager of ITT Electronic Services, presents the prize of a box of chocolates to Miss Gill Harford, winner of a sales desk competition. Miss Harford averaged 9.95 seconds to look up any product in the new 1969 Stock Catalogue.

22% TIME SAVING WITH NEW CATALOGUE

Ten seconds is enough to find what you are looking for in the new 1969 Stock Catalogue issued by ITT Electronic Services.

A thumb index has been incorporated to produce what ITT Electronic Services claim to be the quickest reference catalogue published by any electronics distributor.

They put it to the test with a competition among staff on the sales desk. Using both the new catalogue and the previous one, expert salesmen and salesgirls looked up products pre-selected at random.

Winner was Gill Harford, who averaged 9.95 seconds to find any product in the new catalogue against 12.85 seconds in the 1968 edition.

ITT Electronic Services 1969 Stock Catalogue contains 1,076 pages, with full illustration and clearly-stated prices directly adjacent to product descriptions. Over sixteen thousand products are listed. Available free to buyers and engineers in industry from ITT Electronic Services, Edinburgh Way, Harlow, Essex (Harlow 26777).

G.E.C. RADIO FOR COVENTRY BUS CREWS

Within the next few months, 37 Corporation buses in Coventry will be fitted with GEC mobile radio communications systems which will provide crews with a permanent and instant radio contact with their new traffic control centre in the centre of Coventry.

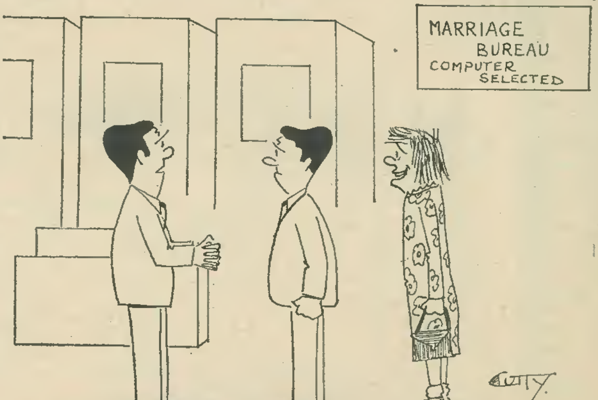
The equipmen consists of the GEC RC/600 high power v.h.f. frequency modulated transmitter/receiver which provides an extremely flexible communications system, capable of covering the whole area of operations of the Coventry bus service. The equipment is fully transistorised, except for the 20 watt power output and driving stages, which use 'quick-heat' valves of proven reliablity and stability. The main transmitter unit with its power supplies is housed in a single unit, mounted under one of the seats. The receiver and system controls are in a small unit, mounted in the driver's cab. The receiver itself can be withdrawn from this mounting, and carried by the driver to keep him in touch with the base if he should have to leave his cab for any reason.

BIG DEMAND FOR OUR NEXT ISSUE

In our October issue, to be published on 1st October, we are including FREE with each copy Workshop Plans, containing a full scale point-to-point wiring diagram, drilling plans, tables, etc., for constructing the *Neophyte* amplifier. The plans are on special cartridge paper to allow for hard workshop use.

The *Neophyte* is a practical, easy to build, 5 watt amplifier, designed exclusively for our readers and will be very popular. We shall also be repeating our special offer, again exclusive to our readers, of motoring accessories such as roof racks, head rests, etc., and the issue will be packed with good articles and the usual features.

We advise readers to place an order for the next issue with their newsagent, as soon as possible, as there will be a big demand.



"No, Sir, there's no mistake – it's just that the computer has such strange tastes!"

THE RADIO CONSTRUCTOR'S 'EASY VIEW' DIARY

FOURTH QUARTER 1969

OCTOBER

Sun		5	12	19	26
Mon		6	13	20	27
Tues		7	14	21	28
Wed	1	8	15	22	29
Thur	2	9	16	23	30
Fri	3	10	17	24	31
Sat	4	11	18	25	

NOVEMBER

Sun		2	9	16	23/30
Mon		3	10	17	24
Tues		4	11	18	25
Wed		5	12	19	26
Thur		6	13	20	27
Fri		7	14	21	28
Sat	1	8	15	22	29

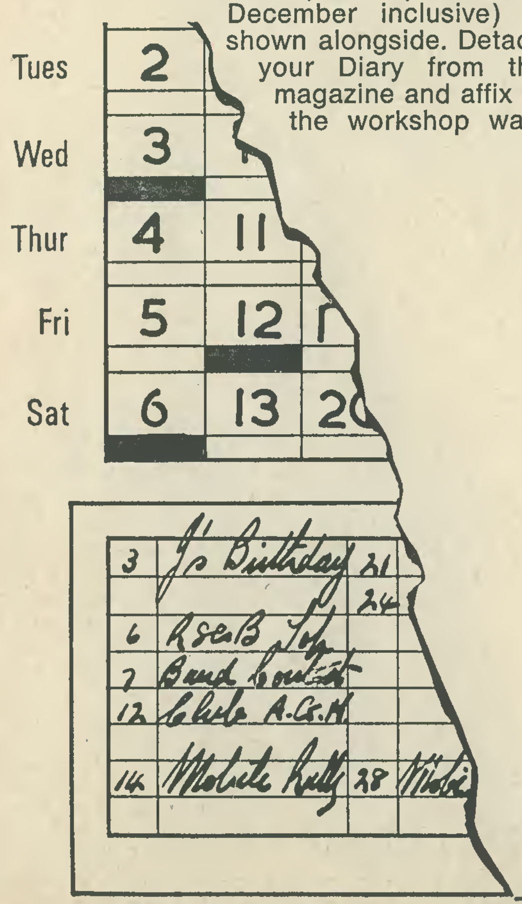
DECEMBER

Sun		7	14	21	28
Mon	1	8	15	22	29
Tues	2	9	16	23	30
Wed	3	10	17	24	31
Thur	4	11	18	25	
Fri	5	12	19	26	
Sat	6	13	20	27	

DIARY NOTES

HOW TO MAKE FULL USE OF YOUR DIARY

Underline the dates of both personal and radio events in which you are interested or concerned, as shown in the illustration below, and enter brief details of these in the Diary Notes. A list of forthcoming events of radio interest taking place during the fourth quarter (October to December inclusive) is shown alongside. Detach your Diary from the magazine and affix to the workshop wall.



SUGGESTIONS FOR YOUR **EASY-VIEW** DIARY

OCTOBER

1–4	RSGB International Radio Engineering & Communications Exhibition, Royal Horticultural Society's New Hall, Greycoat Street, London, S.W.1 (10 a.m. to 9 p.m.)
4–5	VK/ZL/Oceania Phone Contest
5	RSGB Second 1296 Mc/s (Open) Contest
11–12	VK/ZL/Oceania CW Contest
11–12	RSGB 28 Mc/s Telephony Contest
18–19	Boy Scouts (USA) Jamboree
18–19	KR6 Dx Contest
25–26	CQ WW Dx Phone Contest
25–26	RSGB 7 Mc/s (CW) Contest

NOVEMBER

3	RSGB Eighth 144 Mc/s (SSB) Contest
8–9	RSGB 7 Mc/s (Phone) Contest
8–9	ARRL SS Phone Contest
15–16	RSGB Second 1.8 Mc/s Contest
15–16	ARRL SS CW Contest
29–30	CQ WW Dx CW Contest

DECEMBER

6–7	Tops CW Club 3.5 Mc/s Contest
7	RSGB Fifth 70 Mc/s (CW) Contest

"MILLIWATT" SILICON REFLEX T.R.F. RECEIVER

by

G. W. SHORT

Power consumption in this simple but effective receiver design is reduced to less than 2 milliwatts by operating the transistors at the lowest practicable current. The result is greatly enhanced battery life

THE STARTING POINT FOR THE DEVELOPMENT OF THE receiver described here was an enquiry from a friend whose daughter is at a boarding school. Illicit listening to pop music in bed, after 'lights out', is very much the done thing at this school—and perhaps at many others. The trouble is, as my friend explained, that the listener tends to fall asleep, leaving the set switched on all night. Rather bad for the batteries, this, so could I suggest a way round the problem?

My first idea was to modify an existing set by adding a sort of 'dead man's handle' in the form of a push-button switch which would turn off the set when the sleeper's hand relaxed. This was rejected on the ground that the user was more than likely to find some way of keeping the button pressed by lying on it.

The altternative was to reduce power consumption so much that an occasional overnight run became tolerable. This approach was adopted, and the resulting circuit is shown in Fig. 1.

CIRCUIT DESIGN

Readers may recognise the circuit as a development of one of the writer's earlier designs, the 'Silicon Reflex T.R.F.' described in the January, 1968, issue.* This proved to be a very reliable design, and it seemed better to stick to a good thing for the present purpose rather than start on something quite different and possibly less satisfactory.

For the benefit of readers unfamiliar with the original, this type of circuit maximises overall gain by making all two transistors contribute to both r.f. and a.f. amplification. TR2 acts as an emitter follower to r.f. and presents a high input impedance to TR1, thus maximising the r.f. gain of the first stage and providing a relatively low impedance drive to the detector diode. TR2 can thus be regarded as an impedance matching device which, while it produces no voltage amplification itself, nevertheless serves to increase the overall r.f. gain.

The a.f. output of the detector is passed to TR1 and thence to TR2 in the usual way. At audio frequencies, therefore, the circuit is a straight-forward two-stage amplifier.

LOW-CURRENT OPERATION

The original circuit was not at all fussy about transistor types. Practically any silicon n.p.n. transistors worked in it, though naturally some worked better than others. In the present 'Milliwatt' version, the choice of transistor types is much more restricted. The gain and, more especially, the cut-off frequency of transistors fall off as the collector current is reduced below the normal operating value, but in this circuit the transistors must provide high r.f. gain and low r.f. and a.f. noise at collector currents of 100μA or less. Very few transistor types meet all these requirements.

Fortunately, the new epoxy encapsulated planar transistor type SF115 has the necessary characteristics. In particular, it has low internal capacitances, a prime need in circuits with high-value resistance loads operated as wideband r.f. amplifiers, as occurs here. The SF115 is equivalent to the metal type BF115, but is much cheaper. Its one disadvantage is that it will not work well at very low collector voltages. This is why the detector diode specified is a silicon planar type instead of the usual germanium point-contact diode. The voltage drop across a silicon diode when just biased to conduction is 0.5V, whereas the corresponding voltage for a germanium diode of the OA70 class is only about 0.1V. In the present circuit, the drop across the diode forms part of the collector-emitter voltage of TR1. (This point may not be very obvious at first, but a study of Fig. 1 will show that the collector-emitter voltage of TR1 is the sum of the base-emitter voltages of the two transistors and the drop in D1). Using a silicon diode raises the total from about 1.3V to about 1.7V, and this provides a useful margin for reliable operation. It is important to use a high-speed planar diode for D1. An ordinary silicon rectifier type will not do because it will not work at radio frequencies. (The specified IS44 diode and the SF115 transistors are available from Amatronix, Ltd.)

The receiver consumes about 170μA at 9V, and is not unduly dependent on the battery voltage, which can fall to 6V or less without impairing the performance badly.

EARPHONE

The set was designed for use with a crystal earpiece

*G. W. Short, 'Silicon Transistor Reflex T.R.F.', *The Radio Constructor*, January, 1968.

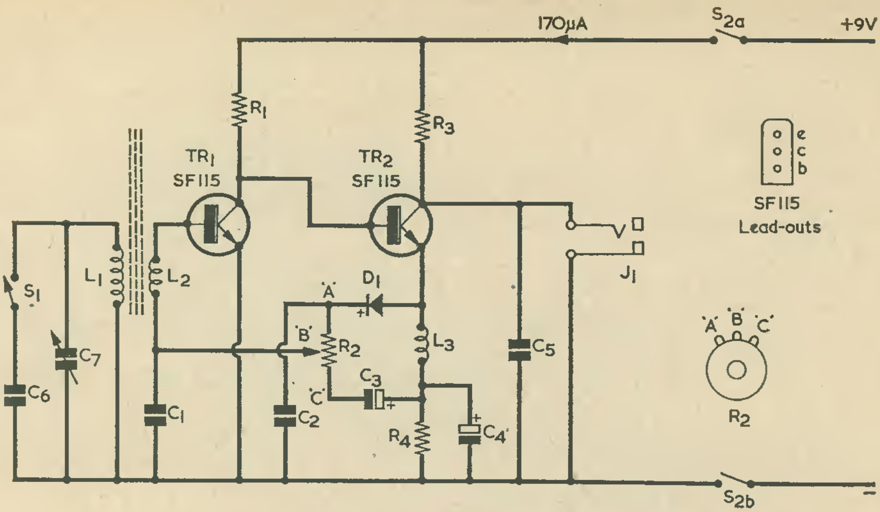


Fig. 1. Circuit diagram of the 'Milliwatt' Silicon reflex receiver

because these are suited to low-current high-voltage circuitry. It is, however, possible to use high-impedance magnetic earphones. The writer does not know of any miniature earpieces with the required impedance (4,000Ω or more), so for clandestine listening magnetic earpieces may be out. For normal purposes a good pair of magnetic phones, such as government surplus type CHR, with the earpieces connected in series can be connected in place of R3. It is also possible to use a step-down transformer to match low-impedance earpieces. For an 8Ω earpiece the turns ratio should be about 60 to 1. The primary inductance must be high (20H with 70µA d.c. flowing).

CONSTRUCTION

It is vital to keep the stray capacitance at the collector of TR1 and the base of TR2 as low as possible. This means that TR1, TR2, and R1 should be positioned close together so that leads can be kept short, and it also means that if a printed circuit or Veroboard base is used then the area of copper involved in joining the relevant three leads must be as small as possible. A pin-board base following the layout of Fig. 2 was used in the prototype, with all three leads on one small pin.

(For the benefit of readers who have not experienced the joys of this cheap and simple form of construction, here is a short description. The layout diagram is placed on a piece of dry wood. Ordinary domestic pins of the shiny plated type obtainable at office stationers are driven in at every junction point.

The heads are then cut off, leaving enough stem to act as solder tags for the leads. Perfectionists tin the stems first before attaching anything. The resulting wiring board is virtually self-checking and components are easily removed. Since everything is on one side of the board testing is easy, and the board can ultimately be made part of a case for the set.)

For reasons which are explained later, the lead-outs of choke L3 should be a little longer than is necessary for connection, in order that it may be orientated relative to the ferrite rod. Initially, its former should be at right angles to the rod.

In t.r.f. receivers, where the r.f. gain is always

COMPONENTS

(N.B.—Some of the components may have values differing from those listed here. Details are given in the text.)

Resistors

(All fixed values ¼ or ⅛ watt 10%)

R1	68kΩ
R2	10kΩ potentiometer, log, with switch S2
R3	47kΩ
R4	10kΩ

Capacitors

C1	0.01µF
C2	1,000pF
C3	10µF electrolytic, 2V wkg.
C4	125µF electrolytic, 2V wkg.
C5	1,000pF
C6	see text
C7	see text

Inductors

L1, L2	see text
L3	1.5mH choke type CH5 (Repanco)

Semiconductors

TR1	SF115
TR2	SR115
D1	IS44

Switches

S1	s.p.s.t., rotary or toggle
S2	d.p.s.t., part of R2

Socket

J1	phone jack socket

Miscellaneous

Crystal earpiece with jack plug
9-volt battery
Knobs, as required

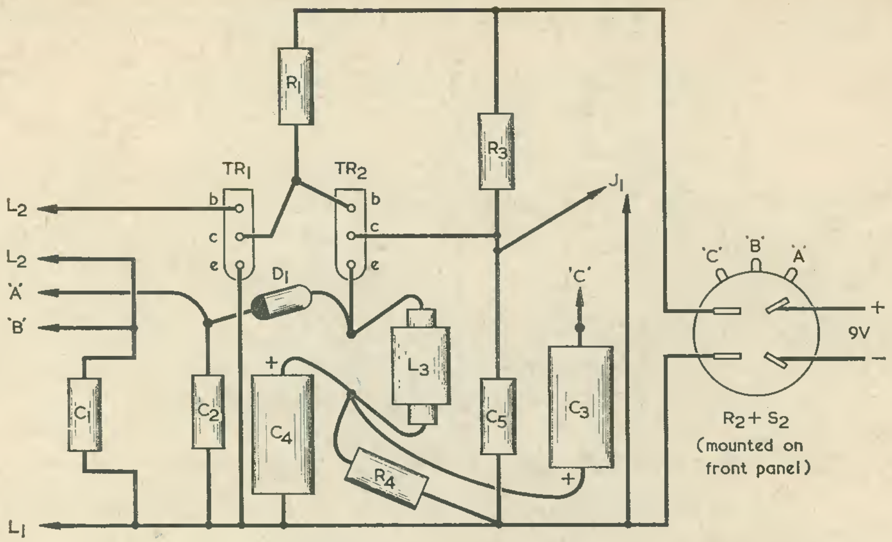


Fig. 2. Layout and wiring of the main components of the receiver. Identify the tags of S2 with a continuity tester before wiring to this component, as tag positioning with different switches may vary from that shown here

limited compared with superhets with their h.f., mixer, and i.f. stages, it is always advisable to keep the ferrite aerial rod well clear of everything else, in order to maximise signal pickup. In this design, the rod should also be kept at least 1½in. from L3. (See below under 'Reaction'.) The tuning capacitor and long-wave components S1 and C6 should be clear of the main circuitry, to reduce stray coupling which might cause instability. These considerations lead naturally to the sort of constructional layout sketched in Fig. 3.

The front panel and base dimensions are not critical, and the constructor may select these to suit the components he is employing. With the ferrite rod used in the prototype, the front panel may be some 5in. wide by 3in. to 4in. high. The base can be about 3in. deep, and could then accommodate a PP3 battery.

AERIAL CIRCUIT

The aerial tuned circuit should have a high Q, and a ferrite rod of reasonably large size should be used to provide a good input signal. In London, good results have been obtained with a 4½in. x ⅜in. round rod of Plessey NW25 ferrite (obtainable from Amatronix Ltd.).

The value of tuning capacitor C7 is not very critical and any standard air-space or solid dielectric variable capacitor offering a maximum value of about 200pF or more will be satisfactory. (A 300pF Jackson Bros. 'Dilemin' capacitor was employed in the prototype.) C7 tunes L1 over the medium wave band. Reception of one selected long wave station is provided by switching capacitor C6 across the tuning capacitor by means of S1. In the U.K., the long wave station is likely to be Radio 2 on 200kHz, and in this case C6 should normally be seven times the maximum capacitance of C7.

WINDING THE AERIAL ROD

Amateur constructors often have in their possession tuning capacitors salvaged from old sets. Unfortunately, the capacitance is not usually known, and even if it is the constructor is often discouraged from making his own ferrite aerial by the absence of information about the characteristics of the ferrite rod. Nevertheless, the winding of a rod for a set like the present design is not at all difficult if the constructor goes about it the right way. All that is needed is patience and a good supply of wire.

The method described here calls for no equipment other than the receiver itself, plus the usual tools, glue, and plastic sticky tape. To begin with, the rod is kept detached from the rest of the circuit, so that changes can easily be made. Only after the windings have been got nearly right is the rod installed and the final adjustment made.

First make up the rest of the circuit, providing in the process a pair of easily accessible tags for connections to L2 and one tag for making an 'earth' (i.e. supply negative) connection for L1 and C7. Check that the set is working by short-circuiting the L2 tags and listening in the earpiece with the volume control turned up. A gentle hiss should be audible. The constructor may then proceed with winding the coil for the rod.

First prepare the rod by wrapping a few turns of brown paper round the middle two inches or thereabout. Fix the paper with sticky tape or glue to prevent it unwinding, but if possible allow it to behave as a paper tube loose enough to be slid along the rod to provide fine adjustment of inductance. This paper tube is the coil former. Readers may have seen ferrite aerials in which the windings are directly on the ferrite. This is not good practice for all grades of ferrite; and some work better if the coils are spaced away from the surface. (The spacing reduces

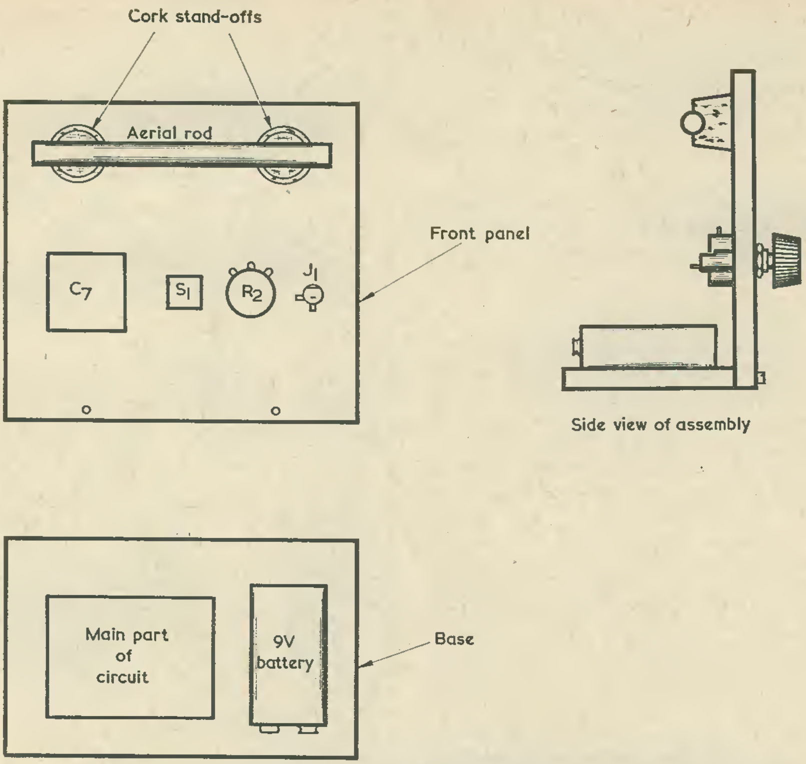


Fig. 3. A suitable layout for the front panel and base of the completed receiver. The rectangle designated 'main part of circuit' may enclose the components (apart from R2) shown in Fig. 2

certain r.f. losses.) L1 can be wound with any kind of litz wire (which can often be salvaged from old i.f. transformers) or with solid wire of around 30 s.w.g., silk or cotton covered. L2 can be wound with ordinary plastic covered hookup wire. Both coils are single-layer, close-wound. L2 can be wound on top of the earthy end of L1.

The number of turns needed depends on the capacitance and characteristics of the rod. As an indication, the rod just mentioned needs approximately 57 turns of 7/46 litz wire to tune over the medium wave band with a 300pF tuning capacitor. In finding the right number of turns by trial and error, it is best to begin with too many and then remove turns rather than to begin with too few and add them. If, on the other hand, plenty of wire is available, it may well be best to scrap the initial trial winding when the correct number of turns has been found, and then finally re-wind. In the latter case, it is a fairly safe bet that 50 turns will tune to some point in the medium wave band. If coverage down to the low frequency end at about 530kHz is not obtained, turns can be added. Should the set tune to lower frequencies than are needed, turns are removed. To make the initial trials, put on a temporary 3-turn winding for L2 with about 9in. of loose wire at each end. Twist the loose wire into flex and connect the ends up to the L2 tags on the circuit board, removing the short-circuit which was put on for the earlier test. The rod can now be kept well away from the circuit while L1 is adjusted. During adjustments, L1 and C7 may be connected with fairly long loose leads and the ferrite rod and variable capacitor can be placed on a wooden table top or other instulating support. It is not necessary to 'earth' the moving vanes of C7 to the negative supply line of the receiver at this stage.

Using a trial coil of 50 to 100 turns for L1, tune in and identify stations, and add or remove turns as required to tune to the low frequency end of the medium wave band. When the correct number required is beginning to become clear, slide the coil along the rod so that L1 is central. Readjust the turns slightly if necessary.

The ferrite rod and C7 can now be mounted. The best position for the rod is behind the top of a front panel of Formica or similar insulating board. Keep it away from metal, including the volume control and C7. If possible, mount the rod on stand-offs (pieces of cork or dowel) so that the winding can be easily adjusted *in situ*. Trim off excess leads and connect up again to the circuit. Also complete the 'earth' connection to C7 and L1. There should be no marked change in performance. If there is, adjust L3 as described later under 'Reaction'. A slight final adjustment of inductance, if required, can be made by sliding the coil along the rod. If it has to be put right at the end of the rod, remove a couple of turns and start again.

So far, nothing has been said about the tuning at the high frequency end of the medium wave band. In general, if the low frequency end is all right, so also is the high frequency end. The only exceptions are, first, that if the tuning capacitor has a built-in trimmer this may have to be set to minimum to obtain full coverage and, second, that if the tuning capacitance is too small the self-capacitance of the coil may be so large that it prevents full high frequency coverage. In the latter case there is nothing much to be done about it. As a guide, tuning capacitors of less than about 150pF maximum are in the 'danger area'.

The final job consists of fitting and wiring C6 and S1. If necessary, slightly alter the calculated value of C6 to bring in the Radio 2 transmission comfortably.

REACTION

Preset reaction is adequate to pep up the performance of this receiver. It is obtained in two simple ways, at no expense. Should L3 be near enough to L1 and L2 for there to be an appreciable amount of mutual coupling, then feedback is introduced between the input and output of the r.f. amplifier. If this feedback is negative, gain and selectivity both suffer. If it is positive, gain and selectivity are improved, and if the coupling is too high the circuit oscillates. The sense and magnitude of the coupling are adjusted by positioning L3. Initially, it should be placed so that it is approximately opposite the centre of L1 and at right angles to the rod; i.e. the former of L3 is pointing straight at a point near the middle of the rod. This is the position for minimum coupling. If L3 is now turned away from the right-angles position coupling with L1 is increased. There is no easy way of telling beforehand whether the result will be negative or positive feedback, but this becomes obvious when the receiver oscillates. L2 is finally positioned so that the set just fails to oscillate with a new battery.

The second method is to connect a short stiff insulated lead to the non-earthy side of L1 and place the free end near to or touching L2. If the sense of the windings on the rod is right, oscillation is obtainable. If not, reverse the connections to L2 and try again. Either or both of these methods of obtaining reaction may be used. There is some advantage in using both, since the L3 coupling method is usually most effective at the low frequency end of the band and the reaction wire method at the high frequency end. With both, the performance can be optimised over the band.

If necessary, an extra reaction wire can be connected to the non-earthy end of C6 to provide a separate adjustment of reaction for the selected long wave station.

GENERAL NOTES

The receiver is easily built, and a small battery lasts a long time. Apart from the tuning, there are no critical adjustments, and no critical component values. The volume control is a necessity in this low-consumption circuit, because it is essential to be able to turn down the volume on strong transmissions to avoid serious distortion caused by overloading on audio peaks; on the other hand its value is not critical and anything from 5kΩ to 100kΩ can be used. The electrolytic capacitors need not have the exact value specified. C3 can be 5 to 50μF and C4 50 to 500μF, both with any working voltage above the 2V specified.

■

DOUBLE SPEAKER UNIT FOR THE SWL

by

FRANK A. BALDWIN

This simple double-speaker unit provides the short wave listener with two sources of audio output, each of which may be selected at the turn of a switch. The speakers differ with respect to audio response, and that best suited is brought into circuit according to the requirements prevailing. Additionally, an output is provided for tape recording facilities

With a communications receiver set to its most selective state operating over the short wave Broadcast bands, the writer often found that the single speaker he previously used—a 7in. x 4in. elliptical type—was apt to offer an accentuated bass response. This state of affairs was largely a result of the sideband cutting given by the receiver in its most selective condition.

Requiring a higher pitched audio response, an inexpensive 3in. round speaker was experimentally connected into circuit and the elliptical speaker removed. The subjective improvement was surprising—the transmission being received having a much higher audio content with the smaller speaker. The former 'boomy' audio response vanished almost completely and the signal became perfectly intelligible. However, when the communications receiver was then set for wideband reception, audio quality (at least in communication terms) was sadly lacking.

Further checks with c.w. reception revealed that the smaller speaker produced a much better audio response than did the larger speaker, judicious use of the b.f.o. pitch control rendering morse signals much more intelligible. Indeed, the signal selected could be made to stand out with almost crystal clarity.

It occurred to the writer that a twin-speaker unit containing both speakers, together with a switch for selecting one or the other, would provide the best of both worlds. Since the writer also makes extensive use of a tape recorder, the opportunity was taken to provide an output for this instrument as well.

The end result is a simple twin-speaker unit which is comparatively inexpensive and easy to put together.

CIRCUIT

The simple circuit employed is shown in Fig. 1. The components are contained within a 12in. x 5in. x 3in.

COMPONENTS

Chassis
Aluminium 12in. x 5in. x 3in. (H. L. Smith & Co., Ltd.)

Speakers
3in. round
7in. x 4in. elliptical

Switch
Single-pole, two-way rotary

Knob
To suit switch

Mounting Feet
4 of rubber, grey (H. L. Smith & Co., Ltd.)

Miscellaneous
4BA nuts and bolts, speaker mesh, screened cable, p.v.c. covered wire, solder, etc.

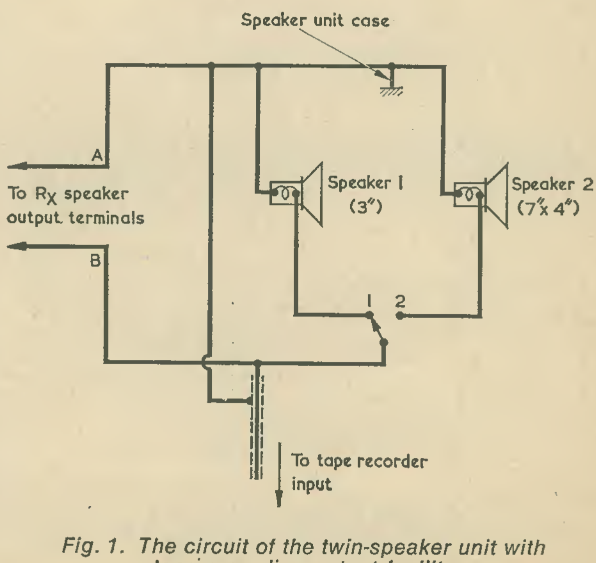


Fig. 1. The circuit of the twin-speaker unit with tape recording output facility

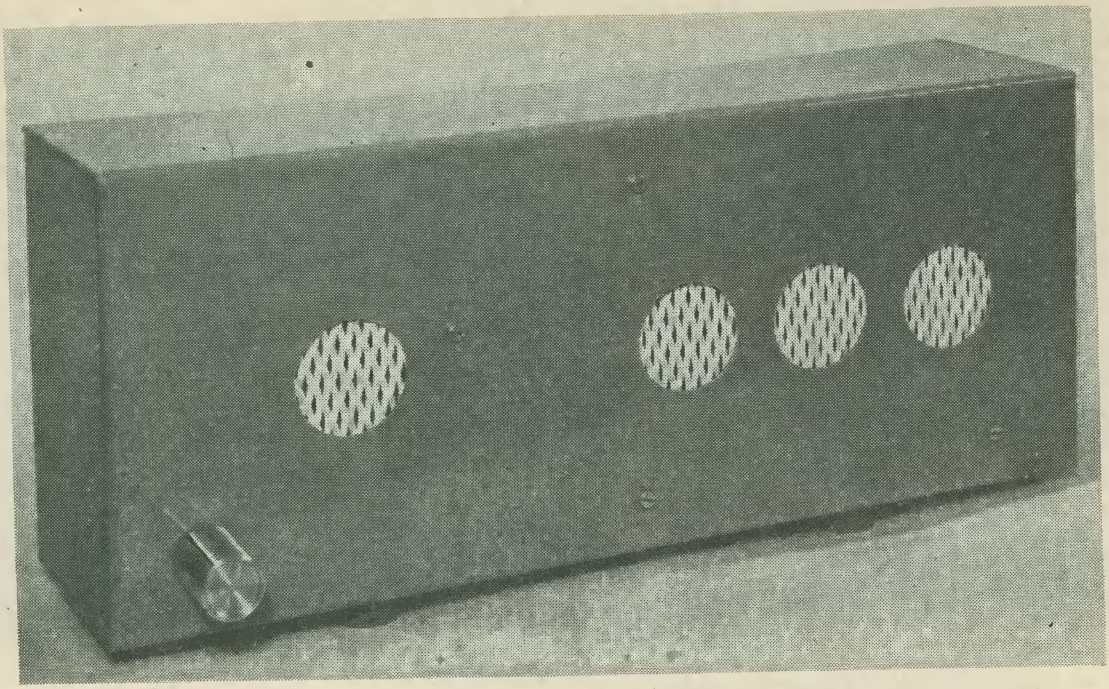
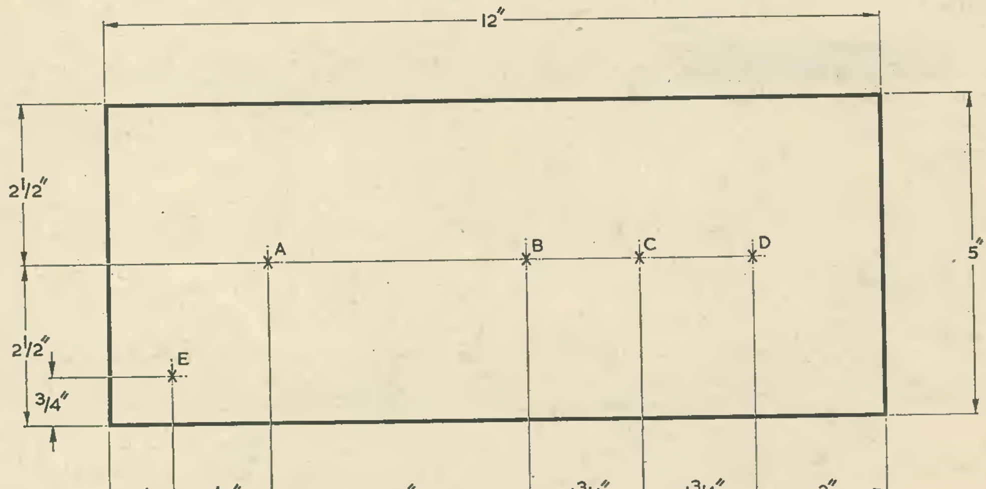


Fig. 2. Drilling details of the chassis deck – this being the speaker unit front panel when completed. Hole A is for the 3in. speaker and holes B, C and D are for the 7in. x 4in. speaker

aluminium chassis—see illustration—the input to the unit being taken from the receiver speaker output terminals on the rear of the receiver chassis.

The intending constructor of this unit should look at the circuit diagram of his communications receiver and ascertain whether or not one side of the output transformer secondary winding is connected to chassis. If this is the case, the receiver output terminal at chassis potential couples to input A of the unit (see Fig. 1) whilst the other output terminal connects to input B. Should neither side of the output transformer secondary be connected to receiver chassis, and if no harm to or malfunctioning of receiver circuits would result if such a connection were made, then couple one of the receiver output terminals to the receiver chassis and wire input A to this point, as before. In the unlikely event that neither of the receiver output terminals can be connected to chassis the 2-speaker unit may still be used, but no connection is made to the unit case and the output facility for the tape recorder has



Chassis deck — plan view

The completed twin-speaker unit. Speaker 1 is at the left and speaker 2 at the right. Note the rubber mounting feet and speaker aperture mesh to be omitted. It is assumed in this last instance that there is no h.t. or otherwise dangerous potential on the output terminals.

The 2-speaker unit must *on no account* be used with a receiver having its chassis connected to one side of the mains. It may only be used with receivers having an isolating mains transformer and a reliably earthed chassis. It may also, of course, be used with battery operated transistorised receivers.

Inputs A and B may be connected via twin flex, lead A inside the unit connecting to a chassis tag secured under one of the speaker mounting nuts and thence to the two speakers, and lead B passing to the arm of the switch. The switch contacts then connect to the remaining speaker tags.

The tape recorder output is taken by screened cable, as shown, the screening connecting to the speaker unit chassis tag. Coaxial cable provides a satisfactory screened cable. Although this method of taking a tape recorder output from the receiver is not ideal—it would be preferable to take the output from an early point in the receiver a.f. amplifier stages—it has the advantage of simplicity and it ensures that no internal connections have to be made to the receiver. The writer found that recording quality was better with the small speaker switched into circuit.

Both speakers should have approximately the correct impedance specified for the particular receiver with which they are to be used.

CONSTRUCTION

Fig. 2 provides drilling details for the twin-speaker unit and from this, and the accompanying illustration, it will be seen that hole A is for the small 3in. round speaker whilst holes B, C and D are for the 7in. x 4in. elliptical speaker. Hole E is for the switch.

In the prototype, holes A, B, C and D are $1\frac{1}{8}$in. diameter, being cut with an octal-sized chassis cutter. The two speakers are secured into position behind these holes on the chassis deck —which then becomes the 'front' panel—by means of 4BA nuts and bolts. The speaker apertures are covered with a white plastic mesh as shown, but any suitable material or metal mesh could, of course, be used. The rear of the speaker unit is left completely open.

Prior to mounting the switch, speakers and mesh, the chassis should be cleaned, and cellulose sprayed or painted to the colour choice of the individual constructor. When dry, four rubber mounting feet can be secured to the underside of the unit either by means of a suitable adhesive or by self-tapping screws or suitably sized nuts and bolts. The mesh, the two speakers and the switch are then secured into position and the circuit wired up. A suitable knob is fitted to the spindle of the switch.

The coaxial cable should be connected to the tape recorder radio input, the recorder handbook being consulted to ensure that correct connections are made.

Once in use, the short-wave enthusiast will soon wonder how on earth he ever managed previously with only a single speaker. ■

TRANSISTORISED G.D.O. FOR THE H.F. BANDS

We regret that, due to pressure on space, this article has been held over and will appear in the next issue – October – due to be published on 1st of October.

NOMOGRAM FOR PARALLEL RESISTANCE OR SERIES CAPACITANCE

by

R. H. DOUGHTY

This simple nomogram can be made to any convenient size with the aid of standard graph paper

When one is dealing frequently with the practical solution of an equation containing more than two related variables, alignment charts or nomograms can often be used to advantage. This article describes a simple nomogram capable of providing solutions to the well known equation,

$$\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2},$$

for two resistors in parallel. A similar equation exists for two capacitors in series.

BASIC NOMOGRAM

The basic nomogram is shown in Fig. 1. The two outer scales, OA and OC, are each inclined at 60° to the centre scale OB. The spacing between graduations on all three scales is the same.

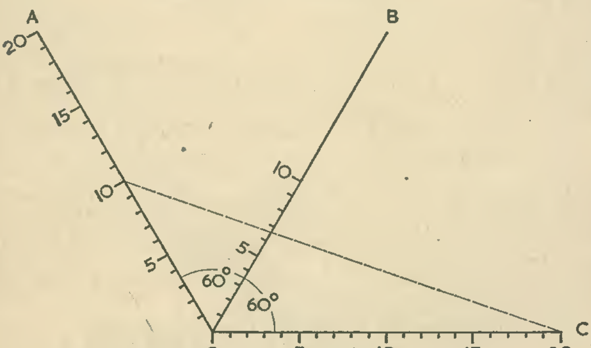


Fig. 1. The basic nomogram. As an example of its use, the dashed line indicates that a total resistance of 6.7Ω is given by resistances of 20Ω and 10Ω in parallel

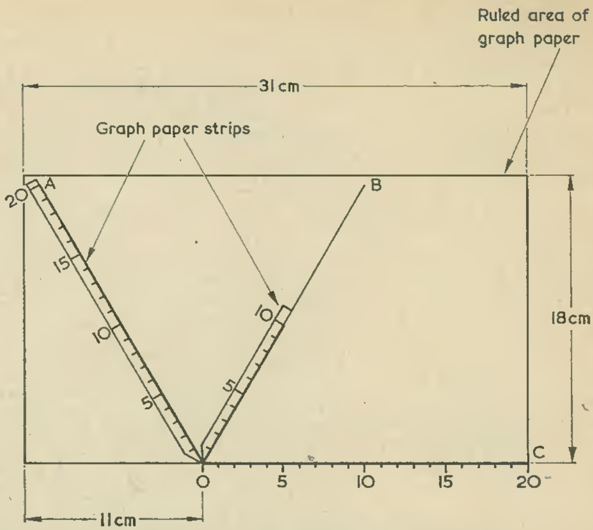


Fig. 2. Making up a large version of the nomogram on a sheet of centimetre graph paper

To determine the resultant of paralleling two resistors their values are set on the two outside scales with a straight edge and the resultant is read off at the point of intersection with the centre scale. The chart can, of course, be used in the reverse manner to determine what resistance must be placed in parallel with a given resistor to reduce it to a required new value.

Where the resultant of a number of resistances in parallel is required, the third resistance and the resultant of the first two are set on the outside scales and the result of combining three is read on the centre scale, and so on.

While the diagram shown in Fig. 1 could be used for approximate determinations, larger and more accurate nomograms may be constructed simply, using sheets of centimetre graph paper of foolscap or similar size. The squared area of these is usually about 31cm by 18cm.

Take a sheet of the graph paper with the 31cm dimension running from left to right, as in Fig. 2, and choose a point 11cm from the left hand border along the bottom edge of the ruled area as the centre from which the three scales radiate. This will enable each scale to be 20 units (each 1cm) long.

A line may be drawn along the bottom edge to give scale OC, after which lines can be drawn on the paper to give scales OB and OA. The requisite angles can be set with a protractor or a 60°/30° set-square if available. The scales are graduated along the lines in cm and mm. This may be done for OA and OB simply by cutting strips from a second sheet of graph paper and sticking them in position alongside the lines with transparent tape or gum. The scales can represent ohms or picofarads to any power of ten required, but the multiplier must be the same for each scale.

PROOF

The relationship between the lengths read on the three scales may be proved by similar triangles. If corresponding angles of two triangles are equal then the lengths of each pair of corresponding sides are in the same ratio.

Fig. 3 shows the three graduated scales meeting at a point O with the straight edge cutting them at A, B and C, giving scale lengths of a, b and c. Add the perpendiculars AD and BF.

From the similar triangles ADC and BFC,

$$\frac{AD}{BF} = \frac{DC}{FC}$$

$$= \frac{DO + OC}{OC - OF} \quad \ldots (1)$$

From the similar triangles ADO and BFO,

$$\frac{AD}{BF} = \frac{AO}{BO},$$

also since these triangles have angles of 30°, 60° and 90°,

$$DO = \tfrac{1}{2}\ AO, \text{ and}$$
$$OF = \tfrac{1}{2}\ OB$$

Substituting in (1),

$$\frac{AO}{BO} = \frac{\tfrac{1}{2}\ AO + OC}{OC - \tfrac{1}{2}\ OB},$$

$$\therefore \frac{a}{b} = \frac{\tfrac{1}{2}\ a + c}{c - \tfrac{1}{2}\ b},$$

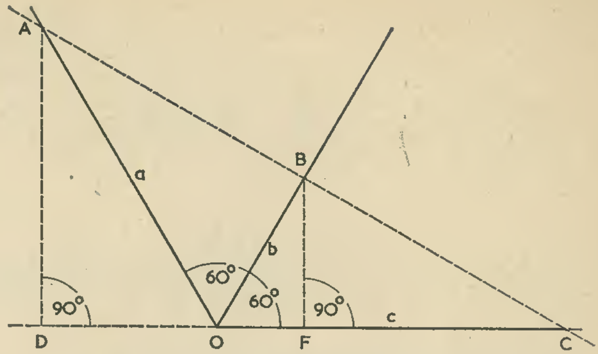


Fig. 3. Illustrating how the lengths of OB, OA and OC satisfy the equation for two resistances in parallel

$$\therefore ac - \tfrac{1}{2}\ ab = \tfrac{1}{2}\ ab + bc,$$

$$\therefore ac = ab + bc.$$

Dividing through by abc,

$$\frac{1}{b} = \frac{1}{c} + \frac{1}{a}.$$

The lengths read on the three scales thus obey the equation for parallel resistance or series capacitance. ■

QUEEN'S AWARD FOR BBC

Four years ago, a special Queen's Award to Industry was instituted to give public recognition to British industrial firms for outstanding achievement in the fields of export or technological innovation. This year, one of these highly coveted awards has gone to the BBC for its development of television standards converters, which make international exchanges of television programmes possible by changing the scanning standards and colour system of one country into those of another.

Through the inventions of its own engineers, the BBC was able to design and construct the first equipment capable of converting electronically both scanning standards and colour systems. The first electronic field-store standards converter, to give it its full name, was brought into use in 1967, when, for the first time, transatlantic colour television, transmitted via the Early Bird communications satellite, was broadcast in Britain. The converter provided colour pictures of very good quality, but the conversion process used resulted in the picture being somewhat reduced in size.

The second BBC converter, known as the advanced field-store television standards converter, brought a complete solution to the problem, the output pictures being of full size. This advanced unit has been described as the most intricate, complex and sophisticated piece of broadcasting equipment the BBC has ever used for television broadcasting. It was completed in time to provide Britain and other European countries with high quality live colour pictures of the Olympic Games from Mexico last year, and is now used regularly in the BBC television services. Nine countries used the output of the converter as a source of colour pictures from Mexico; and an additional eighteen countries, which were not yet ready to transmit colour, transmitted the pictures in monochrome.

The BBC has agreed that two British firms – Rank Precision Industries and Pye – can manufacture the BBC converter under licence and market it abroad. This will mean that high quality colour transmissions from America will be available to television audiences throughout the world. A Rank spokesman has estimated that there is a potential market for about a hundred of these converters, the first of which should be available next year.

ALARM FOR MAINS RADIOS

by

J. C. EADE, B.A.

This article describes successive steps in the design of a circuit which enables a modified alarm clock to switch on a mains-driven radio receiver. It must be pointed out that the circuits discussed here must only be employed with receivers having chassis which are isolated from the mains supply, and that the alarm clock wiring must be such that the clock frame connects to a reliable mains earth

Two recent articles in *The Radio Constructor* have described circuits which enable a transistor battery radio to be switched on in the morning by means of a modified alarm clock.* If a normal alarm clock is examined it will be seen that it has a metal disc concentric with the set alarm hand spindle, and that this disc moves forwards and releases the striker escapement at the preselected alarm time. In both the previous articles the clock was modified so that the disc, on moving forward, completed a circuit. This circuit was made via the clock chassis, the disc, and an additional contact mounted to the clock chassis by means of a small insulated block. In the first article the clock circuit connected a battery supply direct to a transistor radio. In the second circuit it triggered a thyristor which then switched on the receiver.

MAINS RECEIVERS

The author, having recently changed from a battery radio to a mains receiver, decided to see whether this could similarly be switched on by an adapted alarm clock. Since it is essential that the clock switching circuit be isolated from the mains supply, it then becomes necessary to use a relay to switch on the set.

It must be emphasised at this stage that the circuits described in this article must only be used with a receiver whose chassis is reliably earthed and which is fully isolated from the mains by a mains transformer. On no account may the circuits be employed with a receiver whose chassis is connected to one side of the mains. The alarm clock must be wired so that its chassis connects to the receiver chassis. If a 2-way plug and socket is used between the receiver and the clock circuit, this must be of a non-reversible type.

The first circuit tried is that shown in Fig. 1, and it operates by simply inserting the clock contacts in series with the loudspeaker. This system works, of course, but it suffers from several disadvantages. First,

* A. G. Blewett, "Home Constructed Radio Alarm", August, 1967, issue; G. A. French, Suggested Circuit No. 217, "Thyristor Alarm Switch", December, 1968, issue.

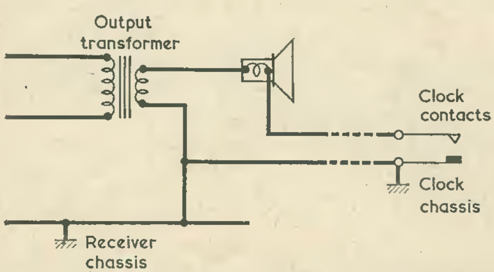


Fig. 1. A simple means of using alarm clock contacts to control a mains-driven radio

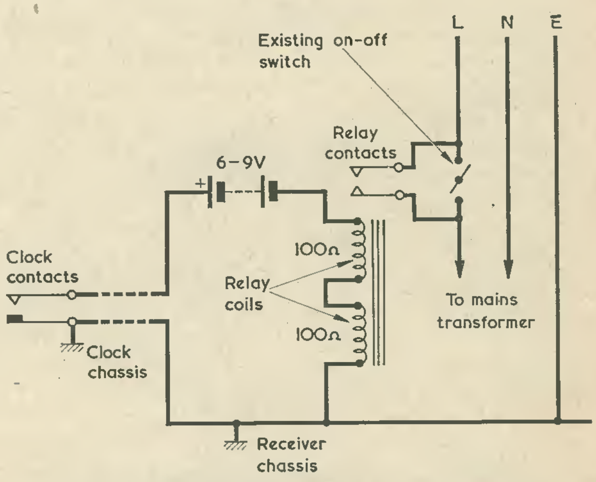


Fig. 2. Here, the contacts switch the receiver by way of a relay. The receiver should have a single-pole on-off switch inserted in the mains line input

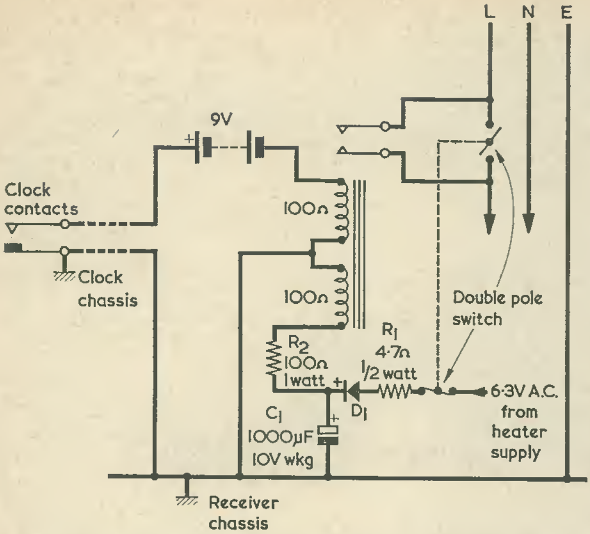


Fig. 3. A circuit in which the relay latches on when energised. A double-pole on-off switch is now required, the second pole being wired in the latching circuit

the receiver has to be left switched on. Second, damage can occur to the output transformer of some sets, due to high a.f. voltages in the primary, if the secondary does not have a load. (The author's set is a communications receiver and is so designed that the loudspeaker circuit is open-circuited for phones operation, anyway.) Third, the loudspeaker would only be connected for as long as the contacts in the clock remained closed. (However, in the author's case this occurred for about an hour and was not really a disadvantage.)

It was decided that something a little less crude was required, and this led to the circuit shown in Fig. 2, where a relay is used. The main disadvantage here (apart from the fact that the receiver is only switched on over the period when the clock contacts are closed) is that the relay continually draws current from the battery. The relay employed by the author had a double coil of 100Ω plus 100Ω and these two in series would draw 45mA from a 9-volt battery. Such a current is far too high for economic running.

To eliminate the heavy battery drain it was therefore decided to develop, first, a self-latching relay circuit and, second, a means of triggering the relay without causing a continuous battery drain. Fig. 3 shows the next circuit, which is self-latching. A double coil relay is necessary and also a double-pole mains switch to break the self-latching circuit. Otherwise there would be no way of switching the receiver off other than taking the mains plug out. There is no point in the circuit of Fig. 3 unless the battery voltage can be applied only momentarily. If an alarm clock can be adapted so that the contacts are closed for a short period only, then this circuit would be suitable.

FINAL CIRCUIT

As we have seen, Fig. 3 is only a partial solution since the heavy battery drain is still not eliminated. What was now required was some simple way of obtaining a single pulse from the battery so as to just initially energise the relay.

Fig. 4 shows the final circuit. The charging current taken by C2 is sufficient to close the relay for a short moment, after which the current taken from the battery falls to a level depending largely on R3, and also on the capacitor leakage current. R3 is necessary in order that C2 may be sufficiently discharged, after the clock contacts open again, to enable a large enough current to flow to energise the relay when they next close.

Several values for R3 were tried. With R3 at 100kΩ the minimum time between operations was 10 minutes and the eventual current drain from the battery, with the clock contacts closed, was 100μA. A value of 1MΩ increased the minimum time between operations to 30 minutes, with an eventual current drain of 12μA. If R3 was omitted the minimum time between operations rose to several hours, with the eventual current drain depending on the condition of C2. In the writer's case the eventual current was less than 5μA. It was decided that, for reliability, the best value for R3 would be 1MΩ.

A high degree of smoothing is given to the rectified heater voltage by C1, this smoothing being introduced for two reasons. Firstly, if there were no smoothing the relay would act as a transformer, turning the pulsed d.c. into a.c. and causing alternating current to flow in the battery circuit. Secondly, C1 acts as a reservoir capacitor and prevents the relay unlatching due to momentary interruptions of the mains supply—which seem to be common in the author's area.

An important point is that the battery must be connected with correct polarity. The relay will not latch if the two voltages applied to its two coils are working in opposition.

In practice, the circuit of Fig. 4 worked well. The relay should be safely mounted in place inside the set, care being taken to ensure that wiring carrying

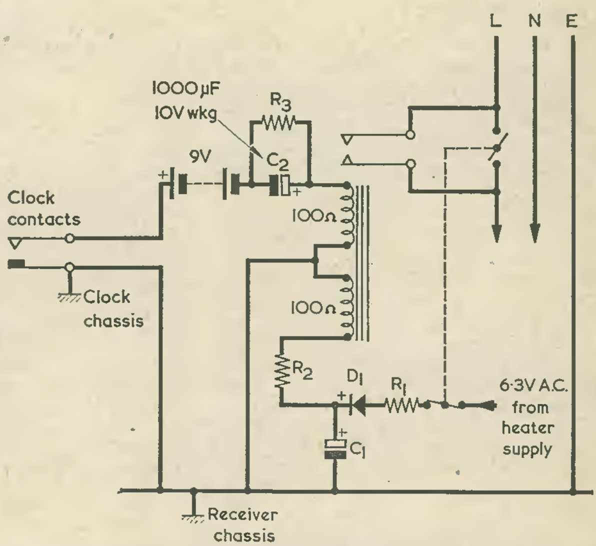


Fig. 4. The circuit finally devised. This requires only a short pulse of current from the battery to initially energise the relay. R1, R2 and C1 have the same values as in Fig. 3

high voltages cannot touch other wiring, including in particular the wiring to the clock. As already stated, the radio chassis *must* be connected to a reliable mains earth and the clock circuit *must* be connected so that its chassis is common to the receiver chassis. Do not work on the set unless the mains plug is out, don't rely on just switching off at the set itself.

Editor's Note

Post Office 3000 relays with 100Ω + 100Ω coils are available from L. Wilkinson (Croydon) Limited, Longley House, Longley Road, West Croydon, Surrey, and for the present application should have twin platinum high voltage contacts. Only one make contact set is required. If a Post Office 3000 relay is employed, the relay metalwork should be insulated from the receiver chassis. R1 in Figs. 3 and 4 is a surge limiting resistor. Diode D1 may be a small silicon rectifier, such as the Lucas DD000.

First World Dx Club Convention

WORLD DX CLUB CELEBRATED the end of its first year of operations with a Convention held at the King Edward Hotel, Neath, in South Wales, over the weekend of June 20th/21st, 1969. A gathering of some 20 Dx'ers assembled there for a weekend of talks about the many problems which are currently concerning BC-band Dx'ers, and had a jam-packed programme of tapes and live items in the formal part of the programme.

WDXC President, Alan Thompson accompanied by his wife, Audrey, and son, David 'chaired' the informal Dinner which opened the proceedings on the Friday evening and read a list of greetings from overseas friends who were unable to be present: the greetings included kind wishes for the success of the proceedings from Anker Petersen, the President of the Danish Shortwave Club International, Gunhard Kock on behalf of Suomen Dx-Kuuntelijat r.y., Leo Van Der Walt of Radio South Africa, and many others.

The international assembly included many well-known British Dx'ers, amongst them being Charles Molloy (*Medium Wave News*), Noel Green (British Representative of the Danish SW Club International) and Martin Hall (who acted as co-chairman with the President throughout the weekend), whilst there was quite a sprinkling of well-known overseas guests present—they included Arthur Cushen and his wife, Ralda (from New Zealand); Maarten Van Delft (from Holland); Wolfgang Seyfried (from West Germany); Alan Roth (from the United States where he represents the Danish SW Club International), and Gerry Wood (one of the co-editors of *Contact*, the WDXC bulletin, who originates from Rhodesia). One of those with his feet in both camps—British and overseas—was Desmond Colling, the new Executive Editor of *Contact*, who now looks after the "Broadcast Bands" pages of *Monitor* for the I.S.W.L., and who is often heard over HCJB Quito, with contributions to "Dx Party Line" where he represents the American SW Listeners Club.

Following a delightful dinner, the drinks and the talk flowed freely until the small hours of Saturday morning whilst those present got to know one another and had an opportunity of poring – with avidity and, maybe, just a small touch of jealousy! – over the magnificent QSL albums which Arthur Cushen had brought with him from New Zealand. The Pacific Islands album, with its semi-nude maidens adorning numerous QSL's from "exotic" places and stations, was overwhelmingly voted (by the men present!) *the* high-light of Arthur's whole magnificent collection which now runs to something over 5,000 QSL's from 200-plus countries.

On Saturday morning, the Convention members were accorded a Civic Welcome at Neath's new Civic Centre by the Mayor and Mayoress of Neath (Councillor and Mrs. Leslie Morris) who showed much interest in the Club and the Dx hobby, whilst the visitors admired the superb views obtainable from the upper storeys of the fine building, and warmed to the cordial hospitality afforded them in the sumptuous Mayoral Parlour, and eagerly accepted the Mayor's invitation to sign the official visitors' books.

The formal part of the proceedings started early on Saturday afternoon and were a mixed bag of live and taped talks on all aspects of the Dx hobby – discussion ranged fast and free! Arthur Cushen and Maarten Van Delft delivered short talks on the work of the Dx parliament (recently held in Sweden) and on the European Dx Council, immediately after the Club President, Alan Thompson, had spoken on the theme of "Dx Clubs and Bulletins – Now and in the Future". Many issues arising from this part of the agenda showed that there is much concern that EDXC should not proceed without some participation by Britain and Alan Thompson was able to announce that he had been invited to take part in the activities of a Working Committee of EDXC which is to look at the question of 'Club' versus 'Country' representation in that body.

On the real Dx side of the proceedings, Noel Green delivered a talk – with lots of excellent taped loggings – of his Afro-Asian Dx, whilst Charles Molloy enthralled his audience with some superb extracts from his tape library of medium-wave Dx. Nostalgia was the mood for 30 minutes whilst Clive Jenkins reviewed the 'pirate' scene, and from North America, Bill Mathews treated us to a round-up of the many types of North American stations as they are heard on his side of the water! A very interesting 15 minutes was spent, too, listening to Malcolm Peddar talking about the early days of the small Club which he started six years ago and which has now grown into World Dx Club – those present must have felt some surprise that the puny babe had grown into the healthy lad it is today!

Following a break for more refreshments, the Club President presented a "Dx Quiz" on tape from which ordeal, Noel Green emerged as the winner (see picture) – with the restoration of order (the President refusing to accept a motion that he was clearly sadistic to have concocted such an item!), the meeting passed into "Open Forum" and discussed a very wide range of subjects ranging from the technical to the organisational: from the humorous to the most serious! With such a widely drawn gathering it was inevitable that much was said "off the cuff" and it would, perhaps, not be wise to report this part of the proceedings in too much detail!

As 11 p.m. approached, the President brought the Convention to a close and the informality returned with the guests moving to the President's home where the discussion continued well into the night on many differing subjects–your reporter recalls barging through one group sitting on the stairs arguing the merits of various types of report letters: breaking up another argument about mini-skirts (what have they to do with Dx'ing?) in order to complete a taped record of an interview with every guest, whilst his shack was occupied by ten or 12 arguing whether he really had had Vatican Radio's interval signal on that 'Quiz' tape (no – he didn't!).

Throughout Sunday we said various 'goodbyes', and 'see you's' and finally it was all over! Was it a success? If you judge it in terms of what was achieved we shall not know the answer until we have had a chance to see what emerges from it. However, in terms of helping to exchange ideas and views in free and frank argument there can be no argument – it was a great success and we look forward to Convention 1970! ■

Alan Thompson, President of World Dx Club (right) presents Noel Green with a bound volume of The Radio Constructor as the first prize in a "Dx Quiz", which was part of the First WDXC Convention held in Neath, on June 20th and 21st, 1969. Noel Green, who specialises in Afro-Asian Dx on the 60 metre broadcast band, is currently the British Representative of the Danish SW Club International, as well as being one of the 'Logbook' Editors of 'Contact', which is published by WDXC

INTERNATIONAL RADIO ENGINEERING AND COMMUNICATIONS 1969 EXHIBITION

The 1969 Exhibition will again be held at the Royal Horticultural New Hall, Greycoat Street, Westminster, London, S.W.1, from 1st to 4th October.

Cable & Wireless Ltd. will be taking part for the first time, and we are pleased to announce that their Chairman, Colonel D. McMillan, C.B., O.B.E., has kindly consented to open the Exhibition on Wednesday, 1st October, at 12 noon.

An innovation last year was the display by the Diplomatic Wireless Service; as a follow-on this year the main stage feature will be presented by Cable & Wireless Ltd.

Of topical interest will be the large centre satellite set-piece and operations equipment shown by the Royal Air Force. The Royal Navy will have a greater display than before of radio and test gear, and the Royal Signals A.R.S., and the General Post Office will again be demonstrating various equipment and projects.

Manufacturers will have on show the world's latest radio receivers and transmitting equipment, test gear, hi-fi and components, as well as new developments in s.s.b. transceivers.

A feature which is always awaited with avid interest is the live transmitting station at the Exhibition. This will be in communication with stations throughout the world, using remote control and also a.m., s.s.b., phone, c.w., modes and teleprinter.

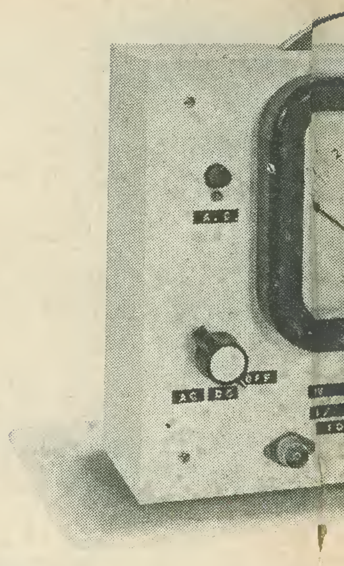
Another annual event is the Construction Contest. The winner will be awarded the annual Silver Plaque, and there will be many other awards and certificates.

Technical book sales at the 1968 Exhibition broke all records and *the actual cash sales averaged over £1 per head of total attendance.* Another record was the number of visitors from abroad.

International Day will be held on Friday, 3rd October, and this will end with a reception in the evening.

The Exhibition will be open from 10 a.m. to 9 p.m. from Wednesday, 1st October, until Saturday, 4th October, at an admission price of 3/6d.

Cover Feature



SOLID STATE D.C. VOLTMETER AND A.C. MILLIVOLTMETER

by

G. A. STANTON, G3SCV

This neat and ingenious design enables both a d.c. voltmeter and an a.c. millivoltmeter to be combined in a single unit sharing a common meter. Special features are f.e.t. input for both d.c. and a.c., and simplified construction on a single aluminium panel. Only one d.c. and one a.c. voltage, both monitored by an external meter, are required for calibration

TWO OF THE MOST USEFUL INSTRUMENTS FOR THE constructor's test bench are the electronic d.c. voltmeter and the a.c. millivoltmeter. The former enables d.c. voltages to be measured without loading the circuit under test, and the latter enables low voltage measurements to be made in a.c. circuitry. The millivoltmeter is particularly useful in testing audio equipment. In pre-semiconductor times both instruments tended to be bulky due to the valves used and to the related power supplies. In those days an attempt to combine the two units would have resulted in an even bulkier instrument and was generally considered impractical. Using semiconductors and modern components and circuitry both instruments can easily be miniaturised, and it is quite practical to combine the two as has been done in the unit to be described. This dual purpose unit not only saves space on the bench, but also saves expense, for one indicating meter serves for both functions.

The specification for the combined voltmeter and millivoltmeter is given in the accompanying Table.

D.C. VOLTMETER SECTION

The basic circuit of the d.c. voltmeter section of the instrument is given in Fig. 1(a) and it will be noted that this incorporates an inexpensive field effect transistor. If the circuit is redrawn as in Fig. 1(b) it will be seen that the f.e.t. forms one arm of a bridge circuit. With no input the circuit is balanced by means of VR2 so that the indicating meter M1 reads zero. If a small d.c. voltage is applied to the gate of the f.e.t. the balance of the bridge is disturbed and an indication given on the meter, the indication being proportional to the voltage applied to the input. Experiments showed that using the components given, full-scale deflection could be obtained with an input of less than half a volt. By means of VR1 in series with the meter the sensitivity can be reduced and this enables the instrument to be adjusted for calibration purposes. With the lowest range set to read 0.5 volt full scale, the instrument is remarkably linear in operation.

The field effect transistor—unlike its bipolar cousin—has a very high input resistance, the input characteristics being very similar to those of a valve. Because of this, the input resistor network in Fig 1(a) totals 11MΩ, and gives a sensitivity of 22MΩ per volt on the lowest range and 22,000Ω per volt on the highest range. This is similar to many of the valve voltmeters in current use, but is achieved at a much lower cost.

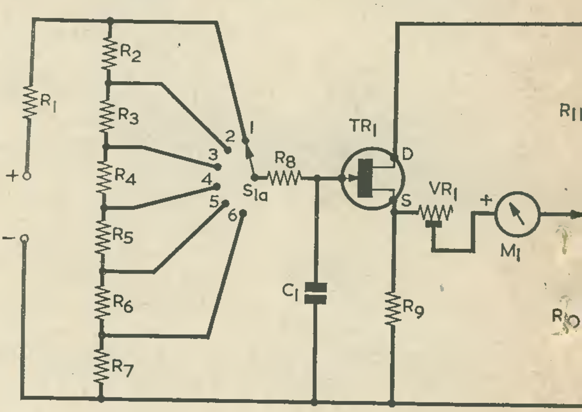


Fig. 1 (a). The basic circuit
(b). The d.c. voltmeter ma

MILLIVOLTMETER SECTION

The circuit of the a.c. millivoltmeter section appears in Fig. 2. This, it will be seen, is basically a small signal amplifier the output of which is measured by a full wave rectifier and meter system. Input is fed via C2 and R28 to the gate of TR2, a field effect transistor connected in a "source follower" configuration. This is the f.e.t. equivalent of the familiar valve cathode follower and, like the cathode follower, it has an extremely high input impedance combined with a low output impedance. This stage gives no amplification but acts as a buffer between the circuit under test and the amplifier proper. Due to the high input impedance, measurements can be taken without undue loading effects.

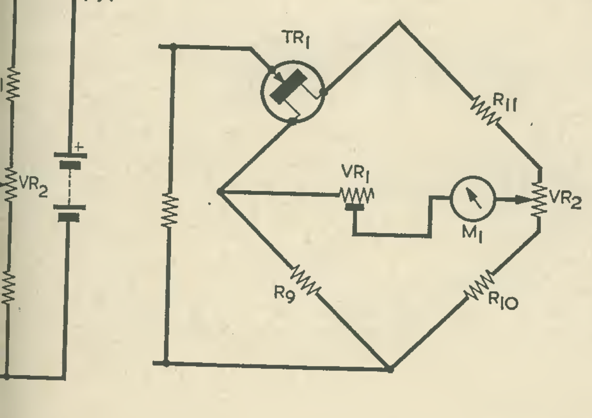
The function of zener diode ZD1 is to prevent excessive voltages being applied to the gate of TR2, with consequent risk of gate-source breakdown. Without ZD1 such voltages could appear for a short period if the input were applied, with C2 discharged, to two points having a high d.c. potential between them. The zener diode limits positive-going voltages by acting as a zener diode and negative-going voltages by acting as an ordinary diode. The diode used by the author was a Texas 1S7075A, this being a 7.5 volt 400mW type. However, any small zener diode having a zener voltage between seven and ten may be fitted in the ZD1 position.

Output from TR2 is taken from its source, the load being the attenuator network comprising R13 to R18. The values of the resistors in this network are chosen to give six ranges from 5mV full scale to 1 volt full scale.

The amplifier proper consists of TR3 and TR4. The main requirements here are threefold. There must be sufficient gain to enable an input of less than 5mV to give full-scale deflection on the meter; a flat frequency response over at least the audio range; and linearity of operation. These requirements are achieved with two direct coupled n.p.n. silicon transistors and ample negative feedback. The frequency response is flat from 40Hz to well over 20kHz; at 20 Hz, output is 3dB down. The gain of the amplifier can be controlled by means of VR3 and this provides for adjustment of calibration in use.

On low ranges meter and rectifier combinations are non-linear in operation, due to the characteristics of the rectifier diodes. In the present instrument non-linearity is reduced to acceptable proportions by means of R26 and R27. For extreme accuracy the meter scale would still have to be specially prepared and calibrated, but for ordinary test purposes the accuracy with the existing meter scale has been found adequate.

The emitter of TR4 requires a high bypass capacitance to the negative supply line. This is provided here by connecting two electrolytic capacitors, C4 and C5, in parallel.



(b)

of the d.c. voltmeter section
y be presented as a bridge

TABLE

Solid State D.C. Voltmeter and A.C. Millivoltmeter

Specification.

D.C. Ranges: Input resistance 11MΩ

A.C. Ranges: Input impedance 6.8MΩ
Frequency response flat from 40 Hz to 20kHz (3dB down at 20Hz)

Range	D.C. (volts)	A.C. (mV r.m.s.)
1	0.5	5
2	5	10
3	10	50
4	50	100
5	100	500
6	500	1,000

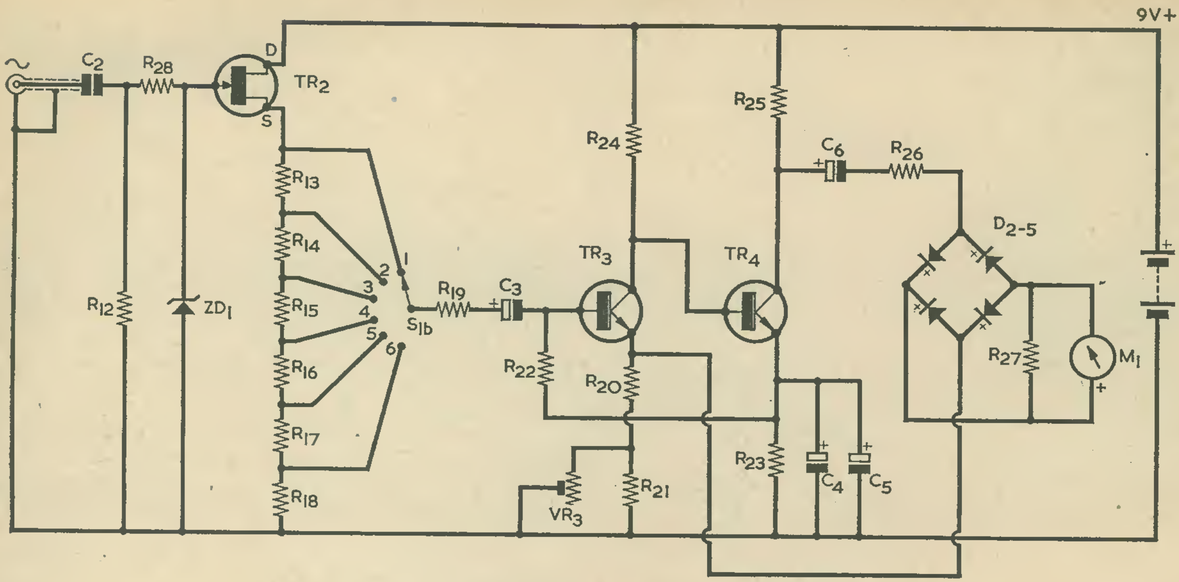
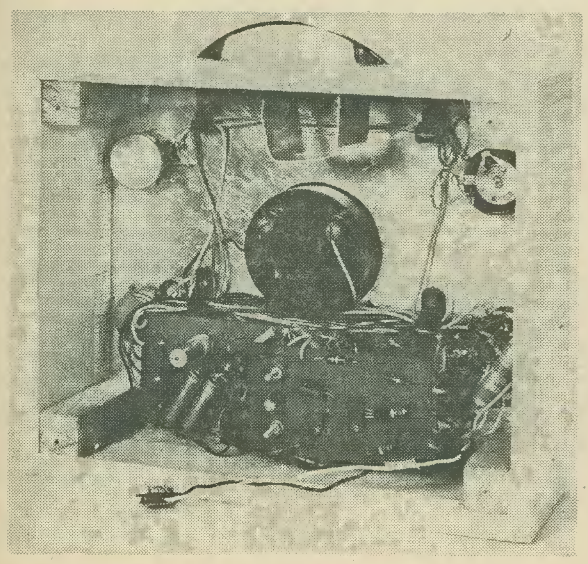


Fig. 2. The basic circuit of the a.c. millivoltmeter section

COMBINING THE SECTIONS

If desired the sections as described so far could be built as separate units, the only additional component needed being an on/off switch for each circuit. Separate units would, however, mean two indicating meters, two range switches, two batteries, two panels and two cabinets. A considerable saving can be made if the units are combined as in the full circuit, which is given in Fig. 3. In fact the only additional component needed to combine the two units is the four-pole three-way switch, S2. This is the function switch and, as such, connects the meter to the d.c. and a.c. sections in turn and switches the instrument off. In the off position it short-circuits the meter and thus damps the movement, preventing any damage in transit. Additional protection is afforded to the meter by means of the silicon diode (D1) wired in parallel. The diode prevents damage should excessive current flow in the meter circuit.



An inside view of the instrument. The clamp at the top secures the battery in position when this is fitted

The battery is connected to both sections of the instrument simultaneously, and this ensures that C6 is fully charged before the meter is connected to the millivoltmeter section, thereby preventing the sudden surge through the meter which would otherwise occur. It is thought that the protection to the meter given by this mode of operation is worth the extra drain on the battery. The total current consumption is still under 8mA.

It was found, with the prototype, that battery voltage could be reduced to 7.5 volts without unduly affecting the performance. In consequence, it was decided not to include a supply voltage stabilising circuit. The only critical factor, as supply voltage drops, is the "zeroing" of the d.c. section.

The meter may be any standard moving-coil instrument with an f.s.d. of 50μA. That employed by the author was an ex-R.A.F. type with an internal resistance of 2,500Ω. Its scale was re-marked for the present application.

A minor point which needs to be mentioned with reference to Fig. 3 is that the inset showing the f.e.t. lead-outs indicates that the drain lead-out is in the centre, whereas some (but not all) Motorola literature shows the source as the centre lead-out. In practice, the source and drain of the MPF105 are interchangeable since this is a symmetrical transistor. TR1 and TR2 are connected to the printed circuit boards (described later) with the lead layout given in Fig. 3.

The 2N2926 Yellow transistors specified for TR3 and TR4 are the basic 2N2926 with an hfe between 150 and 300. They are available from a number of

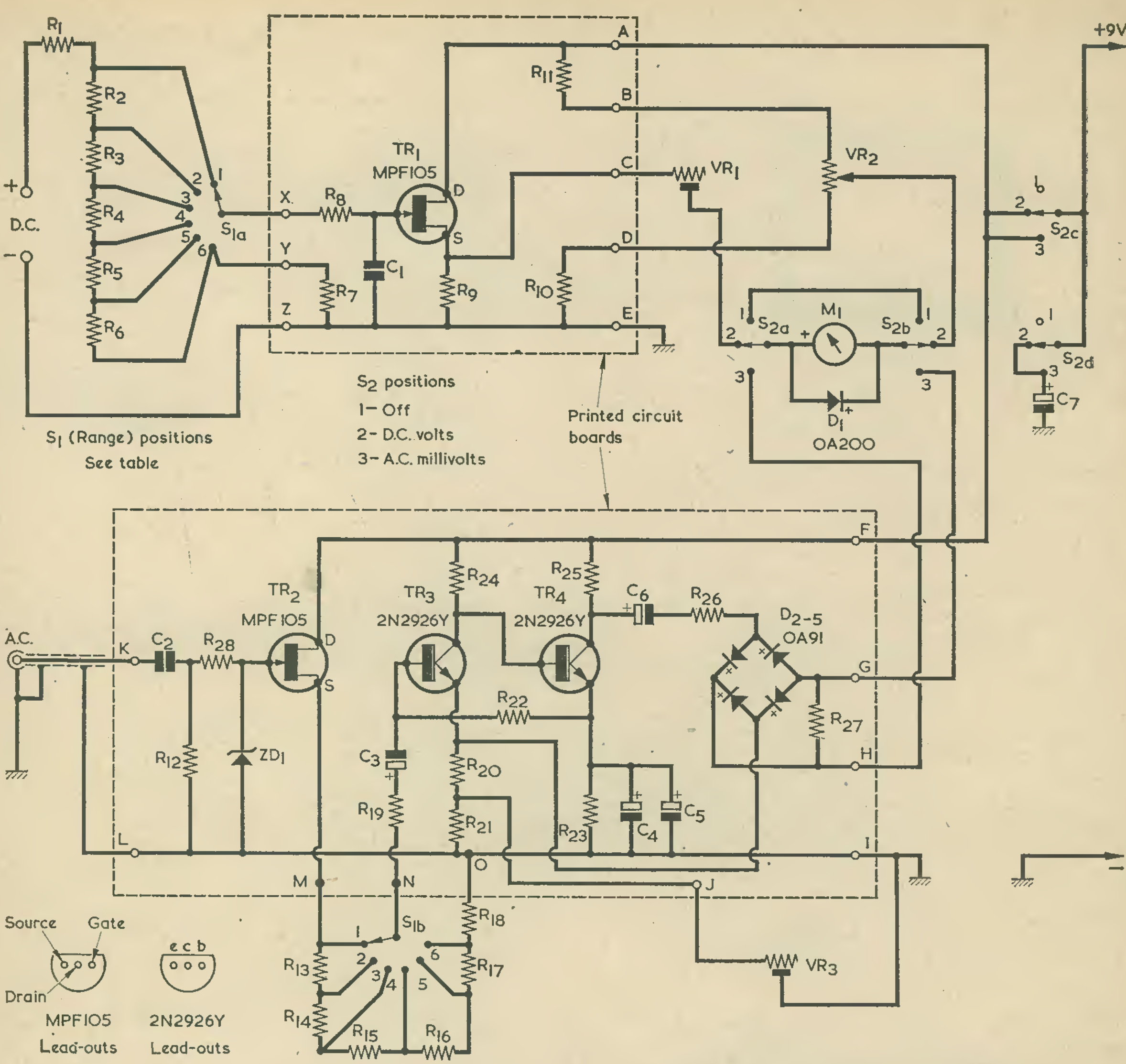


Fig. 3. The complete instrument, offering both d.c. voltmeter and a.c. millivoltmeter facilities

suppliers, including Electrovalue, 32a St. Judes Road, Englefield Green, Egham, Surrey.

CONSTRUCTION

Construction is quite straightforward and the general layout is given in Fig. 4. All the larger components are mounted direct to a 16 s.w.g. aluminium panel, there being no "chassis" in this instrument. The range switch is of the "Maka-Switch" type and two printed circuit boards carrying the smaller voltmeter and millivoltmeter components are mounted to the side-struts of this switch in a manner which is described in detail later. The exact dimensions of the panel will largely depend upon the meter employed. This in the author's case is a large type with a 5in. scale, but even so the whole instrument easily fits into a plywood cabinet 8in. high, 10in. wide and 3in. deep.

The two sections of the instrument are built on separate panels of printed circuit board, details of which are given in Figs. 5(a) and (b). In these two diagrams the copper side of the board is towards the reader. Assembly of the boards follows standard practice except for the input components of the millivoltmeter panel of Fig. 5(b). Because of the sensitivity of the circuit, TR2 and C2 are very prone to hum pick-up and require screening. In the prototype the f.e.t. is screened by having a coil of 22 s.w.g. insulated connecting wire slipped over it, with the end of the coil anchored and soldered to an earth point on the panel. The coil is formed by close-winding eight turns round a ¼in. rod, leaving a tail for the earth connection. See Fig. 6. This in practice forms an effective screen. Capacitor C2 is screened by wrapping a length of metal foil around it, this being secured by a few turns of bare 22 s.w.g. wire soldered together. This operation should be carried out before assembly

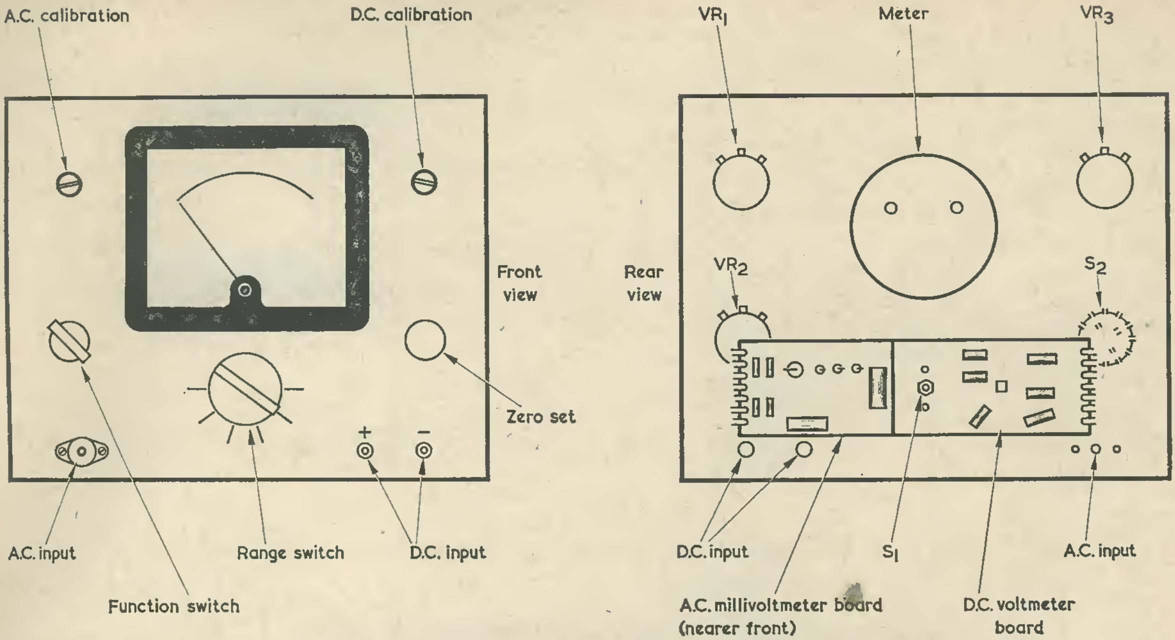
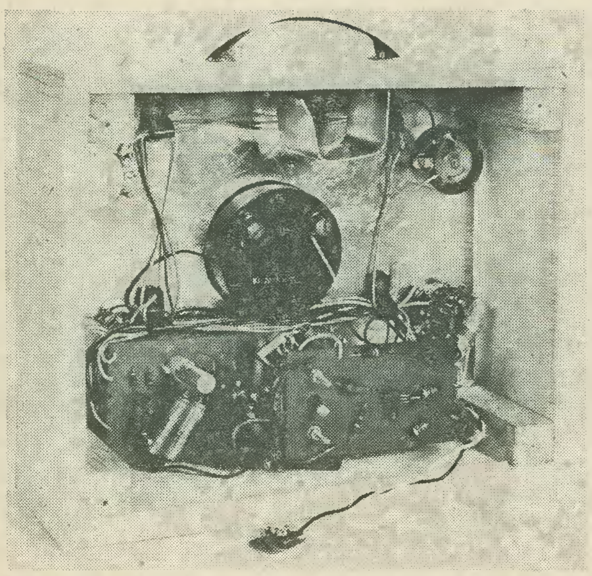


Fig. 4. Front and rear views of the panel, on which the larger components are mounted. The two printed circuit boards are affixed to the range switch

and care taken that the screen does not touch either of the capacitor's leads. When fitted, the screen should be connected to an earth point near the capacitor.

In the d.c. section (Fig. 5(a)) the value of R11 will depend upon the particular MPF105 used. Taking a number of these at random R11 was found to vary from 1kΩ to 5kΩ. In view of this a small skeleton type 5kΩ pre-set potentiometer could be substituted and adjusted accordingly. Alternatively R11 can be a 6.8kΩ fixed resistor plus a second resistor wired in parallel during the final setting up process.



Another rear view. Note the two printed circuit boards secured to the range switch assembly

The printed circuit panels are completed by adding suitable lengths of connecting wire to the various terminal points, including those for connection to S1. If wires of different colour are available construction will be that much easier. In this respect it should be noted that interconnections between printed circuit boards, components mounted on the main panel and the range switch are all identified by letter in the circuit diagram of Fig. 3. The same letter coding is employed in Figs. 5(a), 5(b) and 7.

Assembly of the various sections is greatly facilitated if a definite sequence is followed. The first step is to mount the meter, controls and terminals to the front panel and, working from Fig. 3, complete all wiring which does not involve connections to the printed circuit boards or S1(a) and (b). The printed circuit boards appear inside the dashed line rectangles in Fig. 3.

The second step is to add the "Maka-Switch" mechanism. With this kit two side struts are included; the heads of these should be carefully removed and the "headless' struts screwed into position on the index mechanism. The struts are then locked into position by two 6BA nuts, care being taken not to foul the mechanism. Having done this the millivoltmeter panel is then slipped into position on the struts in the manner shown in Fig. 8, and the necessary connections made to other components on the panel. At this stage, the millivoltmeter panel will not be held down securely.

Before placing the switch wafer in position, this should be checked for correct functioning and resistors R2 to R6 and R13 to R17 wired into place as indicated in Fig. 7, which illustrates the wafer viewed from the rear. (R18 and R19, shown in Fig. 7, are already fitted to the millivoltmeter panel, as in Fig. 5(b).) In order to prevent any possibility of short-circuits during use a suitable length of sleeving should be

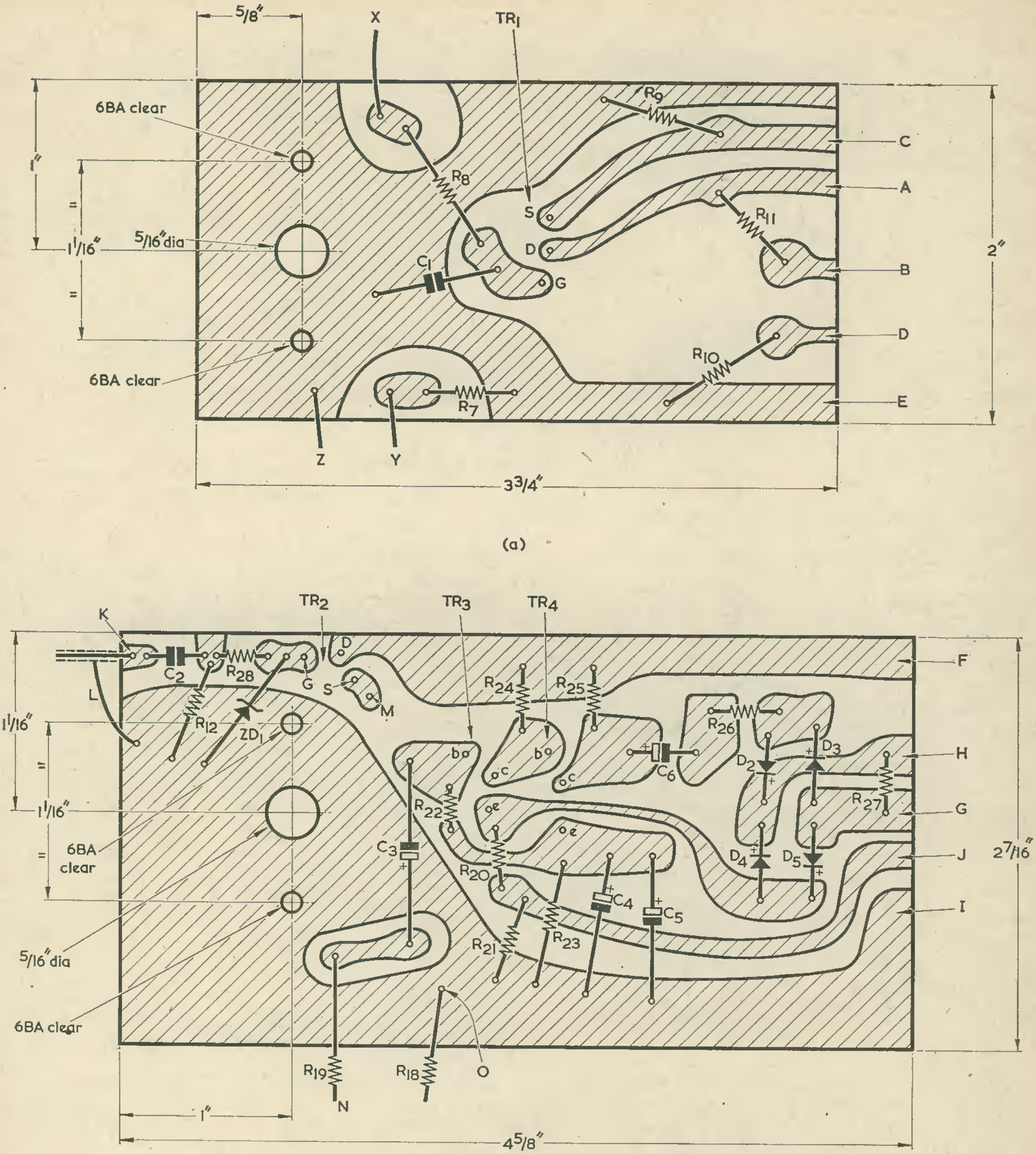


Fig. 5. The printed circuit boards for (a) the d.c. voltmeter section and (b) the a.c. millivoltmeter section, with copper side towards the reader. These are reproduced full size and may be traced, if desired

slipped over each resistor before mounting. The switch wafer is separated from the two panels by means of ½in. spacers, and is fitted so that the sides with R2 to R6 and R13 to R17 take up the positions indicated in Fig. 8. Complete the wiring between the wafer and the millivoltmeter panel and take a lead from the wafer tag conected to the free end of R2 (see Fig. 7) to the d.c. positive terminal via R1. R1 is not mounted on the boards. Next add the voltmeter panel and secure the whole switch and circuit board assembly by the 6BA nuts of the side struts. The assembly should now appear as in Fig. 2. Connect all leads from

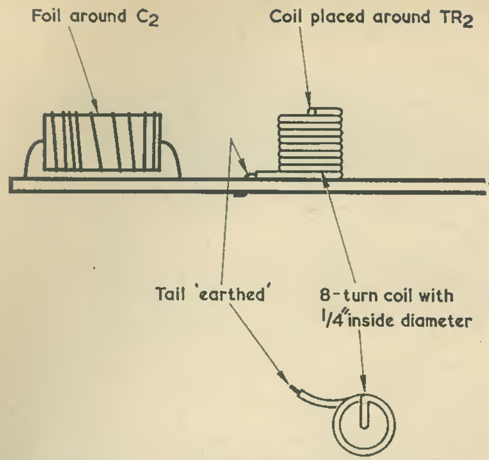


Fig. 6. Illustrating how TR2 and C2 are screened in order to reduce hum pick-up

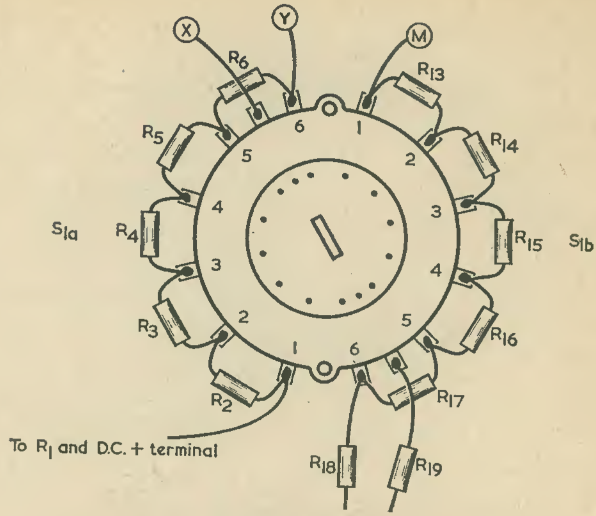


Fig. 7. Connecting the attenuator resistors to the switch wafer

the voltmeter panel and complete any other outstanding wiring.

This completes the construction of the instrument.

CALIBRATION

Before the instrument can be calibrated the value of R11 in the voltmeter section must be determined. In order to do this VR1 is set at maximum resistance and VR2 at its mid-point position. If R11 has been made a preset variable resistor this is adjusted until the meter reads zero and no further attention is required. If a 6.8kΩ fixed resistor has been wired in for R11 then a 25kΩ variable resistor should be temporary clipped across it and adjusted for zero reading. The variable resistor is then removed and its value measured; a second fixed resistor near this value is then soldered across R11. The use of fixed resistors in this way is perhaps more trouble at this stage, but it is to be recommended for long term stability.

Calibrating the instrument is a simple process, and it is only necessary to provide one known direct voltage between 0.25 and 500 volts, and one known alternating voltage between 5mV and 1 volt. Figs. 9(a) and (b) show two suggested schemes. In Fig. 9(a) a 1kΩ potentiometer is connected across a 1.5 volt cell and adjusted to give a reading of 1 volt in any voltmeter known to have good accuracy. The instrument

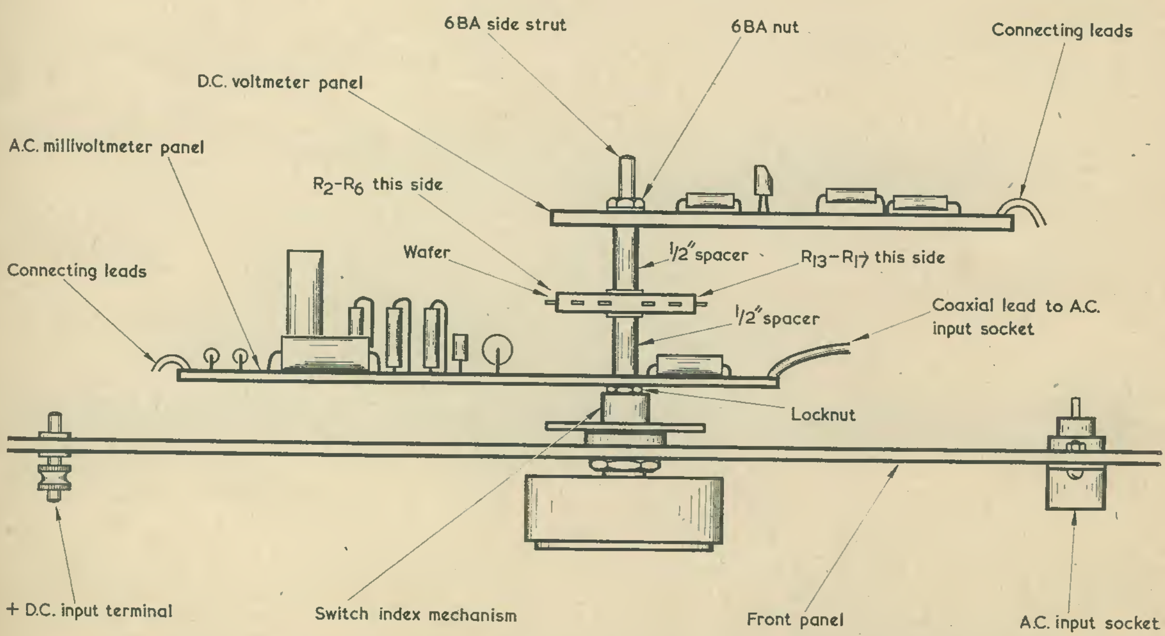


Fig. 8. The two printed circuit boards are affixed to the range switch in the manner shown here

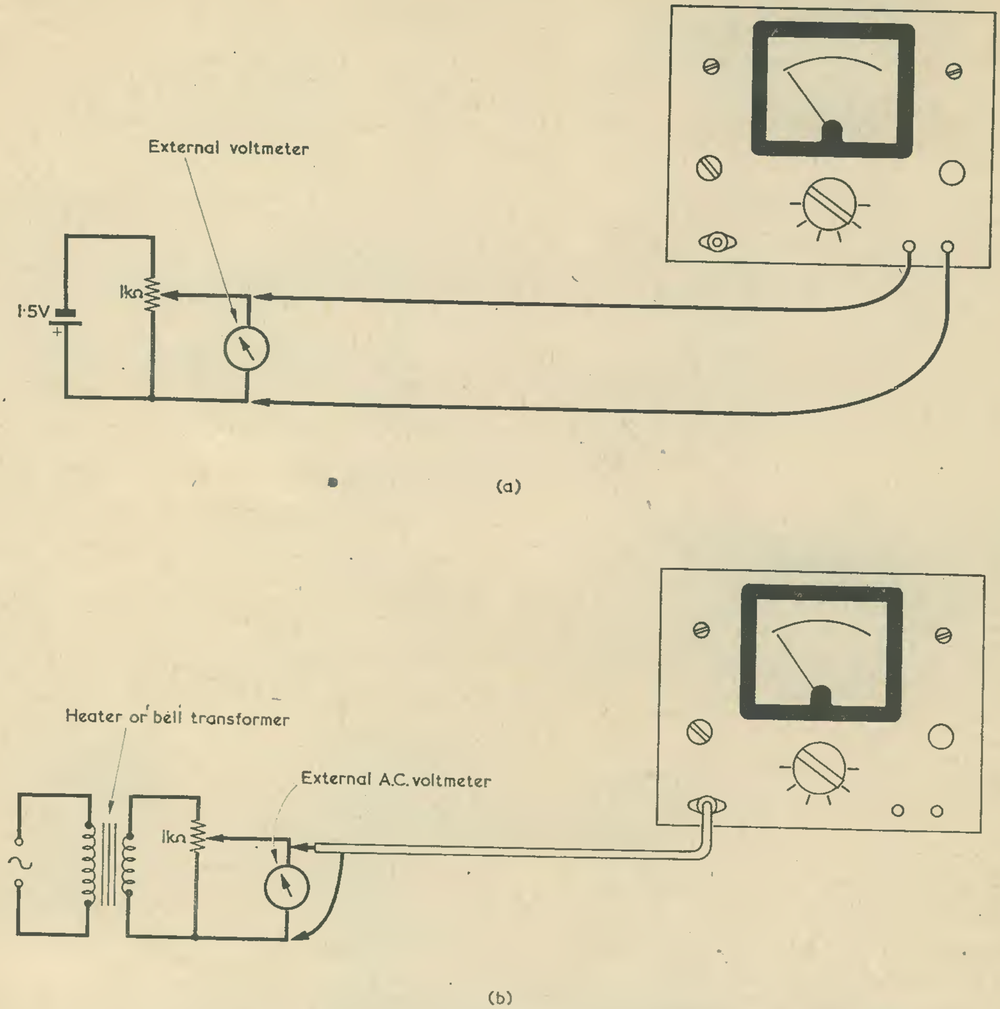


Fig. 9. Calibrating the d.c. and a.c. sections of the instrument. Each section requires only one calibration voltage

is first switched to read direct voltage and, without its test leads connected, set to zero by VR2. S1 is set to Range 2. The test leads are then connected across the external voltmeter and VR1 adjusted for a reading of 1 volt in the instrument.

In Fig. 9(b) a known alternating voltage of 1 volt (as monitored by an external meter known to have good accuracy) is selected by the 1kΩ potentiometer. The instrument is switched to read alternating voltage, S1 is set to Range 6 and the test leads connected to the known source of voltage. VR3 is adjusted for a reading of 1 volt.

Both VR1 and VR3 are included on the front panel so that calibration can easily be checked and re-set during use.

The accuracy of the instrument will depend almost entirely on the two attenuator networks R2 to R7 and R13 to R18. For accurate work these should be 1% tolerance high stability types. Some of the values specified may be a little difficult to obtain from the usual mail order houses, in which case two resistors may be used in series or parallel. Thus, R2 could be 2.2MΩ in series with 6.8MΩ. Similarly, R16 could be two 82Ω in parallel, and R17 and R18 each two 10Ω in parallel. If the experimenter requires indications rather than exact measurements, tolerances up to 5% could be substituted for R2 to R7 and R13 to R18. As already explained a degree of non-linearity is likely on the a.c. ranges and for extreme accuracy a graph could be plotted and used. A really keen constructor could of course calibrate the meter scale from this for accurate direct readings.

In use ordinary test leads are suitable for the d.c. ranges and a length of coaxial cable for the a.c. ranges. This should be kept as short as convenient in order to prevent losses on the higher frequencies.

COMPONENTS

Resistors

(All fixed values ¼ watt 5% unless otherwise stated.)

R1	1MΩ ½ watt, hi-stab
R2	9MΩ 1%, ½ watt, hi-stab (see text)
R3	500kΩ 1%, ½ watt, hi-stab
R4	400kΩ 1%, ½ watt, hi-stab
R5	50kΩ 1%, ½ watt, hi-stab
R6	40kΩ 1%, ½ watt, hi-stab
R7	10kΩ 1%, ½ watt, hi-stab
R8	1MΩ
R9	4.7kΩ
R10	1kΩ
R11	See text
R12	6.8MΩ
R13	500Ω 1%, ¼ or ½ watt, hi-stab
R14	400Ω 1%, ¼ or ½ watt, hi-stab
R15	50Ω %, ¼ or ½ watt, hi-stab
R16	40Ω 1%, ¼ or ½ watt, hi-stab (see text)
R17	5Ω 1%, ¼ or ½ watt, hi-stab (see text)
R18	5Ω 1%, ¼ or ½ watt, hi-stab (see text)
R19	680Ω
R20	10Ω
R21	27Ω
R22	6.8kΩ
R23	330Ω
R24	6.8kΩ
R25	470Ω
R26	1kΩ
R27	1kΩ
R28	1kΩ
VR1	10kΩ potentiometer, linear, preset (panel mounting)
VR2	1kΩ potentiometer, linear
VR3	100Ω potentiometer, linear, preset (panel mounting)

Capacitors

C1	2,000pF ceramic
C2	0.33µF paper or plastic foil
C3	100µF electrolytic, 6V wkg.
C4	500µF electrolytic, 6V wkg.
C5	500µF electrolytic, 6V wkg.
C6	64µF electrolytic, 12V wkg.
C7	200µF electrolytic, 12V wkg.

Semiconductors

TR1	MPF105 (Motorola)
TR2	MPF105 (Motorola)
TR3	2N2926 Yellow spot (see text)
TR4	2N2926 Yellow spot (see text)
D1	OA200 (Mullard)
D2-D5	OA91 (Mullard)
ZDI	7.5 volt zener diode (see text)

Meter

M1	50µA moving-coil

Switches

S1	Radiospares "Maka-Switch" kit, with one 2-pole 6-way wafer and four ½ in. spacers*
S2	4-pole 3-way, rotary

Miscellaneous

Coaxial socket
2 terminals
3 knobs
Aluminium panel
Printed circuit board
9-volt battery

* Radiospares components may only be purchased through retailers.

■

CAN ANYONE HELP?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time.

Sobell TV T280 & Philips Radio 341A.—M. J. Levy, 19 Totternhoe Close, Kenton, Middlesex — manuals or data sheets, purchase or loan.

"Radio Constructor" July 1964. — G. Sawyer, St. Agnes, Elm Tree Road, Locking, Weston-super-Mare, Somerset — this issue of the magazine is required, particularly the article "Transistor Tape Recorder Circuits" Part 2. Loan or purchase.

Bush TV T99CB & HMV TV 6405S/T. — E. O. Odunfa, P.O. Box 1460, Ibadan, Nigeria — loan or purchase of service sheets for these models.

AVO Valve Tester No. 3. — Havering Technical College, Ardleigh Green Road, Romford, Essex — operating instructions required.

Taylor Valve Tester, Model 45B. — G. S. Ghataure, Box 10785, Nairobi, Kenya — would like to add noval base, can any reader suggest a circuit for this modification?

Hallicrafter SX71 Receiver. — G. W. Perkins, 35 Kingstown Road, Carlisle, Cumberland — loan or purchase of manual or circuit diagram — even information on the correct valve line-up would help!

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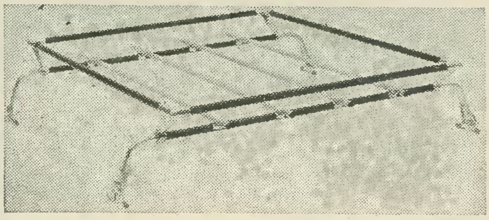

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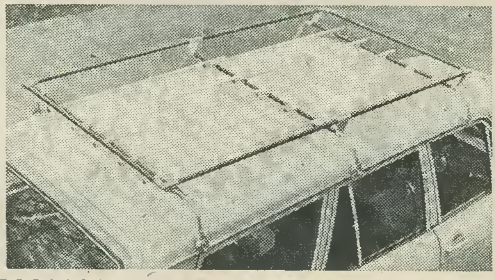
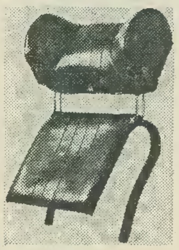
If roof rack and conversion kit ordered together – carriage free



★ HEAD REST



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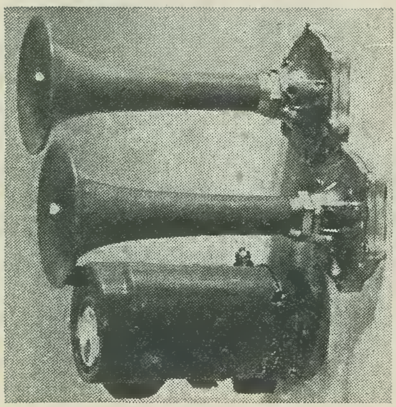

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Model and year of car.................... Please state voltage required....................

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EQUIPMENT REVIEW . . .

THE EDDYSTONE EC 958 RECEIVER

A NEW, SOLID-STATE RECEIVER, WHICH COVERS THE complete frequency range from the high frequency band down to the very low frequency band in a continuous sweep from 30MHz to 10kHz, and which provides facilities for high stability working, is announced by Eddystone Radio, Limited.

This new receiver, type EC 958, provides monitoring facilities over a wide range of frequencies which have previously required the use of two separate receivers, or elaborate 'add-on' units with a normal high frequency receiver. The low frequency band is still, of course, widely used for marine communications, broadcasting, and for a number of point-to-point services.

R.F. INPUT PROTECTION

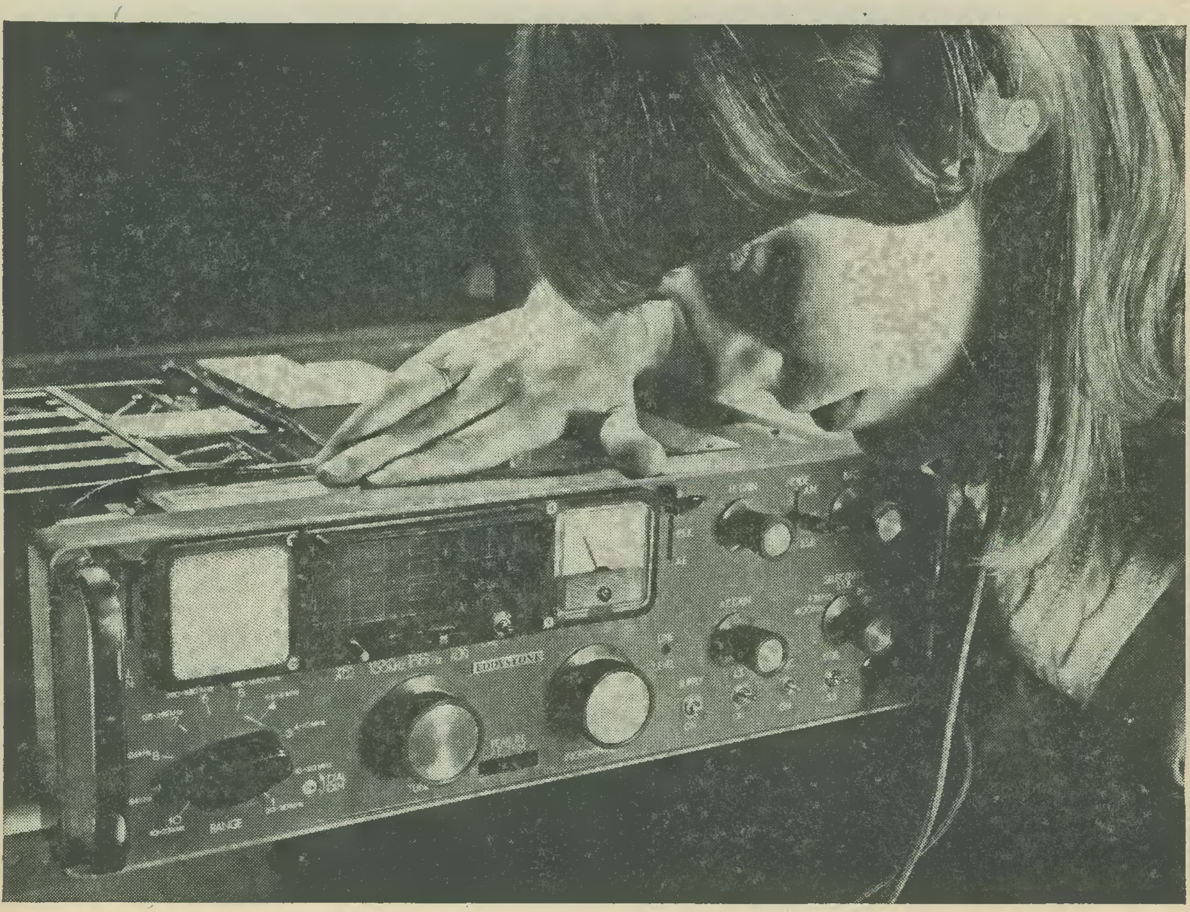
The aerial input stage of the EC 958 receiver employs a junction MOSFET device with the high breakdown voltage of 25 volts. This circuit is further protected by four high-current silicon diodes, connected directly across the aerial input. These reduce on-tune signals to a maximum of about 2.4 volts peak-to-peak, while out-of-tune signals are further reduced by a high-Q bandpass input circuit which provides same 40 dB of attenuation at 10% off-tune. The input also has a trimming circuit incorporating capacitance diodes, which further protect the input circuits by de-tuning them when the r.f. potential exceeds some 5 volts.

This combination of circuit features provides a degree of protection to the completely solid-state r.f. circuits which compares favourably in this respect with a valve input. It also provides all the advantages of solid-state circuitry in terms of reliability and stability.

COMPLETE SPECTRUM IN TEN RANGES

Ten ranges cover the complete spectrum, from 30MHz down to 10kHz. The first four ranges cover the h.f. band. In these ranges, a triple conversion

(continued on page 111)



The EC 958 receiver is seen here with the main cove, removed. The optical projection tuning scale is at the top of the front panel, beneath the operator's hand

UNDERSTANDING RADIO

THE Q-MULTIPLIER

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

by W. G. Morley

IN LAST MONTH'S ISSUE WE EXAMINED THE MANNER IN which a quartz crystal may be employed to increase the selectivity offered by a superhet receiver. In this application the crystal appears in the i.f. amplifier of the receiver and it offers minimum attenuation to signals at its series resonant frequency. Since, in both its series resonance and parallel resonance modes, the crystal behaves like a tuned circuit having an extremely high value of Q, the crystal then functions as a sharply selective device for signals at or very close to its series resonance frequency.

As was also explained last month, a single crystal filter circuit incorporates a phasing control, this being a variable capacitor connected into the circuit such that it is capable of neutralising the capacitance of the crystal holder. Adjusting the phasing control effectively alters the parallel resonant frequency of the crystal, thereby allowing increased rejection to be offered to interfering signals close to the series resonant frequency of the crystal.

Crystal filters can employ two or more crystals when it is desired to pass a band of frequencies, as occurs when it is intended to receive amplitude modulated signals.

We turn next to another circuit device which is similarly capable of increasing the selectivity given by a superhet receiver.

INCREASING TUNED CIRCUIT Q

When, in earlier articles, we dealt with t.r.f. receivers (in which all the tuned circuits before the detector are resonant at the frequency of the aerial signal) we saw that the selectivity offered by a single tuned circuit may be considerably enhanced by the application of regeneration. Regeneration, in this context, is frequently referred to as "reaction". The regeneration is normally provided at the detector stage, and the usual practice consists of using the grid leak type of detector and of feeding back to the tuned circuit coupled to its grid a portion of the amplified r.f. signal appearing at its anode. The anode signal fed to the grid is arranged to be in phase with the grid signal, whereupon the feedback is positive. A feature of the circuit is that the amount of signal fed back can be controlled, this being done typically by means of a series variable capacitor. In consequence, it is possible to gradually increase the proportion of signal fed back until, eventually, the circuit breaks into oscillation. If the feedback control is adjusted so that the circuit is just below the point at which oscillation occurs, the selectivity offered by the grid tuned circuit is considerably increased, because the positive feedback has very nearly cancelled out the inevitable "losses" in that tuned circuit.

Since the apparent efficiency of the grid tuned circuit is increased due to the regeneration, the sensitivity of the circuit is similarly increased.

It would appear attractive, at first sight, to employ a somewhat similar type of regenerative circuit in the i.f. amplifier of a superhet receiver, the regenerative circuit appearing either in one of the i.f. stages or at the detector. Indeed, superhet designs incorporating a regenerative i.f. stage or detector have been produced in the past, but the use of the technique is in no way general. A regenerative stage may occasionally be encountered in inexpensive commercially made receivers intended for short wave listening.

An alternative approach towards taking advantage of the very high Q offered by a tuned circuit to which regeneration is applied is given in the *Q-multiplier*, which forms the subject of this month's article. The Q-multiplier appears in the form of a separate unit which may be coupled to an existing superhet as an "add-on" device. Its use is almost entirely confined

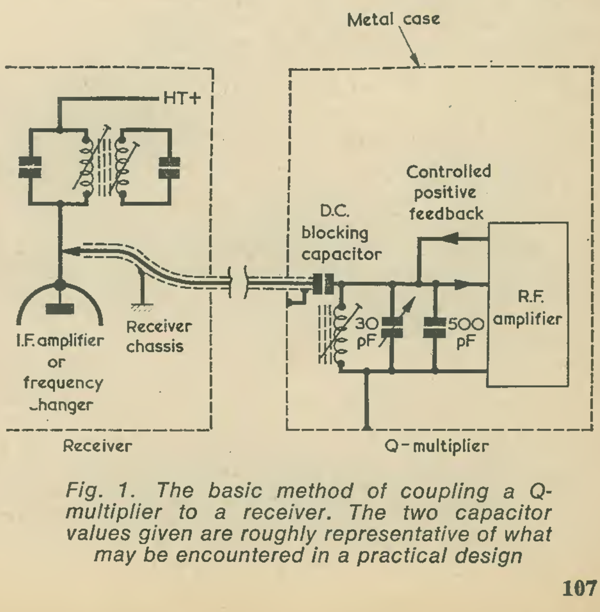


Fig. 1. The basic method of coupling a Q-multiplier to a receiver. The two capacitor values given are roughly representative of what may be encountered in a practical design

to receivers operated by amateur transmitting enthusiasts and short wave listeners, the function of the *Q-multiplier* being to improve the selectivity of an existing superhet receiver at relatively low cost.

There is no fixed circuit design for a Q-multiplier and a number of individual circuits have appeared in amateur and constructional publications. These all rely, for their operation, on the ability of a tuned circuit to offer a very high Q when regeneration is applied. Some Q-multipliers are designed to offer a sharp response curve for the *acceptance* of signals, whilst others are designed to offer a sharp response curve for the *rejection* of signals. Both these facilities are often available in a single design. It is usual, when discussing Q-multipliers, to initially think in terms of a device which provides a sharp response curve for signal acceptance, and we shall commence next by examining Q-multipliers of this type.

Basically, the Q-multiplier is coupled to an existing receiver in the manner shown in Fig. 1. A length of low-capacitance screened cable, such as aerial coaxial cable, is introduced inside the cabinet of the receiver. The inner conductor of the cable is connected to the anode of an i.f. amplifier, or to the anode of the frequency changer, and the braiding to any convenient chassis point close to the anode terminal. The self-capacitance of the screened cable is effectively in parallel with the primary of the associated i.f. amplifier and the alignment of this primary may then be readjusted so that it is resonant at the same frequency as before. Alternatively, and as will shortly be described, the detuning effect at the i.f. transformer primary can be removed by means of an additional coil in the Q-multiplier unit.

At the other end of the screened cable is the Q-multiplier unit, its components being fitted in a screened metal case which is positioned outside the receiver cabinet. The screened cable connects, via a d.c. blocking capacitor, to a tuned circuit consisting of a coil, a fixed capacitor and a variable capacitor, these components having values which allow the resonant frequency to be adjusted over the band of frequencies passed by the i.f. amplifier of the receiver. This tuned circuit is, in its turn, coupled to an r.f. amplifier which allows controlled regeneration to be fed back to it. If the regeneration level is adjusted such that the r.f. amplifier is just below the oscillation point, the tuned circuit effectively offers a very high level of Q.

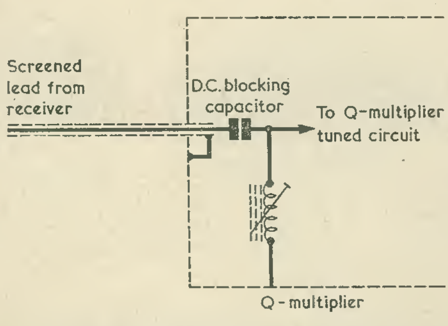


Fig. 2. If an additional coil is fitted in the Q-multiplier, as shown here, it may be made to resonate with the self-capacitance of the screened cable at the receiver intermediate frequency

In use, the associated receiver is tuned in to a signal in the normal way. Should the extra selectivity available from the Q-multiplier be required, this is next switched on and its variable capacitor adjusted so that the resonant frequency of the Q-multiplier tuned circuit is at the intermediate frequency given by the desired signal. Due to its high effective Q, the Q-multiplier tuned circuit exhibits a response curve having a very sharp peak at its resonant frequency. In consequence, the required signal suffers negligible attenuation due to the Q-multiplier tuned circuit, whereas signals close in frequency to the desired signal can be attenuated to a considerable degree.

It should be noted that the frequency of the Q-multiplier response peak is capable of being varied *within* the band of frequencies passed by the receiver i.f. amplifier. The Q-multiplier variable capacitor can be employed, therefore, to "peak" individual signals passing through the i.f. amplifier without making any adjustment to the tuning control of the receiver.

For best results the tuned circuit in the Q-multiplier unit must be designed so that it offers a high Q on its own before regeneration is applied to it, and this entails employing a highly efficient coil with very low "losses". The regeneration, if carefully applied and controlled, can increase the effective Q of such a tuned circuit until it approaches the performance offered by a crystal.

The fixed capacitor in the Q-multiplier tuned circuit ensures, in practice, that adjustments of the variable capacitor do not necessitate wide variations in regeneration control to keep the circuit just below oscillation point. The fixed capacitor also reduces drift of the resonant frequency due to shifting stray capacitances across the tuned circuit, as could for instance be given by inter-electrode capacitances in a valve r.f. amplifier as it warms up. The values given in Fig. 1 for these two components are, incidentally, merely intended as a rough indication of what is to be expected in a practical circuit.

CANCELLING CABLE CAPACITANCE

It was stated a little earlier that the self-capacitance of the screened cable coupling the Q-multiplier to the receiver i.f. amplifier or frequency changer anode detunes the primary of the i.f. transformer in that anode circuit, and that the detuning may be corrected by realigning the primary. An alternative and better approach consists of adding a coil at the Q-multipler end of the screened cable, as illustrated in Fig. 2. This coil has an adjustable iron dust core, and its inductance is varied so that it becomes resonant, in company with the stray capacitance of the screened cable, at the centre of the receiver i.f. pass-band (i.e. the band of frequencies passed by the receiver i.f. amplifier). As will be apparent from Fig. 2 the coil and the self-capacitance of the screened cable form a parallel tuned circuit. Since the self-capacitance of the screened cable will be low – of the order of 20pF – the inductance in the coil of Fig. 2 needs to be greater than that of the Q-multiplier proper if it is to become resonant at the intermediate frequency of the receiver. According to Q-multiplier design, the inductance may be some 3 to 10 times greater. The existence of an added parallel tuned circuit across the i.f. transformer primary in the receiver does not significantly affect receiver performance in practice, but it is nevertheless desirable to ensure that the self-capacitance in the screened cable is kept low (by

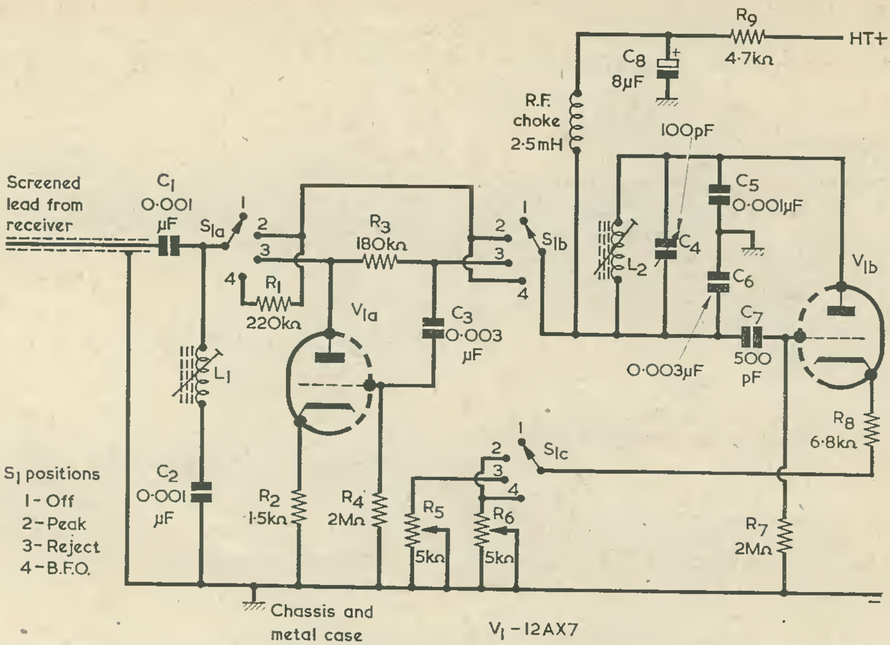


Fig. 3. The Q-multiplier circuit due to G2BVN. This can offer a sharp acceptance response or a sharp rejection response. It may also be switched to provide a b.f.o. signal

keeping the cable short) and to use an efficient coil at the Q-multiplier end. The Q-multiplier coil has the same effect on receiver performance regardless of whether the Q-multiplier is switched on or off. After the Q-multiplier has been coupled to the receiver, the coil of Fig. 2 is adjusted such that receiver i.f. performance is the same as was given previously. This is normally achieved by tuning in a steady signal, or applying a signal to the i.f. amplifier from a signal generator, after which the coil of Fig. 2 is adjusted for maximum signal level at the receiver detector.

It is almost inevitable that the receiver i.f. transformers will be aligned by means of adjustable iron dust cores, whereupon the use of the coil of Fig. 2 is to be preferred. This is because the fairly large core adjustment required by the Fig. 1 arrangement could also seriously upset the mutual inductance between the primary and secondary windings of the receiver i.f. transformer.

Q-MULTIPLIER REJECTION

As has already been mentioned, a Q-multiplier may, instead of providing signal acceptance, alternatively offer a sharp degree of rejection at a specific frequency. To see how this may be achieved we turn next to the practical Q-multiplier circuit shown in Fig. 3. The ingenious design illustrated here is due to R. F. Stevens, G2BVN.*

*Details of functioning, frequencies and coil inductances for the circuit of Fig. 3 are given in the Third and Fourth Editions of the R.S.G.B. Amateur Radio Handbook, published by the Radio Society of Great Britain, 35 Doughty Street, London, W.C.1. The circuit, with suitable recommendations for components, also appears in the sales literature of Electroniques, Edinburgh Way, Harlow, Essex.

If, initially, we examine circuit operation with switch S1(a)(b)(c) in the "Peak" position, we may see that the screened cable from the receiver couples to the tuned circuit offered by L2, C4, C5 and C6. This is the Q-multiplier tuned circuit and it functions in the manner already discussed, the r.f. amplifier which provides regeneration being V1(b). Control of regeneration is given by the variable resistor, R6, switched in by S1(c). Coil L1, in Fig. 3, performs the same function as did the coil in Fig. 2.

When S1(a)(b)(c) is set to "Reject", valve V1(a) is introduced into circuit. Disregarding, for the moment, the tuned circuit incorporating L2, we may see that i.f. signals from the receiver are passed, in attenuated form, to the grid of V1(a) via R3 and C3. In consequence, amplified signals of opposite phase appear at V1(a) anode. Without L2, and due to the initial attenuation given by R3, these anode signals will not have a high amplitude and will not seriously affect receiver operation.

When, however, we introduce the L2 tuned circuit a different set of circumstances comes into being. If the correct amount of regeneration is applied to the tuned circuit around L2 this offers a very high Q, together with a similarly high impedance at its resonant frequency. In consequence, signals at this resonant frequency suffer much less attenuation due to R3 than do signals removed from the resonant frequency, and the anti-phase version of the resonant frequency signals at the anode of V1(a) is also correspondingly high. At resonant frequency, therefore, the V1(a) anode signals largely cancel out the original signals which produced them, and the circuit achieves a state of equilibrium where the original signals are allowed to have just sufficient amplitude

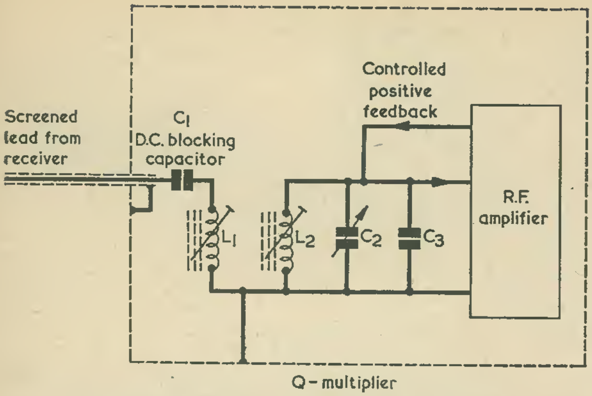


Fig. 4. A Q-multiplier offering sharp rejection. Coils L1 and L2 are coupled together inductively

to maintain the complementary cancelling signals.

The outcome, so far as receiver performance is concerned, is that a high degree of signal rejection occurs at the frequency at which this effect takes place, and it is possible to obtain a "notch" of similar type to that given by a crystal filter phasing control, the frequency at which the "notch" appears being controlled by C4.

Regeneration, when the "Reject" facility is selected, is controlled by R5.

For completeness, Fig. 3 also includes the "B.F.O." position of S1(a)(b)(c). When "B.F.O." is selected, R6 is advanced until V1(b) oscillates. The oscillator output is then fed into the receiver via R1, giving an audible beat note with received carriers according to the setting of C4. The facility provided here is similar to that provided by a conventional b.f.o. fitted normally in a communications receiver.

An alternative approach towards the use of a Q-multiplier for signal rejection is shown in Fig. 4. This version takes advantage of the *absorption effect* which occurs if the coil of a parallel tuned circuit is inductively coupled to the coil of another tuned circuit. If the second coil has a signal current flowing in its windings, and if the first tuned circuit is resonant at the frequency of that signal, the first tuned circuit will absorb energy from the second coil.

In Fig. 4, coil L1 is employed for cancelling out screened cable self-capacitance in the same manner as was the coil of Fig. 2. Coil L2 is in a parallel tuned circuit whose function is to extract energy by absorption from L1. If the two coils are carefully positioned in relation to each other, and if the tuned circuit around L2 has a very high Q, the absorption effect appears over a very narrow band of frequencies, resulting in a "notch" in the i.f. pass-band of the associated receiver. The frequency at which the "notch" appears is controlled by C2, whereupon this capacitor has an effect which is similar to the phasing capacitor in a crystal filter. The requisite high Q in the tuned circuit around L2 is provided by a regenerative circuit, the regeneration being adjusted until the circuit is just below the oscillation point.

COMPARISON WITH CRYSTAL FILTERS

As will have been gathered, Q-multipliers in their various forms are comparable with crystal filters since, according to version, they can offer either a peak or a "notch" in receiver response. However, a Q-multiplier cannot offer both a peak and a "notch" at the same time, as can a crystal. The Q-multiplier does not, in general, offer quite as good an absolute performance as does the crystal. Also, the adjustment of the controls of a Q-multiplier tends to be critical as the oscillation point of its tuned circuit is approached.

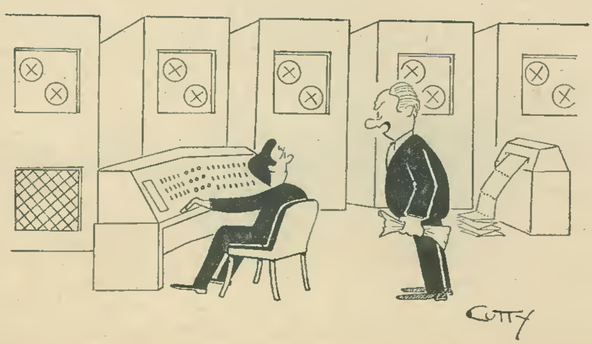
On the other hand, the advantage of the Q-multiplier is that it may be added to a receiver which does not employ a crystal filter and that it introduces no significant losses in receiver sensitivity. A crystal filter, on the other hand, attenuates the signals which pass through it, and is normally fitted as an integral part in the original design of a receiver, the latter having sufficient gain elsewhere to accommodate the loss introduced by the crystal.

We have seen that a Q-multiplier incorporates an r.f. amplifier, and it follows that this will require some form of power supply. Such a supply may be obtained from the receiver itself, or suitable supply components may be fitted into the Q-multiplier unit.

As a final point it may be stated that a Q-multiplier is usually coupled to an early stage in the i.f. amplifier of the receiver. It is, in fact, common practice to couple the Q-multiplier to the frequency changer anode.

NEXT MONTH

In next month's issue we shall examine other selective devices employed in receiver i.f. amplifiers. ■



"Ask it—who does it think it is anyway?"

THE EDDYSTONE EC 958 RECEIVER

(continued from page 106)

superheterodyne system is employed, with intermediate frequencies of 1,335kHz (nominal), 250kHz and 100kHz. Below 1.6MHz, the conversion is direct to the second or third intermediate frequency, depending on the input frequency range in use.

HIGH SELECTIVITY

The main selectivity and gain of the receiver are provided at the final i.f. (100kHz). Selectivity is provided by a switched L-C filter, with bandwidths of 400Hz and 1.3kHz for c.w. and f.s.k. operation respectively. For d.s.b. operation, bandwidths of 3kHz and 8kHz are available. A further position is provided on the selectivity switch for s.s.b. operation, this introducing a multi-pole crystal filter.

The third signal mixer can be fed from crystal-controlled oscillators at either 150kHz or 350kHz. The final i.f. of 100kHz is then derived from the 250kHz stage input as a difference frequency, but the polarity of the sidebands can be reversed, depending on the oscillator selected. This enables the upper and lower sidebands to be filtered and amplified, using only one sideband filter arrangement.

PROJECTION TUNING SCALE

The tuning scales in the EC 958 receiver use an optical projection system to throw an image, derived from a 10in. circumference film disc, on to a ground glass screen in the front panel of the receiver. In this way, tuning scales with an effective length of 50in. are provided ,to enable the operator to set both the main and incremental tuning with an accuracy appropriate to the setting accuracy of the control circuits.

OUTPUT CIRCUITS

The output of the final i.f. amplifier is fed to either an a.m. detector, or to a c.w./s.s.b. detector incorporating a b.f.o. An output from the master oscillator provides carrier insertion for high stability s.s.b. operation. The a.f. output is fed to a Class-A audio amplifier providing an output of 1 watt which can be fed to an internal monitoring loudspeaker or to an external 3Ω speaker.

A separate a.f. amplifier is provided which gives an output of 10mW to a 600Ω line outlet. An additional drive, at 100kHz, is provided for an optional f.s.k. converter which can be mounted inside the unit.

SPECIFICATION

Some of the more important specification details are as follows.

Reception facilities consist of c.w., m.c.w., a.m. (d.s.b.) and s.s.b. in A3A, A3H and A3J modes, upper or lower sideband. F.S.K. facilities are available when an optional module (Type LP.3058) is fitted.

The power supply can consist of single-phase a.c. mains 100-125 and 200-250 volts (40-60Hz), or low voltage d.c. using an external d.c./a.c. converter.

The aerial input is 75Ω unbalanced throughout the entire range. An additional 600Ω input (balanced or unbalanced) is available below 1.6MHz.

The receiver incorporates 39 transistors (including f.e.t.'s), 43 diodes and seven integrated circuits. It may be bench mounted or fitted to a standard 19in. rack. The panel height is 5.25in. only.

The price of the EC 958 is £750 f.o.b. ■

COURSES OF INSTRUCTION

GRIMSBY

The Adult Education Institute, Grimsby, is offering a course of instruction in basic radio theory, entitled 'Radio for Amateurs'.

Intended primarily for those interested in Amateur Radio Transmitting, the course will cover the syllabus of the City and Guilds Radio Amateurs' Examination, but anyone interested in radio as a hobby will find much of interest in this course.

The course will be held at the Hereford Centre, Ely Road, Grimsby, on Monday evenings from 7 to 9 p.m. Enrolment will be on 16th, 17th and 18th September between 7 and 9 p.m. and fees are 22/6d. per term, or 10/- per term for persons under 18 and not in full-time employment.

An additional fee is payable for those who wish to take the examination.

LONDON BOROUGH OF HOUNSLOW

At Brentford Centre for Adult Education, Brentford Secondary Girls' School, Clifden Road, Brentford. Enrolments 11th, 12th, 15th and 16th September, 1969, 6.30 to 8.30 p.m. Fees 50/- for one subject, 20/- for each additional subject.

High Fidelity and Tape Recording

The course is designed to give an insight into the technique of high fidelity, tape reproduction and recording and to get the best out of existing apparatus and machines, including notes on construction and maintenance. Programming and special applications, both stereo and mono, will be dealt with, as will be sound on tape or film for cine work. Wednesday. Classes begin on 24th September, 1969.

Radio Amateurs' Course

This course is in preparation for the City & Guilds Examination which qualifies the successful candidate for recognition by the Postmaster-General for the purpose of Radio Transmission. The work includes: simple magnetism and electricity, principles of radio, valves and transistors and circuits, radio receivers, low-power transmitters, aerials, measurement of frequency meters. After the examination the course will include lectures on equipment design. Monday. Class starts week commencing 22nd September, 1969.

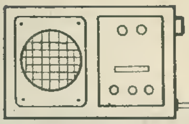
KNARESBOROUGH

At the Knaresborough Further Education Centre, Stockwell Road, Knaresborough. Evening Courses (7 to 9 p.m.) leading to the City & Guilds Radio Amateurs' Examination, including Morse Code. Timetable for the 1969–1970 Session as follows:–

RAE (1st year) Monday, Sept. 22nd, 1969 – Dec. 15th, 1969; January 5th, 1970 – March 16th, 1970.
RAE (2nd year) Thursday, Sept. 25th, 1969 – Dec. 18th, 1969; Jan. 8th, 1970 – March 19th, 1970.

Fees will be 30/- from September to March: a further fee of not more than 15/- will be charged for the Summer Term, 1970.

In your work-shop



On the last day of work preceding what is euphemistically referred to as the Late Summer Bank Holiday, Dick and Smithy find that they have an unexpected period of spare time on their hands. But they are able, as always, to take full advantage of this situation, and they devote the time to discussing the latest hints received from readers.

"MESSING AROUND WITH THE calendar", complained Dick, "that's what it is".

Smithy heaved a sigh.

"What", he asked wearily, "are you dripping on about now?"

"This stupid Bank Holiday Monday business", retorted Dick aggrievedly. "I was always brought up to take my Bank Holiday Monday at the beginning of August. But they've now gone and shifted it to the *end* of August".

"When you've got a moan", pronounced Smithy censoriously, "you certainly believe in sticking to it. Dash it all, Dick, you've been bitching away about the change in Bank Holiday date ever since it was introduced five years ago".

"And rightly so, too", snorted Dick. "Changing the date of a Bank Holiday is nothing less than flying in the face of Nature. Mark my words, Smithy, an alteration in the set order of things, such as this is, bodes ill for the future of mankind".

Smithy swallowed.

"You can always", he suggested sweetly, "come into work *during* the Bank Holiday if you like".

"There's no necessity for me to do that", answered Dick hastily. "In any case seeing that I was robbed, by *force majeure*, of my rightful holiday at the beginning of this month, I have no alternative but to grudgingly accept next Monday as a day off in lieu".

READERS' HINTS

Smithy glanced over at his assistant as he sprawled gracelessly on the edge of the stool alongside his bench. It was the last Friday of August and there was half an hour left before the Workshop was locked up for the forthcoming week-end plus the subsequent Late Summer Bank Holiday Monday. All servicing work had been cleared up, and the pair had busied themselves during the previous hour in tidying and clearing up their benches. A process, it may be added, which had caused the suspension in the air of such a great volume of dust that the Workshop door had had to be vigorously swung open and shut from outside with all the windows open before the coughing Dick and Smithy could re-enter and take up their rightful positions beside their benches again.

After this display of energy they had decided to relax before official packing-up time, and had entered into a desultory conversation which had terminated in Dick's bitter tirade against those who alter our long-established customs.

A thought occurred to Smithy.

"Tell you what", he remarked brightly. "How about having a session on readers' hints?"

Dick straightened up.

"Now that", he remarked keenly, "really *is* a good idea. How many hints have you received since we last had a go at them?"

"Quite a few", replied Smithy, as he reached into a drawer under his bench and took out a bundle of letters. "And, as always, there are some very good ideas amongst them, too".

Eagerly, Dick carried his stool over to Smithy's bench and perched himself on it. He had completely forgotten his previous complaints about the forthcoming misplaced Bank Holiday.

Smithy selected a letter and read it carefully.

"Now here", he remarked, "is a good hint to start the ball rolling. As I'll explain to you in a minute, this idea is a wee bit in the experimental class. However, the experimental work is easy enough to carry out once you understand the basic operation".

Smithy indicated a circuit diagram drawn out in the letter. (Fig. 1(a)).

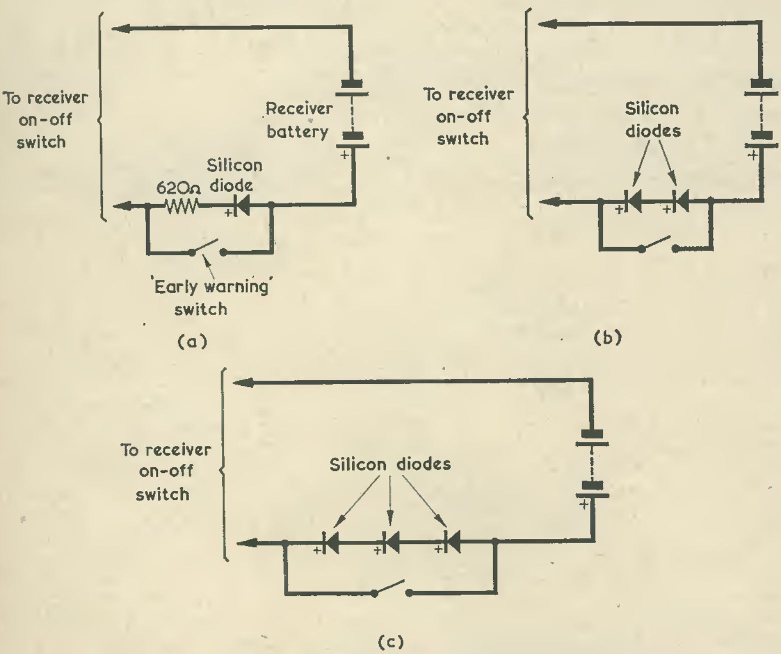


Fig. 1(a). A simple circuit which gives 'early warning' when a receiver battery is approaching exhaustion
(b). As suggested by Smithy, silicon diodes without a resistor may alternatively be employed. The two shown here drop about 1 volt when the switch is opened
(c). With three diodes, the voltage drop is approximately 1.5 volts

"The idea behind this circuit", he continued, "is to provide a simple 'early warning' of battery failure in a transistor radio. As you know, it's very annoying to have a transistor radio battery run out on you when you don't have a replacement immediately available. Normally, the switch in this 'early warning' circuit is closed, whereupon the radio operates in the usual manner. When the switch is opened, however, the silicon diode and 620Ω resistor are connected in series with the battery, whereupon a voltage is dropped across the conducting diode and the resistor. If the battery is near exhaustion and its voltage is correspondingly low, the receiver oscillator will cease to function when the switch is opened. This warns you that it's about time you got a new battery for the radio, because the present one won't last much longer".

"That's neat", commented Dick. "I suppose that, if the radio continues to operate with the switch opened, you then know that the battery has got a reasonable amount of life left in it".

"Exactly", agreed Smithy. "One of the advantages of this idea is that you can insert the switch and the voltage dropping components in series with the positive battery lead without having to alter any of the receiver circuits themselves. The switch and the components can be added quite easily to most transistor radios as a permanent feature".

"I wonder", said Dick thoughtfully, "why the resistor has to be 620Ω".

"Now that", replied Smithy, "is where the experimental bit comes in. The components in this circuit happen to be those which suited the particular transistor radio used by the reader who sent us the hint. What you have to do is to select voltage dropping components which will be applicable to your own radio. Speaking personally, I would prefer to use diodes only, rather than a diode and a resistor. Two conducting silicon diodes (Fig. 1(b)) will give a drop of about 1 volt when they're switched into circuit and three (Fig. 1(c)) will give a drop of about 1.5 volts. One or other of these two alternatives should be adequate to provide 'early warning' of battery failure with the majority of transistor radios. Incidentally, it's a good plan to find the dial setting at which the receiver oscillator first fails to operate as the supply voltage drops. If, for instance, this occurs at the low frequency end of the medium wave band, you can test the battery by opening the switch and tuning at that end of the band".

"I notice", said Dick, "that the test circuit is inserted in series with the positive connection to the battery. Couldn't it be connected in series with the negative battery lead instead?"

"Oh definitely", stated Smithy. "Provided, of course, that you connect the silicon diodes the other way round".

"What sort of silicon diodes should be used?"

"Well", replied Smithy, "the diodes *could* pass a fairly heavy surge current if they are in circuit when the transistor radio is switched on, and this current might well be in excess of the maximum forward current rating of some of the smaller silicon diodes which are intended for signal circuits. The more knowledgable experimenter who, say, buys his silicon diodes in bulk will know how to deal with this problem. So far as the less experienced home-constructor is concerned, however, I would suggest that he plays safe on this score by using small silicon power rectifier diodes. A good choice would be the popular Lucas DD000. This is quite a small diode and its forward current characteristics are more than adequate enough for the present application".

NO CHARGE FOR CORKAGE

Smithy turned to another letter in the pile.

"Ah", he chuckled. "Now here's a very smart little scheme for saving solder".

Smithy showed Dick a sketch attached to the letter. (Fig. 2).

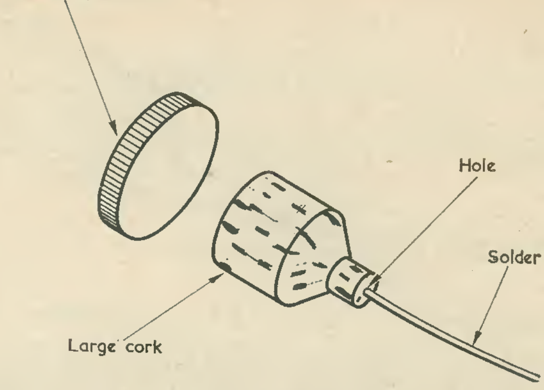


Fig. 2. A simple solder holder which enables odd bits of solder to be finally used up

"What you do", he continued, "is to take a large cork and cut it to the shape shown here. If it's got a plastic top which has a wider diameter than the body of the cork, you cut this top off. The next thing to do is to make a small hole in the tapered end of the cork, this hole being just large enough to take a piece of resin-cored solder. You now have a solder holder which, first of all, enables you to manipulate long lengths of solder more easily and which, secondly, protects your hand from heat when you're using very short lengths of solder".

"That idea", said Dick, impressed, "would be just right for me. I'm always ending up with little bits of solder about an inch and a half long. I've got a tin full of them somewhere on the bench!"

"Then you can start using them up with this solder-saving gadget", pronounced Smithy. "The next time you order a bottle of Beaujolais with your egg and chips down at Joe's Caff, ask him to keep the cork for you".

"Fair enough", replied Dick equably. "But it won't be Beaujolais because Joe doesn't stock it. It'll probably be a hock like Liebfraumilch or something like that. The trouble with Joe is that he's rather fussy about the wines he serves with his chips".

Smithy cast a suspicious glance at Dick's patently innocent face.

"Oh well", he remarked uncertainly, "you'd better use whatever sort of cork you can lay your hands on".

The Serviceman hurriedly turned to the pile of letters on his bench and made a third selection.

"Now, this letter", he announced, after a moment's perusal, "describes a probe for an oscilloscope or millivoltmeter".

Smithy showed Dick the drawing of the probe. (Fig. 3).

"As you can see", went on Smithy, "this is built in the case of a fibre pen, the type employed by our correspondent being a Scripto 'Fibapen'. The outside insulation on the coaxial cable connecting to the probe is stripped back 1 inch from the end and the braiding removed over most of this length. A stranded earth lead is soldered to the braid which remains, and is passed through a hole in the case, as shown. A Veroboard terminal pin or any other plated pin suitable for a probe is, after being soldered to the inner wire of the coaxial cable, passed into the plastic case. The three entry

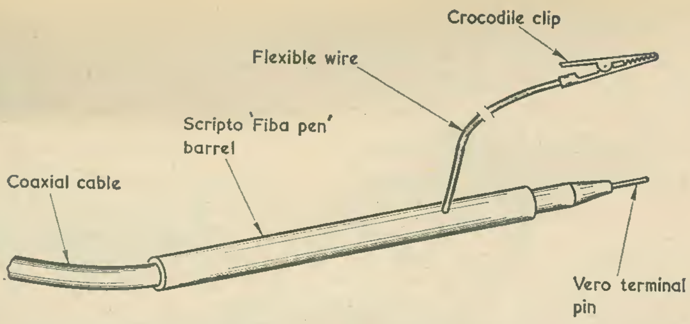


Fig. 3. Making up a screened oscilloscope or millivoltmeter probe in the case of a discarded fibre pen

points are then sealed with Araldite. When completed, the probe is capable of reaching into really awkward and inaccesible places. Also, it retains a high degree of screening due to the presence of the braiding inside the plastic case".

"That's a knobby scheme", remarked Dick approvingly. "It's amazing how many useful gadgets you can knock up for radio purposes out of quite simple basic materials".

"True enough", agreed Smithy. "Now let's take a look at the next hint. Ah now, this is another simple device but it can still be jolly useful during servicing work. The idea was conceived after encountering the difficulty of removing small silicon transistors of the BF173 variety from printed circuit boards in hybrid TV sets. The removal of these transistors can be particularly difficult when they're closely surrounded by other components, and the solution consists of making an extractor tool from a polystyrene or bakelite coil former of the type which accepts a 6 m.m. dust core. A piece of plastic sleeving is first slipped inside the former to give a good friction grip. The former is then passed over the transistor body, whereupon the grip is tight enough to allow the transistor to be drawn free of the printed panel once the solder is removed from the connections".

Dick looked at the sketch in the letter Smithy was holding. (Fig. 4).

"That's a useful idea", he commented. "Some of those little transistors can make life very frustrating when you want to unsolder them from a crowded circuit board".

"They can indeed", concurred Smithy. "An added bonus with this extractor tool is that you can use it to hold the transistor in position if you want to make ohmmeter checks to its lead-outs. Hold the base of the coil former in a vice, and the transistor is firmly positioned with its leads pointing conveniently upwards".

"Good point", approved Dick. "Transistors can be fiddling little components when you want to connect test leads to them".

"They *can* be irritating in that respect", agreed Smithy. "Well, let's see what the next letter has to tell us. Ah, this has to do with magnetising and demagnetising. As you know, Dick, we sometimes like to have screwdrivers and similar tools magnetised because they can then be used to pick up screws and things from awkward places. The trouble is that, once magnetised, the tools are difficult to demagnetise again afterwards, whereupon the magnetisation can occasionally become a nuisance. The present hint describes a simple and useful method of demagnetising such tools, this being done with the aid of an ordinary mains driven solder gun. You hold the tip of the iron near the object to be demagnetised and pull the trigger. The field around the solder gun tip is usually strong enough to do the job very effectively".

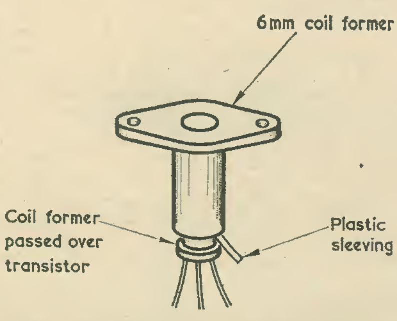


Fig. 4. Employing a coil former as an extractor for transistors fitted to crowded circuit boards

TERMINAL STRIPS

"That's a new one on me", commented Dick. "I'd never looked upon a solder gun as being a degaussing tool before!"

But Smithy had already opened the next letter, and he passed over the sketches enclosed with this to his assistant.

"Have a shufti at these", he said, "whilst I tell you what's in the letter. This, incidentally, describes two separate hints. The first of these involves the use of what are known in the trade as 'barrier terminal strips'."

"I think I know what they are", said Dick. "Aren't they those polythene strips with individual metal connectors in them, each connector having two screw terminals?"

"That's right", agreed Smithy. "They're normally 12-way and are rated at mains voltages, and you can sub-divide them very easily with the aid of a knife. They're sold in Woolworth's as well as in shops dealing with electrical parts. Well now, if you like experimenting with different circuits, two of these terminal strips mounted parallel to each other can offer very convenient anchor points and are readily capable of taking temporary connections. (Fig. 5). You fit the components between the strips and simply secure their lead-outs under the terminal strip screws. The termiinals should not be used for any r.f. wiring which needs to be particularly short, but they are extremely convenient for bias networks, decoupling components, and for circuits working at audio frequency. The most convenient terminal strips for this application are those rated at 2 amps".

"Next time I'm in Woollie's", said Dick, "I think I'll make a small purchase of two of those strips".

"Fair enough", said Smithy approvingly. "The second hint in this letter applies to constructors who prefer, perhaps due to lack of facilities, to avoid too much metal-bashing. You take two pieces of wood measuring 1 inch square and 6 inches long, and fix to them two further pieces measuring $1\frac{1}{2}$ inch by $\frac{1}{2}$ inch by about 10 inches long. (Fig. 6). You then add a front panel. whereupon you have an almost complete chassis. The front panel can be of aluminium or plywood, as required. You can screw an aluminium sheet over the $1\frac{1}{2}$ inch pieces if you like or, even, mount components directly to the wood. If the two $1\frac{1}{2}$ inch pieces of wood are spaced by the requisite distance you can mount valveholders to them by having one valveholder mounting screw on one piece of wood and the other on the second piece of wood. The larger iron-cored transformers and chokes can be straddled across the two lengths of wood in a similar manner".

"That's certainly a novel idea", remarked Dick. "Do the 1½ inch pieces of wood *have* to be 10 inches long?"

"Oh no", said Smithy, consulting the letter in his hand. "The 10 inch dimension just happens to be a convenient one for most home-constructor projects. However, it can easily be increased or shortened to take any set of components you may require for a specific job."

Smithy put down the letter and turned to the next one in the pile on his bench.

"Now this", he said, studying the letter carefully, "is a *really* unusual one. Our correspondent likes to experiment with receivers and preselectors and he's evolved a knobby idea for mounting ferrite rod aerials to these, this consisting of a rotatable ferrite rod assembly which can be plugged in to the unit with which it is to be used. The base of the assembly is provided by an electric light ceiling rose, the centre hole in this being opened out to accept a 'skeleton' jack socket of the type which is mounted by a single bush nut. A jack plug with a fairly long body plugs into this, the ferrite rod being mounted at its top. This is what it all looks like".

Smithy showed Dick a diagram in the letter he had been reading. (Fig. 7(a)).

"The type of jack plug used by our correspondent", continued the Serviceman, "was of the surplus variety and its body was made of an insulating material which melts with heat. In consequence, it was possible, with the aid of a soldering iron, to make a nice groove along the top of the body to take the centre of the ferrite rod. Individual constructors not having this type of jack plug can, of course, use other methods of mounting the rod. In our correspondent's case Paxolin discs were initially stuck to the body of the jack plug, a rectangular piece of Paxolin being secured over the ferrite rod at the top with the aid of two long bolts. (Fig. 7(b)). These bolts also provided the connections between the ferrite rod aerial winding and the plug contacts. Two wires from the latter were passed through holes in the side of the body".

"That *is* an unusual idea", agreed Dick. "You could do quite a bit of experimenting with different ferrite aerials, just by plugging them in. And, of course, they're free to rotate".

"What catches my imagination here", stated Smithy, "is that this jack plug and socket idea has potential applications for quite a lot of gubbinses other than ferrite aerials. Let's say that you want to knock up

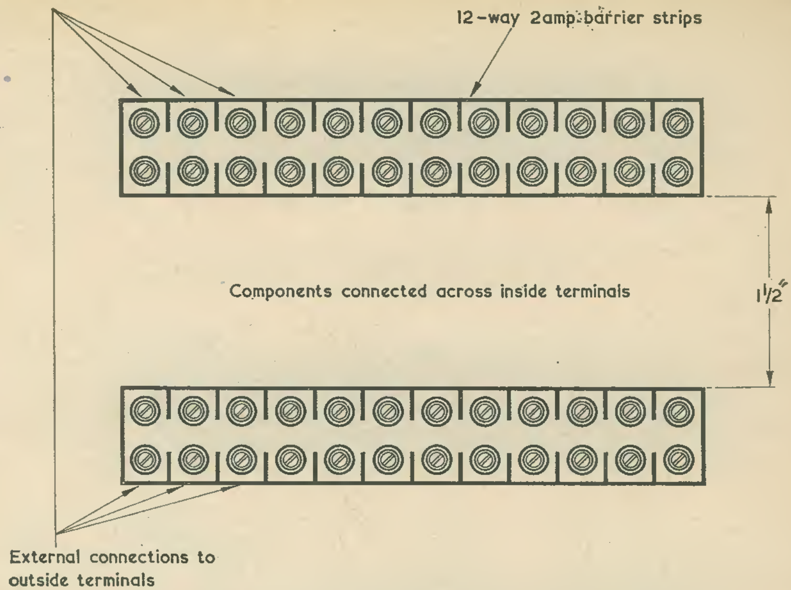


Fig. 5. Temporary and experimental circuits can be readily made up with the aid of standard electrician's barrier terminal strips

a gadget in which one part can be made to rotate around a centre whilst continual electrical connection is made to it. This jack plug and socket scheme provides an excellent solution to such a problem. First of all, it gives you a ready-made spindle and bush and, secondly, it gives you continual electrical contact to the rotating part via the contacts of the plug and socket".

"Just like a pair of slip-rings", said Dick. "I seem to remember that you can get jack plugs with three contacts. If you used one of these you'd have what is effectively three slip-rings'".

"Three-pole jack plugs *are* available", confirmed Smithy, "And they're made by Bulgin. With a three-pole jack plug, both the tip and a short length of sleeve are in-

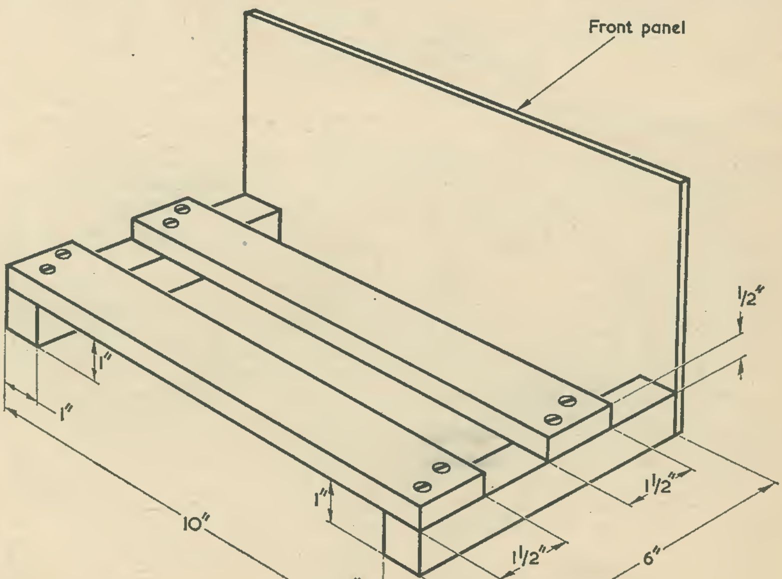


Fig. 6. A simple means of making up a chassis for the constructor whose metal-working facilities are limited

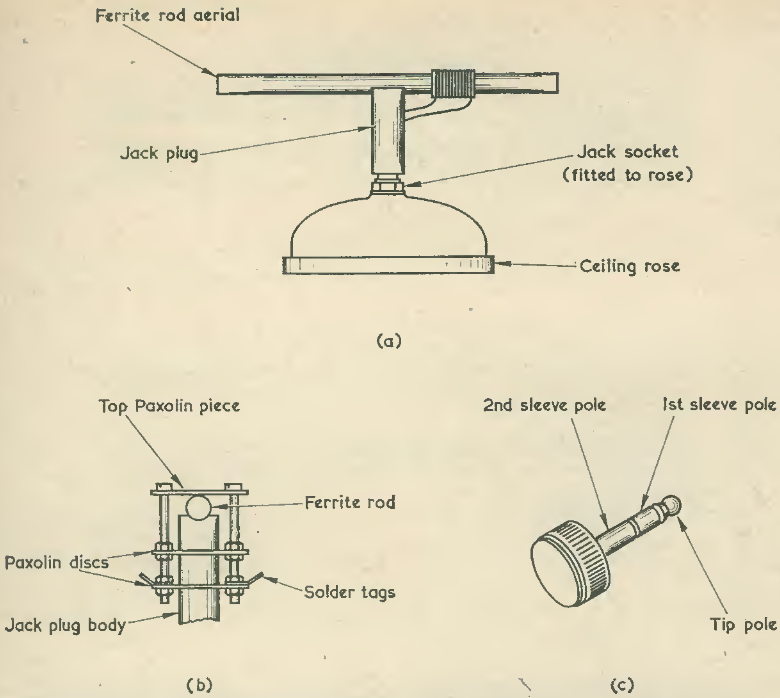


Fig. 7(a). The basics of an unusual ferrite aerial mounting system (b). A suitable method of securing the ferrite rod to the jack plug. The two solder tags act as anchors for the coil lead-outs (c). The Bulgin 3-pole jack plug type P505. This, together with suitable sockets, is available from Home Radio (Components) Ltd.

sulated from the main part of the sleeve". (Fig. 7(c)).

"That would be just the job then", said Dick triumphantly. "It would give you *three* electrical connections continually made to the rotating part".

FLEXIBLE TORCH

"True enough", agreed Smithy absently, as he read a further letter. "Now, here's something which falls into quite a different category. It's a hint for making up what our correspondent describes as a 'flexible torch'. Actually it's a narrow diameter bulb holder which can be wired to coaxial cable, and it is very useful for illuminating inaccessible places. The other end of the cable connects to a suitable battery or heater transformer secondary."

Dick examined with interest the sketches accompanying the letter. (Fig. 8).

"These bits and pieces", he remarked, "look like parts of coaxial plugs".

"They are", confirmed Smithy. "Actually they're parts of standard Belling-Lee coaxial cable plugs and coaxial cable sockets. Do you know what I mean by 'coaxial cable sockets'?"

"I suppose", replied Dick, "that those will be the sockets which have the same general appearance as coaxial plugs, and which can be wired up to coaxial cable in much the same way as the plugs are wired".

"That's right", agreed Smithy. "They're used for extending the length of a coaxial cable and for similar jobs. A more correct name for them, by the way, is 'free coaxial socket'. For the present application, the plug or socket which actually houses the bulb should be of the type having an insulated cap as opposed to the type with a metal cap. Also, the end of the plastic cap is cut off".

Smithy returned to the letter.

"Right!" he announced briskly. "Now there are two ways of making up these bulbholders. The first is intended for ordinary flash-lamp bulbs. First, you take a coaxial plug and discard the inner parts. You next insert the bulb and, if necessary, wrap a sufficient length of tin or aluminium foil around its thread to ensure that it makes good contact to the outer part of the plug and fits in tightly. Then take a coaxial cable socket, and add to it a small spiral spring that just fits over the centre socket, allowing the spring to protrude by about $\frac{3}{8}$ inch. A suitable spring can be obtained from a discarded retractable ball point pen. You wire up a length of coaxial cable to the socket in normal manner, push the socket into the modified plug and – hey presto! – you have a bulb-holder".

"Blow me", remarked Dick. "Well, *that* doesn't represent a great deal of work".

"It doesn't", said Smithy. "Now, there's a second approach. This doesn't require the spring and it's intended for lens-end bulbs. You fit the bulb into a cable socket, using tin or aluminium foil as before. In this instance, the bulb centre tip connects to the centre metal section of the socket. It may be necessary to cut away some of the insulation on this centre section to allow the bulb tip to make good contact. You next wire the coaxial cable to a coaxial plug, which is inserted into the other end of the socket. The result? Another bulb-holder!"

"These little bulb-holders", commented Dick, "should be jolly useful for servicing work."

"That's their main purpose, of course", replied Smithy. "The coax running to the bulb-holder assembly can be any convenient length. You could, for instance, wire up one of these bulb-holders permanently on a work bench with, say, about two yards of coax coupling to a heater transformer. Another idea would be to fix the bulb-holder to the handle of a soldering iron. It could be held in place by a couple of springs, these being cut, say, from a length of curtain spring".

"I must", stated Dick, "have a dig in our box of coax plugs and sockets when I come back from holiday".

A frown creased his brow.

"Which reminds me", he continued, "that I still think it's a poor show that the Bank Holiday has been shifted to the end of August".

"Dear, oh dear", said Smithy. "Are you still moaning about *that*?"

'Too true I'm moaning", returned Dick hotly. "We're pushed around far too much these days by our administrators. If there's much more of it I'm darned well going to go Nationalist".

"You can't go Nationalist".

"Why not?"

"Because you're English", stated Smithy. "It's you the Nationalists are *against*".

Dick absorbed this information.

"Is it?"

"Of course".

"Hell's teeth", complained Dick. "There's just no avenue at all for keen young militants such as myself".

"And a good thing, too", snorted Smithy. "Anyway, there's five minutes left, so we'll make the next hint the last one for this particular session".

Dick forgot the injustices of the world for the moment.

"All these hints we get are very good, aren't they?"

"They always are", replied Smithy, "and they're all very much appreciated, too. Anyway, here's the last one for today, and it deals with a method of working out Veroboard component layouts. You take a piece of Veroboard, the largest you are likely to use, together with a piece of matt white Formica of the same size. With the white side of the Formica upwards, you place the Veroboard on top and, using a sharp scriber, pierce the Formica through every Veroboard hole in turn. (Fig. 9). You next take away the Veroboard, whereupon the Formica is ready for use. To work out a component layout you simply draw the components on the surface of the Formica with pencil, employing a red pencil at the places where the Veroboard copper strips have to be cut. The final job consists of preparing the Veroboard and wiring it up, copying the layout you've drawn on the Formica surface. You can use the piece of Formica over and over again, because the pencilled layout diagram can be easily cleaned off with a damp cloth, leaving just the scriber marks".

OFF AND AWAY

"Well, I'm dashed", said Dick enthusiastically. "What a crafty scheme!"

"Isn't it?" agreed Smithy, collecting the letters together and returning them to the drawer in his bench. "It's a very nice one to finish this hint sesh off with, too".

A thoughtful expression appeared on Dick's face.

"Do you know, Smithy", he remarked. "Despite what I said earlier on I've got half a mind to look upon next Monday as an ordinary working day after all and to come on in here".

"Blimey", said Smithy, impressed. "You really *must* be serious over this Bank Holiday business".

"I'm extremely serious about it", replied Dick fervently. "Don't forget that I'm an idealist, and that I believe in putting my ideals into practice".

"Well", said Smithy helpfully, "I can let you have the Workshop keys if you like".

"That would be fine", responded Dick enthusiastically. "By coming in I'll be making just the sort of passive demonstration that's needed to strike a blow for civil liberty".

Smithy decided to concentrate on the harder and more mundane facts of life.

"I presume", he commented, "that, since there are no sets to fix, you'll be carrying out work of a private nature".

"Actually", stated Dick guardedly, "I'd thought of trying some of the hints we've discussed today".

"Excellent", commented Smithy. "And I must compliment you on

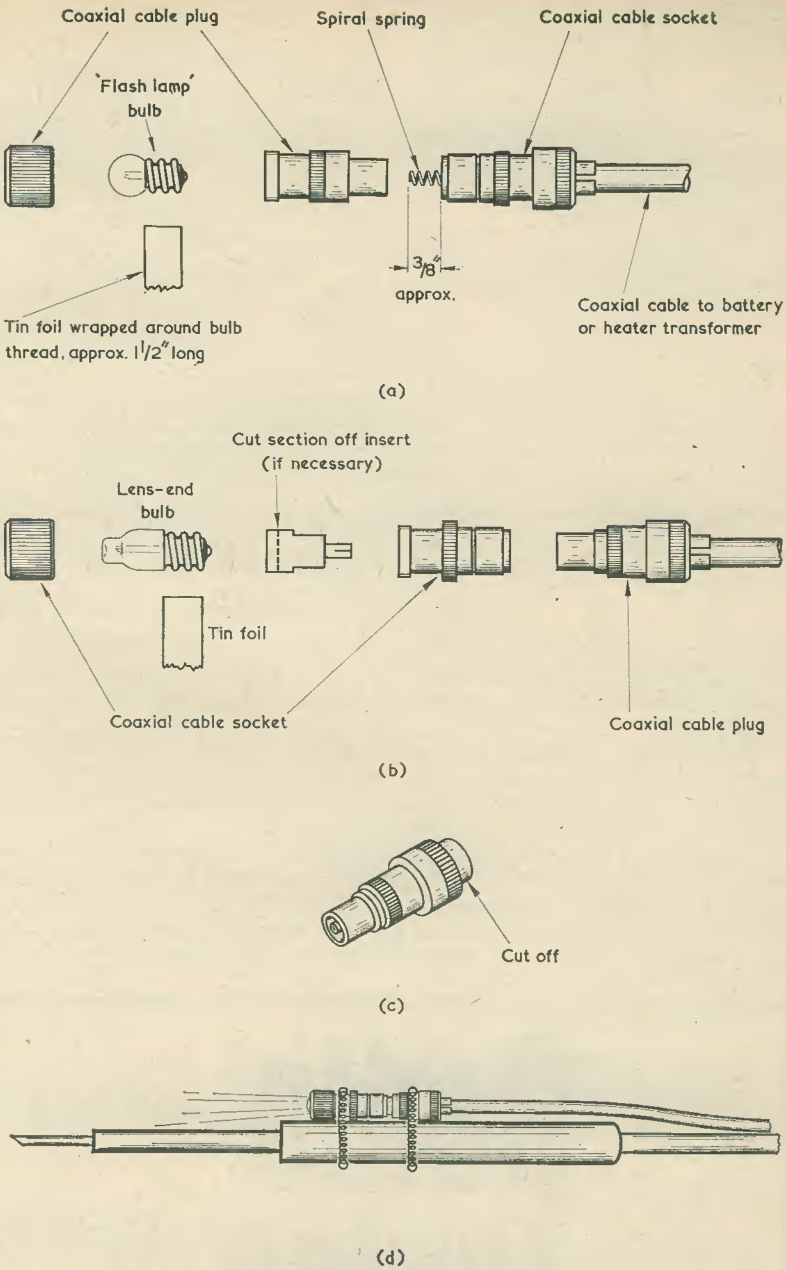


Fig. 8(a). Details of a simple bulb-holder having a narrow diameter
(b). An alternative assembly incorporating a lens-end bulb
(c). The end of the plastic cap at the bulb end should be cut off, as shown here
(d). Mounting the bulb-holder assembly on a soldering iron

your enthusiasm. Seeing, though, that you won't be doing any official work on Monday you can't, of course, expect to be paid for coming in".

There was silence for a moment.

"Can't I?"

"Oh no".

The silence returned.

"I think", said Dick slowly, "that this will have to be another occasion when I have to bow my head to Authority".

"What do you mean?"

"Although it goes against the grain", explained Dick, "I'm going

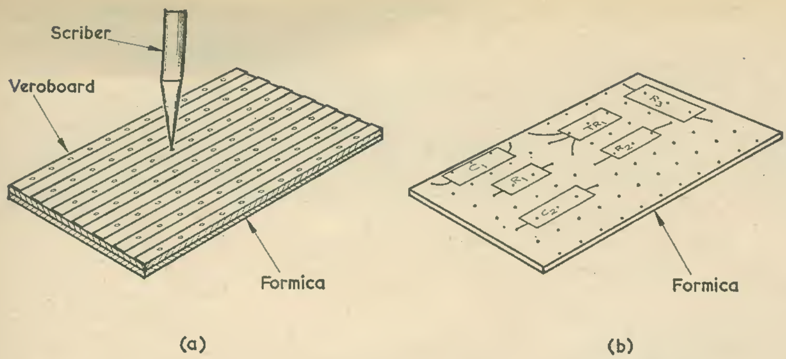


Fig. 9. Successive steps in planning a Veroboard component layout. In (a) the scriber is passed through the Veroboard holes in turn. In (b) the components are drawn on the Formica surface in pencil

to *have* this dratted Bank Holiday off. But I'll take jolly good care to see that I don't enjoy it!"

Which final statement on the part of Dick only serves to demonstrate, once more, the truth of the old and well proven dictum that the most successful idealist of them all is the one who keeps his eye fixed firmly on the loot.

EDITOR'S NOTE

The hints described in this episode of 'In Your Workshop' were submitted, in the order in which they appear, by D. Salmon, D. Fitzgerald, M. F. Docker, W. D. Graham, G. M. Watson, P. B. Moss, B. Richardson, A. J. Thorndyke and A. L. Dawson. Further hints for this feature are welcomed, and payment is made for all that are published.

DOMINICA ON THE AIR

Marconi Transmitter in the West Indies

The people of Dominica are to increase the power of their radio service, with the construction of a new station to be equipped by the Marconi Company. This station, due to be on the air by October, is part of a general development plan drawn up by the Government of Dominica for the Island, and will be built near Roseau, the Island's capital.

The contract includes a Marconi 10 kW m.f. broadcasting transmitter together with studio facilities. The type B6029 transmitter is designed for use anywhere in the world and embodies the latest developments in solid-state technology. Being completely self-contained, it is easily installed and, since no rear access is needed, requires only minimal floor space.

Dominica, in associate statehood with Britain, is centrally placed in the islands of the Eastern Caribbean. The new radio station will cover not only Dominica, but also many of the surrounding islands. The station will broadcast a varied programme including local news, educational items and general entertainment, and a British news service. Also, because the islands are on the edge of a hurricane zone, the station will, when necessary, broadcast advance warning of bad weather conditions to the islanders.

Radio Topics

By Recorder

After having just read Desmond Morris' *The Naked Ape* (now available in paper-back from Corgi Books—albeit with a front illustration that necessitates the cover being folded firmly back whilst reading in the train) I have been pondering a little on the processes of evolution. As you may recall, in his book Dr. Morris examines Man from the point of view of the zoologist, with results that are enlightening, entertaining and, in places, hilariously funny.

But it is the question of evolution, as treated in *The Naked Ape*, which is the most intriguing. A species dies out if it eventually becomes incompatible with its environment. At the same time, the changes needed in a species to enable it to adapt and to advance are not consciously ordered. Instead, quite accidental deviations from the norm occur continually and, should any class of deviator be more successful in survival than the mean of the species, that class eventually dominates in status and in numbers. It is rather chastening to think that *homo* only acquired his *sapiens* by virtue of a few fortuitous divergences way back there in the jungle.

ELECTRONIC EVOLUTION

It then occurred to me that a modified form of evolution with time could well be taking place in the material world of electronic components and devices. Here, however, it would seem that newly introduced devices, such as the transistor, should more accurately be described as being created rather than evolved. But *are* they created? Are they not evolved from what has gone before with just a small change here and a small change there until we suddenly find ourselves confronted with what appears to be a brand-new device? The transistor originally appeared in point contact form, having arisen from work on point contact diodes. After that it has evolved to the state in which we know it today. Point contact transistors fell by the wayside when the more efficient junction transistors took over. In their turn, the earlier junction transistors became superseded by the later versions, which offered even better and more useful performances.

If you look at the history of any commonly used electronic component, you will find a similar story of apparent evolution. It may now be remarked that this form of evolution isn't the same as the zoologist's definition of evolution, as applied to living things. With electronics there may well be deviations from the mean which result in one type of component being superseded by another, better one, and quite a few such deviations could indeed fall into the category of "accidental". But the overall course of this evolution of electronic components is actively controlled by Man.

Hmm! Perhaps human evolution is similarly not so accidental after all.

EXPERIMENTAL RECORD AMPLIFIER

Do you remember the adventures of Dick and Smithy when, in "In Your Workshop" published in the last January issue, they set about improving the performance of one of those low-cost commercially made record players which employ a single UL84 a.f. amplifier valve? You'll need to turn back to that January issue to obtain the full story but, in general, it can be said that Smithy elected to add a triode voltage amplifier between the pick-up and the UL84, introducing also a higher value of resistive load for the pick-up, a sizable amount of feedback and a far more civilised type of tone control.

A reader, Mr. J. D. Owen of Pendine, Carmarthen, has sent us an alternative amplifier circuit employing transistors, for insertion before the UL84. So that you can follow this alternative circuit, the accompanying Fig. 1 shows the original single UL84 record-player amplifier in its unmodified state before Smithy set to work on it. Fig. 2 gives Mr. Owen's circuit, and I must stress that this is presented

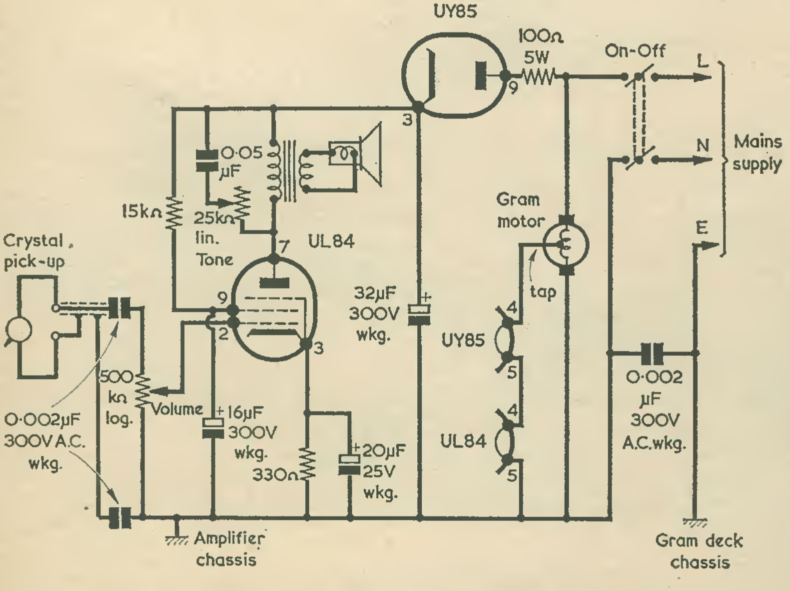


Fig. 1. The circuit of a low-cost record player amplifier incorporating a single UL84

as an experimental project only. As can be seen, the circuit of Fig. 2 fits in between the volume control slider of Fig. 1 and the control grid of the UL84. The 470kΩ resistor in Fig. 2 following the 2N4289 is merely a grid resistor for the UL84. The zener diode is shown as a 39 volt component but it can, in practice, be anywhere between some 36 and 40 volts. It should be capable of dissipating 80mW, which shouldn't be too difficult to arrange since most of the higher voltage zener diodes seem, in any case, to be in the 0.5 to 1.5 watt ranges.

Note that one side of the speaker transformer secondary connects to the positive side of the sub-amplifier supply and that negative feedback is provided via the 50kΩ preset potentiometer. When the amplifier is completed it will be best to initially leave this potentiometer out of circuit. Be careful to keep the volume control low when checking the amplifier in this condition because, if the record player has a small loudspeaker, excessive output might damage it. Then introduce the potentiometer set to insert full resistance, and gradually reduce this resistance until the desired overall gain is obtained. If, at any time, the amplifier goes into oscillation the feedback is positive. As soon as oscillation is heard, switch off quickly and reverse the feedback connections at the transformer secondary.

Mr. Owen's circuit does not take account of a tone control. The horrible top-cut affair using a 25kΩ variable resistor and 0.05μF capacitor across the speaker transformer primary which is shown in Fig. 1 *could* be retained. But this would be very naughty, as the tone control is inside the feedback loop. It would be better to either dispense with a tone control, or experiment with a circuit along the lines followed by Smithy.

The 2N4289 is available from Amatronix, Ltd. Alternatively, both transistors are available from Electrovalue, 32a St. Judes Road, Englefield Green, Egham, Surrey.

Mr. Owen states that he hasn't tried his circuit in a record player amplifier such as that in Fig. 1, because one wasn't available. But he says that the circuit gives good results under roughly similar conditions when fed with a ceramic cartridge.

SINGLE TRANSISTOR OUTPUT

Our popular contributor, Sir Douglas Hall, has sent us some thought-provoking notes on the subject of output stages using single transistors. These notes are not sufficiently long to constitute an article in their own right, and I gladly relinquish space here to allow their publication.

Single transistors (writes Sir Douglas Hall) are quite often used as Class A output devices in mains driven receivers or amplifiers, or in apparatus powered by car batteries. If a transformer is used the maximum undistorted output is confined by the dissipation capability, within reason, of the transistor employed. It is necessary for the transformer to have a suitable ratio, a large enough core, and a sufficiently low primary resistance. In these circumstances the greater the current

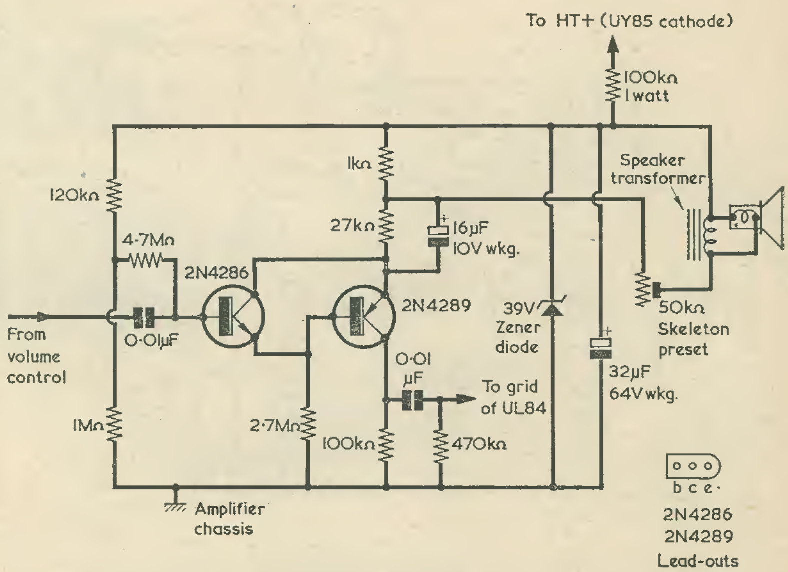


Fig. 2. A suggested amplifier circuit for improving the record player performance

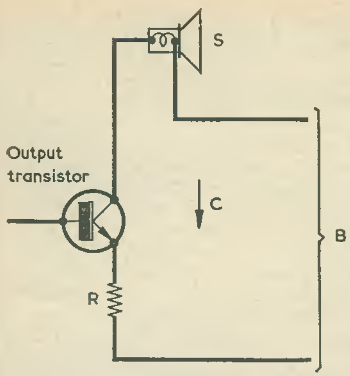


Fig. 3. Illustrating the conditions in a single transistor transformerless output stage

passed through the components the greater will be the output, and an efficiency not far short of 50% may be expected.

In recent years single transistor output stages have often used comparatively high impedance speakers so as to dispense with the output transformer. The impedance rating for these speakers is usually 15, 25 or 35Ω or, in the case of miniature battery receivers, 80Ω. The d.c. resistance of such speakers has about the same value as the nominal impedance. When a circuit of this sort is employed it is no longer possible to increase output indefinitely by increasing the current passed. There is an optimum current which, if exceeded, will result in a drop in output because of excessive drop of direct voltage across the speaker.

In order for maximum power to be passed by the transistor to the speaker, the impedance of the speaker should equal the impedance of the transistor. Then, as the impedance and resistance of the speaker are the same, the right conditions will occur when half the direct voltage available for the transistor and speaker combination appears across each. This will not be quite half the voltage of the power supply because of a small drop across the inevitable stablising resistor. It follows that with a transformerless Class A output circuit rather less than 25% efficiency can be obtained because, first, half the direct voltage available is lost across the speaker and, second, only half the audio power given by the transistor can appear across the speaker.

In the diagram (Fig. 3) and the equations which follow,

C=collector current in mA for maximum undistorted output,
S=impedance and resistance of speaker in ohms,
R=stabilising resistor in ohms,
B=power supply in volts,
O=maximum undistorted output in mW.

From Ohm's Law and the expression for power in a.c. circuits, it follows that

$$C = \frac{1{,}000B}{2S + R}, \text{ and}$$

$$O = \frac{CSB}{4S + 2R}.$$

These equations apply whether the transistor is connected as shown, or as a common collector device with the speaker in the emitter circuit and the stabilising resistor either in series with the speaker or, in some cases, in the collector lead. However, if the common collector configuration is used, the losses due to *mismatching* will be smaller because of the effect of negative feedback.

The accompanying table shows optimum current and maximum output for various combinations of speakers and supply voltages. The figures for R have been chosen such as to drop about 5% of the supply voltage. In some cases it may be possible to reduce the resistance of R a little.

TABLE

Calculated output currents and powers for different values of S, R and B in a transformless single transistor output stage.

S	R	B	C	O
15	1.8	6	189	267
		9	283	601
		12	378	1,070
		18	566	2,403
25	3.0	6	113	160
		9	170	361
		12	226	640
		18	340	1,443
35	4.0	6	81	116
		9	121	258
		12	162	464
		18	243	1,034
80	10.0	3	18	12
		4.5	26	28
		6	35	49
		9	53	112

Some of the figures are rather surprising. For instance, about 260mW is the absolute maximum power that can be obtained from a 6 volt supply and a 15Ω speaker; and with a 35Ω speaker about 18 volts are required for supply before 1 watt output can be achieved.

The figures for power are slightly optimistic as they assume that 50% of the power given by the transistor will appear across the speaker, whereas there are certain losses which will reduce the efficiency somewhat. ■

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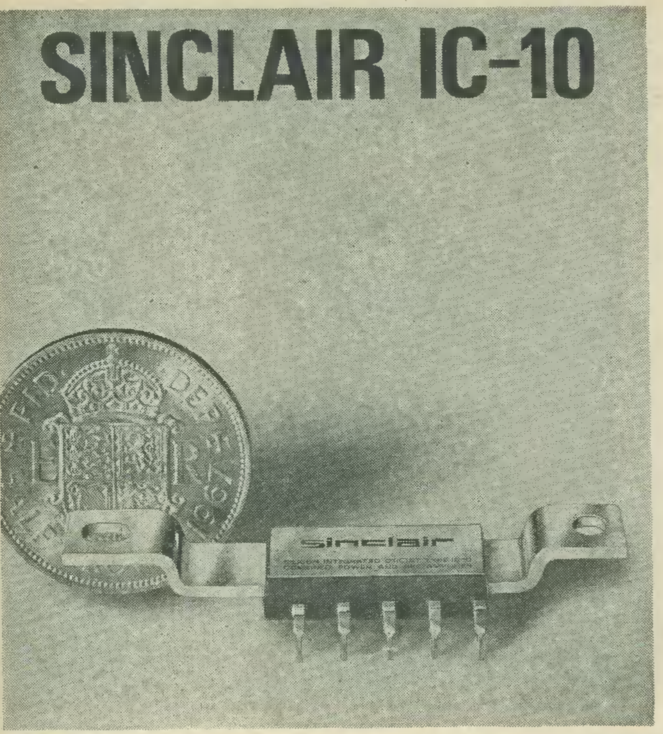

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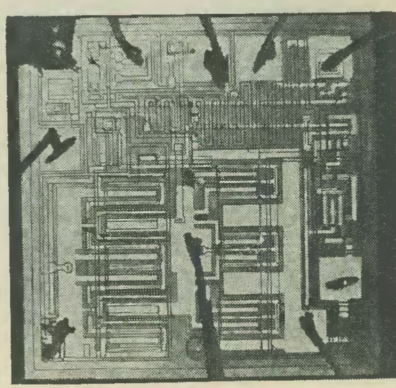

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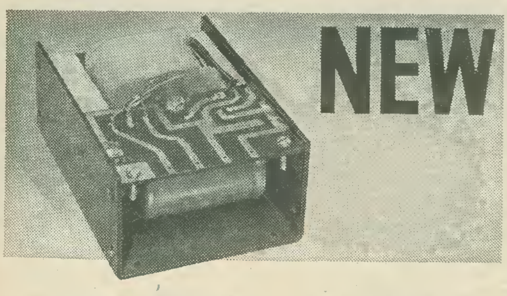

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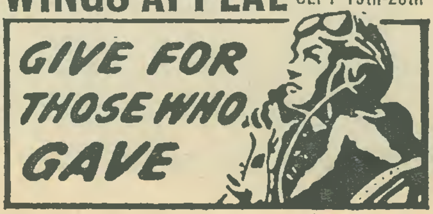

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1	1.000	21	4.583	41	6.403	61	7.810	81	9.000
2	1.414	22	4.690	42	6.480	62	7.874	82	9.055
3	1.732	23	4.796	43	6.557	63	7.937	83	9.110
4	2.000	24	4.899	44	6.633	64	8.000	84	9.165
5	2.236	25	5.000	45	6.708	65	8.062	85	9.220
6	2.449	26	5.099	46	6.782	66	8.124	86	9.274
7	2.646	27	5.196	47	6.856	67	8.185	87	9.327
8	2.828	28	5.292	48	6.928	68	8.246	88	9.381
9	3.000	29	5.385	49	7.000	69	8.307	89	9.434
10	3.162	30	5.477	50	7.071	70	8.367	90	9.487
11	3.317	31	5.568	51	7.141	71	8.426	91	9.539
12	3.464	32	5.657	52	7.211	72	8.485	92	9.592
13	3.606	33	5.745	53	7.280	73	8.544	93	9.644
14	3.742	34	5.831	54	7.348	74	8.602	94	9.695
15	3.873	35	5.916	55	7.416	75	8.660	95	9.747
16	4.000	36	6.000	56	7.483	76	8.718	96	9.798
17	4.123	37	6.083	57	7.550	77	8.775	97	9.849
18	4.243	38	6.164	58	7.616	78	8.832	98	9.899
19	4.359	39	6.245	59	7.681	79	8.888	99	9.950
20	4.472	40	6.325	60	7.746	80	8.944	100	10.000