

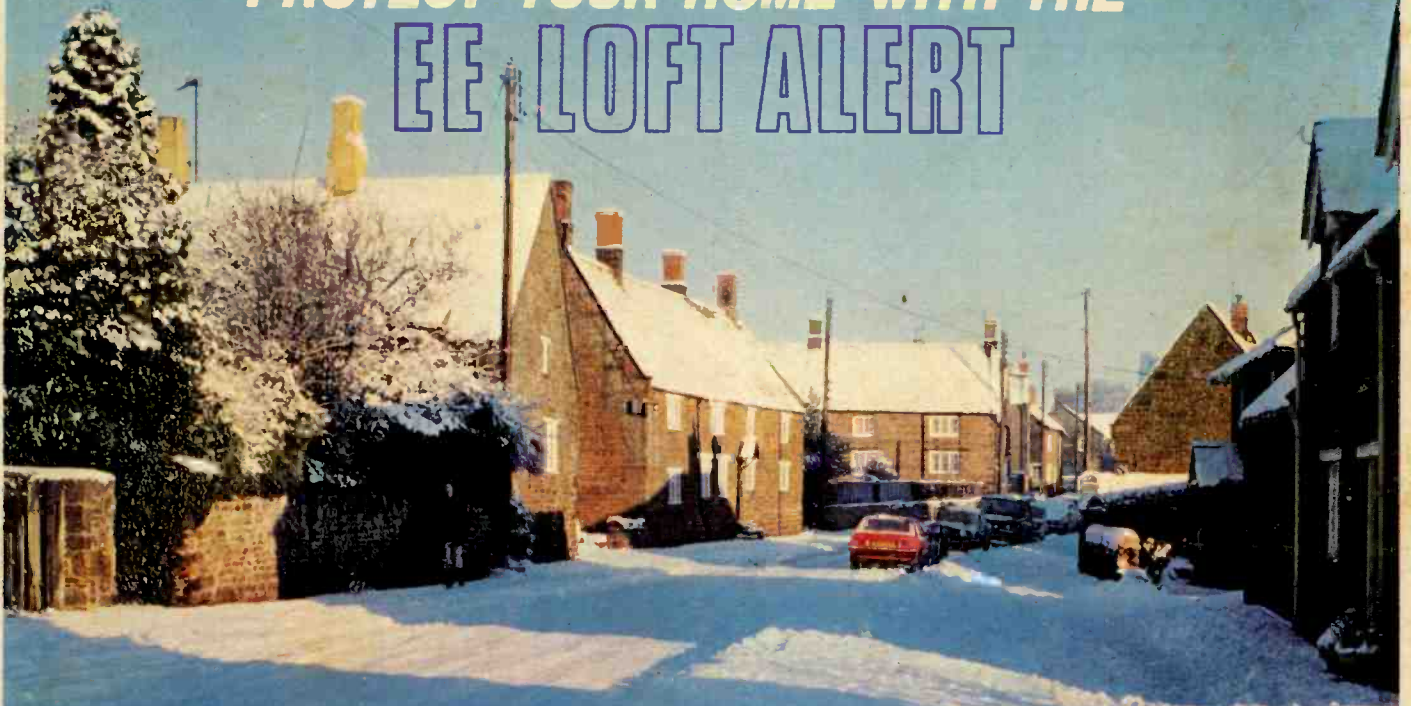
Easy to build projects for everyone

Everyday ELECTRONICS

JAN. 80
45p

FREEZE-UPS • BURSTS • FLOODS
PROTECT YOUR HOME WITH THE

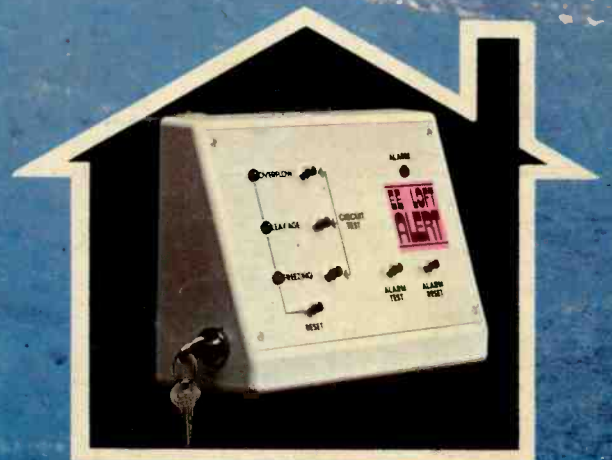
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MAINS ON/OFF TIMER

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MODEL LC18 18 watts



Lightweight, high-performance iron for all soldering from calculators to T.V. sets. Fitted with 3.2 mm bit and complete with spare bits 1.6 mm, 2.4 mm and 4.7 mm. £7.89 including P & P and V.A.T. 240 volts standard but also available 12 and 24 volts.

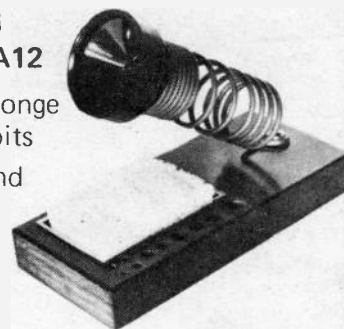
MODEL LA12 12 watts



Similar to LC18 but with extra slim shaft and bits for fine work. Fitted with 2.4 mm bit and complete with spare bits 1.2 mm and 3.2 mm £6.69 including P & P and V.A.T. 240 volts standard, also available 6, 12 and 24 volts.

No. 3 SAFETY SPRING STAND for LC18 & LA12

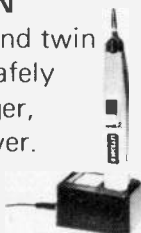
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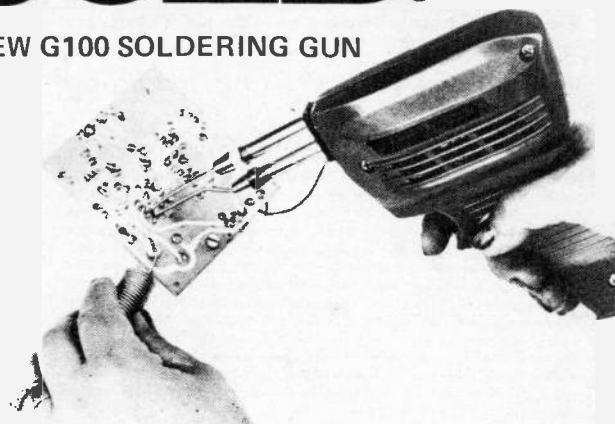


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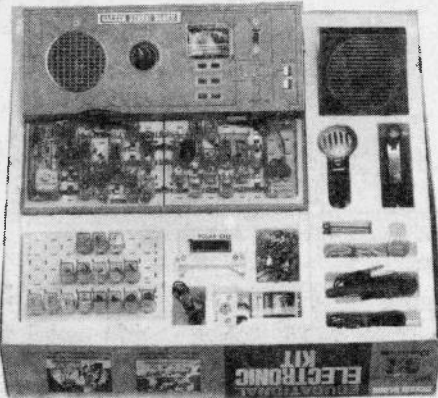
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(illustrated 16 × 14 × 3½")

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16 pin	12p	28 pin	40p	3½ × 2½	62p
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				No track cutting	55p
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		AC176	28p	2N2369A	28p	2N4401	27p	1 Amp -ve	90p
		AD149	70p	2N2926	8p	2N4401	27p	5V	70p
		AD181/2	45p	2N3053	25p	2N4401	27p	12V	70p
		BC107/8	15p	2N3055	40p	2N4401	27p	15V	70p
		BC177/8	12p	2N3442	140p	2N4401	27p	18V	70p
		BC178	18p	2N3773	300p	2N4401	27p	24V	90p
		BC182/3	19p	2N3819	25p	2N4401	27p	1 Amp -ve	90p
		AC184	11p	2N3702/2	12p	2N4401	27p	5V	90p
		BC212/3	11p	2N4123	27p	2N4401	27p	12V	90p
		BC214	12p	2N4401	27p	2N4401	27p	15V	90p
		BC548	18p	2N4519	83p	2N4401	27p	18V	90p
		BCY71/2	22p	2N5194	90p	2N4401	27p	24V	90p
		BC131/2	50p	2N5245	40p	2N4401	27p	1 Amp -ve	90p
		MPSA12	50p	2N5401	40p	2N4401	27p	5V	90p
		TIP31A	50p	2N5457/8	40p	2N4401	27p	12V	90p
		TIP32A	60p	2N5459	40p	2N4401	27p	15V	90p
		TIP33A	60p	2N6107	48p	2N4401	27p	OTHER	
		TIP34A	115p	2N6254	130p	2N4401	27p	LM317T	200p
		TIP41A	65p	2N6247	190p	2N4401	27p	LM329K	600p
		TIP42A	70p	2N6290	85p	2N4401	27p	78H05	825p
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Metac Price



£79.50

M11

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Weekly alarm - can be set
for every day at designated
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Alarm set time displayed
above time of day.
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£89.95

M10

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day, 24 hour alarm, 12
hour chronograph, 1/10th
secs. Laptime, Back light,
Stainless steel, mineral
glass.



METAC PRICE

£92.95

M19

SEIKO Calculator Watch

Full specification
calculator with
memory, plus multi
function watch.
Hours, mins, secs,
day, date, backlight.
Automatic calendar.
Long life battery.



£99.95

M27

CASIO CHRONO 95QS-3LB

Stainless steel case,
water resistant to 66 feet.
Hours, mins, secs, am/pm,
year, month, date, day.
Auto-calendar
pre-programmed
until the year 2029.
12/24 hour. Stopwatch
function.
Range 7 hours. 1/100 sec.
(Mode) Net time/lap-time/
1st-2nd place times.
Dual time function.
Accuracy 15 secs per month.
Battery life approx 4 years.

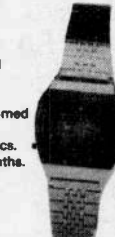


£22.95

M22

CASIO LADIES 86CL-23B-1

Elegant slim line.
Stainless steel bracelet,
fully adjustable.
Hour, mins, 10 sec symbol
second by flash, am/pm.
Month, date, day.
Auto-calendar preprogrammed
for 28th day in Feb.
Accuracy per month 15 secs.
Battery life approx 15 months.



£29.95

M23

CASIO F-200 Sports Chrono

Attractive Mens watch
in black resin with
mineral glass.
Hours, mins, secs, am/pm.
Month, date,
alpha-numeric day.
Auto-calendar set
28th Feb.
Stopwatch working
range 1 hour,
units 1/100 sec. Mode,
Net Time/lap/time/
1st-2nd place times.
Accuracy approx 15 secs
per month.
Battery-12 months.



£14.95

M24

CASIO ALARM CHRONO 81CS-36B

Hours, mins, secs, day,
and also day, month and year
perpetual automatic calendar.
100th sec chronograph to
7 hours.
Net time/lap/time/1st
and 2nd place times. User
optional 12/24 hr display, 24
Alarm. User optional,
hourly chime.
Backlight, mineral glass,
stainless steel.
Water resistant to
100ft.
Battery life approx 4 years.



£34.95

M25

BELTIME Chronograph

(9-Functions)
Hours, mins, secs,
day, date, month.
Interchange feature,
automatic calendar,
backlight, Net
time/lap/time.
Stainless steel bracelet.
Battery life 1 year.



£14.95

M34

BELTIME Multi Alarm

29 Functions
Hours, mins, secs,
date, day.
Alarm, chronograph.
Light.
Watch 8 functions,
Alarm 4 functions,
chronograph 17
functions.
Stainless steel
bracelet.



£29.95

M35

CASIO F-8C 3 Year Battery life.

Hours, mins, secs,
am/pm, date, day.
Auto calendar set
28th Feb.
Stopwatch function.
Accuracy 15 secs per
month. Battery life
approx 3 years.



£9.95

M36

CASIO CALENDAR 200

47CS-23B-1 Black. Stainless steel.

Hours, mins, 10 second
symbol, second (by flash),
am/pm. Month, day, date.
Auto-calendar set from
1901 to 2009.
Full month calendar display,
Dual time function.
Accuracy 10 secs per
month. Battery life
approx 15 months.



£59.95 M37

MELODY Multi Alarm Chronograph

Hours, mins, secs,
Day, Date, Count-
down alarm,
Dual time zone,
1/100th sec
stopwatch.
Lap/split time,
1st and 2nd place
times, Melody test
function.



£26.95

M30

DUAL TIME-ALARM CHRONOGRAPH

Incorporating module
of world famous
Japanese watch
manufacture.
Hours, mins, secs,
days of week, month,
day and date,
24 hour alarm,
12 hour chronograph,
1/10th secs,
lap time, Back light,
stainless steel case
and bracelet,
Mineral glass,
Battery hatch,
long life battery.



£35.00

M12

PICOQUARTZ Microprocessor Alarm Chronograph

Multilanguage-day of
the week can be set
to English, French,
German, Italian or
Spanish.
Chime - every full
hour combined with a
response signal,
beeping at every
pressing of the
functions.
Can be switched off.
12-24 hour format.
Backlight.
Chrono - 1, full scale
chrono with lap,
counting hours upto
24 hrs. Mins, secs,
1/100th secs.
Two Alarm systems.
Two time zones.



£37.95

M32

SEIKO CHRONOGRAPH

Hours, mins, secs
and day of the week.
Month date and
day of the week.
Stopwatch display -
Hours, mins, secs
up to 12 hours
(mins, secs, 1/100 secs
up to 20 minutes).
Lap timing,
Continuous time
measurement of two
competitors.
Stainless steel,
mineral glass.



£56.00

M33

Metac

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QUARTZ LCD 5 Function

Hours, mins, secs., month, date, auto calender, back-light, quality metal bracelet.

£6.65

Guaranteed same day despatch.
Very slim, only 6mm thick.



M1

SOLAR QUARTZ LCD 5 Function

Genuine solar panel with battery back-up. Hours, mins., secs., day, date. Fully adjustable bracelet. Back-light. Only 7mm thick.

£8.65

Guaranteed same day despatch.



M2

QUARTZ LCD 11 Function SLIM CHRONO

6 digit, 11 functions. Hours, mins., secs., day, date, day of week. 1/100th, 1/10th, secs., 10X secs., mins. Split and lap modes. Back-light, auto calendar. Only 8mm thick. Stainless steel bracelet and back. Adjustable bracelet. Metac Price

£10.65 Thousands sold!
Guaranteed same day despatch.



M3

QUARTZ LCD ALARM 7 Function

Hours, mins., secs., month, date, day. 6 digits, 3 flags plus continuous display of day and date or seconds. Back-light Only 9mm thick.

£12.65

Guaranteed same day despatch.



M4

MULTI ALARM 6 Digits 10 Functions

- Hours, mins., secs.
- Months, date, day.
- Basic alarm.
- Memory date alarm.
- Timer alarm with dual.
- Time and 10 country zone.
- Back-light.
- 8mm thick.

£18.65

M5



FRONT-BUTTON Alarm Chrono Dual Time

6 digits, 5 flags. 22 functions. Constant display of hours and mins., plus optional seconds or date display. AM/PM indication, month, date. Continuous display of day. Stop-watch to 12 hours 59.9 secs., in 1/10 second steps. Split and lap timing modes. Dual time zones. Only 8mm thick. Back-light. Fully adjustable open bracelet.

£22.65

M6



SOLAR QUARTZ LCD Chronograph with Alarm Dual Time Zone Facility

6 digits, 5 flags. 22 functions. Solar panel with battery back-up. 6 basic functions. Stop-watch to 12 hours 59.9 secs., in 1/10 sec., steps. Split and lap timing modes. Dual time zones. Alarm. 9mm thick. Back-light. Fully adjustable bracelet.

£27.95

M7



ALARM CHRONO with 9 world time zones

- 6 digits, 5 flags.
- 6 basic functions.
- 8 further time zones.
- Count-down alarm.
- Stop-watch to 12 hours 59.9 secs. in 1/10 sec. steps.
- Split and timing modes.
- Alarm.
- 9 mm thick.
- Back-light.
- Fully adjustable bracelet.

£29.65

M8



SOLAR QUARTZ LCD Chronograph

Powered from solar panel with battery back-up. 6 digit, 11 functions. Hours, mins., secs., day, date, day of week. 1/100th, 1/10th, secs., 10X secs., mins. Split and lap modes. Back-light, auto calendar. Only 8mm thick. Stainless steel bracelet and back. Adjustable bracelet. Metac Price

£13.65

Guaranteed same day despatch.

M9



QUARTZ LCD Ladies Day Watch

Only 25 x 20mm and 6mm thick. Hours, minutes, seconds, day, date, backlight and auto calendar. Elegant metal bracelet in silver or gold fully adjustable to suit very slim wrists. State colour preference.

£9.95

Guaranteed same day despatch.

M15



QUARTZ LCD Ladies Fashion Watch

Elegant bracelet in bronze/gold finish or silver colour. Hours, mins, secs, day, date, backlight and auto calendar. Adjustable for the slimmest of wrists. State colour preference.

£14.95

Guaranteed same day despatch

M17



QUARTZ LCD Ladies Cocktail Watch

Highly functional watch which also suits those special occasions. Beautifully designed with a very thin bracelet which retains strength as well as elegance. Hours, mins, secs, day, date, backlight and auto calendar. Bracelet fully adjustable to suit slim wrists. State gold or silver finish.

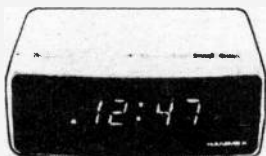
£19.95

Guaranteed same day despatch

M18



HANIMEX Electronic LED Alarm Clock



Features and Specification
Hour minute display Large LED display with p.m. and alarm on indicator 24 Hours alarm with on/off control. Display flashing for power loss indication. Repeatable 9-minute snooze. Display bright/dim modes control. Size 5.15" x 3.93" x 2.36" (131mm x 11mm x 60mm)
Weight 1.43 lbs (0.65 kg). AC power 220V.

£10.20 Thousands sold!

Mains operated.

Guaranteed same day despatch.

M13

EXECUTIVE ALARM WATCH

6 Functions plus Alarm: Conference signal. 5 minute snooze alarm. Conference signal sounds 4 secs., before main alarm to give advance warning and an option to cancel. Snooze sounds 5 mins. after main alarm and is always preceded by the conference signal.

£14.95

M60



MACY QUARTZ ANALOGUE

Automatic Calendar Day and Date infinite bracelet. This mans watch has elegance as well as the robust appearance provided by a watch with traditional features. Accuracy is provided by a quartz crystal powered by a long life miniature battery.

£24.95

M21



Metac price breakthrough for an Alarm Chronograph with Dual Time only

£18.95

OUTSTANDING FEATURES

- DUAL TIME. Local time always visible and you can set and recall any other time zone (such as GMT). Also has a light for night viewing.
- CALENDAR FUNCTIONS include the date and day in each time zone.
- CHRONOGRAPH/STOPWATCH displays up to 12 hours, 59 minutes, and 59.9 seconds.
- On command, stopwatch display freezes to show intermediate (split/lap) -time while stopwatch continues to run. Can also switch to and from timekeeping and stopwatch modes without affecting either's operation.
- ALARM can be set to anytime within a 24 hour period. At the designated time, a pleasant, but effective buzzer sounds to remind or awaken you!

Guaranteed same day despatch. **M16**



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8 ohm. 2 1/2in. £1.50. 3in. £1.50. 5in. £1.50. 10in. £3.12in. £4.
16 ohm. 6 x 4in. £1.50. 7 x 4in. £1.50. 5in. £1.50. 8in. £2.60. 10in. £3.12in. £4. 10 x 6in. £3.50.

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500mF 12V 15p; 25V 20p; 50V 30p;
100mF 12V 17p; 25V 35p; 50V 47p; 100V 70p; 1200mF/76V 80p.
2000mF 6V 25p; 25V 42p; 420mF/500V £1.30.
2500mF 50V 62p; 3000mF 25V 47p; 50V 65p.
3300 63V £1.20. 4700mF 63V £1.20. 2700mF/76V £1.
5000mF 6V 25p; 12V 42p; 35V 85p. 5600mF/76V £1.75.

HIGH VOLTAGE ELECTROLYTICS

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32/500V 75p 16+16/450V 50p 100+100/275V 65p
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MANY OTHER ELECTROLYTICS IN STOCK

SHORT WAVE 1000p air spaced gangable tuner. 95p.
TRIMMERS 100pF, 500pF, 5p, 100pF, 150pF, 15p.
CERAMIC 1pF to 0.01mF. 5p. Silver Mica 2 to 5000pF. 5p.
PAPER 350V-0.1 7p; 0.5 13p; 1mF 150V 20p; 2mF 150V 20p; 500V-0.001 to 0.05 12p; 0.1 15p; 0.25 25p; 0.47 35p.
MICRO SWITCH SINGLE POLE CHANGEOVER 20p.
SUB-MIN MICRO SWITCH, 25p. Single pole change over.
TWIN GANG, 385 + 385pF 80p; 500pF slow motion 75p.
365 + 365 + 25 + 25pF. Slow motion drive 85p.
120pF TWIN GANG, 50p; 365pF TWIN GANG, 75p.
TWIN GANG 25pF slow motion 95p.
NEON PANEL INDICATORS 25V. Amber or red 30p.
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Ditto 5%. Preferred values 10 ohms to 10 meg. 5p.
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Superior quality ideal for Halls/PA systems. Disco's and Groups. Two inputs with Mixer Volume Controls. Master Bass, Treble and Gain Controls. 50 watts RMS. Three loudspeaker outlets 4, 8, 16 ohm. AC 240V (120V available). Blue wording on black cabinet.

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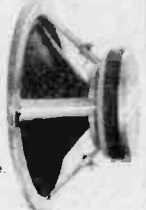
Complete kit of parts with R.C.S. printed circuit. Three channels. Up to 1,000 watts each. Will operate from 200mV to 100 watts signal source. Suitable for home Hi-Fi and all Disco Amplifiers. Cabinet extra £4.50. £18

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BAKER SPEAKERS "BIG SOUND"



Robustly constructed to stand up to long periods of electronic power. Useful response 30-16,000 cps. Bass resonance 55 cps.

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12in. 45 watt 4, 8 or 16 ohms.

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With tweeter. And crossover. 10W. State 3 or 8 ohm. £9.95

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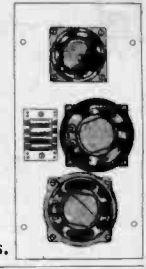
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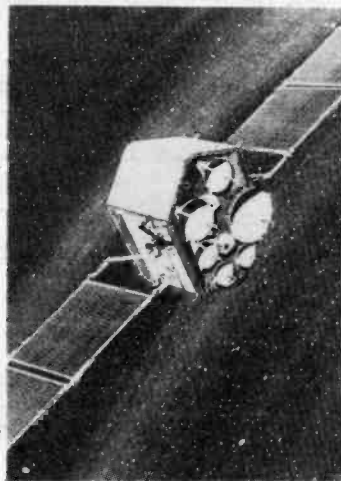
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Projects... Theory...

and Popular Features ...

No doubt some rueful remembrances of last winter will be awakened by this month's cover picture. Hopefully we shall not suffer the same severe and treacherous conditions in the opening months of '80. But there's no knowing, so it will be prudent to emulate the Boy Scouts and be prepared. Which leads us to the *Loft Alert*.

Apart from fire, flooding is probably the most frightening and damaging catastrophe that can happen to our homes. Extensive flooding can occur because quite small defects such as bursts in pipes or frozen ball cocks are undetected in sufficient time to take remedial action.

To be forewarned is to be forearmed. Hence the importance of our *Loft Alert*. The wise householder will build and instal this monitoring system without delay. Then regardless of the severity of the winter, the occupants can at least be relieved of anxiety concerning the state of things up a'loft.

As will be immediately apparent, the usefulness of this device is by no means limited to the winter months. Any time of the year defects or malfunctioning of parts in the water system can occur, which could lead to a disastrous situation.

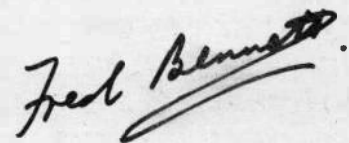
A further reassuring feature provided by our *Loft Alert* is an instant "system check" facility. And being

battery operated it is entirely independent of the mains supply.

As from next month the price of EVERYDAY ELECTRONICS will be increased to 50p. Considering that you could pay this sum for a mere Christmas or birthday card, there can be no question that EE is value for money. Nevertheless we realise any increase could be a serious blow to the younger reader. If so, we suggest an approach to Dad for a subsidy. It should not be difficult to convince him that his investment will be returned with interest in the form of useful projects for the home in the course of the coming year.

As we leave '79 and enter '80, all of us on EVERYDAY ELECTRONICS thank our readers for your support and encouragement as often expressed in your letters to us.

Best wishes for the New Year.



Our February Issue will be published on Friday, January 18. See page 27 for details.

Readers' Enquiries

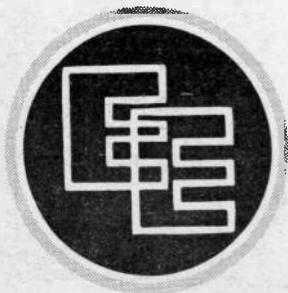
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Component Supplies

Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

All reasonable precautions are taken to ensure that the advice and data given to readers are reliable. We cannot however guarantee it, and we cannot accept legal responsibility for it. Prices quoted are those current as we go to press.



Everyday ELECTRONICS

VOL. 9 NO. 1

JANUARY 1980

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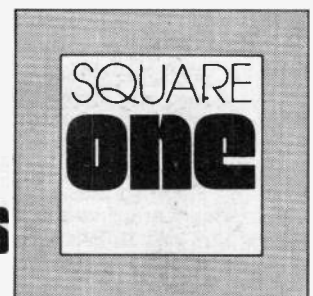
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**OUR
REGULAR
FEATURE
FOR
BEGINNERS**

Is on page 61



FREEZE-UPS • FLOODS • BURSTS



AVOID THESE HAZARDS WITH OUR EE LOFT ALERT

By S. E. Dollin, B.Sc.

THE Loft Alert is an electronic warning system designed to warn the householder of an overflowing water tank, burst or leaking water pipes, and also the approach of freezing conditions. It consists of three sensing circuits which, when activated, give a visible and audible warning and shows which channel has been activated so that remedial action may be taken quickly before great damage is done.

An important feature of this unit is the fact that it is battery operated making it immune from the mains power failures that are possible during the winter months when this sys-

tem will be most needed. This also makes installation very much easier and safer. Provision is made for an extension warning device or lamp which can be mains or battery operated.

PRINCIPLE OF OPERATION

The system can be broken up into several distinct stages. When a fault, say a burst pipe, is detected, this produces a voltage which is fed to the appropriate latching circuit. This has the effect of lighting an l.e.d. and applying a "high" input to the or gate which results in its output going

high. This arrangement is necessary to prevent sensor circuits interacting and interfering with each other.

The output of the or gate is fed via a voltage clamp circuit to the alarm circuit.

This voltage clamp (TR1) is designed to keep the output from the or gate firmly at 0V when in the off condition. This is necessary as pin 4 of the following astable multivibrator must be kept at 0V to prevent it turning on when no alarm signal is present, since the output from the or gate is a little above 0V in its low state.

When the astable is running (pin 4 high) the associated l.e.d. flashes until the alarm condition is removed and the latch reset.

The alarm signal (stepping clamp voltage) is also processed to produce a trigger pulse for the monostable which energises a relay. The relay contacts supply power to an audible warning device for a length of time. This alarm is muted when the monostable times out.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Loft Alert is shown in Fig. 1. The sensors for water overflow and leakage are identical in principle. Water bridges two contacts and causes a signal voltage to be applied via resistors R1 (R9) to the gate of thyristors CSR1 (CSR3). When this happens the thyristor conducts and the cathode rises to a little below battery voltage thus illuminating D1 (D5).

The operation of the freezing detector is slightly different but the effect is to produce a voltage at the thyristor gate when the temperature drops to, or approaches freezing.

The resistor R2, potentiometer VR1 and thermistor RTH1 form a potential divider chain. At room temperature the thermistor has a low resistance of about 1 kilohm. This means that the voltage on the gate of CSR2 is near to zero. However as the temperature falls the resistance of thermistor RTH1 rises causing the voltage across it to rise. At a certain thermistor resistance the voltage across the thermistor is sufficient to turn on the thyristor thus causing the voltage on the cathode to rise to just below battery voltage which lights up D2.

The thyristor cathodes are all wired into a discrete 3 input or gate made up of D3, D4, D6 and R5, R6, R8, R10.

ALARM CIRCUITS

The output of the or gate is fed via R8 to the base of TR1. This stage is the voltage clamp and is simply a transistor switch. The emitter is at 0V until a high from the or gate

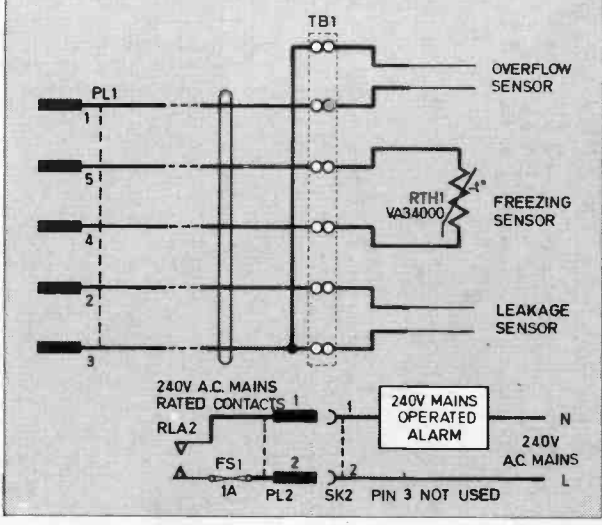
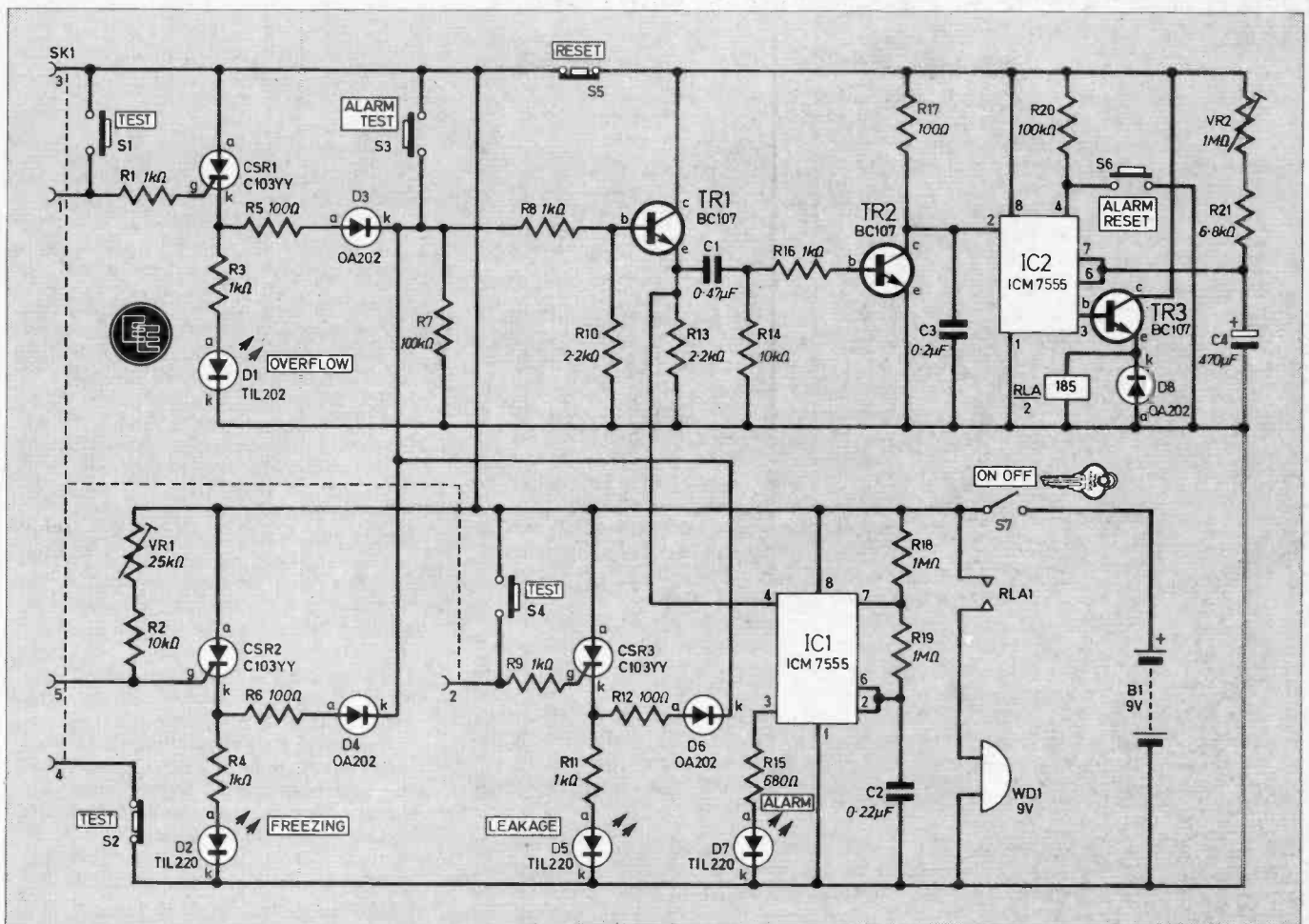


Fig. 1. Complete circuit diagram of the Loft Alert.

appears on the base whereupon the transistor switches on and the emitter voltage rises to just below the positive rail voltage.

At this point the signal takes two paths. The first is to the reset pin of IC1 (pin 4) wired as an astable multi-vibrator. Pin 4 is used here as an inhibit input.

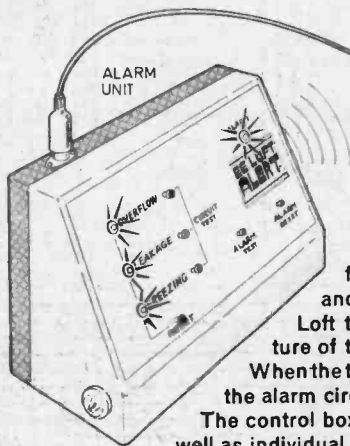
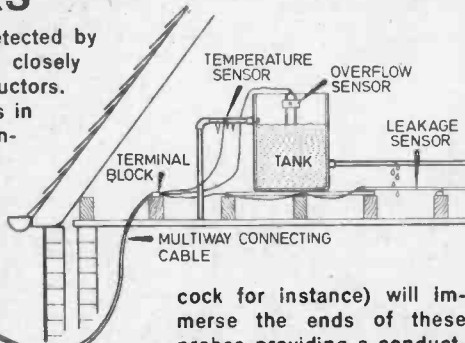


Front view of the EE Loft Alert showing front panel layout and lettering.

HOW IT WORKS

The presence of water is detected by simple probes made up of a closely spaced pair of uninsulated conductors.

To sense overflow conditions in the main tank a pair of fixed conductors is hung over the side such that their ends are just above the normal water level. Any abnormal rise in this level (caused by a faulty ball



cock for instance) will immerse the ends of these probes providing a conducting path between them. This will enable an electrical signal to be passed to the electronic circuitry thus actuating the alarm systems.

To sense burst pipes or other leakage in the plumbing, a sensor consisting of two closely spaced wires is run directly beneath the pipe work. Dripping water falls on these wires completing the circuit and setting off the alarm.

Loft temperature, or more precisely the temperature of the water pipe, is monitored by a thermistor. When the temperature falls to near 0 degrees Centigrade the alarm circuit is triggered.

The control box features both visible and audible alarms as well as individual monitoring of all circuits. This unit is installed in some convenient position in the house such as on the landing.

CONSTRUCTION

starts here

CIRCUIT BOARD

Construction should start with the circuit board. This consists of a piece of 0.1 inch matrix stripboard size 50 holes by 36 strips. It is advisable to make the breaks in the copper strips and drill the mounting holes before mounting components. Assembly is quite straightforward, although it is advisable to start with the resistors, then larger passive components and finally the transistors (see Fig. 2).

The i.c.s are mounted in sockets and the relay is mounted straight on to the board. It should be secured by glueing or by tightly wrapping a loop of insulated wire around the body and securing under the board well away from any copper strips used for electrical connections.

Veropins have been placed in locations on the board where connections to panel-mounted components are made. This makes interwiring and testing very much easier.

CASE

The prototype unit is housed in a Verobox type 202-21032D.

As soon as the voltage on this pin rises above about 0.4V the i.c. turns on and stays on so long as the "high" voltage to pin 4 is maintained. This causes the l.e.d. attached to pin 3 to flash on and off until the alarm is reset.

The other signal path is to IC2, another 555 i.c., this time wired as a monostable. This activates the relay coil for a certain time period after which the coil is deactivated. The in-built audible alarm (and extension alarm) is on for this time period (t) which is governed by the formula:

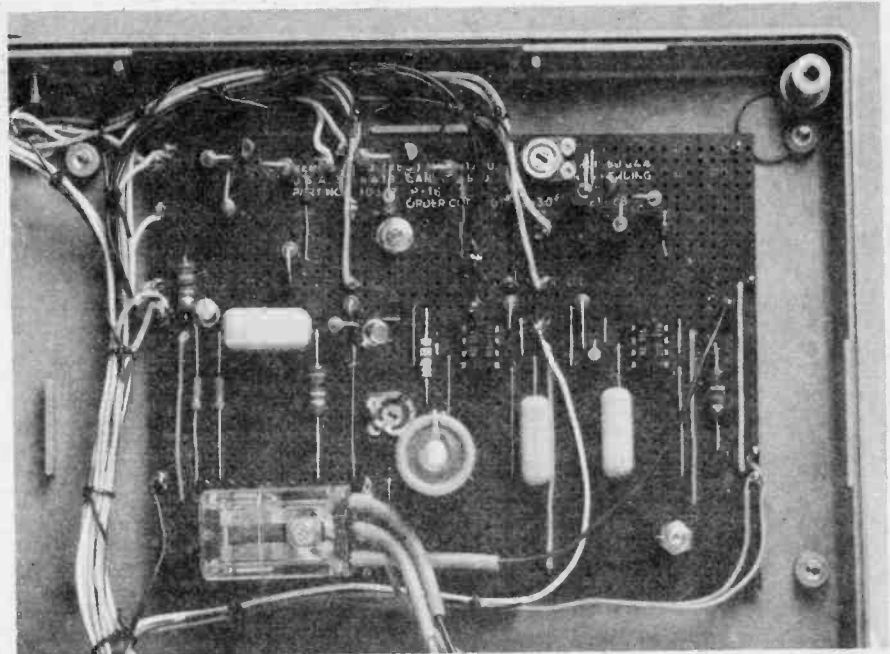
$$t = 1.1 \times (VR2 + R1) \times C4 \text{ seconds}$$

where the resistance is in ohms and capacitance in farads. The maximum time period obtainable is about 8 minutes which can be altered by VR2.

To trigger this arrangement pin 2 needs to be grounded momentarily. When the alarm is triggered TR1 emitter goes to and remains at a level of about 8V. This voltage step is applied to the RC network R14 and C1 which produces a positive-going voltage spike at the base of TR2. The transistor momentarily switches on and its collector drops to 0V. This negative-going voltage spike is applied to pin 2 of IC2 causing it to trigger and energise the relay via buffer amplifier TR3 for time t .

Circuit test switches S1, S2 and S4 simulate an alarm condition by causing a voltage to be applied to the thyristor gates. The alarm test switch

S3 when operated applies a voltage to R8 thus simulating alarm conditions. Switch S6 grounds pin 4 of IC2 thus resetting it and S5 breaks the supply to reset the thyristors.



The completed circuit board mounted in position on the inside back panel of the case.

LOFT ALERT

COMPONENTS

Resistors

R1	1k Ω
R2	10k Ω
R3	1k Ω
R4	1k Ω
R5	100 Ω
R6	100 Ω
R7	100k Ω
R8	1k Ω
R9	1k Ω
R10	2.2k Ω
R11	1k Ω
R12	100 Ω
R13	2.2k Ω
R14	10k Ω
R15	680 Ω
R16	1k Ω
R17	100 Ω
R18	1M Ω
R19	1M Ω
R20	100k Ω
R21	6.8k Ω
All $\frac{1}{4}$ W carbon \pm 5%	

Potentiometers

VR1	25k Ω horizontal miniature preset
VR2	1M Ω horizontal miniature preset

Capacitors

C1	0.47 μ F ceramic or plastic
C2	0.22 μ F ceramic or plastic
C3	0.2 μ F ceramic or plastic
C4	470 μ F 25V elect.

Semiconductors

IC1,2	555 CMOS timer i.c. (2 off)
TR1,2,3	BC107 npn silicon (3 off)
CSR1,2,3	C103YY or MCR102 thyristor (3 off)
D1,2,5,7	TIL220 l.e.d. or similar (two red, one yellow, one green)
D3,4,6,8	OA202 or similar small signal silicon diode (4 off)

Miscellaneous

S1,3,4,6	miniature push-to-make single pole switch (4 off)
S2,5	miniature push-to-break single pole switch (2 off)
S7	single-pole key operated on/off switch
SK1	5-pin DIN socket
SK2	miniature mains cable socket
PL1	3-pin miniature mains chassis plug
PL2	5-pin DIN plug
RLA	miniature 12V relay, 185 ohm coil resistance with two sets mains rated normally open contacts
WD1	miniature 9V audible warning device
RTH1	GM102 or VA3400 glass bead type thermistor
TB1	6 way screw terminal block
B1	9V type PP9

Stripboard: 0.1 inch matrix 36 strips \times 50 holes; 5-way multi-core cable (or ribbon cable); connecting wire; twin-core 3A mains cable (for extension alarm); case (Verobox 202-21032D or similar); Battery connector clips; hardboard, panel pins, tinned copper wire, 2 pin plug and cable (for sensors).

See
**Shop
Talk**
page 19

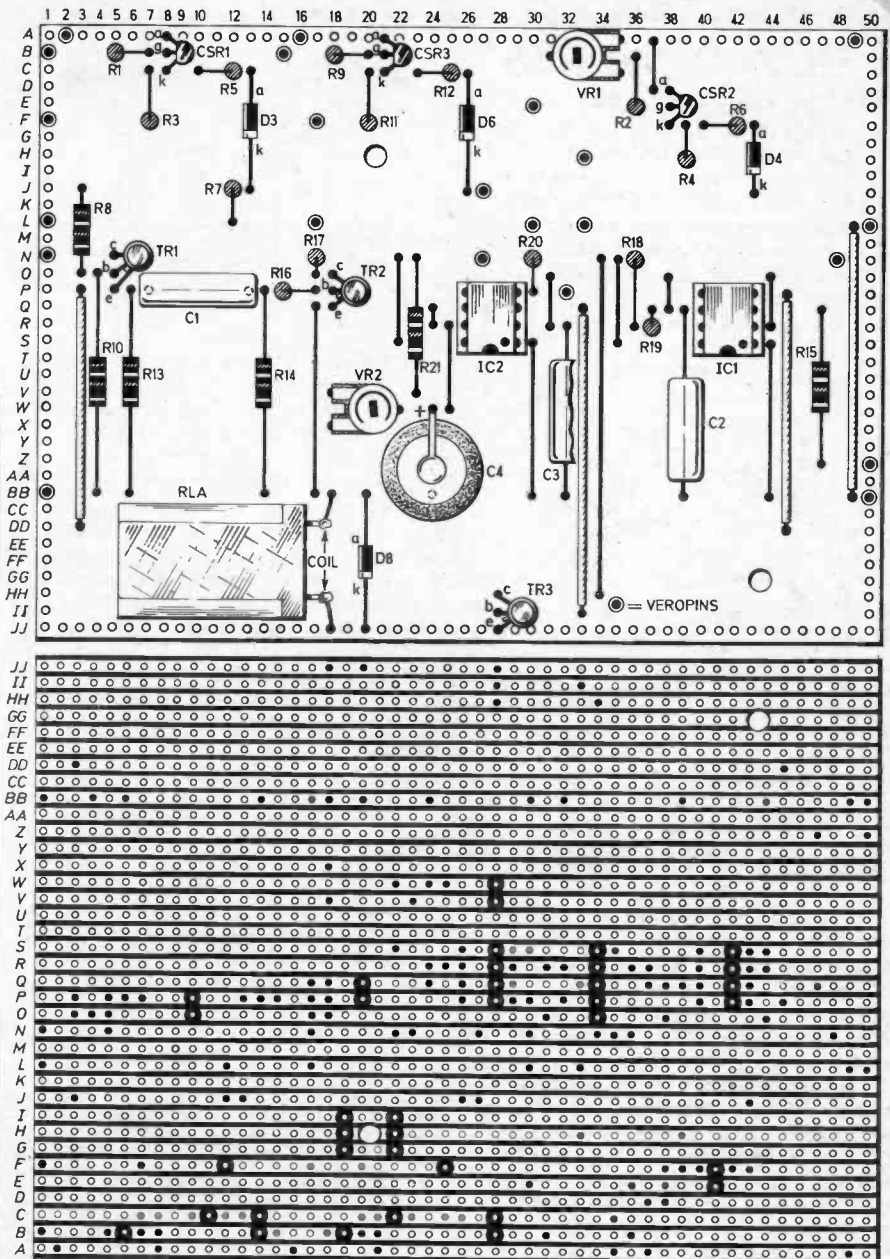


Fig. 2. Stripboard layout. Note that connections to off-board components are made via Veropins situated at appropriate locations on the stripboard. For wiring details of the relay see Fig. 3.

COMPONENTS
approximate
cost **£20**
excluding case and
sensors

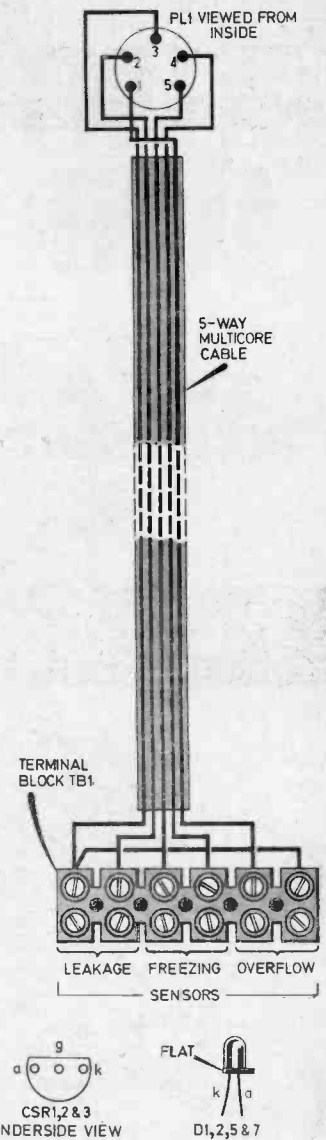
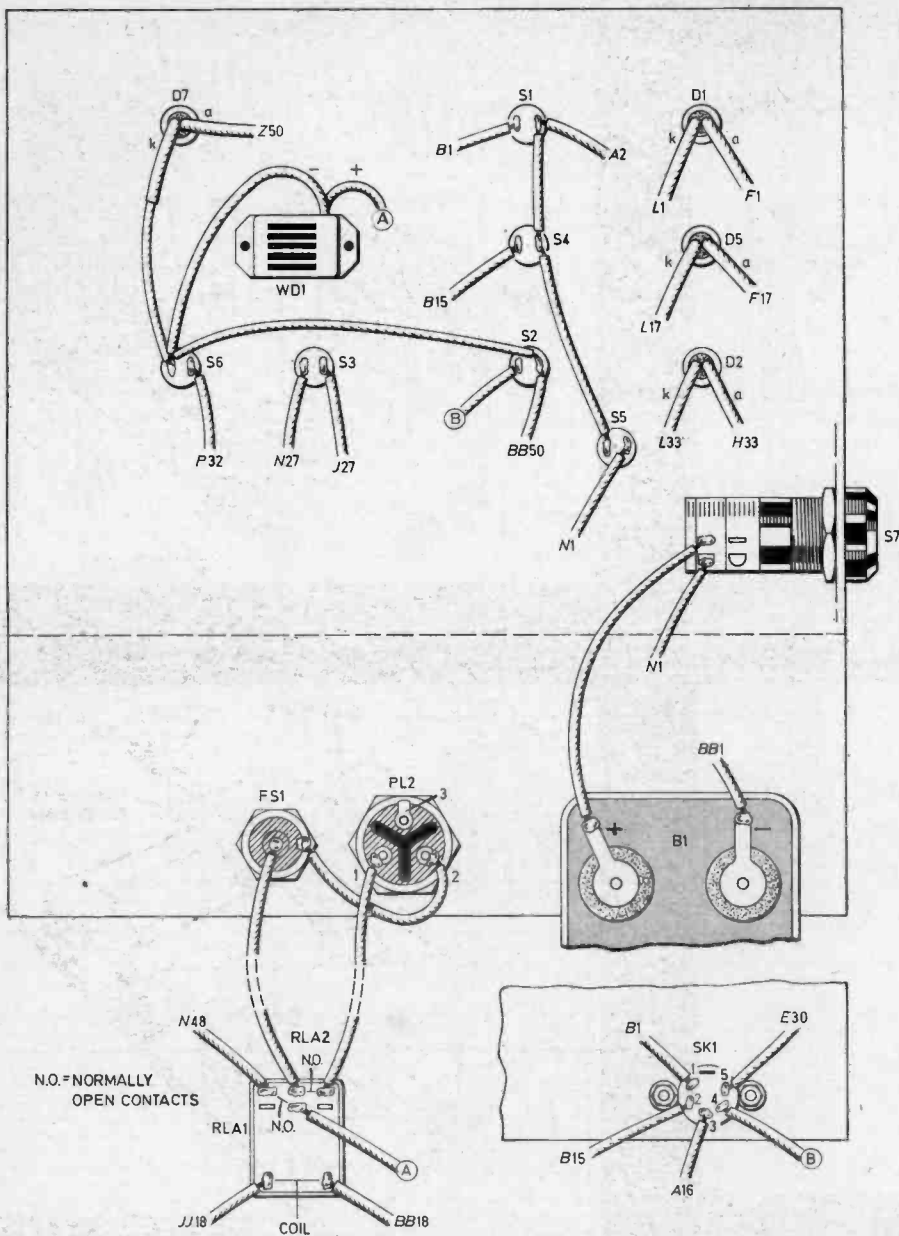
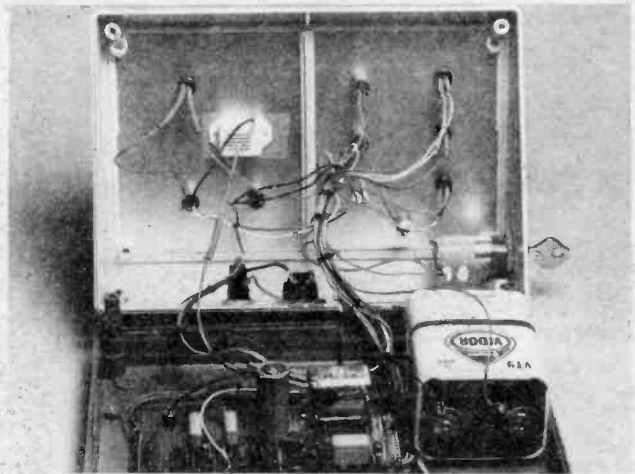
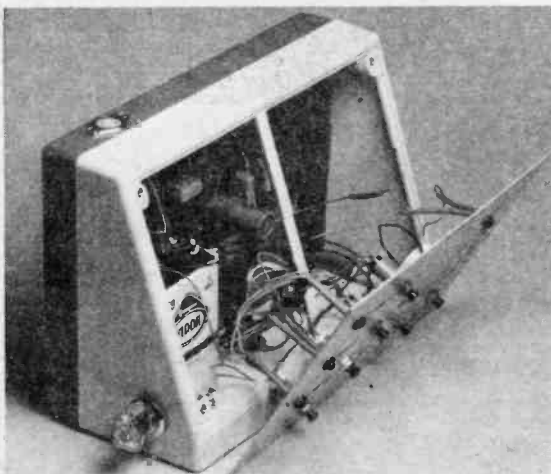


Fig. 3. Internal layout. Note that all letter/number combinations refer to Veropin locations on the main circuit board and single letters to other locations. SK1 is mounted on the top of the case and FS1 and PL2 on the bottom.

Fig. 4. Wiring of the interlinking cable from the unit to the sensors and its connectors.



EE LOFT ALERT

SENSOR CONSTRUCTION & INSTALLATION

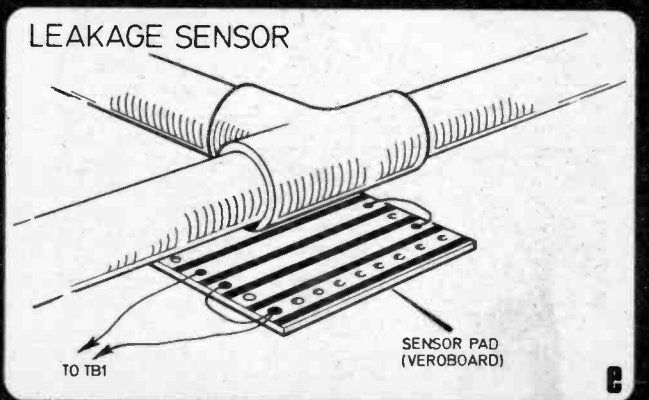
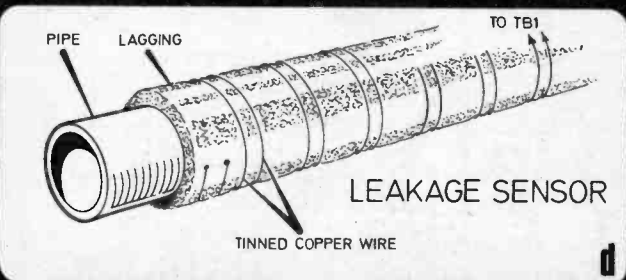
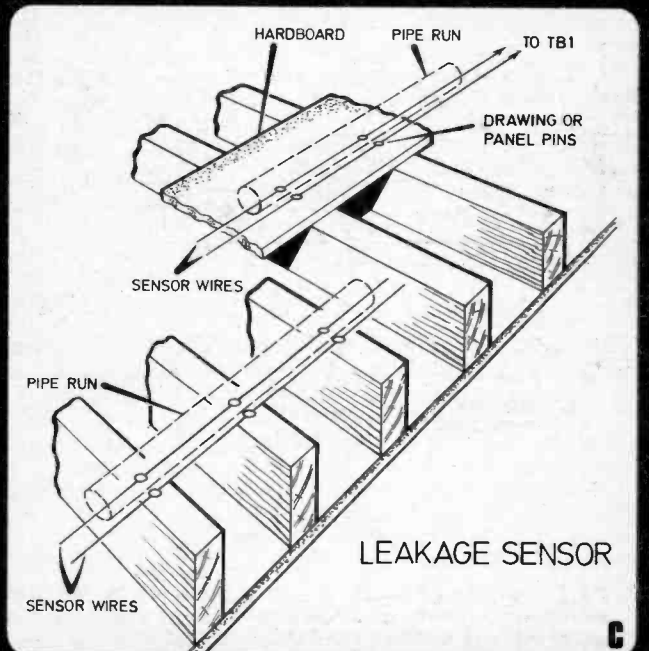
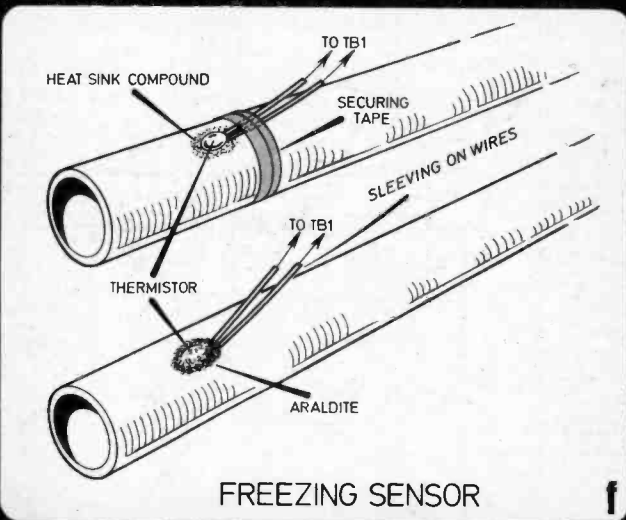
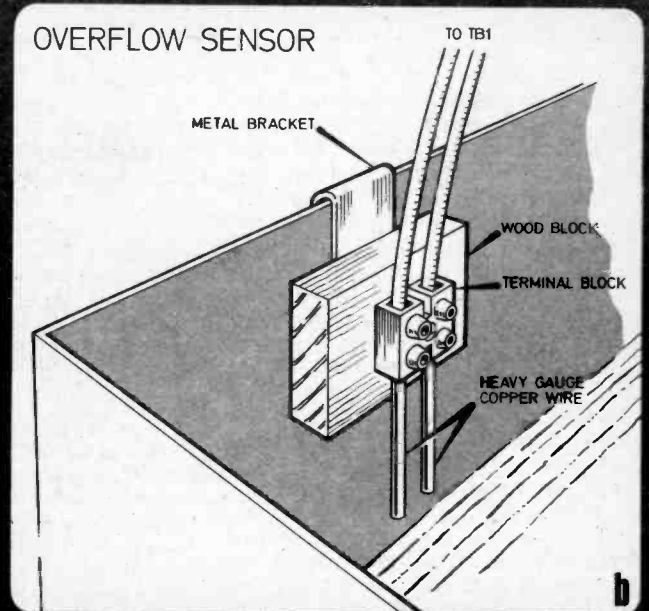
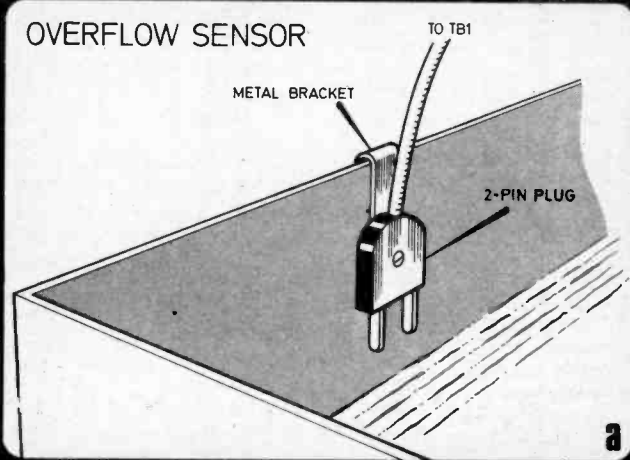


Fig. 6. Some suggested ideas for the sensors. Remember that if there is more than one sensor for any one circuit then these must be wired in parallel. For those whose pipes run along the top of the joists, leakage detection can be made easier by fastening the detector wires to short lengths of hardboard which are placed between the joists and under the pipe in question.

Assembly can begin by mounting the mains chassis plug PL2, fuse holder FS1 and 5-pin DIN socket SK1 in the case. Next the completed circuit board is bolted to the back of the case using 6BA countersunk bolts and nuts. The front panel is next marked out and drilled to accommodate the panel-mounted components.

Finally the internal wiring is completed as shown in Fig. 3. Although this layout is by no means critical, care should be taken to make sure front panel components do not foul internal parts if another layout or case are used.

A 5-pin DIN socket is used as the termination for the sensor inputs and the spare set of relay contacts are wired via a 1A fuse to a miniature mains chassis plug PL1 to act as an on/off switch for the extension alarm. Great care must be taken with this especially if it is likely to be used for switching mains voltage.

It is possible to connect any sort of mains device to this plug, for example a lamp, bell or buzzer, up to a maximum power rating of 250 watts for the relay specified.

The battery simply sits in the space next to the circuit board and a simple clamp is fitted to hold it in position.

Finally to secure the device against accidental switch-off, a key switch is used as the master on/off switch. This is not vital and can readily be replaced by any other on/off switch to reduce the overall cost of the system.

THE SENSORS

The sensor input to the unit is via a 5 pin DIN plug, hence it is necessary to run a length of 5-way cable from the unit to the loft. This is then connected to a 6-way screw terminal block as shown in Fig. 4.

Basically there are three types of sensor—one for overflow, one for leakage and one to detect freezing conditions. Various ideas for the sensor are shown in Fig. 5.

The overflow sensor is very simple, and consists of two electrodes mounted in the cold water tanks above the usual water level. See Fig. 5(a) and (b). A convenient ready-made sensor is available in the form of a 2-pin razor plug. This is robust with pins far enough apart so that when the level subsides there isn't any moisture left behind bridging the gap.

The other method uses a 2-way screw terminal block with short wires forming the probe. Care should also be taken to site this sensor far enough above the water level so that it isn't accidentally triggered by rushing water as the tank fills.

LEAKAGE DETECTOR

The leakage detector in practise is a little more complicated. One method

is to have twin runs of tinned copper wire about 2mm apart beneath all pipes at risk fitted to the joists vertically beneath the pipe run.

Alternatively the wire can be fastened onto hardboard in a straight line using panel pins. This assembly can then be laid underneath the pipe-work, perhaps on a slight slant so any dripping water will run down on to the wires and set off the alarm.

If the pipes are lagged then two parallel lengths of tinned copper wire could be wrapped around the length of the lagging. See Fig. 5 (c) and (d) for details.

If complete pipe-run monitoring is not considered essential a number of small sensors consisting of stripboard with alternate strips bridged and placed under particularly risky spots could be tried. All of these sensors would of course be wired in parallel. This is shown in Fig. 6 (e).

FREEZING SENSOR

The freezing detector is straightforward as it consists simply of a miniature bead thermistor. This is attached to either the tank ballcock or pipe most susceptible to freezing. For a permanent arrangement, the thermistor can be glued to the pipe using Araldite. Alternatively the thermistor can be coated in a heatsink compound and taped to the pipe, see Fig. 5 (f).

Readers will no doubt be able to adapt these ideas to their own circumstances or even invent better ideas of their own. In any event if more than one sensor is used for a particular channel, they should all be wired in parallel.

All the sensors are terminated in the loft at a 6-way screw terminal block TB1 to which the 5-way cable to the unit is attached.

SETTING UP

Once the unit has been assembled its function can be tested using the built-in test buttons. When any of the CIRCUIT TEST buttons is pressed the relay coil should be activated causing WD1 to sound, diode D7 should flash and the l.e.d. associated with the particular circuit should light up. Pressing ALARM RESET will mute WD1 and pressing RESET will reset the whole device.

Similarly the alarm devices alone can be tested by pressing ALARM TEST and reset by pressing ALARM RESET.

Having built and tested the unit the freezing circuit should be set up next. To do this, the thermistor should be temporarily attached to the unit via the 5-pin DIN socket, and fastened to the side of a metal container with adhesive tape. A mixture of water and ice is then poured into the container and the temperature of the

container is allowed to stabilise. The potentiometer VR1 is then adjusted until the alarm just triggers under these conditions.

At this point the sensors in the loft can be installed and the 5-way cable run down to the unit. Extension warning devices can be attached via PL2, the battery checked and the device is ready for use.

USING THE DEVICE

The Loft Alert has been designed to have a very low quiescent current consumption in the standby condition (typically less than 0.4mA), to allow the unit to be battery powered and left on continuously. Under these conditions the specified life of the PP9 battery will be close to its shelf life which is about one year.

However, should the alarm be triggered, the current consumption during the alarm period reaches about 70mA. This means that once the alarm condition has been dealt with the battery should be checked before the system is reset and left, to make sure that it was not exhausted whilst the alarm was activated.

Assuming the unit is going to be in regular use, periodic inspection and checking of the sensors and battery is a good idea and a half-yearly overhaul is certainly recommended.

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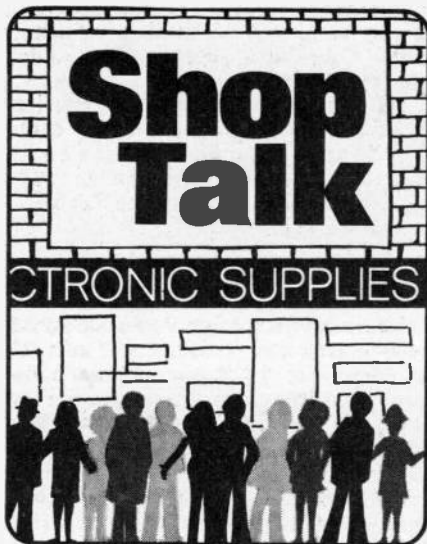
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By Dave Barrington

Light Controller

It would seem that Discos do not have the monopoly on special effects this year. We are reliably informed that the measure of a good festive party this season will be its lighting effects—what's happened to stimulating conversation and good food?

Aimed more at the disco market with a price tag of £99, including VAT, the latest "light controller" from TUAC should create a stir.

The Starchaser 4000 is an extremely versatile four-channel (750W per channel) lighting control console offering 16 distinctive and varied lighting patterns. Basic light effects are selected by four switches, but by using another five switches it is claimed that the operator has a possible 1000 different patterns and effects at his finger tips.

Use of automatic gain control (a.g.c.) is a standard feature, and zero reference triac firing circuitry is incorporated to minimise r.f. interference. Also featured are two audio control modes giving a single shot and an audio controlled sequencing facility. Both audio control modes are designed to be "bass sensitive" being triggered by instruments such as drums and bass guitar.

A master dimmer allows all channels to be faded simultaneously. A crossfade facility enables each channel light to be brightened and dimmed at a controlled rate, producing a merging effect.

The crossfade switch also has a short on or "flash" position which reduces the lamp on time of any channel during sequencing to produce a simulated "strobe" effect.

The Starchaser 4000 is available direct from Tuac Ltd, or from selected stockists. Further information and addresses of stockists can be obtained from Tuac Ltd, Dept EE, 121 Charlmont Road, London SW17 9AB.

Link-up

Readers embarking on our new *Teach-In 80* beginners series may like to investigate the latest link-wire kit for breadboards from Lektrokit for possible use with the *EE Tutor Deck*.

Although intended for their own range of breadboard systems they

will fit most commercial matrix boards. Each kit contains 350 wires and comes in a plastic compartmentalised box. All of the wires are of solid tinned 22 a.w.g. with p.v.c. insulation sleeving.

Fourteen different lengths are included ranging from 0.1in, for linking adjacent holes on a 0.1in matrix board, to wires with a 5in span. All wires have both ends stripped and bent to 90 degrees and each group of wires has a different coloured sleeving for easy identification of individual link wires.

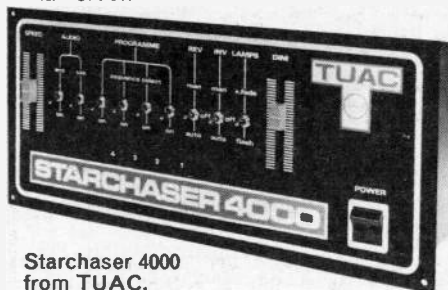
For more information and addresses of local stockists, readers should write to Lektrokit Ltd., Dept. EE, Sutton Industrial Park, London Road, Earley, Reading, RG6 1AZ.

Good Trading

Due to remarkable trading response during 1978/9, Newbear Computing Store recently decided to reorganise its operations for 1980 under three divisions.

Catering for business, industrial and educational requirements, Newbear Systems will be supplying microcomputers built to professional standards with matching peripherals and software.

The growth of the demand for technical books has meant the forming of Newbear Books. Several hundred titles are available "off-the-shelf" and services offered include, a claimed, 24 hour turnaround on mail order.



Starchaser 4000 from TUAC.

The Components Division holds very large stocks and includes a wide range of microcomputer components, including kits from Acorn, Nascom and Bearbag 77-68 series. A comprehensive range of integrated circuits are also stocked.

A further result of their good trading figures, has been the opening of a new 1500 sq. ft. Northern branch store at Mersey House, 220 Stockport Road, Cheadle Hulme, Cheshire.

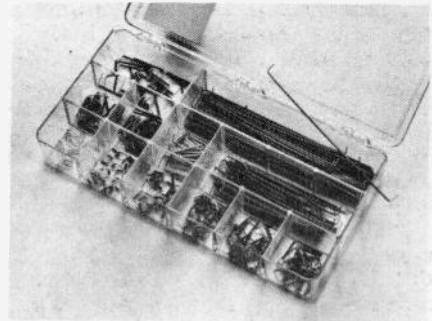
The latest piece of information we have received from Newbear is the announcement of a Christmas Sale.

A number of ex-demo microcomputers and peripherals are being offered to callers at the Newbury (40 Batholomew Street, Newbury RG14 5LL) and Northern showrooms. A large range of components, keyboards and other small items will also be available at reduced prices.

Small Orders

Another well established company who have long recognised the enormous potential of the amateur electronic constructors' market is Neosid Ltd.

A major supplier of ferrite components, coil assemblies and plastics coil formers, this company has now formed a Small



Lektrokit Link-wire pack.

Order Division to cater for the amateur's special needs.

A Small Order Catalogue is available from Neosid Small Orders, Dept EE, P.O. Box 86, Welwyn Garden City, Herts, AL7 1AS. Send a large self stamped addressed envelope.

Constructional Projects

As the *EE Loft Alert* is likely to be our most popular project, and be tackled by the less experienced as well as the more advanced constructor, we recommend that only first grade components be used.

The thyristor type C103YY is available from R.S. retail outlets. A type MCR102 from Maplin and the 2N5060, 2N5061 from Watford Electronics can be used.

If any other type of bead thermistor than that specified is used it will obviously mean circuit "tuning". The type used in our unit was an RS Components miniature bead type (stock No. 151-136) equivalent for the VA3400.

Any relay may be used provided the coil resistance is above 100 ohms and will operate with a voltage of 6 to 9V. A suitable type is the Keyswitch SM2P/12/185 which is a nominal 12V type but works down to 5V. Another two types which seem suitable are the Maplin FX27E and the Watford RL.

Part three of the *EE Radio Control System* this month deals with the Receiver.

We understand that designer approved parts for the complete *EE System* are available from Cheshire Model Supplies Ltd., 55 Cheadle Road, Cheadle Hulme, Cheshire.

Because of the small size of the receiver, and the "dense packing" of components on the printed circuit board it is essential that the specified types of capacitors and resistors are used. Resistors rated at up to ¼W should be suitable, but ¼W types (as available from Electrovalue Ltd) are recommended.

The firm S.L.M. (Model) Engineers Ltd., Chiltern Road, Prestbury, Cheltenham, Glos., can supply control pots, cases and those other items specifically indicated "SLM" in our components lists. They do **not** however supply standard circuit components.

The short spring-line module called-up in the *Spring-Line Reverb Unit* is only available from Maplin Electronic Supplies, stock No. XL08J. All other components for this project are readily available from most advertisers.

The ZN1034E timer i.c. for the *Mains On/Off Timer* is listed by C. N. Stevenson, T.K. Electronics, Technomatic and Watford Electronics.

No buying problems are envisaged for the *Uniboard 9V Power Supply* project.

UNIBOARDS

**SIMPLE
TRANSISTOR
DESIGNS**

By A.R. Winstanley

3

9V POWER SUPPLY

**CONSTRUCTION
starts here**

The prototype unit was housed comfortably in a readily-available PB1 type plastic box, measuring 115 x 75 x 35mm. It is recommended however that the heater transformer is acquired first, and then a plastic box of appropriate dimensions chosen to house it.

The circuit is built on 0.1 inch matrix stripboard measuring 10 strips x 24 holes as shown in Fig. 2. There are no problems with this aspect of construction, but it is extremely important that both the p.c.b. mounting electrolytic capacitor and the bridge rectifier are correctly orientated.

The completed board is mounted on the inside face of the end opposite main cable exit by means of 6BA spacers, nuts and bolts.

The interwiring is as shown. A cable retaining clamp should be fitted to the main cable to prevent it from pulling out. Also, note how the earth input of the mains cable is connected by means of a solder tag to the transformer mounting frame, using one of the mounting bolts.

The l.e.d. can be positioned and secured using the special-purpose plastic clip normally provided. Finally, a 1 amp fuse must be fitted in the mains plug.

VENTILATION

It was found that the transformer itself did tend to get rather warm during normal operation. To counter this a series of ventilation holes have been drilled in the case. If necessary, a piece of aluminium mesh, or perforated zinc, should be glued behind the holes to prevent any objects poking through the holes and possibly touching mains wiring inside.

Jack sockets have been used in the individual projects to facilitate the connection of the 9 Volt Power Supply. A common audio lead, terminated with a 3.5mm jack plug each end, is all that is required to make the connection.

Note that the audio lead must be connected up before the p.s.u. is switched on: if the p.s.u. is switched on first and then plugged into the project, it is possible that the jack plug can temporarily short out the power supply, perhaps having a detrimental effect.

Next Month: Touch Switch

WITH one exception, all projects described in this series have been designed to operate from a 9 volt rail. In certain instances, however, it would be considerably more convenient to power the project from the domestic mains supply.

The 9 Volt Power Supply was designed with economy in mind. It was to be built as cheaply as possible, and as such it should eventually pay for itself in terms of the cost of dry batteries. Although the circuit is rather basic (and is not transistorised) the unit has proven quite adequate to operate the projects in this series.

CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 1. Transformer T1 is a valve heater transformer with a mains primary and a 6.3V a.c. 300mA secondary. Mains voltage is applied to the primary and stepped down to

6.3V. This low a.c. voltage is presented to D1—D4.

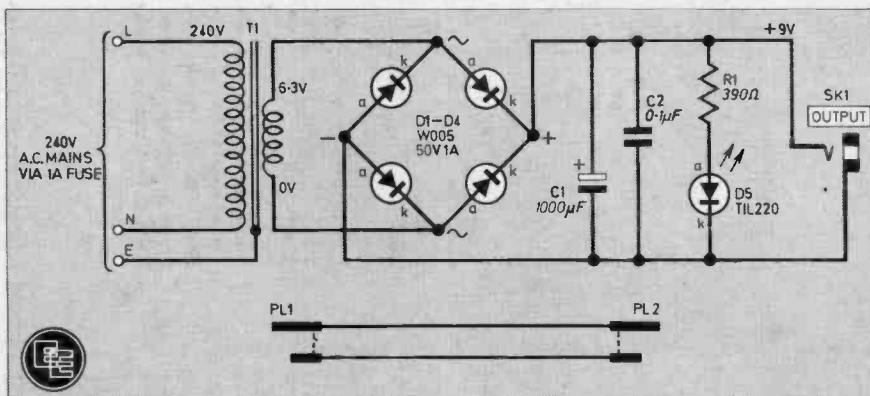
The diagram illustrates four separate rectifiers but in fact a single encapsulated unit, containing four rectifiers, called a "bridge rectifier", is used.

The bridge rectifier converts the a.c. into a pulsating d.c. voltage. Capacitor C1, being a very large value electrolytic capacitor, smoothes out the pulses to give a nominal d.c. voltage of about 9V with a reasonably low ripple content sufficient for our purposes here.

Finally, a light-emitting diode, D5, together with its associated current-limiting resistor R1, forms a "power on" indicator. A further bonus is that if for some reason, the output of the p.s.u. is shorted, the l.e.d. will extinguish, so indicating a fault present.

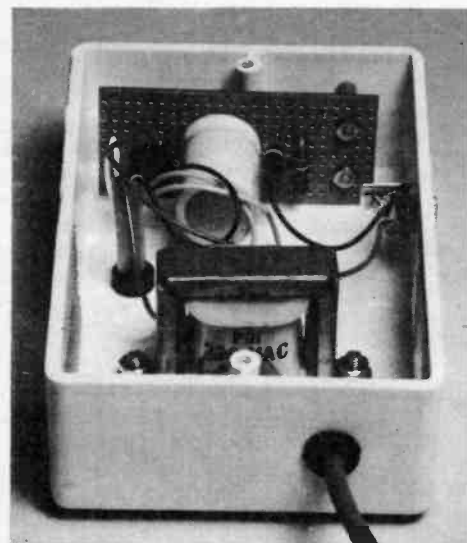
A 3.5mm jack socket SK1 is used as the outlet for the 9V supply. The tip of the plug inserted in SK1 is connected to +9 volts.

Fig. 1. Circuit diagram for the 9V Power Supply. The output connecting lead is terminated with jack plugs PL1 and PL2. The jack tips carry the positive (+9V) supply.

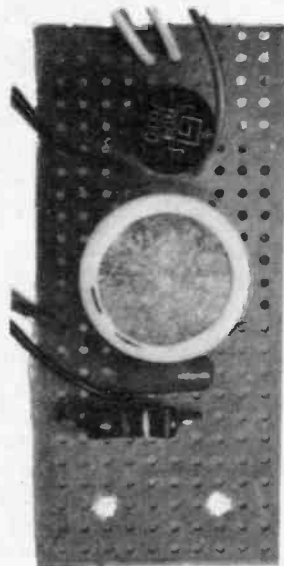




The finished power supply showing the small ventilating holes and the 9V output jack socket.



Layout of components inside the case. The circuit board is mounted on the side of the case using 6BA spacers.



Completed circuit board.

COMPONENTS

Resistors

R1 390Ω ¼W carbon ±5%

Capacitors

C1 1000µF 25V radial elect.
C2 0.1µF polyester type C280

Semiconductors

D1—D4 50V 1A diode bridge type W005 or similar
D5 TIL220 I.e.d. or similar

Miscellaneous

T1 mains primary/6.3V 300mA secondary
SK1 3.5mm jack socket
PL1,2 3.5mm jack plug (2 off)
Stripboard: 0.1 inch matrix size 10 strips × 24 holes; mounting bush for D5; case type PB1, see text; cable retaining clip/grommet; p.v.c. insulated connecting wire; 3-core mains cable; 6BA fixings, nuts bolts, washers, stand-off spacers, solder tag;

Approx. cost Guidance only
£3.25

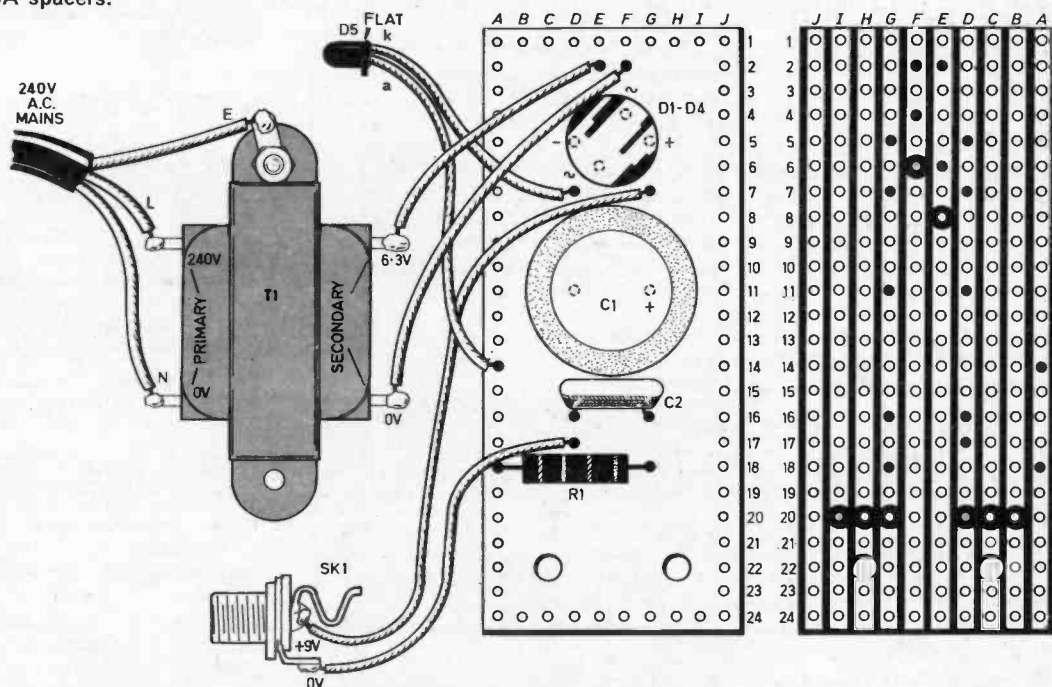


Fig. 2. Layout of components on the topside of the stripboard, breaks to be made on the copper strips on the underside and interwiring details to the mains transformer, light emitting diode (D5) and output jack socket (SK1).

Part 4

By S. R. Lewis,
B.Sc.



using separate names and Fig. 4.1 shows the circuit symbol for a diode next to an actual diode with their terminals marked with their commonly accepted names—**anode** and **cathode** (the latter usually abbreviated to "k"!). The symbol for a diode is an arrow and this gives a clue to its properties.

When current flows through the diode from anode to cathode (in the direction of the arrow) the diode presents very little resistance to that current—it is a good conductor. If we try to pass current from the cathode to the anode (against the arrow) we will have great difficulty. In fact, the diode will break down under the voltage before it will pass any appreciable current.

We can liken the diode to an electronic switch which is either open or closed depending on the direction of the current. It behaves very like a valve (mechanical not electronic) in a tyre which allows air in but not out (Fig. 4.2).

When a diode has a voltage across it such that current tends to flow from anode to cathode we say the diode is **forward biased**. If the voltage is in the opposite direction then the diode is **reverse biased**.

RECTIFICATION

The widespread use of diodes has mainly come about because the majority of electronic equipment

THE success of electronics as we know it today is based entirely on the growth of the semiconductor industry. Whilst electronics was certainly thriving in the valve era the real potential of electronics could only be realised by producing a small, cheap, low-power alternative to the valve.

Investigation and development just after the last war led to the production of the first **transistor**. It was apparent that the basic components of the transistor—**semiconductor junctions**—could also be used to build a range of devices each with special characteristics.

In this part of the series we will look at the simplest semiconductor junction device—the **diode**. Understanding the operation of this relatively simple two-terminal device will aid the understanding of the more complex three-terminal transistors.

ONE-WAY CURRENT

The major point to understand concerning diodes is that whilst they have two terminals just like a resistor the two ends are not identical. Looking at an actual diode the two ends appear the same with the exception that the body of the diode has a ring at one end, so just what is the difference?

The answer to this is that the diode is a device sensitive to the *direction* of flow of current through it. It does not matter which way round a resistor is put in a circuit, it will still behave in the same way. A diode, on the other hand, appears like two different devices depending on which way round it is connected.

We obviously need to be able to refer to the two ends of a diode

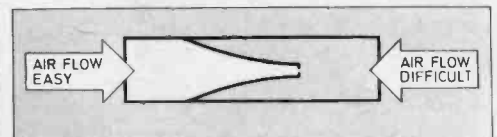
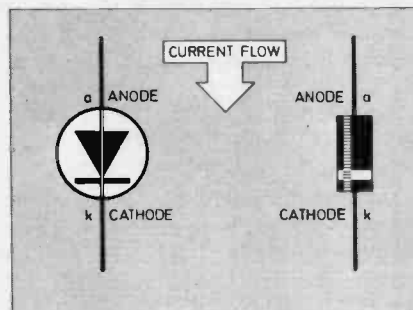


Fig. 4.1 (left). Circuit symbol and names of the two terminals of a diode. Current can only flow in the direction of the arrow.

Fig. 4.2 (above). A tyre valve provides a mechanical analogy of the diode.

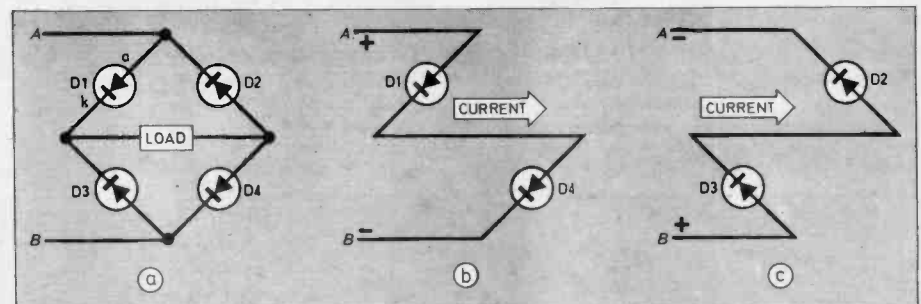


Fig. 4.3. (a) Four diodes connected as a "bridge". The "load" represents either a single component or a whole circuit. (b) shows the path of the current when A is positive with respect to B and (c) the path when B is positive with respect to A.

will only operate when supplied with a steady voltage which does not change direction or value with time.

Power as supplied by the electricity generating stations is the opposite to this; it is constantly changing value and direction—in fact doing this 100 times a second.

Diodes are the easiest way (though not the only way) of converting this constantly reversing voltage into one which is in one direction only. In fact four diodes are needed, the arrangement being shown in Fig. 4.3 and usually referred to as a **diode bridge**.

DIODE BRIDGE

When point A is positive with respect to point B, diodes D2 and D3 are reverse biased; so little current flows through them that they are virtually open circuit. Diodes D1 and D4 on the other hand are forward biased presenting very little resistance to current. The flow of current is thus as shown in Fig. 4.3b.

When the voltage is reversed, that is B positive with respect to A, diodes D1 and D4 are reverse biased while D3 and D2 are forward biased so that the current flows as in Fig. 4.3c. We thus have a circuit where the voltage across the load is the same no matter what the polarity of the power source.

We could use this circuit for protecting a circuit which could be damaged if the battery were connected the wrong way round.

SINUSOIDAL

If the voltage across A and B is from the mains it will be varying regularly from positive to negative as shown in Fig. 4.4(b). We call this type of waveform **sinusoidal**.

The positive-going half-cycle will be passed by D1 and D4. The negative-going half-cycle will be passed by D2 and D3. After passing through the diode bridge circuit the waveform appears as at (c). Notice that while it is still varying, it is always of the same polarity (the way in which this "pulsating" voltage is converted into a steady d.c. voltage will be described later in this series).

The process of converting an alternating voltage into a single polarity voltage is referred to as **rectification**. Very often the four

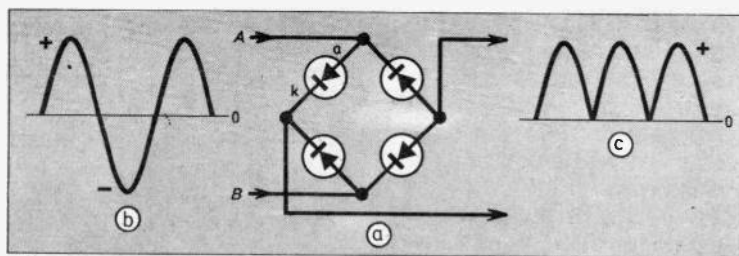


Fig. 4.4. (a) Mains voltage being rectified by a diode bridge. The bidirectional voltage (b) has been converted into a voltage of a single direction (c)

diodes needed are supplied in a single package with four leads. This is known as a **bridge rectifier**.

NON-LINEARITY

It was stated earlier that a forward-biased diode presents very little resistance to current flow but this statement needs some elaboration.

It is found that, in the forward direction, the diode has a **non-linear** relationship between applied voltage and current. In other words, if the current is 1mA with a forward voltage of 0.5V it is not true that 2mA will flow with an applied voltage of 1V.

A graph of current plotted against voltage for a typical silicon low-current diode is shown in Fig. 4.5. Two points concerning the graph are of particular interest.

The first is that the voltage range of the graph is very small, only going from 0 to 1V. If we look at the graph near the point where 0.7V is applied to the diode we see that a very small change in voltage is needed to produce a large change in current. Alternatively this may be stated as large changes in current produce small changes in diode voltage drop.

It turns out that this voltage is mainly dependent on the materials from which the diode is made. Silicon diodes have a constant voltage characteristic around 0.7V and germanium diodes (now rather uncommon) at 0.2V.

The second point is that at low applied voltages the current is very small, that is the diode has high resistance.

What conclusions can be drawn from the graph? Firstly we can deduce that even when passing a high current the diode will be dropping about 0.7V. In order for the diode to be an efficient rectifier, this voltage should be small with respect to the voltage to be rectified.

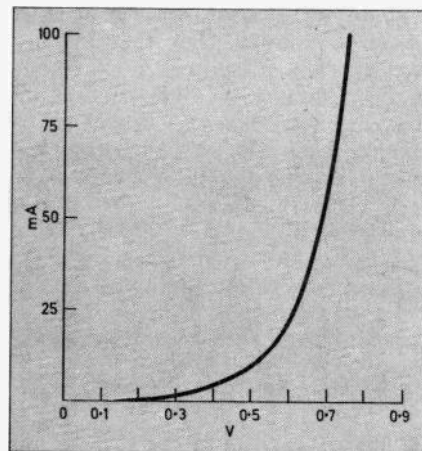


Fig. 4.5. Current plotted against voltage for a typical low-current silicon diode.

The fact that the voltage across the diode is relatively stable and predictable leads to another use of the diode: as a **constant voltage source**. Audio amplifiers often use forward biased diodes to derive stable bias voltages for output stages.

SEMICONDUCTOR JUNCTIONS

Whilst understanding how diodes behave in a circuit is fairly simple, understanding how they are made and how they actually work is far more difficult. One really needs a thorough knowledge of physics to appreciate semiconductor operation but the general principles are as follows.

Diodes nowadays are made from a single piece (or chip) of silicon which is specially treated when in its molten state. The two halves of the diode are exposed to two types of gas which give each half distinct properties.

The process of introducing tiny amounts of impurities into the silicon in this way is known as **doping**.

One half of the diode-to-be is "doped" with a carefully chosen material whose atoms have one

more electron than the basic silicon—it is like creating a surfeit of electrons. The other half is doped with a material whose atoms have one less electron than silicon—this is like creating a deficit of electrons.

Where the two forms meet, a field appears which tends to oppose any electrons which try to cross from one side to the other; we call this a **potential barrier**.

A forward bias on the diode tends to reduce the "height" of the barrier allowing more electrons to flow, hence conduction in this direction is easy. Applying a reverse bias however tends to increase the size of the barrier so very little conduction takes place (until the field is so high that the barrier breaks down). See Fig. 4.6.

This description obviously raises a lot of questions but it should give a feel for the sort of processes occurring in a diode.

LIGHT EMITTING DIODES

When electrons cross the potential barrier in a forward biased diode they change from a high energy state to a lower energy state. The energy that they lose can appear either as heat or as light.

The materials from which diodes are made determines in which form the energy appears. By making a diode out of gallium, arsenic and phosphorus it is possible to produce a diode which releases a high proportion of the energy change of the electrons as visible light. When these diodes are placed in special translucent packages we have **light emitting diodes (l.e.d.s)** which are becoming so familiar today. The symbol is shown in Fig. 4.7a.

Light emitting diodes usually require a forward current of about 10 to 20mA for efficient light generation. At these sort of currents the voltage drop across the diode is around 1.6V although it may be up to 2V for some types of l.e.d. At the present time the colours available are red, through orange and yellow to green. Blue has proved a very difficult colour to produce although it was recently announced that a blue diode has been manufactured albeit very inefficient.

As well as single light emitting diodes, arrays of diodes can be

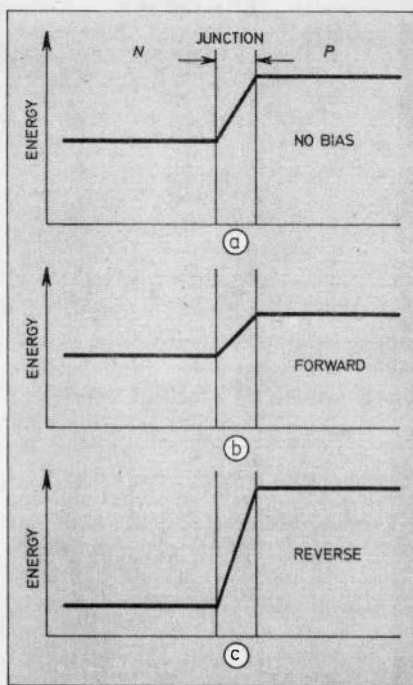


Fig. 4.6. The potential barrier in (a) an unbiased junction (b) a forward-biased junction and (c) a reverse-biased junction.

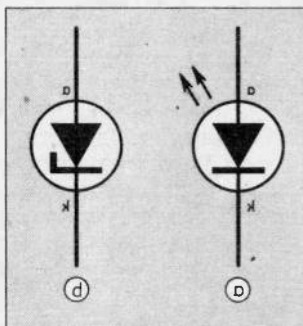


Fig. 4.7. (a) Circuit symbol of a light emitting diode (b) circuit symbol of a Zener diode.

combined to form **seven-segment l.e.d. displays** so familiar in calculators and digital clocks and watches.

ZENER DIODES

As the reverse voltage across a diode is steadily increased there comes a point where the diode "breaks down" and suddenly becomes a good conductor. If the current is controlled so that the diode does not burn itself out we have a very useful component: the **Zener or reference voltage diode**.

By controlling the geometry of their diodes, manufacturers have been able to produce diodes with a huge range of **breakdown or Zener voltages**.

The useful thing about the breakdown characteristic is that the current can be varied over a large range with hardly any change in voltage. A typical Zener diode can produce voltages stable to a few tens of millivolts at a voltage of 10V.

Zener diode specifications usually refer to both the Zener voltage and the maximum power dissipation of the diode. The maximum current that must be allowed to pass through the diode is the maximum power dissipation divided by the Zener voltage. Thus a 4.7V 400mW diode must not carry more than $400/4.7$ or about 85mA. The symbol for a Zener diode is shown in Fig. 4.7b.

DIODE SPECIFICATIONS

Diodes come in a variety of shapes and sizes. Manufacturers specify two main properties of their diodes: the **maximum forward current (I_{max})** and the **peak inverse voltage (p.i.v.)**, that is the maximum safe voltage that can be placed across the diode in the reverse direction that will not cause breakdown.

A diode in a transistor radio may have a p.i.v. of 50V and an I_{max} of 100mA. One in a power supply could have a p.i.v. of 600V and an I_{max} of 5A.

When large currents flow through a diode heat is generated so the packages of heavy current diodes are usually designed to bolt onto a piece of metal (a **heatsink**) to help keep the diode cool.

DIODE GATES

We have seen how diodes are similar to switches, having two states one high resistance and the other low resistance, the "switch" being controlled by the direction of the current flow.

The principle can be put to further use in what is known as the **diode gate**.

A "gate" as the name implies can be either open or shut. In real terms this means that a voltage is used to control the flow of current into another part of the circuit.

The circuit of a simple diode gate is shown in Fig. 4.8. The controlling voltage is applied at point A, the voltage to be controlled being that at point B.

EXPERIMENT 4.1: DIODE BRIDGE RECTIFICATION

Components needed: 1kΩ resistor, 100kΩ resistor, 1N4148 diodes (4 off)

The circuit diagram for an experiment to investigate diode bridge rectification is shown in Fig.4.10(a) with the layout of the components on the Tutor-Deck in Fig.4.10(b). Note these additional connections on right hand panel of Tutor Deck: link S1(a) to B1 +9V; link S1(c) to B2-9V.

Switch S1 is used to produce either +9V or -9V at point A. Since the meter can only indicate 100μA or so, a resistor R2 is used as the main current path, with the meter (in series with R1) used to indicate the polarity of the voltage across R2.

It will be found that whatever the setting of S1, the polarity of the voltage across R2 will be the same.

For identification of Tutor Deck components and their associated sockets refer to Fig. 2.8.

EXPERIMENT 4.2: DIODE "AND" GATE

Components needed: 1kΩ resistor, 1N4148 diodes (2 off)

The circuit diagram for the simple two diode AND gate is shown in Fig.4.11(a) with the layout of the components in Fig.4.11(b).

The l.e.d. D1 serves a dual purpose; it forms both the output diode and the load. When either input A or input B is taken to 0V the l.e.d. will be off, since all the current through R1 will flow through D3 or D4. Only when both inputs are taken to 9V (or left open-circuit) will the l.e.d. light. We say the input A AND input B must be at logic "1" before the output is at logic "1".

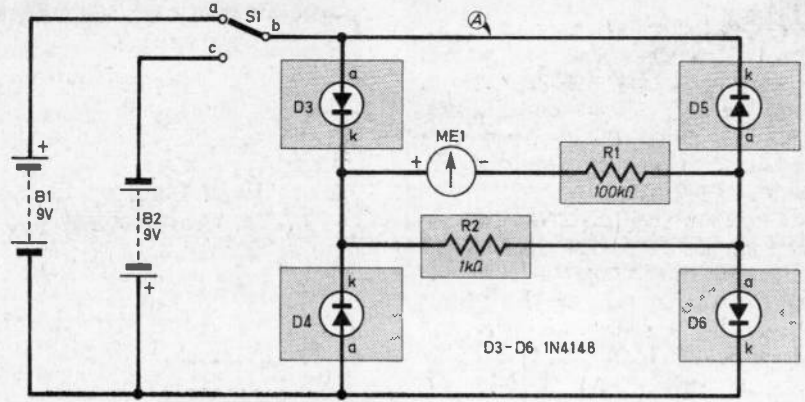
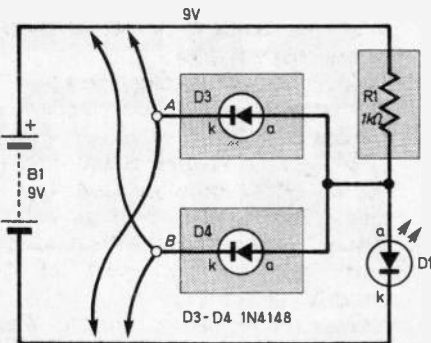


Fig. 4.10 (a) Circuit diagram showing the diode as a rectifier with (b) showing the component layout on the Tutor Deck.

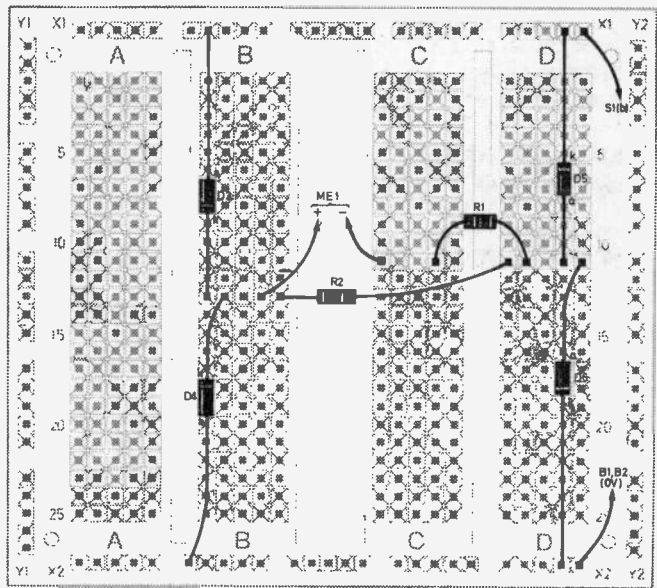


Fig.4.10b

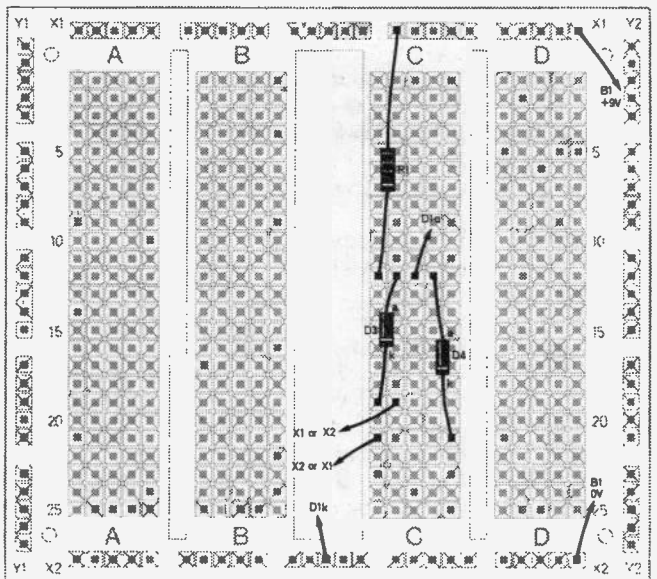


Fig.4.11b

Fig. 4.11 (a) Circuit diagram of a simple two-input diode AND gate. (b) shows the layout on the Tutor Deck.

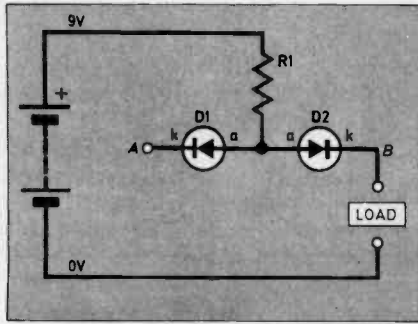


Fig. 4.8. Circuit of a simple diode gate. The voltage at A is used to control that at B.

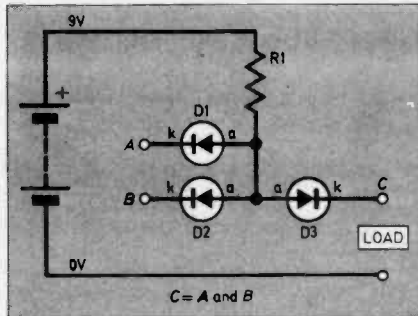


Fig. 4.9. A diode AND gate. All inputs must be at logic "1" (9V) for the output to be high.

Consider what happens when A is taken to 0V. Diode D1 will be forward biased, current flowing through R1. The voltage drop across D1 will be about 0.7V (assuming it is silicon). A load connected from the cathode of D2 to 0V will therefore have no voltage across it.

PART 4 QUESTIONS

- 4.1. A diode with its cathode more positive than its anode is said to be
 a) forward biased
 b) reverse biased
 c) neither
- 4.2. A diode in a circuit is found to have a voltage drop from anode to cathode of 0.2V. Is the diode most likely to be
 a) silicon
 b) germanium
 c) gallium arsenide
- 4.3. A 10V 1.3 watt Zener diode should not be allowed to pass more than
 a) 1.3A
 b) 130mA
 c) 13mA
 d) 1.3mA

4.4. An AND gate output will only be at logic "1" when
 a) all
 b) none or
 c) some of its input are at logic "1".

4.5. The stripe on an 1N4148 diode indicates
 a) the anode
 b) the cathode
 c) the emitter

PART 3 ANSWERS

3-1. c) 3-2 a) and c) 3-3 b) 3-4 c)

If A is now taken to 9V diode D1 will have zero voltage across it. Now all the current will flow through R1, D2 and into the load.

If the usefulness of this circuit is not apparent, consider the case when, instead of just a single diode, two or more diodes are used in place of D1. Now connecting any input diode to 0V will cause zero voltage to appear across the load. What we have is the basis of

a simple logic gate, in fact an AND gate, see Fig. 4.9.

Logic is a whole subject on its own and we will not go into further detail at this stage. However, from these simple beginnings quite elaborate logic circuits were developed leading to the immensely complicated logic circuits used in today's computers.

Next month we will look at capacitors.

EE CROSSWORD No 23 BY D. P. NEWTON

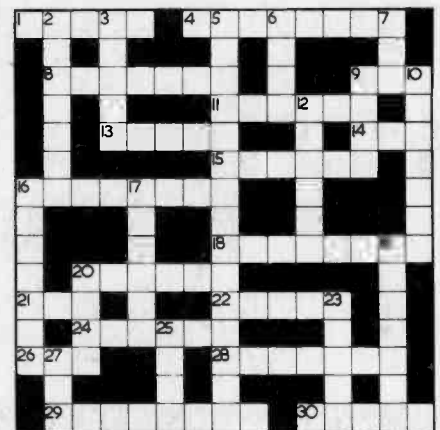
ACROSS

- 1 A kind of biscuit found with chips (5).
 4 Complete temperature scale (8).
 8 Conducts into kidnapping (7).
 9 Grille makes sick (3).
 11 Metallic ion form expressing the perverse timing of Fate (6).
 13 Would another revolution make the i.c. so antique? (5).
 14 Short beats give sustaining activity (3).
 15 Those heartily felt surges (6).
 16 A switch that's a bit shaky (8).
 18 Free electricity? (2, 6).
 20 Sea with icy connections (6).
 21 Phoney part of 25 down (3).
 22 Characteristic curves are seldom so perfect (5).
 24 Often a cause of an open-circuit but has a capacity to be useful (3, 3).
 26 We couldn't solder on with it (3).
 28 A stratum characteristic of the i.c. (7).

- 29 To put down interference (8).
 30 Measuring term (5).

DOWN

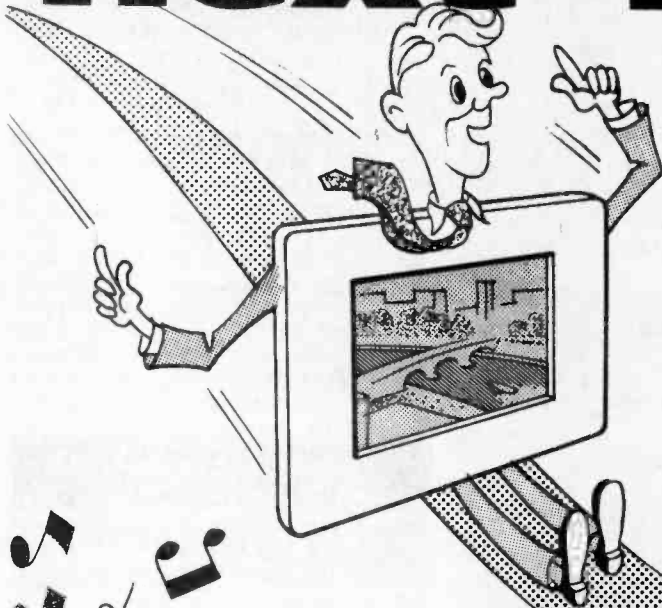
- 2 It avoids mis-match at the terminal (7).
 3 Aged solder partly but more personal (5).
 5 We all must have them to make any start at all (5, 10).
 6 Sound tone clipped to place above (4).
 7 The fishy part of electricity (3).
 9 When 10 down cools off, do we get these? (4).
 10 Type of network (7).
 12 Nothing like 18 across in part (2, 4).
 16 Early galvanometer (7).
 17 Bulb coiler tails off to immersion heater (6).
 19 One electrode turned cooker (7).
 20 All brain but no eye for food (4).



- 23 Glare makes it big (Anag.) (5).
 25 Cog (4).
 27 They are common to the electronics of 13 and 28 across (3).

Solution on page 60

next month



SLIDE/TAPE SYNCHRONISER

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Full details in February issue

Everyday ELECTRONICS

FEBRUARY 1980

ISSUE ON SALE

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By A. R. Winstanley



Mains On/Off Timer

The timing period is given by the formula

$$t = k \times B \times C$$

where t is the delay (seconds)

R is the external timing resistor (ohms)

C is the external timing capacitor (Farads)

and k is a multiplying constant.

The constant, k , is determined by the value of a "calibration resistor." With pins 11 and 12 of the i.c. linked, an internal 100 kilohm resistor is selected, and $k = 2736$.

If pins 11 and 12 are linked by a 50 kilohm resistor then the calibration resistor is increased to 150 kilohms and $k = 4095$. If instead a 300 kilohm resistor is connected between pin 12 and ground then k becomes 7500, and in this mode the i.c. is able to produce its longest delay periods. If the internal resistor is used, this will give the best coefficient of temperature, but whatever method is chosen, the calibration resistor should not exceed 300 kilohms.

When choosing values of R and C , the following limits apply:

$$5k\Omega \leq R \leq 5M\Omega$$

$$C \geq 3300pF$$

The timing period commences when the device is triggered by grounding pin 1. Two complementary outputs are available at pins 2 and 3; pin 2 (\bar{Q}) is normally high and goes low during timing; the opposite is true of pin 3 (Q).

COMPONENTS
approximate
cost **£25**

PERHAPS one of the less pleasant ways of starting a day is to be awoken to the nerve-shattering jangling of one very large and very loud alarm clock! There must be better ways of being roused from sleep, and this project would seem to make life a little easier in this respect.

TIMED DELAYS

The Mains On/Off Timer is a versatile unit which will generate timed delays of up to twelve hours in one-hour increments. Once this period is up the Timer will switch on or switch off any mains load connected to its output sockets, and this load can have a power rating of up to 1800 watts; therefore the unit is suitable for driving many appliances.

Thus by connecting a mains radio to the Timer and setting the appropriate delay, one can be awoken to the more acceptable strains of Terry Wogan.

The Timer utilises the Ferranti ZN1034 precision timer i.c. to produce very accurate timing periods using low value timing components when compared with typical component values used with, for example, the NE555 timer.

Also, the ZN1034 is equally at home producing delays of one second or one week—compare this with the maximum one hour delay generated by the 555. Indeed, by using two ZN1034 timers a delay of up to one year is attainable.

THE TIMER I.C.

The internal circuitry of the ZN1034E (the 'E' denotes a 14-pin d.i.l. package) is very simply illustrated in Fig. 1. The i.c. features an on-chip oscillator and twelve-stage divider. The frequency of oscillation is determined by an external RC circuit. When the oscillator has cycled 4095 times the control logic switches over the complementary outputs at pins 2 and 3.

The external RC circuit therefore determines the delay period which the i.c. will generate. The use of an oscillator and counter in this manner enables an RC circuit with a relatively low time constant to be utilised to deliver relatively long delays.

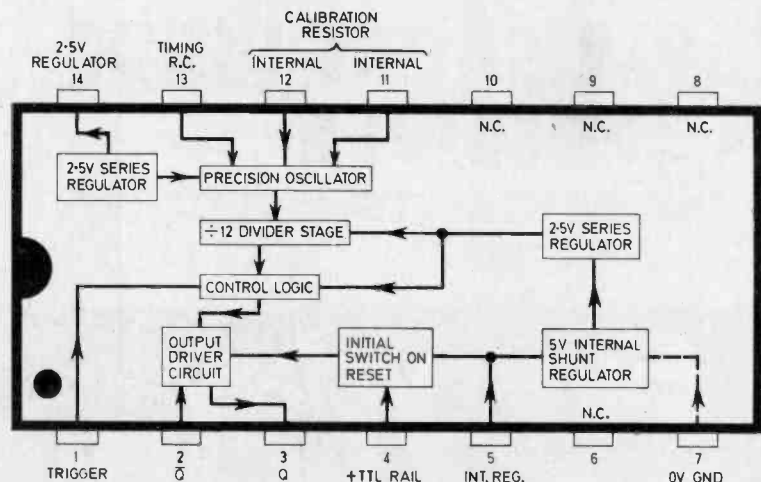


Fig. 1. Block diagram of the internal circuitry of the ZN1034 i.c.

A typical "high" value would be about 3.5V and a "low" would be in the order of 0.3V. When either output is high, it can supply current of up to 25mA to the load connected to it; but when the output is low, if the load is biased correctly then current may sink into the output, and again this current must be limited to 25mA.

POWER REQUIREMENTS

Concerning the power supply rails, the i.c. will operate directly from 5V to 450V d.c. When used with a 5V rail (as with TTL circuits) then pin 4 can be connected straight to +5V. Alternatively when used with a rail exceeding 5V, a series resistor must be connected between pins 4 and 5 and the positive rail. A 5V shunt regulator on pin 5 takes care of the rest.

The value of this series resistance is given by

$$R_s = \frac{(V_s - 5)}{I}$$

where R is the resistor value (ohms)
 V_s is the supply rail voltage
 and I is the current flowing through the resistor. (amps)

The current is 5mA plus any current drawn at the outputs.

A switch-on reset is incorporated into the chip which resets the time delay if the supply is interrupted.

OSCILLATOR FREQUENCY

The actual precision oscillator can be observed in operation by placing a high-impedance frequency meter or cathode-ray oscilloscope on pin 13. The impedance must be at least ten times that of the timing resistor or the test instrument impedance may alter the RC constant.

The actual delay period will be $4095 \times$ period of waveform measured on the 'scope. Measuring the oscillator frequency in this way is often more desirable than having to wait a few hours to check the accuracy of the timer. A provision has been built into the Timer to allow measurement of the oscillator period with an oscilloscope.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Timer is shown in Fig. 2. Mains voltage is stepped down by T1 to 12V a.c. This is rectified by D1-D4, an encapsulated bridge rectifier and smoothed by C1 to produce an unregulated supply of some 17V d.c.; R1 is a series dropping resistor which permits the operation of IC1 from the 17V supply. Capacitors C2, C3 and C4 are used to decouple the supply rails and serve to reduce any spurious noise.

The internal 100 kilohm calibration resistor is brought into circuit by the link between pins 11 and 12. Capacitor C5 is the timing capacitor and

switch S3 is a 12-way rotary switch which selects the timing resistor. With S3 at position 1, a 390 kilohm resistor is selected as the timing resistor. The delay t is thus

$$\begin{aligned} t &= k \times R \times C \\ &= 2736 \times 390k\Omega \times 3.3\mu F \\ &= 3521 \text{ seconds or about} \\ &\quad \text{one hour (58 minutes)} \end{aligned}$$

(Internal 100 kilohm calibration resistor selected, so $k=2736$.)

With S2 in position 2, two 390 kilohm resistors are in circuit and the delay is about two hours, and so on. No preset has been included in the timing resistor chain which might allow exact trimming of the oscillator period to produce spot-on delays (e.g. exactly one hour). Such a preset would obviously be nearly impossible to set up unless an oscilloscope or frequency meter was available to help. In fact reasonable accuracy is obtained when a tantalum capacitor is used for C5.

Socket SK3 is optional and permits the measurement of the basic oscillator period with test equipment. With a 10 megohm c.r.o. and probe, this socket should be usable with the timer set for a delay of up to three hours. After this the scope impedance might cause false readings to be taken.

The i.c. is triggered by grounding pin 1 via S2. The switch-on reset can be utilised to cut short the time delay if required: this can be done by temporarily interrupting the 17V

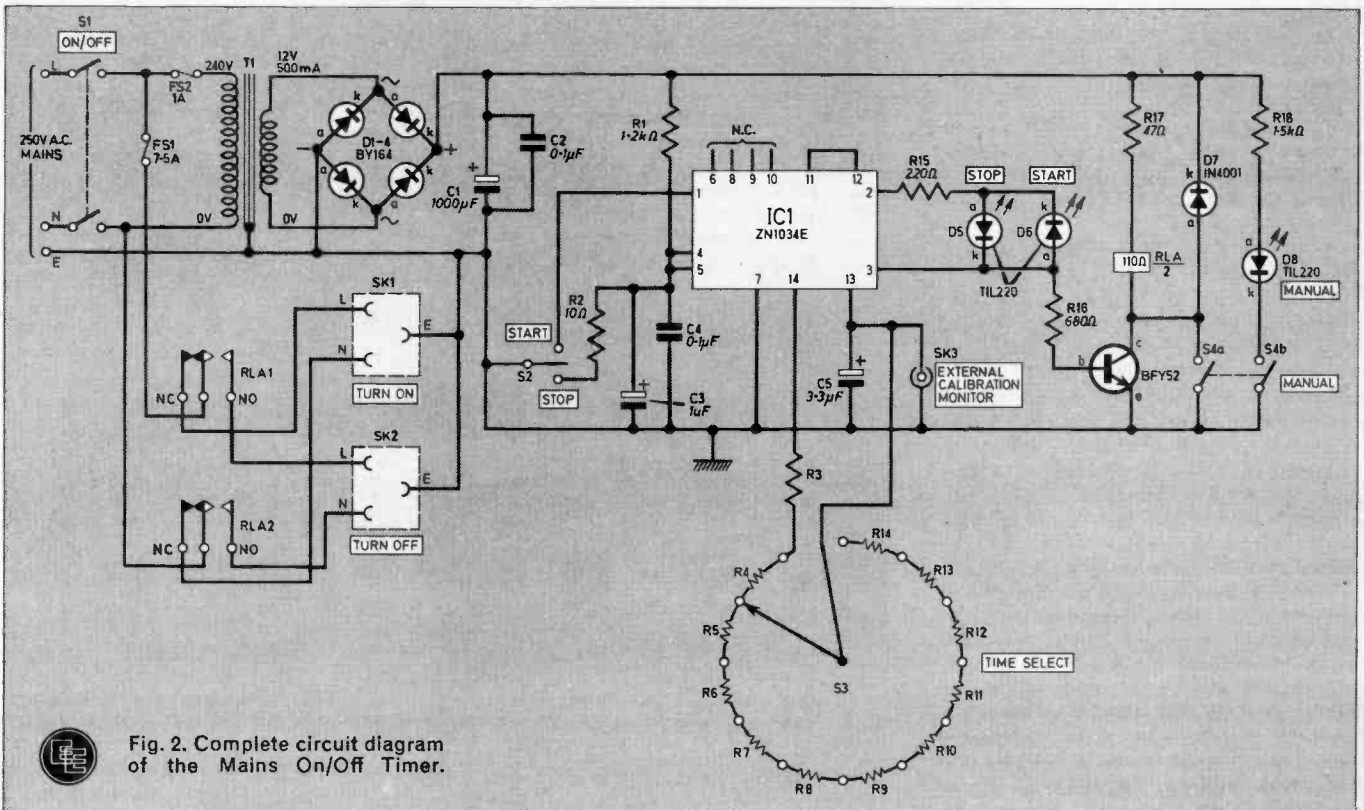
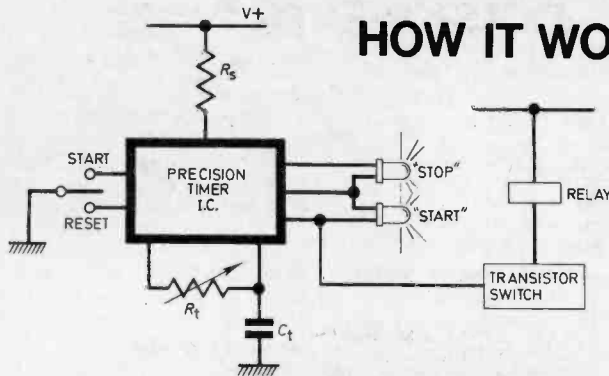


Fig. 2. Complete circuit diagram of the Mains On/Off Timer.

HOW IT WORKS



A precision timer i.c. forms the basis of this design. An external RC network (R_t and C_t) alters the frequency of an internal oscillator. When the oscillator has cycled 4095 times, the internal i.c. logic detects this and causes a transistor to switch off, thereby removing power from the relay coil and turning off the mains load.

Two complementary outputs are available on the i.c., and both are utilised to provide a visual indication by means of two l.e.d.s to signal whether the timer has "started" or "stopped."

The i.c. is both triggered and reset with one switch. Timing resistor R_t is varied in steps by means of a rotary switch to allow different delays to be obtained. The Timer generates delays of between 1 and 12 hours, but in theory the i.c. can deliver delays of between about 15 microseconds and about 3 weeks.

The relay contacts switch the mains load off after the delay is up, but in this design by utilising both sets of changeover contacts, the load can be switched on or off after the delay.

supply to the i.c. with a normally-closed switch. Instead, however, a reset function was derived by grounding pins 4 and 5 with S2—this grounds the i.c. and resets it. Resistor R1 ensures that there is no danger of shorting out the supply, and R2 limits the peak current caused by C3 and C4 discharging to 0V.

By resetting the i.c. in this manner it was possible to incorporate the trigger (START) and RESET functions into one switch.

I.C. OUTPUT

Both of the i.c. outputs are used. When the i.c. is not timing, then pin 2 is high and pin 3 low. Therefore output current flows out of pin 2 and sinks into pin 3, illuminating D5 to indicate the timer has stopped. Light emitting diode D6 cannot illuminate because it is reverse-biased by about two volts. Resistor R15 limits the current flowing in the l.e.d. to less than 10mA—generally enough to cause an easily visible glow.

Upon commencement of the timing period (IC1 being triggered by S2), pin 3 goes high and pin 2 low—D5 must therefore extinguish and D6 illuminates to indicate that the timer has started timing. Also, TR1 switches on with pin 3 going high. This completes the circuit to RLA which now operates. Resistor R17 is a series dropping resistor and is necessary to

enable the 12V 110 ohm relay to be used with a 17V supply. A transistor

is required because the i.c. cannot possibly supply the 110mA or so required by the relay.

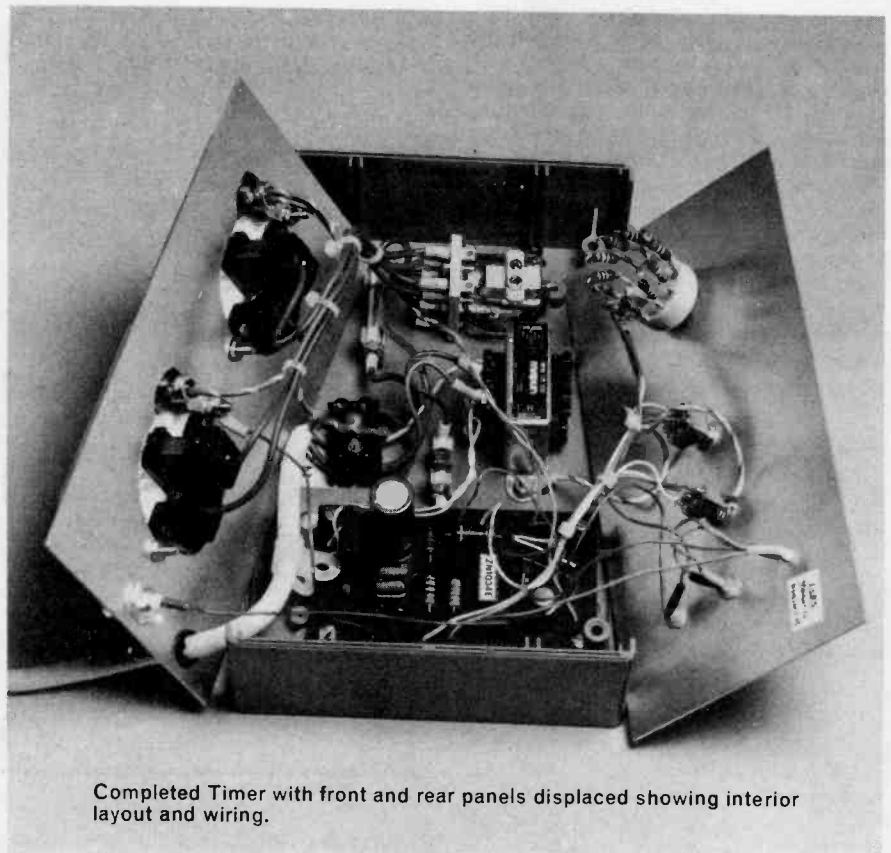
Switch S4 has been incorporated to allow a MANUAL operation of the relay independently of the Timer which switches on the relay itself and illuminates D8 to indicate the manual function.

RELAY

The relay used in the prototype was an R.S. Open Type 348-835 which is equipped with a pair of 10A 250V a.c. changeover contacts. Socket SK1 is connected to the mains through the normally-closed contacts. When the relay operates, these contacts open and switch off the load connected to SK1 which switches on again when the Timer is reset or times out.

The opposite is true of SK2. When the unit is timing, SK2 switches on and switches off when the unit times out. The use of these "complementary" sockets means that any load can be turned on or turned off when the Timer has completed its cycle.

In the final design, the relay contacts have been derated to 7.5A by means of FS1 so that neither the relay contacts or the mains interwiring can be operated at their absolute maximum ratings. Fuse FS2 protects the transformer in case a fault should develop.



Completed Timer with front and rear panels displaced showing interior layout and wiring.

CONSTRUCTION starts here

CIRCUIT BOARD

The circuit is built on a glass fibre printed circuit board for high reliability and strength. The foil layout and component overlay is shown actual size in Fig. 3. The prototype was made using etch-resistant transfers for the tracks and resist ink for the larger areas of copper foil.

There are several points which must be observed when soldering the components to the p.c.b. Firstly make absolutely certain of the polarity of C1. Also ensure the correct orientation of D7. Finally, whilst an i.c. socket was not used on the prototype, it is recommended that one is used to prevent thermal damage to the rather expensive i.c. during soldering. Complete the p.c.b. in accordance with Fig. 3 and then move on to the case-work.

CASE DETAILS

The prototype was housed neatly in a plastic Verobox type 75-1412K which has aluminium front and rear panels. The front panel should be drilled to take the three switches and three light-emitting diodes. Take care to ensure that the front panel is not scratched during this operation as this would greatly detract from its final appearance.

Letter the front panel as necessary and give it several light coats of lacquer for protection. A solid machine-turned aluminium knob and two different-coloured end caps for the miniature toggle switches completes the front panel and gives a very professional finish.

REAR PANEL

The rear panel must be punched or cut to take the two main sockets, mains cable inlet, and also SK3 if used. There will not be much room left on the rear fascia after the two mains sockets are in place, and so this stage of the construction needs to be planned with care.

If flush-fitting sockets are used, then two large cut-outs will be required; on the prototype this was very easily accomplished with a tank cutter and hand brace. Other methods include drilling a ring of holes, punching out the centre and then filing till smooth.

COMPONENTS



Resistors

R1	1.2k Ω
R2	10 Ω
R3-R14	390k Ω (12 off)
R15	220 Ω
R16	680 Ω
R17	47 Ω 1W
R18	1.5k Ω
All $\frac{1}{4}$ W carbon \pm 5% carbon except R17 (1W)	

Capacitors

C1	1000 μ F 25V p.c.b. elect.
C2	0.1 μ F polyester
C3	1 μ F 35V tantalum
C4	0.1 μ F polyester
C5	3.3 μ F 35V tantalum

Semiconductors

D1-D4	BY164 60V 1.4A bridge rectifier
D5, 6, 8	TIL220 or similar i.e.d. with mounting clip (3 off)
D7	1N4001 or similar silicon diode
TR1	BFY52 silicon <i>n</i> p <i>n</i>
IC1	ZN1034E precision timer i.c. 14 pin d.i.l.

Miscellaneous

T1	Mains primary/12V 500mA secondary transformer
RLA	12V 110 ohm coil with two sets of changeover contacts rated at 250V 10A
S1	d.p.d.t. 10A mains toggle
S2	s.p.d.t. miniature toggle, centre biased
S3	1-pole 12-way rotary switch
S4	d.p.d.t. miniature toggle
SK1, SK2	13A 250V flat pin flush mains socket (2 off)
SK3	See text
FS1	1A 20mm
FS2	7.5A $\frac{1}{2}$ inch

Chassis fuse holders for FS1 and FS2; case, Verobox 75-1412-K; glass fibre p.c.b.; 14 pin d.i.l. socket; control knob; 13A cable and plug; p.v.c. insulated interconnecting wire; 10A mains interconnecting wire; 10A connecting block; coloured caps for S2 and S4 (one red and one green); p.c.b. mounting pillars.

See
**Shop
Talk**
page 19

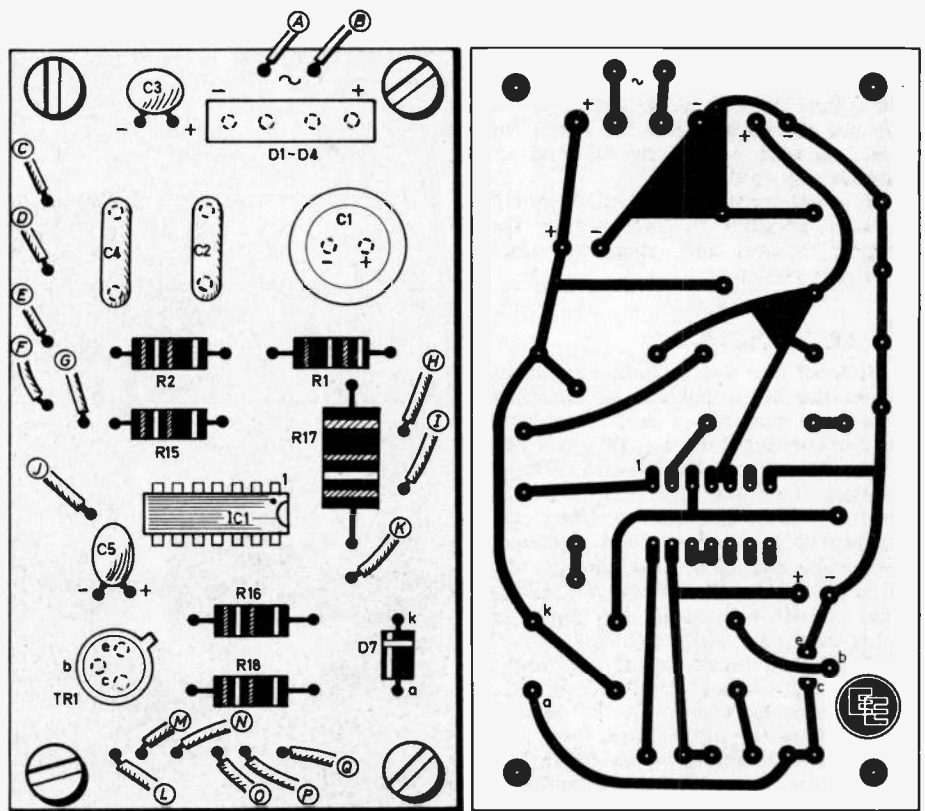
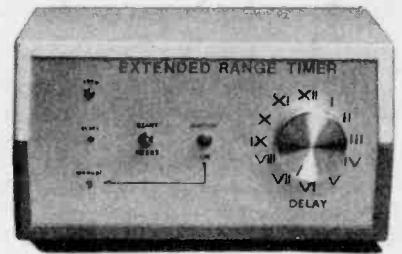
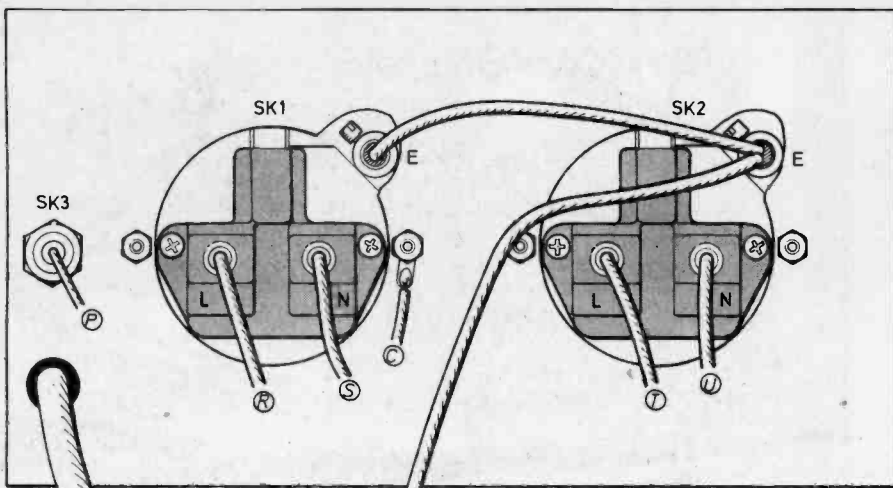
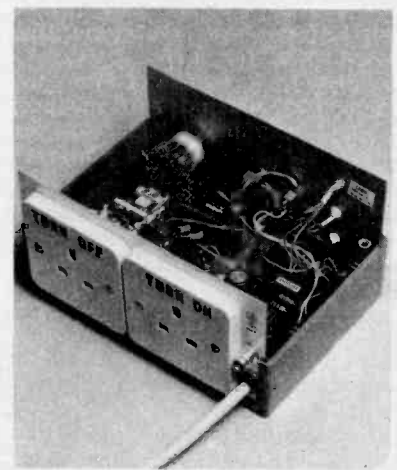
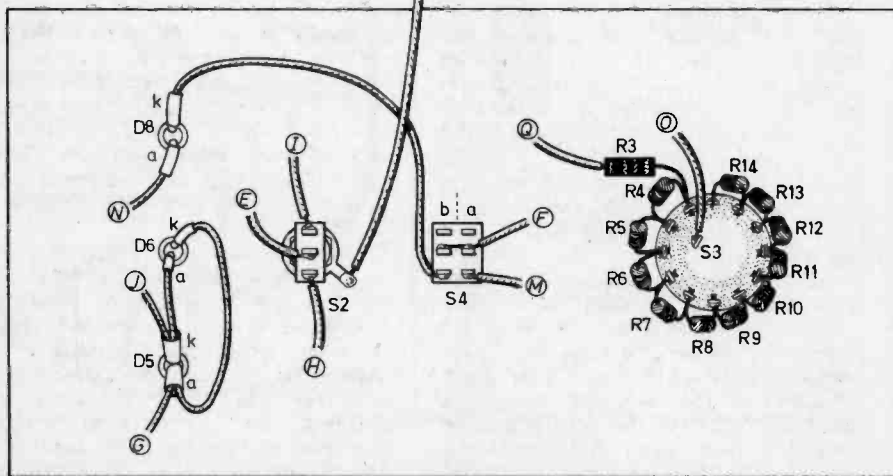
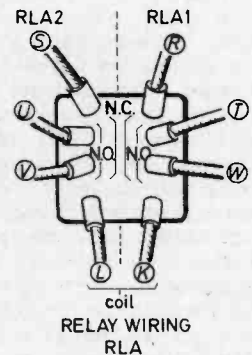
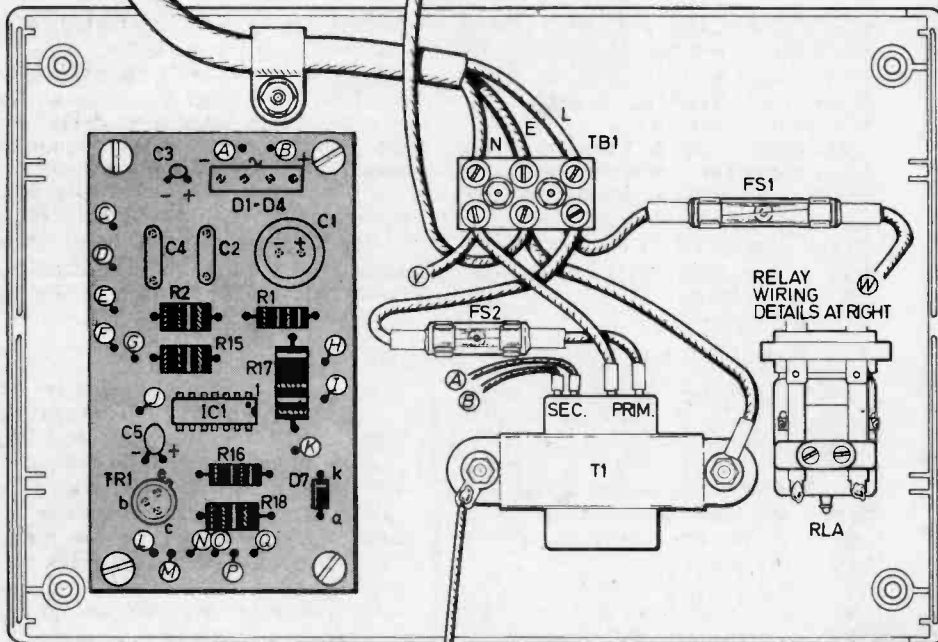


Fig. 3. Printed circuit board component layout and underside foil pattern (actual size).



Mains On/Off Timer

Fig. 4. The case opened out to show the position of the internal components and the internal wiring. All cables carrying a.c. mains must be rated at 240V 13A. This includes the wiring to SK1, SK2, RLA, FS1 and T1 primary. The relay connections are shown below. These may differ if the specified relay is not used. Connections to locations on the p.c.b. are made using veropins.



The resulting large holes were then slightly modified with an Abrafile to take the shape of the earth terminals of the mains sockets.

It will be seen that as the mains inlet hole must be very near the right hand edge of the panel, then an adjacent hollow pillar moulded into the base needs to be trimmed right down to allow the mains cable to pass through unhindered. This pillar must be cut with a hacksaw, making quite sure that you don't cut into the edge of the case itself.

A hole (or two holes, depending on the type of socket used) will be required for SK3, if used. If a BNC socket is used, as in the case of the prototype, then one hole only is needed, the 0V connection being made through the earth. If, for example, two 4mm sockets are used then provision has been made on the p.c.b. for a 0V connection to be extended to one of the sockets.

Fit the sockets to the rear panel and fit a grommet to the mains cable inlet hole. Letter SK1 and SK2 "turn on" and "turn off" respectively.

INTERNAL WIRING

The dark grey chassis is drilled to take the p.c.b. mountings, two fuseholders, transformer, terminal block, relay and mains cable clamp. The positioning of these holes should be carefully marked out so that the holes do not foul with the pre-moulded pillars in the base. The mains cable clamp is a nylon "P" clip which prevents the cable from being pulled out.

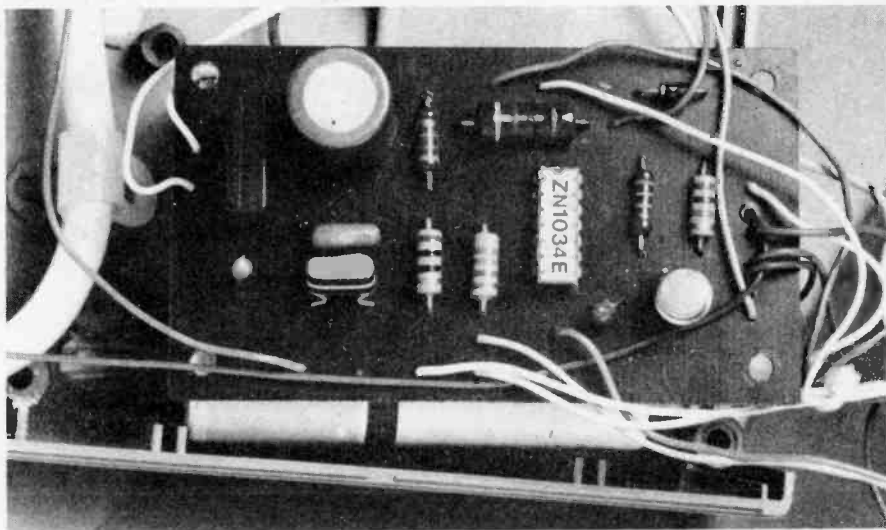
There is quite a lot of interwiring to be carried out but if Fig. 4 is followed carefully then no problems should arise.

All mains-voltage joints must be neatly soldered and insulated with p.v.c. sleeving, and all of this wiring is carried out with 10A (or greater) mains cable coloured blue, brown or green/yellow to coincide with the standard mains colour code. The transformer and FS2 can, however, be wired with normal 6A mains cable. The mains inlet must be rated at 13A. All other wiring can be carried out with lightweight hook-up wire, preferably stranded.

The relay connections shown in the diagram are for the specified relay only, and may differ if other makes of open relay are used.

EARTHING

Concerning the earthing arrangements, the front panel must be earthed using a very large earthing tag placed under one of the miniature toggle switches. An alternative here would be to solder the earth wire directly to the metal body of one of the switches. The rear panel is earthed



Close up view of the top of the p.c.b. showing component positioning and wiring.

with a 4BA solder tag under one of the mains socket mounting bolts. The 0V line of the p.c.b., and the transformer mounting bracket, are earthed in a similar fashion.

The wiring can be tidied up using nylon ties. The wires are arranged into looms, the tie is threaded around the loom and pulled tight. The excess is then snipped off. When forming the looms, keep mains cables away from low voltage wiring.

CHECKING AND SETTING UP

With all of the wiring completed, check carefully all aspects of your work. Check the p.c.b. for errors like reversed components or dry joints, etc. Recheck the mains wiring for quality and make sure that this is in order. Check the polarities of the l.e.d.s are correct.

If a multimeter is available, select a low ohms range and test for a low resistance between the earth pin of the mains plug and the front and rear panels. Test for infinite resistances between the earth pin and live and neutral pins of the plug.

If you are satisfied, fix down the top cover of the case, plug in and switch on. The STOP l.e.d. should be alight. Move S1 to START and allow it to return to centre off. The STOP indicator should extinguish and the START l.e.d. glow. The relay should also be heard switching in. Reset the timer at S1 and the relay should click out and the l.e.d.s switch over again.

Check now that the manual switch operates the relay and MANUAL l.e.d. when moved down. Set the knob for a one hour delay and start the timer; check that roughly a one hour delay is achieved. This last test will give a good indication of the accuracy to be expected with other delay settings. The prototype gave exactly 58 minutes delay on a one hour setting—this is

exactly the period calculated with the formula given earlier.

If a c.r.o. is available, then the basic oscillator period can be measured (up to a maximum three hour delay) and the expected time delay computed with the formula given previously.

If everything seems in order then try the timer on a very long delay setting to confirm its accuracy. Here again the prototype was less than ten minutes out on an eleven-hour setting.

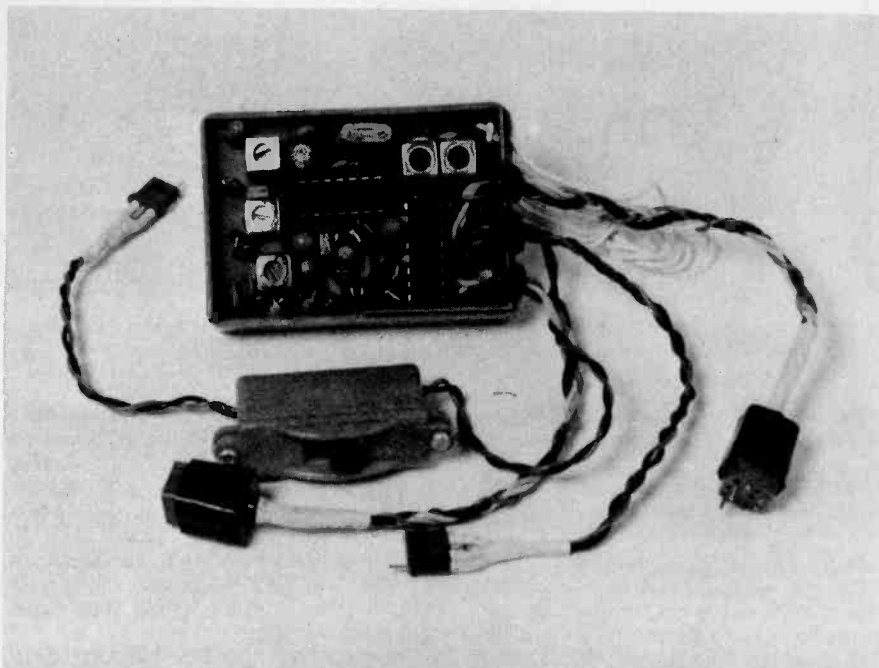
USING THE TIMER

Someone will possibly want to use a cassette recorder with the device. This is in order provided that the cassette recorder is not allowed somehow to remain for long periods in the "play" position with the power removed. Otherwise the rubber pinch-wheel may possibly become physically distorted if it is kept "pinching" the tape against the capstan spindle for too long.

The timer can quite successfully be used with "auto stop" recorders to turn the power off altogether after the tape mechanism has stopped automatically at the end of a tape.

Finally it was discovered that in spite of the decoupling incorporated in the circuit, spurious noise generated by other appliances sharing the same socket being switched on and off sometimes reset the Timer. The Timer will not however start timing when a transient appears on the line.

The only way round this it seems is to use the timer and nothing else off one mains outlet, or plug into a suitable mains "suppression unit". It can be noted that the timer is not susceptible to transients generated by appliances in other parts of the building, and it is in order to share a mains wall socket with loads that are always on all of the time, like digital clocks, for example. □



By L. ARMSTRONG • H. DICKINSON • W. WILKINSON

PART THREE

EE RADIO CONTROL SYSTEM

RECEIVER DESCRIPTION AND CONSTRUCTION

This third part of the series deals with the receiver, its construction and the tuning-up procedure.

This receiver is as sensitive as most commercial receivers and is capable of working in the 25kHz spaced split frequencies provided reasonable care is taken to ensure that the adjacent channel transmitter is not nearer to the model than the control transmitter.

The receiver is housed in a small plastics case. External connections to the servos and the battery are made either by floating connectors attached to the ends of flexible leads, or via a connector block mounted directly on the p.c.b.

FLEXIBILITY

Any number of channels from one to seven may be used, the only difference being in the number of leads brought out. Individual sockets may be used for each channel if so required, or a mixture of single sockets and blocks as shown in the diagrams.

Any servo may be plugged into any receiver output channel provided that particular channel has a control stick on the transmitter. It is not necessary to use the control channels in any set order and the servos should be plugged into the channels required.

Once again i.c.s are used where advantageous, such as in the r.f. amplifier / oscillator stages and the decoder. This also helps to reduce constructional errors in these areas.

RECEIVER IN OUTLINE

A typical 27MHz receiver is shown in block diagram form in Fig. 3.1.

The transmitter signal is received by the aerial and passed on to a tuned circuit which has a high impedance to 27MHz signals but has a low impedance to signals of other frequencies. This ensures that a maximum 27MHz signal is passed to the radio frequency (r.f.) stage for amplification.

The crystal oscillator, which is usually of the third overtone type, runs at a frequency of 455kHz less than that of the transmitted signal.

When the oscillator signal and the output of the r.f. stage are fed into the mixer stage, the sum and difference frequencies of the two input signals are available at the output of the mixer. The output of the mixer is fed into a tuned amplifier which is tuned to 455kHz thus ensuring that only the signals spaced 455kHz away from the crystal oscillator frequency are amplified. This stage is called the intermediate frequency amplifier (i.f.).

The i.f. amplifier output is then fed into a detector stage which effectively removes the 455kHz signal and leaves only the modulation, the modulation in this case being the pulses necessary to drive the decoder circuitry which in turn drives the servos.

It can be seen that the first three stages of the block diagram Fig. 3.1 are contained in one integrated circuit IC1. This i.c. gives a reliable mixer stage which is necessary if repeatability of performance is to be obtained amongst receivers built by different constructors.

A conventional i.f. amplifier using transistors and transformers is used, this then feeds a transistor detector. It was considered whether to use ceramic filters to obtain a better selectivity, but suitable filters cost a few pounds and were not generally available, hence the choice of standard circuitry.

The rest of the receiver consists of the pulse amplifier, sync pulse detector stage and the decade counter decoder IC2 which decodes the pulses suitably for driving the servos.

CIRCUIT DESCRIPTION

In the full circuit diagram (Fig. 3.2) it can be seen that the aerial is connected to the primary of a double-

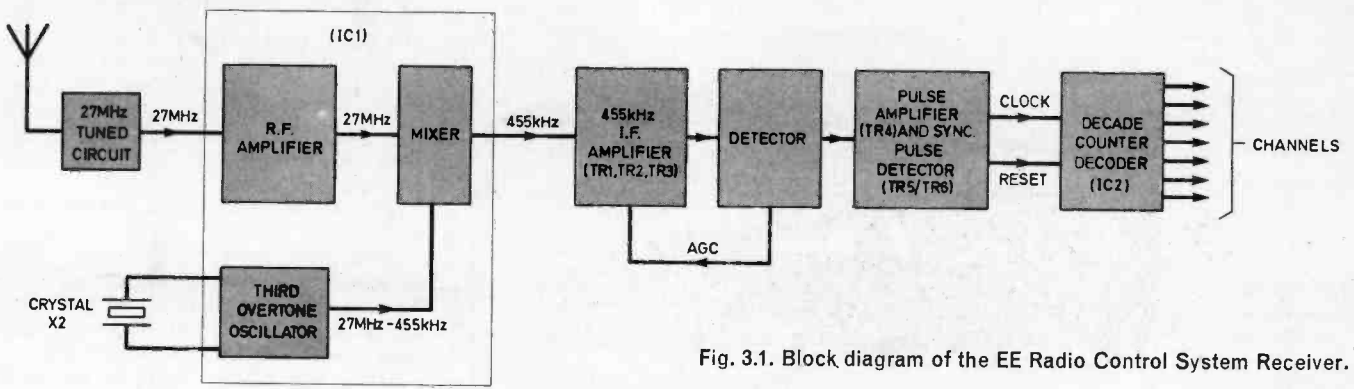


Fig. 3.1. Block diagram of the EE Radio Control System Receiver.

tuned r.f. circuit comprising inductance L1 and capacitor C2. A small capacitor C3 couples the primary tuned circuit to the resonant secondary circuit L2, C4. These two tuned circuits form a highly selective tuned input stage.

Impedance matching into the r.f. stage of IC1 is achieved by using the secondary of L2.

The crystal oscillator discrete components are the crystal X2 and three capacitors, C7, C8, C9; the remainder of the oscillator circuit being in IC1 itself.

MIXER STAGE

The r.f. stage output and the oscillator output are mixed internally, the output of the mixer stage (pin 2)

being fed into the primary of the first i.f. transformer T1 which is tuned to the difference frequency of 455kHz by its internal capacitor and adjustable ferrite potcore. The output of the untuned secondary drives the first i.f. amplifier TR1, the collector currents of TR1 and TR2 being determined by the emitter resistors and the base voltages.

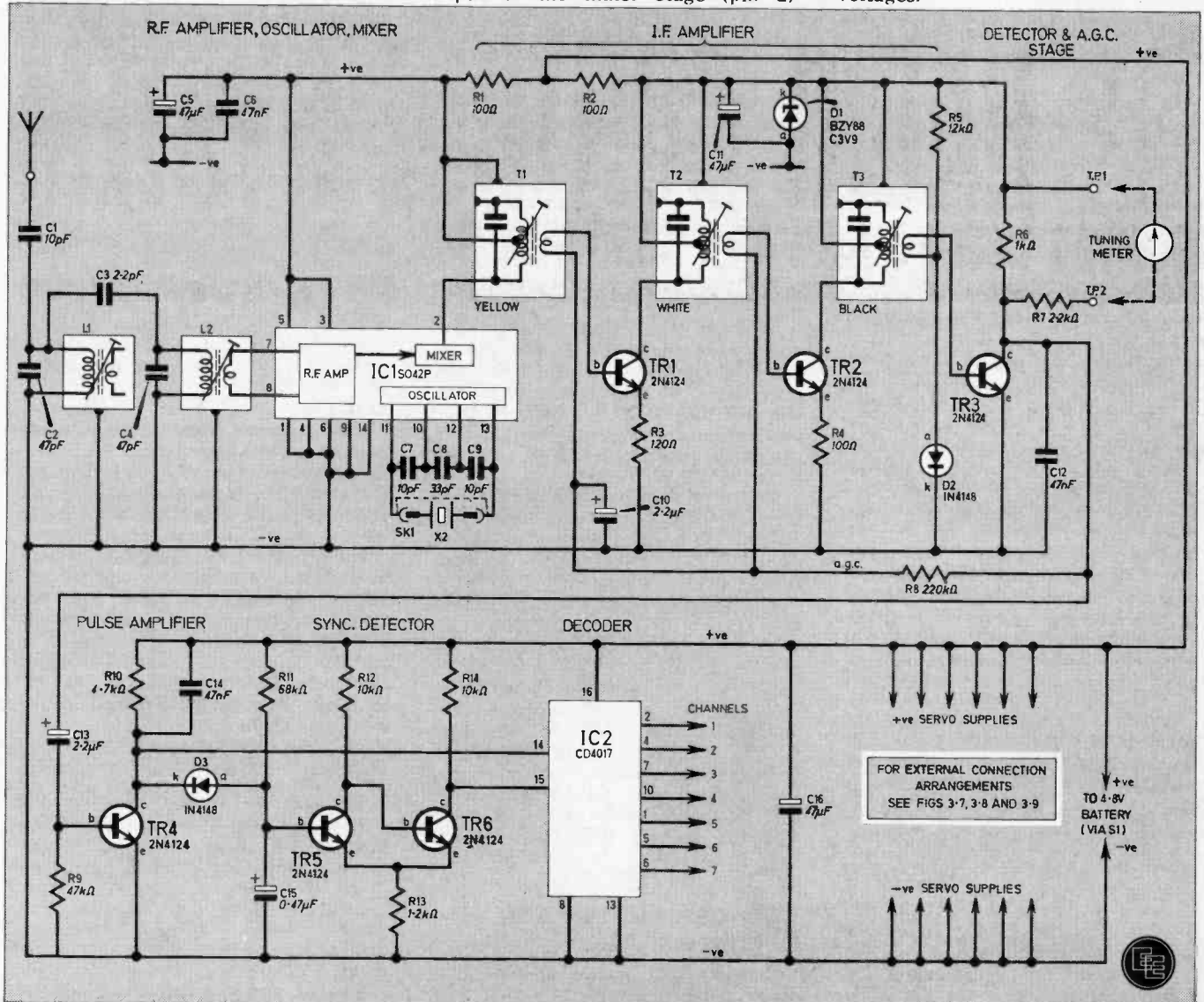


Fig. 3.2. Circuit of the EE Radio Control System Receiver.

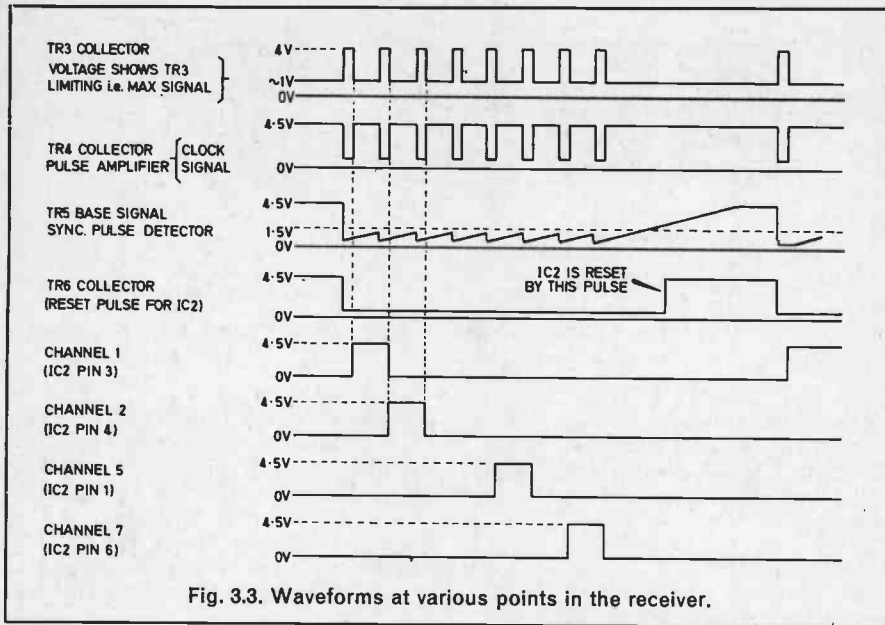


Fig. 3.3. Waveforms at various points in the receiver.

The second i.f. transformer T2 couples the signal into the second i.f. amplifier TR2 which in turn feeds i.f. transformer T3.

The secondary of T3 is connected between a forward biased diode D2 and the base of detector transistor TR3. The forward voltage of 0.5V across D2 is insufficient to turn on TR3 which needs approximately 0.65V base voltage for this purpose. It can be seen therefore if the secondary of T3 supplies a 300mV peak-to-peak i.f. signal, the positive peaks will add to the 0.5V thus supplying the base voltage needed and so turn on TR3.

The larger the signal, the larger the voltage swing at TR3 collector until the maximum swing of (supply voltage—0.4V) is reached. Smoothing capacitor C12 has the effect of changing the 455kHz peaks into a mean d.c. voltage whose d.c. level varies with signal strength, the larger the signal the lower the d.c. voltage at TR3 collector.

When a 200µsec "interruption" in signal occurs (which constitutes a channel gap from the transmitter), TR3 has insufficient base voltage and turns off, capacitor C12 charging swiftly up to positive rail via R6. When the signal resumes, TR3 turns on again discharging C12 and the "interruption" becomes a "pulse". In this way the transmitted pulses are reconstituted at TR3 collector.

AUTOMATIC GAIN CONTROL

Since the d.c. level at TR3 collector is dependent upon signal strength, it is fed via R8 to the bases of the two i.f. amplifier transistors TR1, TR2, the pulse interruptions in signal being "smoothed out" by capacitor C10. In this way the gain of the i.f. amplifier is controlled by the incoming signal strength, since the mean d.c. vol-

tage at TR3 collector drops with large signals thus decreasing the base voltages of TR1, TR2, hence their gain.

The signal from TR3 collector is fed via C13 to the pulse amplifier TR4 which has no bias and hence requires 0.6V pulse to trigger it thus giving a measure of noise immunity. The output at TR4 collector is approximately a 4.5V peak-to-peak signal and is used to "clock" the decoder IC2.

DETECTION OF SYNC PULSE

In order that "Channel 1" always appears at the same output pin of IC2 it is necessary to detect the end of a block of pulses and reset the counter IC2. It is for this purpose that the sync pulse was inserted into the pulse train and this is now detected by D3, R11, C15.

Under no-signal conditions the collector of TR4 is high and hence C15 charges up via R11. When the pulses appear, C15 is discharged to approximately 0.7V via D3, TR4.

The time constant of C15, R11 is such that C15 cannot recharge between channel pulses, but only in the sync pulse period which is relatively long. The voltage across C15 is therefore fed into a level detector TR5, TR6 which has a high output when C15 is charged up and vice versa. Hence under no-signal conditions, or during sync pulse, C15 is charged up and TR6 collector is high thus resetting the decoder IC2 ready for the next pulse train.

DECADE COUNTER AND DECODER

The decoder IC2 is a CMOS five-stage Johnson decade counter with built-in code converter. The ten decoded outputs, of which only seven

are used, are normally low and only go high at their appropriate decimal time period. The output changes occur on the positive-going edge of the clock pulse and the outputs appear in rotation as shown in the waveform diagram, Fig. 3.3.

The sequence of events is therefore as follows:

Assuming sync pulse time, TR6 collector is high thus resetting IC2. The negative-going edge of the first clock pulse takes TR6 collector low thus removing the reset from IC2.

When the positive edge of the first pulse occurs, output 1 of IC2 goes high and remains high until the positive edge of the second block pulse, whereupon output 1 returns to the low state and output 2 goes high. This remains high until the positive edge of the third clock pulse when output 2 returns low and output 3 goes high.

This sequence carries on for each clock pulse up to 7 when the sync pulse occurs and resets IC2. All the outputs are set low again ready for the next pulse train.

Hence it can be seen each output goes high for the period between two adjacent clock pulses thus reconstituting the original pulse from the transmitter for that particular channel.



The receiver is built on a small printed circuit board, Fig. 3.4. Location of components is given in Fig. 3.5.

As with the transmitter, the importance of using a good soldering iron with a small bit must be stressed.

Good joints are most essential here as it is the receiver that will be taking all the knocks and bumps in your model, so any dry and loose joints will be a hazard to its survival. A skilled and practised hand in soldering miniature components is demanded. This is NOT a task for a novice to undertake.

CIRCUIT BOARD

Construction is started with the insertion on to the p.c.b. (plain side) of wire links.

"Link A" goes from IC2 pin 6 to "Channel 7" pad.

Link "B" goes from IC2 pin 12 to position shown. This is for an optional "fail-safe" facility, to be described later.

The r.f. tuned circuits can now be inserted, then the i.f. cans making sure in the case of the latter that

EE RADIO CONTROL RECEIVER

COMPONENTS RECEIVER

Resistors

- R1 100Ω
 - R2 100Ω
 - R3 120Ω
 - R4 100Ω
 - R5 12kΩ
 - R6 1kΩ
 - R7 2·2kΩ
 - R8 220kΩ
 - R9 47kΩ
 - R10 4·7kΩ
 - R11 68kΩ
 - R12 10kΩ
 - R13 1·2kΩ
 - R14 10kΩ
- All $\frac{1}{4}$ W carbon \pm 5%

See
**Shop
Talk**
page 19

Capacitors

- C1 10pF ceramic plate
- C2 47pF ceramic plate
- C3 2·2pF ceramic plate
- C4 47pF ceramic plate
- C5 47μF tantalum bead 6·3V
- C6 47nF ceramic disc 12V
- C7 10pF ceramic plate
- C8 33pF ceramic plate
- C9 10pF ceramic plate
- C10 2·2μF tantalum bead 35V
- C11 47μF tantalum bead 6·3V
- C12 47nF ceramic disc 12V
- C13 2·2μF tantalum bead 35V
- C14 47nF ceramic disc 12V
- C15 0·47μF tantalum bead 35V
- C16 47μF tantalum bead 6·3V

Semiconductors

- TR1-6 2N4124 npn silicon (6 off)
- D1 BZY88C3V9 Zener diode 3·9V
- D2, 3 1N4148 silicon diode (2 off)
- IC1 SO42P R.F. amplifier, tuner & oscillator (Siemens)
- IC2 CD4017 CMOS decade counter

Inductors

- L1, 2 Tuned r.f. coil Toko 113CN-2K159 (2 off)
- T1 i.f. transformer, yellow Toko 4827
- T2 i.f. transformer, white Toko L238
- T3 i.f. transformer, black Toko 4828

Miscellaneous

- Receiver case (SLM)
- $\frac{1}{4}$ inch grommets (3 off)
- Printed circuit board.
- Connectors—as required, see text (SLM)
- Connecting wire (10 strand), various colours. Heat shrinkable plastic tubing.
- Nicad battery box, 4 × HP7, (SLM)
- S1 Noble slide switch d.p.d.t., with box (SLM)
- SK1 crystal socket, low profile (SLM)
- X2 Crystal (see Part 2)

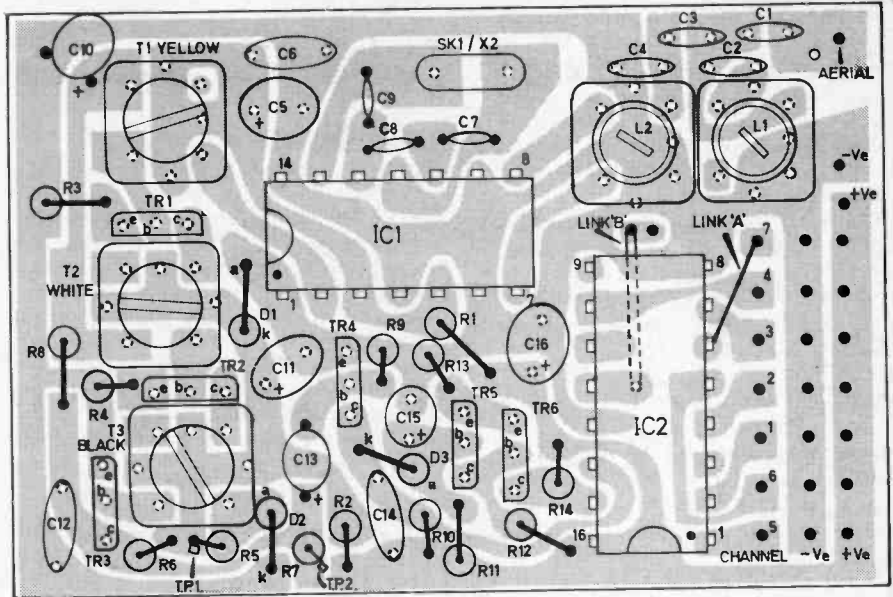


Fig. 3.5. Top view of the printed circuit board with all components in situ. The pattern on the other side of the board is shown in grey to assist when fitting components. Note the two links "A" and "B" which must be fitted before any components are mounted. T.P.1 and T.P.2 are "tuning points"—for connection of multimeter.

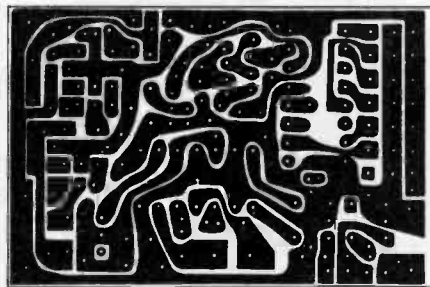


Fig. 3.4. Printed circuit board for the EE Radio Control Receiver, actual size.

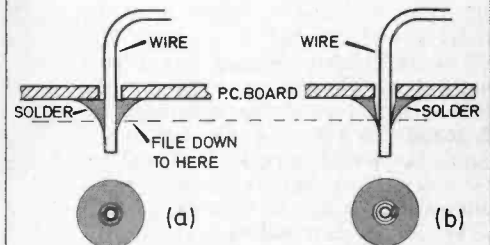
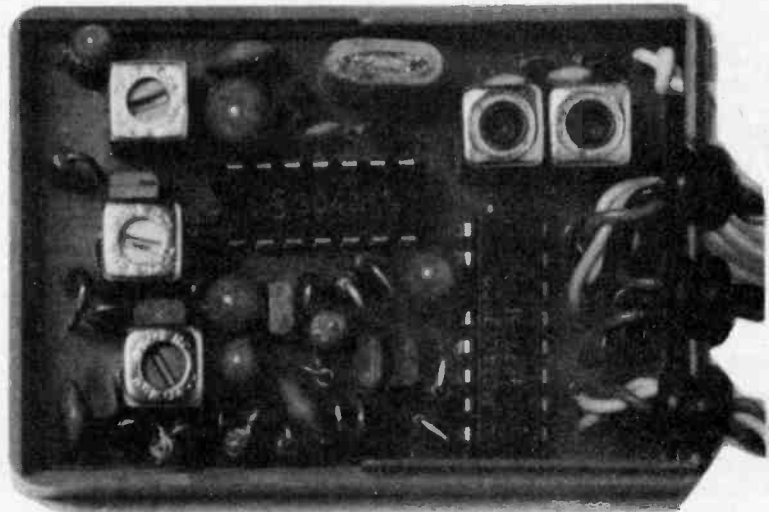


Fig. 3.6. (a) Good joint; any filing shows just solder and wire; (b) Bad joint; filing reveals wire with ring of solder and air gap between the two.



they are inserted in the correct place (identified by their coloured tuning core).

The integrated circuits IC1 and IC2 are inserted next. Take care with IC2 as this is one of those CMOS devices. If in doubt follow the precautions suggested in the transmitter construction section.

The order of placement for the remaining components is not critical, however a suggestion is to insert the physically smaller components first. Make sure that the diodes, tantalum capacitors and the transistors are all inserted the correct way round.

The uppermost leads of R5 and R7 should be bent to form tuning points.

When mounting the crystal socket take care no solder gets down the leads as this will ruin it.

PLUGS AND SOCKETS

The choice of plugs and sockets for connecting between the receiver and servos is left entirely to the constructor as it is dependent upon whether it is to be compatible with parts of an existing system. In the case of the "first time" constructor then Figs. 3.7 and 3.8 show how to connect to the connector block, in this case the SLM 7-way 3-pin type.

This block can be used either as a floating connector on the end of flexible leads, or mounted directly on to the p.c.b.

The writer's preference is to use floating connectors rather than a p.c.b.-mounted block connector, since as the receiver is invariably wrapped in sponge rubber the servos may be plugged or changed in at will without disturbing it. Hence a suggested wiring scheme if more than four channels are required could be as follows:

A single 3-pin socket on a flying lead is used for the first channel since this is invariably the aileron channel and the servo is mounted in the wing of the plane. The remaining channels are wired to the connector block as shown, the battery supply feeding into the plug on the block. When ordering the connector block specify 7-way block and cover (6 sockets plus 1 plug).

The power pins on the blocks are wired in parallel as shown. Two or three strands from the hook-up wire are twisted together and tinned. The wire is then wound round the pins and soldered.

After all the leads are connected, check them *very carefully*. Then cover the back of the block and the joints with 5-minute epoxy and slip the cover on to the back of the block. The epoxy when set fixes the pins and wires into a solid block and prevents any single connector from pulling out of the block.

AERIAL

The aerial should be a 30-inch length of light flexible cable similar to that used for the leads.

FINAL EXAMINATION

When all the wiring is completed (including the servo leads), the bottom of the board should be cleaned to remove any flux. The board should be scrutinised for any solder bridges between tracks and these removed.

Another trick is to file the heads off all the joints and then clean the board again. This usually shows up any dry joints since these *cannot* be tolerated. Think of the model and your time mending it!! See Fig. 3.6.

CHECKING AND TUNING-UP

Measure the resistance between the battery supply leads with a multimeter on the ohms range. It should read approximately 1kohm with the leads one way round and 100ohm the other way round. If much less check for shorts on the back of the p.c.b. and check parts placement.

If the measurements prove correct then connect the correct way round to a 4.8V supply and the following measurements should be checked with reference to the "0" volts (-ve) rail. Measurements should be done under no-signal conditions, that is with the transmitter switched off.

- | | |
|--|----------------|
| 1. Pin 2 IC1 | approx. +4.5V |
| 2. Emitter voltages of TR1, TR2 measured at top of R3 and R4 | approx. +0.25V |
| 3. Can of i.f. transformer T3 | approx. +3.9V |
| 4. Collectors of TR1, TR2 | approx. +3.9V |
| 5. A.G.C. supply voltage (top of R8/collector of TR3) | 4.5V |
| 6. Base of TR3 | 0.6V |
| 7. Collector TR4 | 4.8V |
| 8. Collector TR5 | 1.3V |
| 9. Collector TR6 | 4.8V |

Should any of the above measurements be incorrect then check the placement of the components associated with them.

If the measurements are correct, then plug in the matching crystal into the socket SK1. Place the transmitter, less aerial, very close to the receiver.

Connect a multimeter (of 5kohm/volt a.c. minimum) on the lowest a.c. voltage range nearest 1V between the tops of resistors R7 and R5 (T.P.1 and T.P.2).

Switch on transmitter. If the receiver is anywhere near in tune the meter will start to indicate. Make sure the receiver aerial is clear of any

metal work, etc.

Adjust the i.f. transformers T1, T2 and T3 for maximum voltage deflection then L1 and L2, gradually moving the transmitter further away to keep the meter reading below 0.5V (as this is the maximum deflection obtainable).

Each time the reading approaches 0.5V, progressively move the transmitter further and further away adjusting L1, L2 and T1, T2 and T3 to peak the reading. The meter may well be 10 to 15 feet away at this stage.

The receiver should now be in tune.

If a servo is available, plug it into channel 1 lead, which should be the aileron, and move the transmitter stick to get a servo movement. Typical range with one servo and with no aerial on the transmitter should be about 15 to 20 feet. If no servos are available then this test will have to await next month's issue when the servos will be described.

ALTERNATIVE TUNING METHODS

Two other tuning techniques are available, the first being to connect a crystal earphone between T.P.1 and T.P.2 where the tone of the pulse train can be heard. The same tuning sequence is used to peak the tone to its maximum loudness and clarity.

The other technique is to connect an oscilloscope to the test point T.P.1 and T.P.2 and tune-up watching the waveform. R7 should be increased to 10kohm in this case. The waveforms are as in Fig. 3.3.

FITTING IN CASE

Depending on whether a p.c. block or flying leads are used, the appropriate holes should be cut in the lid of the receiver case with a modeller's knife or file.

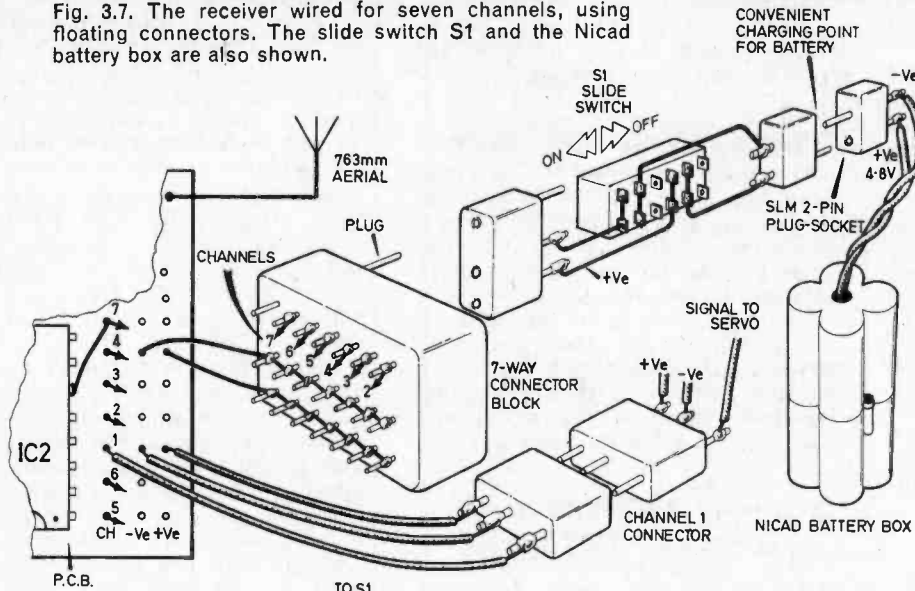
The receiver aerial exits from the case via a small hole and the aerial wire should be knotted on the inside so that no strain is applied to the connection on the p.c.b. if the aerial is tugged.

The p.c.b. assembly should be fitted into the box base and a piece of sponge rubber (about 1/4 inch thick) cut such that when put on top of the receiver, the crystal socket SK1 is uncovered (as is the connector block, if used). This sponge rubber prevents the receiver rattling about in the case and also stops the board lifting when the crystal is removed. The receiver case top should then be fitted and the whole sealed with tape. The receiver is now completed.

BATTERY ASSEMBLY

Fit four Nicad cells into that half of the Nicad holder with the hole in the end. See Fig. 3.11.

Fig. 3.7. The receiver wired for seven channels, using floating connectors. The slide switch S1 and the Nicad battery box are also shown.



EE RADIO CONTROL RECEIVER

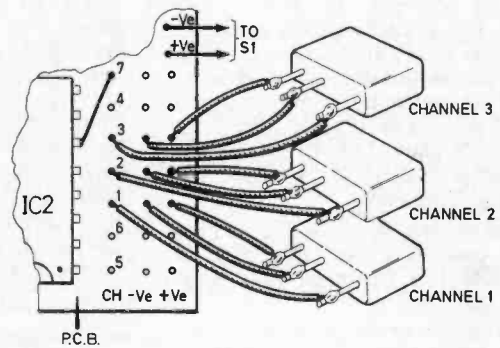
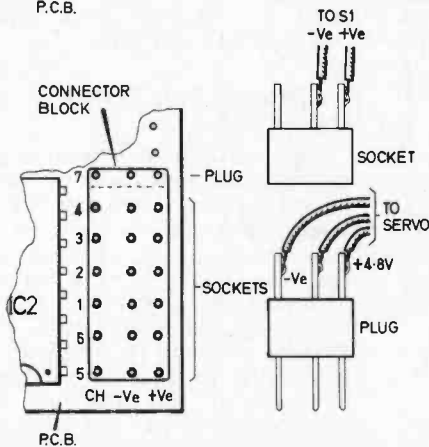


Fig. 3.8. The receiver wired for seven channels using 7-way connector block mounted directly on p.c.b. External connections are via one socket and six plugs.

Fig. 3.9. The receiver wired for three channels using single sockets.

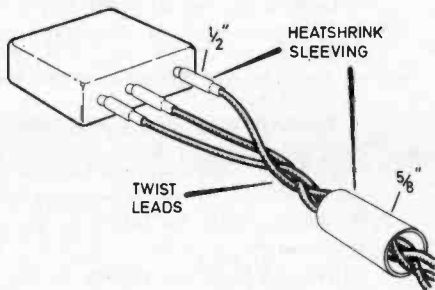


Fig. 3.10 (left). Wiring of single plugs and sockets and fitting of shrinkable plastic sleeves. Apply heat (e.g. from hair drier) and sleeves will shrink to half original diameter, thus securing the lead connections.

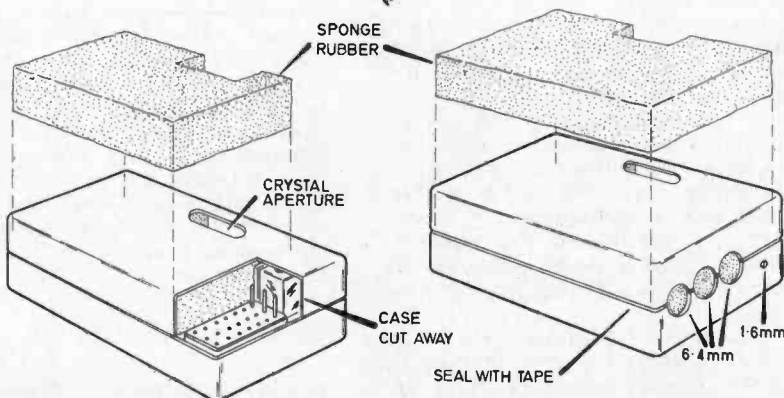


Fig. 3.12. Receiver case showing cut-outs required and sponge rubber pad.

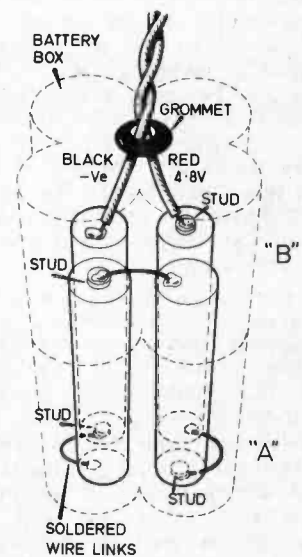


Fig. 3.11. Wiring of the four Nicad cells and their installation within the battery box.

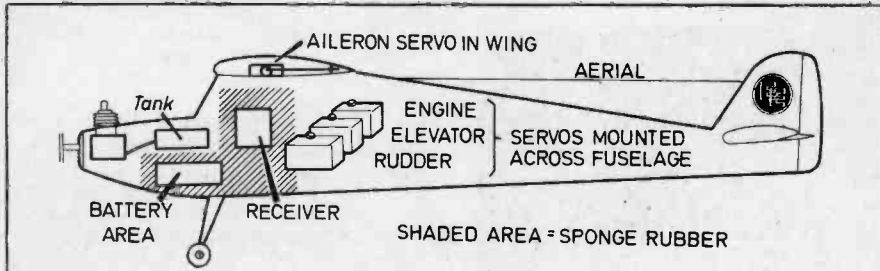


Fig. 3.13. A typical installation of equipment in a model aircraft.

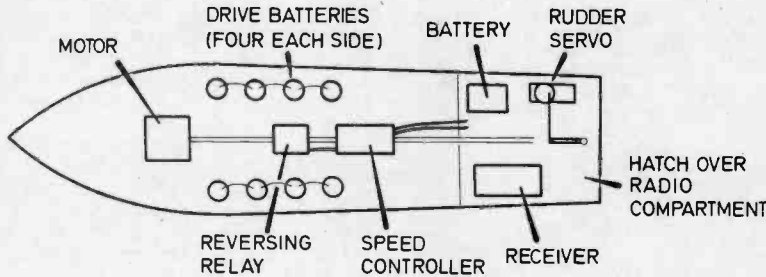


Fig. 3.14. A typical installation of equipment in a model boat.

Wire the exposed ends of the cells as shown at "A". Fit other end of holder over this wired end, invert box and remove top cap. Wire this end now as "B" taking care to fit the battery supply wires through the grommet and the top before connecting to the cells. Finally screw the two halves of the Nicad box together.

INSTALLATION IN A MODEL

Arrangement of the equipment in a model is usually shown on the model plans. If such information is not available, it is suggested that a book on the particular line of modelling in question should be purchased.

These specialist publications give a lot of useful advice based on experience. In a plane for instance, a typical installation is as shown in Fig. 3.13.

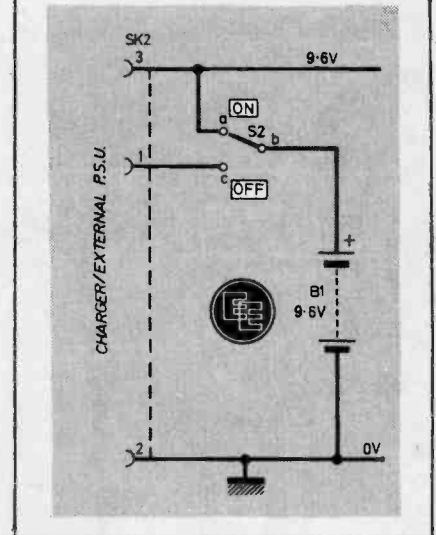
Note the battery is installed at the front so that in the event of a crash the battery does not rush forward and batter the receiver to certain death.

The battery and receiver should be well packed in foam rubber. The servos can either be mounted on commercially available servo trays (which even hold the on/off switch), mounted on bearers via woodscrews and the mounting grommets supplied with each servo, or just fixed inside the model using double-sided adhesive tape.

TRANSMITTER

The transmitter circuit diagram Fig. 1-3 should be amended as follows:

- (i) To conform with Fig. 2.6 and conventional numbering of DIN sockets, renumber SK2 pins as shown below
- (ii) Add letter code to S2 contacts. (Second pole is not used, but slider contact (e) provides anchor point—as in Fig. 2.6.)



In the case of a boat it is best to waterproof all the equipment where possible. This can be easily achieved by putting the receiver battery, receiver and servos inside a plastic sandwich box. It is advisable to mount the speed controller and changeover relay near to the motor in order to cut down any voltage loss which can occur with today's powerful electric motors.

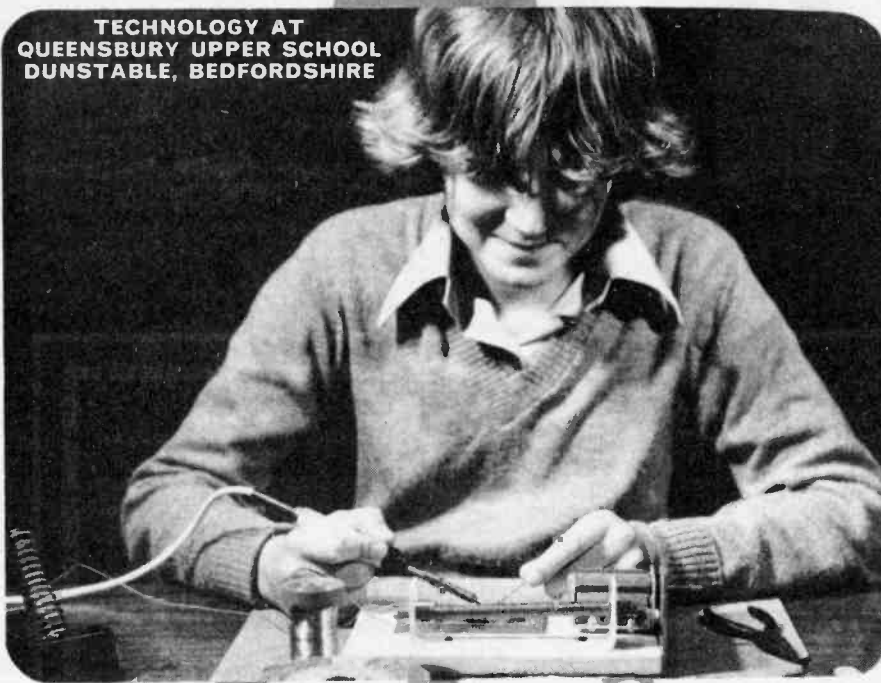
Next Month: Servos and speed controller.

JACK PLUG & FAMILY...

BY DOUG BAKER



TECHNOLOGY AT
QUEENSBURY UPPER SCHOOL
DUNSTABLE, BEDFORDSHIRE



School Report

By M. H. S. Higley

Electronics was introduced into Queensbury School curriculum in September 1974 and then, shortly afterwards, the subject of Design Technology. Both of these subjects are taught within the Craft, Design and Technology department, under the title of Design Technology, and satisfy the School's desire to provide a link between Mathematics/Science and Craft.

Pupils who study Design Technology find they are able to build the AND, NOT and OR gates which they encounter in Computer Studies. Likewise, the very elementary electronics knowledge the pupils obtain in Physics is extended both

in theory and practice during Design Technology lessons.

Exams

The public examinations taken by pupils, having completed the two year Technology course, are C.S.E. Electronics and, either C.S.E. or 'O' level Technology. Within the next two years it is hoped to have sixth formers studying at 'A' level.

Electronic components are, of course, expensive and the constructional projects undertaken by the pupils, in the main, employ discrete components as many of the integrated circuits available are far too expensive for school use. However,

the 741 op. amp and T.T. Logic (TTL), in the 7400 series, are used extensively because these are extremely useful and also inexpensive.

Projects

Recently, they have been experimenting with the ZN414 integrated circuit radio "chip" and this may become the basis of a standard receiver for the pupils. Several simple circuits are used as an introduction to the world of electronics such as, a single transistor radio receiver, a moisture detector, a light operated switch and an elementary metal detector. These are projects which ideally suit the inexperienced constructor. The more advanced pupils have in the past constructed a manual telephone exchange, a digital clock, a logic tutor box and a differential amplifier which is used to demonstrate electrocardiograph techniques.

Work now in progress includes a full-adder demonstration unit using TTL and a model high-speed commuter train driven by an air-screw. This particular project will have circuitry to start, stop and reverse the vehicle at pre-determined points along the track.

Identi-light

One pupil is investigating the possibility of identifying people using a light detector which could be employed in police work or in hospitals. His theory is that different features reflect varying amounts of light and by scanning the face with a light measuring device an electrical output can be obtained which can be stored in many ways.

With the assistance of the Computer Studies department, he will write a BASIC program to store his data in the computer and also carry out a comparison check against previously stored data.

Careers

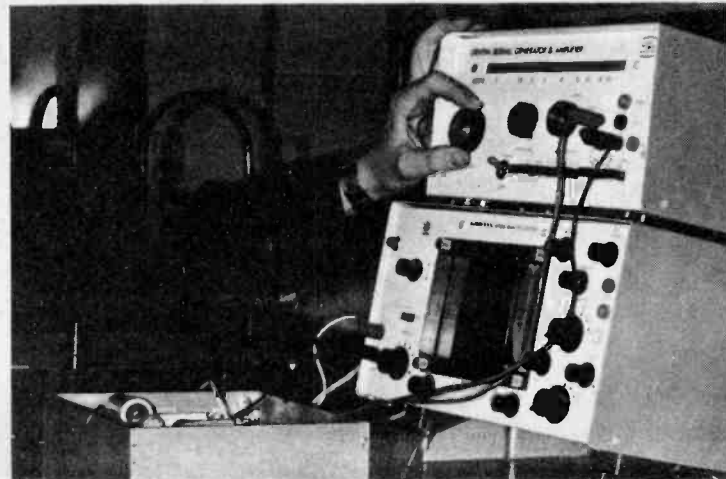
The projects vary in their complexity but it is hoped that all the pupils gain some insight into the ever-expanding fields of electronics. Having experienced the various courses offered through the School curriculum they are better able to choose the career that is suited to their ability.

It is not the intention to produce complete electronic engineers within the school system but to enable the pupils to make the correct choice of career and thence go on to higher education. Should they find in later years they require to cross over into another field then with a good background of Mathematics, Science, English and an appreciation of Technology the transition would be that much easier.

A fifth year pupil taking voltage measurements on the circuit board of his Metal Detector.



A sixth former checking the frequency response of his Mullard 10W Amplifier.





Memory Lane

This being the festive season my indulgent Editor kindly allows me to wander down memory lane and rattle a few old skeletons. In the past I have related incidents in my life that I thought were interesting or amusing without any particular regard to chronological order. This year I thought I would go back in time to my earliest recollections, to see at what point I became entangled in electronics.

It all began when I was about five and was given for my birthday one of those lovely old torches. Perhaps you know the ones. They have a huge bulbous lens and take the Ever Ready 1289 battery. Perhaps they are still around, the batteries are still on sale.

Its amazing after all these years, I think Lawrence of Arabia said the streets of Mecca were lit by electricity while we were still wearing woad. I expect the Arabs used 1289 batteries!

Shock Treatment

Where was I? Oh yes the large torch. Like all small boys I soon reduced it to its component parts and found I could do things with the battery and bulb on their own. I put the bulb in a small aspirin bottle hung it over my bed and wired it up to the battery under by pillow.

So far so good, but I quickly learned that small batteries are soon exhausted, and that led to my next experiment, a more disastrous one. Having decided the battery was dead because there was no electricity in it, where should I get some more? Why of course in the light socket. I promptly removed the bulb and placed the battery contacts on the studs. The result was a violent flash and new fuses required all round.

Moving on a year or two I made the interesting discovery that if two pieces of wire were connected to a battery and joined by a short length of very thin wire it would soon get red hot. The thin wire was placed in the hole in the end of a cotton reel while the hole was filled with gunpowder.

The idea was undoubtedly to explode it from a safe distance. Unfortunately while I was busy stuffing the gunpowder into the hole the two wires some-how contrived to make contact with the battery and caused the loss of my eyebrows, the first of many times it was to happen in my chequered career.

Crystal Clear

It was shortly after that, that crystal sets began claiming my attention. My father brought home a most exquisitely made Marconi set. Rather like a small black attache case with two plated knobs at either side which slid in and out for tuning.

Inside the lid was a panel with switching arrangements for different lengths of aerial and for changing from galena crystal to carborundum. The wiring inside was fantastic, all 16 gauge square sections and every bend an exact right angle. Alas it was several years before they discovered that r.f. currents dislike going round sharp corners and tend to fly off at a tangent. My father was delighted with it and told my brother and I that "Gamages are selling them off for ten bob (50p) and they originally cost fourteen pounds". Even so, we found a simple set using a variometer worked much better.

We then made the amazing discovery that the higher the aerial the louder the sound. Each week we would buy a length

of bamboo pole and push it up another ten feet. The trouble was that each extension had to be thinner than the last until ultimately they were so thin and bent so much that the height advantage was lost.

We made another useful discovery at this time. We found we could run three pairs of earphones from the same set. My father had one pair in the living room and my brother and I each had one by the bed.

We found that to communicate with our parents, we could take off the earphones and talk into them instead of bawling at the top of our voices. This did have its drawbacks. According to my father, I cannot guarantee the veracity of the story, he said he was listening to the news which went as follows "Last night Queen Mary was seen going out with Dad!" The last word being supplied by one of his erring children probably wanting a glass of water. Mind you I have always regarded this story as highly suspect!

Enter the Valve

I had now reached the ripe old age of eleven and was staying in the house of a gentleman who owned a valve set. These had to be seen to be believed. Each valve was turned on slowly by a rheostat, to-day we would call it a variable resistor, and you really could read a newspaper from the light they gave out.

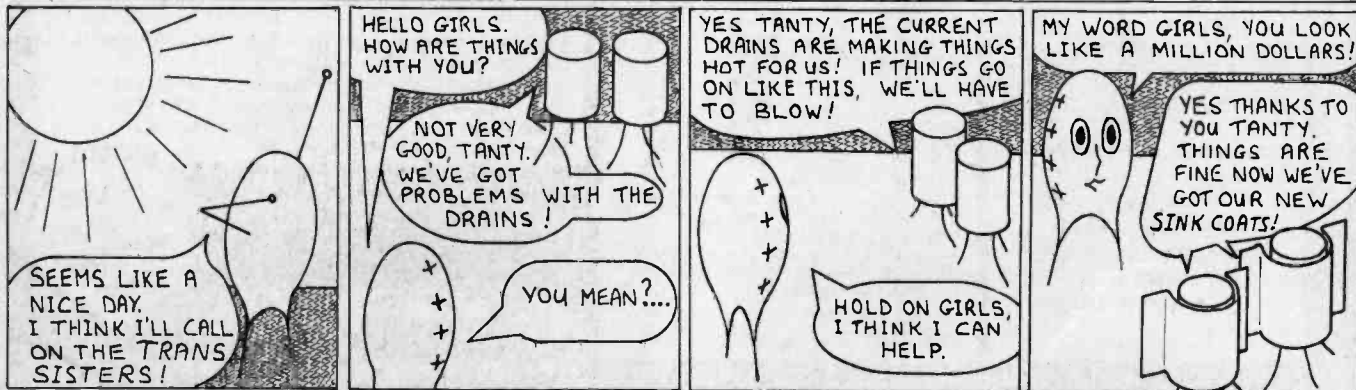
Masses of wires led to an h.t. battery that weighed half a hundredweight, an accumulator fit for a car, and a grid bias battery about a yard long. An enormous coil and slider at the top of the set and two swinging coils on the side, plus a fearsome array of dials and knobs completed the receiver, and crowning all this mammoth out-fit a tiny little horn speaker made by someone called "Brown".

We would all gather round it expectantly and after sundry howls and noises reminiscent of a cat having its tail trodden on, with any luck a squeaky voice would come out of the horn. "This is 2LO London calling in the British Isles, tonight ladies and gentlemen we have for your entertainment that well known comedian Leonard Henry". I wonder how many of my readers remember this or similar announcements.

Say what you will, it was great fun. We were all enthusiastic because we felt we were in at the beginning of a great achievement, and I am delighted to say, those of us in Electronics, to-day, are experiencing the same feelings all over again.

The Adventures of Tanty Bead

By Matthew Reed



Everyday News

A MICRO LASHING FOR INDUSTRY

Judging from the many stories published in these pages over the last year, we find it hard to believe a statement and report from the Minister of State for Industry that less than a third of Britain's top 1,000 companies are applying microelectronics in their business.

This is the finding of a MORI survey conducted for the Department of Industry and revealed recently by Lord Trenchard, Minister of State for Industry.

Brief extracts of a speech he made at a recent London seminar on "Technology and Organised Labour" are given below:

"The lack of British microelectronic applications is reinforcing the huge productivity gap between the UK and our major competitors and provides an explanation as to why UK unit labour costs are so high while our wage levels remains so low."

"In 1978-79 unit labour costs were increasing at a rate of 10 per cent in the UK, twice as fast as in the USA and almost five times as fast as in Germany. Japanese unit labour costs were actually declining at over 3 per cent."

Viewdata Boost

A promise to build thousands a month of viewdata TVs during 1980 has been made by ITT and they will be able to receive the Post Office Prestel Service.

This will go a long way towards remedying Post Office complaints that Britain's TV industry has been producing too few sets, therefore retarding wider useage of Prestel. ITT forecast that by 1985 there will be over a million business users of Prestel and 600,000 domestic users.

GOLDEN AGE

This year's President of the Institution of Electrical and Radio Engineers, Professor William Gosling, called his inaugural address "Electronics—a profession in its golden age".

He pointed out that for the first time in human history we can create artefacts of more than biological complexity and from materials that are as common as dirt.

"I have just returned from Japan whose post-War performance is outstanding. I believe that there are two secrets in the Japanese miracle. First, they really accept that the foundation for a high standard and quality of life must be industrial success and expansion. Secondly, within their companies, they all work together for efficiency and profit. Negotiation of entirely dependable agreements with one union only, in no way conflicts with the drive of all employees towards constant change and greater efficiency."

"With regard to the absolute dependability of agreements and the freedom, indeed requirement, for management to introduce constant change and improvement in Japan, it is not generally realised that even with well ordered industrial relations, it is quite difficult for a factory manager to 'spare up' more than 20 per cent of his time for the introduction of new methods and new sys-

tems to move his company forward. Eighty per cent of his time is already mortgaged in carrying out essential routine duties. If he has to spend up to 50 per cent of his time in constant negotiation at many levels the show moves backwards and not forwards."

"The challenge before us today is whether we can, by combining will with technology right across our industrial and commercial operations, lift ourselves off the lower rungs of the productivity ladder in order to generate the wealth we all need to improve the quality of life for all our people."

"Microelectronics provides us with a means to meet this challenge."

"Why then is it that less than a third of Britain's top 1,000 companies are already applying microelectronics to their production processes, purchasing, design, quality control, and products? This was a finding in a MORI survey commissioned by the

Department of Industry to monitor our national microelectronics awareness campaign."

"The answer is that effective application of microelectronics requires a radical change in work habits and attitudes from the boardroom to the factory floor. The whole company has to learn a new way of operating."

"The MORI survey disclosed that some 5 per cent of the top 1,000 British companies reckon that they have already lost market share because of failure to apply microelectronics and another 9 per cent expect to suffer losses for the same reason."

"In the United States, over 750,000 new jobs have been created during the last three years in California, the home of 'Silicon Valley', while over 5 million new jobs have been generated over the last four years in the USA as a whole. Of even greater significance was the finding of the Birch Report that small firms in the USA employing 20 or fewer people generated 66 per cent of all new jobs. Many of these small firms have come forward on the wave of microelectronic inventions and applications that have been sweeping through the USA."

"There is no reason why we in the UK should not seize our share of these new opportunities, if we turn our attention as a nation away from the sterile internal debates between 'we' and 'they' on whichever side of the fence we are and focus all our energies on acquiring the skills necessary to exploit the new technology whatever our current status or job functions."

The finance may be there, but the millions of pounds investment needed at the new interest rate could make the final unit cost too high for the purchaser?

No doubt readers will have their own views?

A big future for video discs for home entertainment is expected by RCA following a signing with Paramount and Rank for the supply of feature films.

By 1990, RCA estimate that video disc players will have captured as much as 50 per cent penetration of all homes with colour TV with possibly 40 million units in service.

SAFETY IN THE HOME

Originally published to give guide-lines for safety in domestic radios, successive editions of the British Standards Institution safety requirements has had to take in more and more household electronic equipment.

The latest edition, now entitled "BS 415 Safety requirements for mains-operated electronic and related apparatus for household and similar general use", specifies safety requirements for a whole range of mains electronic equipment now available for use in the home. It includes monochrome and colour television receivers, radio receivers, clock radios; stereo amplifiers, tuners and turntables; record players, music centres, tape recorders, video cassette recorders, and electronic musical instruments.

Auxiliary equipment provided for use with this apparatus is also covered, e.g. microphones, loudspeakers, cable connected remote control devices and battery eliminators.



ANALYSIS

THE MIRACLE INGREDIENT

System X sounds as if it ought to be one of those new-formula consumer products promising better action with less effort at lower cost. But System X is no soap substitute. It is the new generation of digital electronic telephone exchanges which are now being constructed and will be installed in ever-increasing numbers in the 1980s. The first large System X exchanges being installed in 1980 and operational in 1981.

If all goes well it certainly promises better action with less effort for the consumer though whether at lower cost remains problematical. And System X also has a miracle ingredient.

The advantage of going all-digital is that a digital network can handle any type of information without discrimination. The system sees no difference between digitized speech or data or facsimile or telephone answering machines or automatic diallers or teleconferencing or wake-you-up calls or radiopaging or Prestel terminals. Once you change everything into digits you get a complete communications and information system on one network.

A digital system also has a big money-saving spin-off in management statistical information, automatic billing to the customer, automatic self-testing and fault diagnosis, and overload control which at busy periods will hopefully solve queuing and rerouting problems.

A small miracle had to happen in the first place to make this mammoth project feasible. This was to get the equipment manufacturers talking to each other and to the British Post Office with everyone, so to speak, on the same wavelength instead of competing with each other as in the past. GEC, STC and Plessey needed to reveal their engineering secrets to each other as well as to the Post Office. And it actually happened, although not without difficulty.

A central theme of System X is that it is not only good for the UK but for the rest of the world as well. The world telephone network of 400 million lines today is expected to grow to a staggering 1,400 million lines by the end of the century and System X could capture 10 per cent of the world market.

It raised a lot of interest at the recent international Telecom '79 show at Geneva where it was the only large scale digital system shown in actual operation as distinct from wall diagrams and glossy pamphlets from other countries.

The first-ever public demonstration was a triumph but it raises the spectre, ever-present with high technology, of being before its time, of already being obsolescent before getting into service.

But have we not forgotten the miracle ingredient? The modular architecture of System X in both hardware and software is such that it can always be up-dated to take advantage of new components and technology. Moreover, it can be tailored to interface with any existing equipment anywhere in the world and can be expanded at will to accommodate more or different services as they become demanded by the user.

Brian G. Peck

THE ELECTRONIC OFFICE

The electronic office was a big feature of the International Business Show at Birmingham where 430 exhibitors reported a good attendance. But, as one observer reported, the huge display of electronic equipment for the office of the 80s was not matched by the mass

of new office furniture, very little of which was designed to accommodate the electronics.

The beginning of a Japanese low-cost invasion was spearheaded by the first UK showing of the Sharp desk-top personal computer priced at from £520 plus VAT.

Britain's Airborne Early Warning (AEW) system is running to schedule. The tactical communications system comprising 120 different electronic units has been ground-tested and is now being air-tested in a special trials aircraft. Main contractor for both the airborne radar and communications is Marconi Avionics Ltd.

The Rank Organisation expects to sell 5,000 colour TVs a year in Israel following the recent introduction of colour TV. The Rank sets will be distributed through Electra of Israel.

VIDEO AWARD

The Sony Corporation has been awarded its third Emmy by the National Academy of Television Arts and Sciences for its role in developing the one-inch Videotape recorder for broadcast production.

Sony developed its one-inch BVH series of recorders in 1976. Since then, one-inch VTRs have been rapidly replacing the two-inch format equipment in television stations around the world.

PERSON-to-PERSON

The chance to speak person-to-person to Post Office telephone subscribers anywhere in the country from the privacy of their own vehicle is now possible through the Network radiophone service.

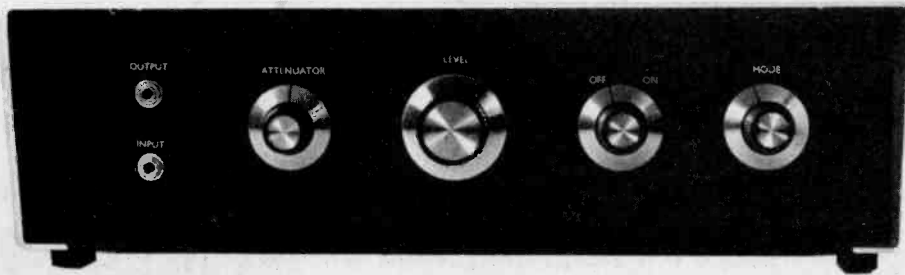
Believed to be the first time an independent message-handling contractor has been granted a licence to break the Post Office's monopoly on telephone communications, the new service is now operational throughout the Greater Manchester area.

Through the Network service's transmitter at Salford, the motoring businessmen can now be "plugged" directly into the Post Office telephone system making it possible to make and receive calls to and from anywhere in Britain or abroad.

Subscribers to the system are charged £60 a month for the rental of the equipment and service, and allowed up to 40 free local telephone calls a month made or received over the Post Office telephone lines. They are only charged for incoming calls if they agree to accept them from the operator.

Perhaps, when radiophones become standard fittings in new vehicles the sight of vandalised public call boxes and long queues will be a thing of the past.—A commercial venture here for the "new" Post Office?





SPRING-LINE

REVERB UNIT

BY R. A. PENFOLD

REVERBERATION is caused by sounds bouncing around the floor, ceiling and walls of a room, and tends, to a certain extent, to sustain sounds and merge them into one another.

Many types of music benefit from a suitable amount of reverberation and sound rather "flat" if it is absent. This can be something of a problem for the home-recording enthusiast because the carpets, curtains and furniture of most homes tend to have good sound absorbing properties, giving very little reverberation.

Fortunately it is possible to artificially add reverberation to a signal using a unit such as the one described in this article, and very realistic results can be obtained in this way. There are several ways of producing the reverberation artificially, but using a spring-line unit is probably the best low-cost method, and is the one employed here.

The unit can also be used with an electric guitar or an electronic organ or other electronic instrument as an effects unit, and can produce very interesting results.

BLOCK DIAGRAM

The block diagram seen in Fig. 1 shows the basic stages in the circuit of the reverberation unit. The input signal is taken to a buffer stage which gives a reasonably high input impedance of about 100 kilohm. Some of the output from this stage is taken to a mixer, and then to the output by way of an output level control.

The rest of the output from the buffer stage is coupled to an audio power amplifier via a volume control type attenuator. The output from the power amplifier is used to drive the spring-line unit.

A spring-line basically consists of a long coiled wire spring having a

transducer at each end. One transducer is fed with the output from the power amplifier, and it converts this signal into sound waves which travel down the spring comparatively slowly due to its inertia. The transducer at the other end of the spring picks up these sound waves after a short delay, and converts them back into electrical signals.

The sound waves are not totally absorbed, however, and are reflected backwards and forwards along the spring numerous times before they die away to an insignificant level. These reflected waves are picked up by the output transducer each time they reach the appropriate end of the spring, and this gives the required reverberation signal.

The reverberation signal is mixed with the main signal, and the attenuator at the input of the power amplifier controls the level of reverberation signal that is added to the ordinary signal. A switch is used to disconnect the ordinary signal from the mixer when only the reverberation signal is required.

The reverberation time, i.e. the time taken for the reverberation to decay to an insignificant level (-60dB), depends upon the type of spring-line

utilised in the project, but is approximately 2.5 to 3 seconds if the specified unit is used. This is ideal for most applications.

THE CIRCUIT

The circuit diagram of the reverberation unit is shown in Fig. 2. TR1 and its associated components form the input buffer amplifier connected in the emitter follower mode so that it provides the necessary fairly high input impedance, and a low output impedance to drive the following circuit with little loss of signal level due to loading.

Capacitor C3 couples some of the output from the buffer stage to the reverberation level control, VR1. From here the signal is coupled direct into the non-inverting input of the audio power amplifier which uses a LM380N device (IC1). The inverting input of IC1 (pin 6) is earthed to the negative rail in order to prevent stray pick up here. Capacitor C5 decouples the supply to the input stages of IC1, and this helps to improve the low-frequency stability of the circuit.

The output from IC1 is coupled to the input transducer of the spring-line unit by way of d.c. blocking

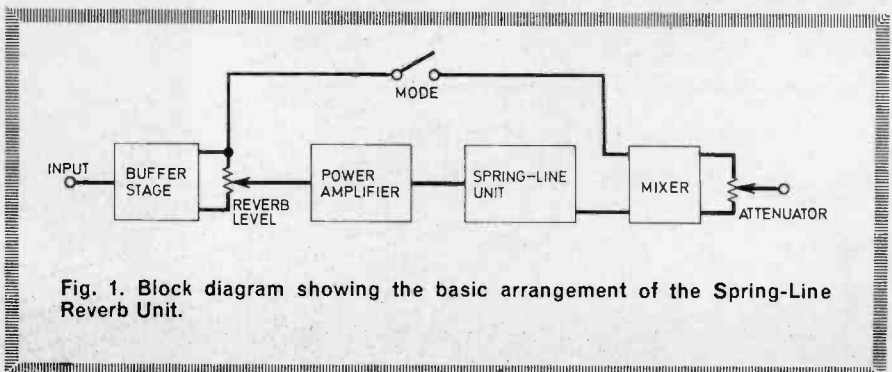


Fig. 1. Block diagram showing the basic arrangement of the Spring-Line Reverb Unit.

capacitor C6. The input transducer is a low impedance (16 ohm) magnetic type, and this is why it is necessary to use a power amplifier to drive it.

The output transducer of the spring-line is a medium impedance (10 kilohm) magnetic type, and its output is coupled by C7 to the mixer stage. This consists of TR2 connected in common emitter mode with input resistors R5 and R6.

The full gain of TR2 is not required and so emitter resistor R9 is used to introduce negative feedback which reduces the voltage gain of TR2 to about 20. There are some losses incurred through R6, but the output from the spring-line still receives a significant amount of amplification. This is necessary due to the quite high signal loss through the unit.

REVERBERATION LEVEL

The second input of the mixer stage is fed with the ordinary input signal from TR1 emitter unless S2 is switched to break this signal path and give only the reverberation signal.

The signal from TR1 emitter will normally be considerably stronger than that from the spring-line, even with the reverberation level control well advanced, and so R5 is given a much higher value than R6. This enables a reverberation level equal to the main signal level to be obtained, as the higher losses through R5 permits the two signals to be roughly balanced. The output from the mixer stage is fed to the output socket via d.c. blocking capacitor C9 and output attenuator VR2.

The voltage gain of the circuit is a little in excess of unity with this control set for maximum output, but

COMPONENTS

Resistors		R6	39k Ω
R1	220k Ω	R7	1.5M Ω
R2	270k Ω	R8	4.7k Ω
R3	3.9k Ω	R9	220 Ω
R4	560 Ω		
R5	220k Ω		
All $\frac{1}{4}$ W carbon \pm 5%			
Potentiometers			
VR1	5k Ω carbon log.		
VR2	10k Ω carbon lin.		
Capacitors			
C1	100 μ F 10V elect.	C6	470 μ F 10V elect.
C2	100nF polyester	C7	1 μ F 10V elect.
C3	10 μ F 10V elect.	C8	100nF polyester
C4	100 μ F 10V elect.	C9	10 μ F 10V elect.
C5	10 μ F 10V elect.		
Semiconductors			
IC1	LM380N 2W audio amplifier i.c.		
TR1	BC109 silicon npn		
TR2	BC109 silicon npn		
Miscellaneous			
S1	s.p.s.t. toggle or rotary switch		
S2	s.p.d.t. toggle or rotary switch		
SK1, SK2	3.5mm jacks (2 off)		

See **Shop Talk** page 19

COMPONENTS
approximate
cost **£12.50**
excluding case

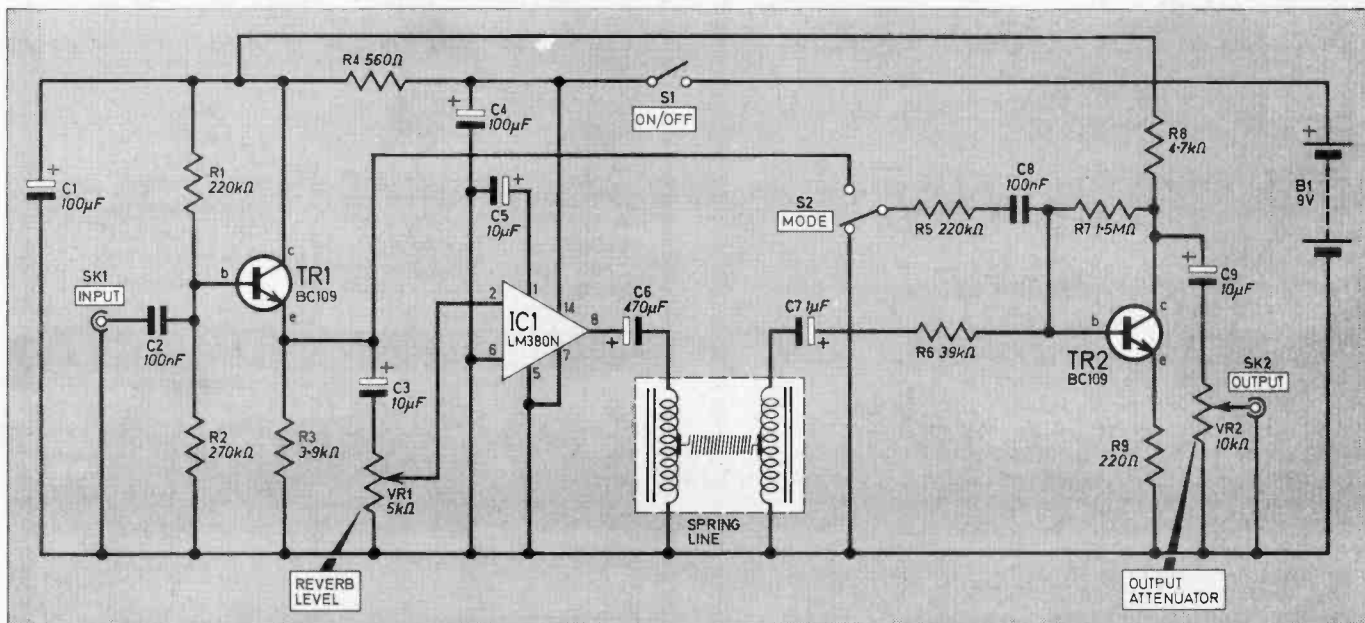
Large metal case (Vero "G Range" case type 91-2674B, 304 x 210 x 84mm or any similar case); 0.1 inch matrix stripboard panel 36 holes x 17 strips; Short spring-line unit (Maplin Electronic Supplies); control knobs; PP9 battery and connectors to suit; connecting wire.

the addition of a high level of reverberation can increase the effective voltage gain to about $\times 2$.

On/off switching is provided by S1, and power is obtained from a 9 volt battery. The quiescent current consumption is only about 9mA, but will usually increase somewhat at high volume levels as the L380N has a class B output stage. In fact on high

level inputs when a high reverberation level is required, IC1 may have to give an output of a few hundred milliwatts r.m.s. into the spring-line in order to give sufficient reverberation, producing a current consumption of as much as 100mA on volume peaks. It is therefore advisable to power the unit from a large battery such as a PP7 or PP9 size.

Fig. 2. Complete circuit diagram for the Spring-Line Reverb Unit.

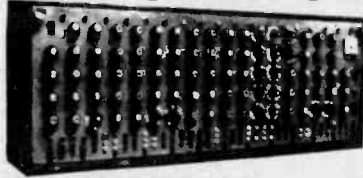


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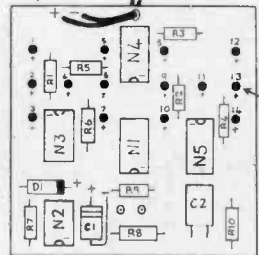
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SPRING-LINE REVERB UNIT

FRONT PANEL (REAR)

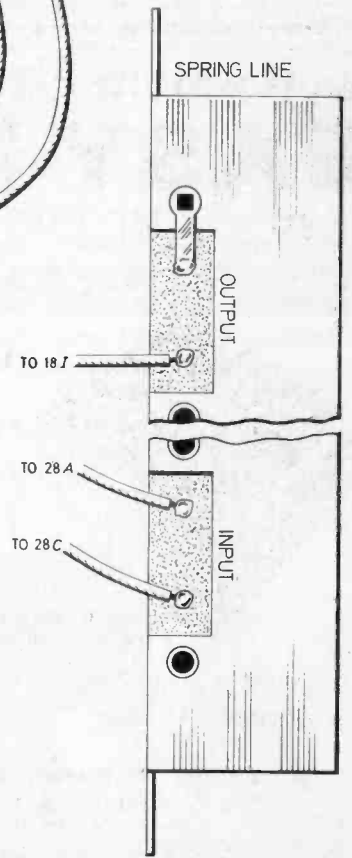
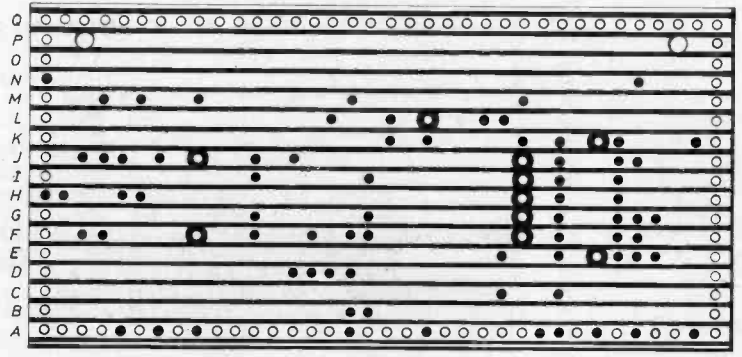
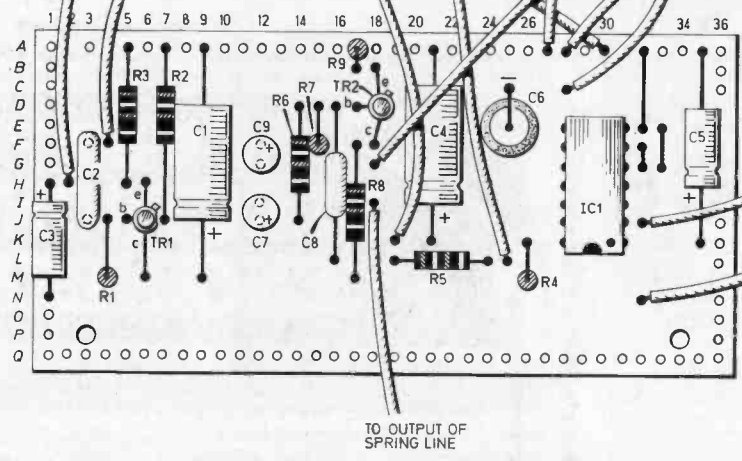
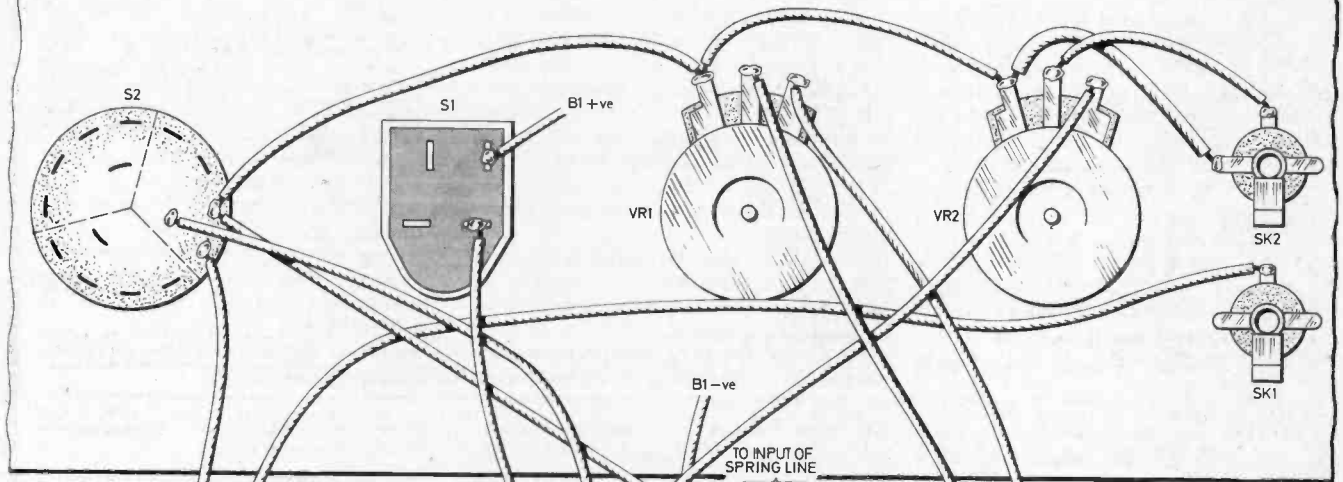


Fig. 3. Complete interwiring details, component layout on the circuit board and underside of stripboard showing breaks to be made in the copper strips.

CONSTRUCTION starts here

THE CASE

A suitable component layout for the unit using a stripboard having 36 holes by 17 strips is shown in Fig. 3. Drill the two 6BA or M3 clearance mounting holes and make the 10 breaks in the copper strips before soldering in the components and three link wires. The semiconductor devices should be the last components to be soldered into circuit.

The case needs to be a fairly large type in order to accommodate all the components, and in particular the spring-line unit which is a little over 200mm in length. The largest size Vero "G range" case makes a very attractive housing for the project and is used as the cabinet for the prototype unit, but any case of about the same size should also be perfectly suitable.

The layout of the unit is not critical, and the arrangement used for the prototype can be seen from the illustrations.

INTERIOR WIRING

All the point-to-point wiring of the unit is illustrated in Fig. 3. S1 and S2 are rotary types on the prototype (S2 being one pole of a 4-way 3-pole type having an adjustable end stop set for 2-way operation), but toggle or slider types can be used if preferred.

The input and output terminals of the spring-line unit are clearly marked, and the leads to the input transducer can be connected with either polarity. One of the output terminals is connected to the metal casing of the spring-line by a solder-tag which is ready wired into place by the spring-line manufacturer.

Assuming a metal case is used there is no need to make a connection to this terminal since it will be earthed to the negative supply rail through the cabinet, which is in turn earthed by the negative supply connection to SK2. Using a separate connecting wire would probably produce an earth loop with consequent instability. Socket SK1 also receives its earth connection via the metal case. However, an earth wire to each socket

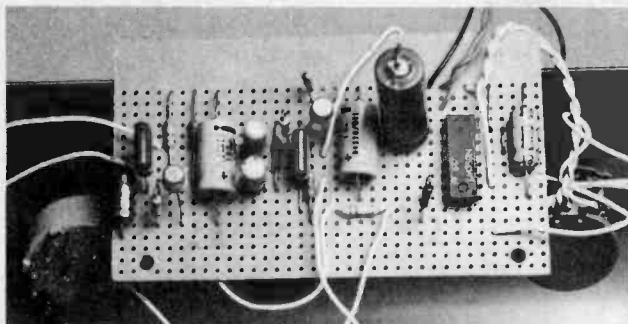
will be required if insulated case jack sockets are used.

USING THE UNIT

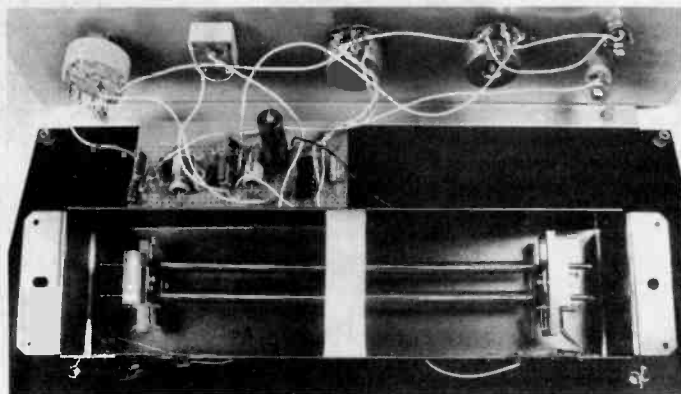
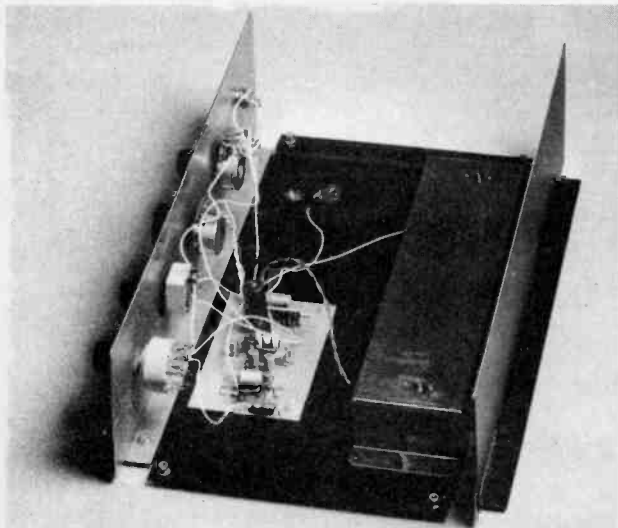
The unit is intended to be used in a high-level signal path, with an input level of about 50 to 1000mV r.m.s. It is unlikely that really good results will be obtained operating the unit from a low-level source such as a dynamic microphone, since the signal to noise ratio will inevitably be effectively reduced. Far better results would be obtained by interposing a suitable pre-amplifier between the source and the reverberation unit.

Except with input levels of about 50mV r.m.s. or less, full reverberation will be reached before VR1 is advanced to its fully clockwise setting. Taking it beyond the point at which full reverberation is achieved would simply cause the signal at the output of IC1 to clip, producing severe distortion on the output signal.

With S2 switched to the position where the ordinary signal is muted and only the reverberation signal is obtained the unit will act as an interesting effects unit for an electronic instrument. It is particularly effective with instruments that provide a glissando signal, as it then gives a weird but not unmusical wailing sound. □

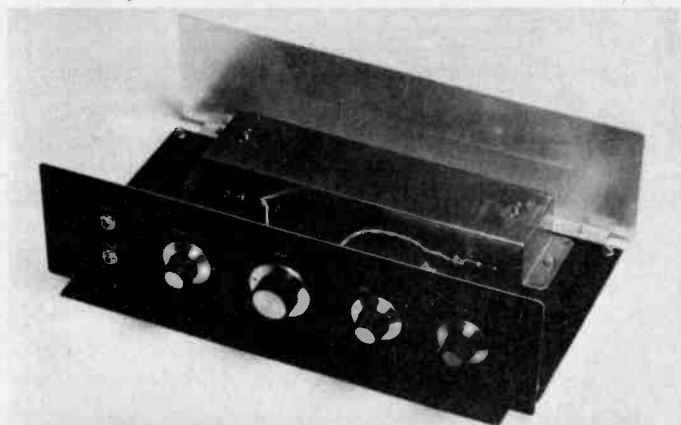


The finished circuit board removed from the chassis. The case "surround" removed showing positioning of circuit board and Spring-Line module.



Interwiring to the front panel controls and detail of the Spring-Line module.

The completed Spring-Line Reverb showing front panel controls and lettering.

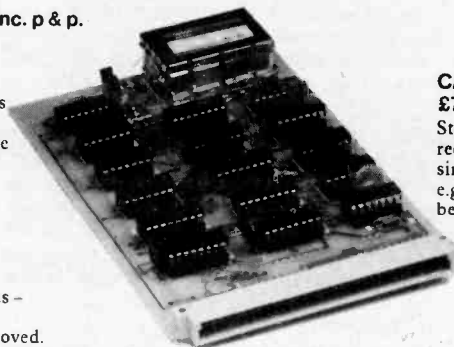


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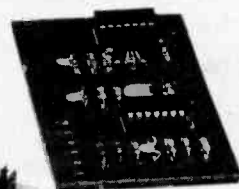
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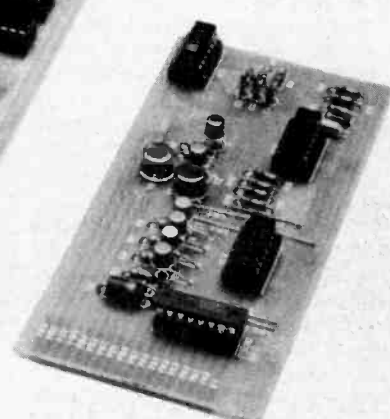
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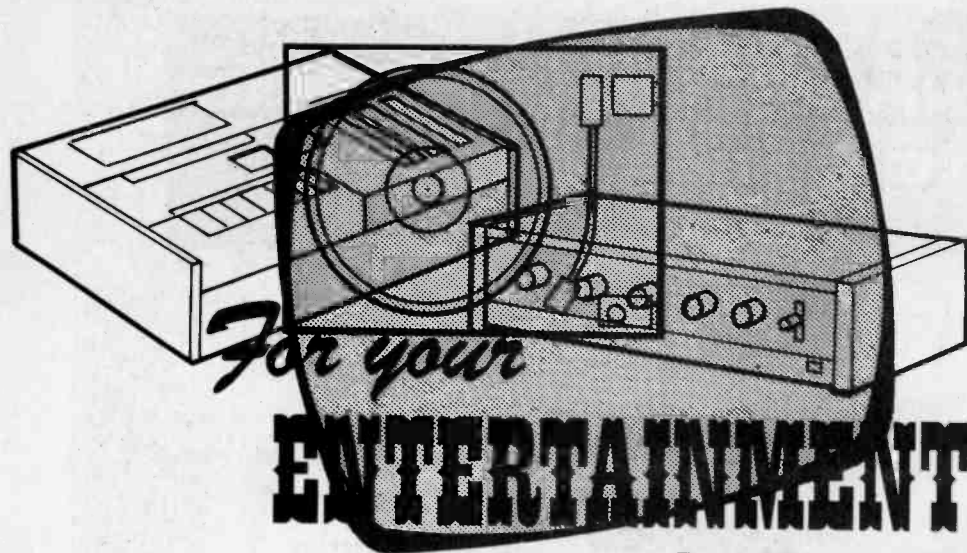
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By ADRIAN HOPE

Singing Lights

Have you ever noticed how electric light bulbs, especially of high wattage "sing" when run off a thyristor dimmer switch? The singing is usually most pronounced when the switch is set at a half-way position.

The reason for this seems pretty clear. The thyristor dimmer works by biting chunks out of the 50Hz mains sine waveform and they are taken out so sharply that the waveform ends up with squared edges. These square edges generate high frequency harmonics which cause interference on medium and long wave radio sets.

It also seems reasonable to deduce that some of the lower frequency harmonics fall in the audible range. By electro-magnetic induction these set the coils of the lamp filament vibrating at an audible pitch. In other words the coils of the lamps behave just like the coils and laminations, which can emit mechanical buzzes and hums of an infuriating level.

Given the fact that the use of a dimmer will vibrate the coiled filament mechanically, an interesting thought now arises. Surely this continual mechanical vibration of the lamp filament can't exactly lengthen the lamp's life.

It has become a factoid (Norman Mailer's delightful term for an unsubstantiated fact that finds its way into the folklore) that the use of a dimmer prolongs lamp life because it cuts down on cold current surge and consistently under-runs the lamp. But over the years I have been led to the reluctant conclusion that lamps run on dimmers need replacing at least as often as lamps run on simple on/off switches.

Could it be that the disadvantage of mechanical vibration outweighs the advantage of limited current surge, so that the use of a dimmer actually shortens, rather than lengthens, lamp life?

Frozen picture

A low dosage X-ray machine produced by EMI Pantak and International Aeradio is being installed at Gatwick and Heathrow airports for airline security baggage inspections. The new Rapidex X100 machines will not fog film and development of X100 represents an interesting change in policy by EMI Pantak.

The company had previously supplied Heathrow with Rapidex high dose machines which fog passenger's film, even when shielded by protective lead bags. The original machines generated an X-ray dose of at least 17 milliroentgens per second and as the inspection process takes up to ten or twelve seconds (for instance if the operator looks closely at a suspicious object) the baggage under inspection may receive a total of up to 200 milliroentgens.

The advantage of the old machines is a very clear picture which reveals the presence of any metallic weapon, however carefully concealed. The disadvantage is a very unhappy passenger who has forgotten to remove all cameras and film beforehand, or relied on shielding by a protective lead bag.

Low dose X-ray systems, as already used by many airports around the world, expose the baggage only briefly to low level radiation. The resultant X-ray picture is then frozen on a fluorescent screen and artificially brightened by an image intensifier.

Low dose systems do not fog film and will not penetrate the lead shield. If the operator sees the opaque outline of a lead bag the passenger is asked to open it for visual inspection. Public pressure has now forced the London airports to follow the rest of the world and install low dose systems.

The new Rapidex X100 uses a similar strength of radiation to the original machine but for just one hundredth of a second. The picture is then frozen on a memory tube.

There is certainly no noticeable effect on photographic film. Pictures taken on even very fast colour stock, rated at 400ASA, and exposed thirty times to the X100 radiation dose, show barely noticeable fogging.

Airline passengers passing through London will thus no longer need to

remember to remove all unexposed film from their baggage for pre-flight security checks.

Queen's English

The Texas Instruments Speak and Spell toy (previously mentioned in this column) is now available in a version which speaks something approaching the Queen's English. The basic three-chip synthesiser circuitry includes a ROM which can be programmed to speak any words in any language.

But the original Speak and Spell was modelled on an American voice, with American pronunciation and the visual display shows American spelling. So anomalies like "color" for "colour" and "skedule" for "schedule" are buried in the ROM to confuse British-speaking users.

Although it is an expensive business to completely reprogramme the ROM, and change the speech accent, Texas has now altered the programme sufficiently to eradicate the most obvious "Americanese" anomalies. Unfortunately, both original and re-programmed models are on sale virtually side by side and it is very hard to distinguish one from the other.

The circuitry synthesizes words from the ROM in purely random fashion and a potential customer might have to test the toy for hours before hitting by chance on a tell-tale word like "honor". Fortunately, there is a very simple way to distinguish the two models.

The Z key on the British version has been re-programmed to say "zed" whereas the American version still says "zee". So anyone buying a Speak and Spell to help their children's education would be well advised to press the "Z" key before parting with their money.

Speak and Spells are already available for under £40 and the price, especially of now obsolete Americanese versions, will probably drop further. Texas is using the basic 3-chip circuitry for a whole range of new applications, for instance a language translator which speaks in a foreign language.

Without doubt there will be all kinds of new speaking gadgetry on the market from Texas and other firms over the next year or so and their prices will fall just as calculator prices have plummeted over recent years. So think twice before buying at current prices.

Is it a Mental Breakdown?

That said, I have to admit to finding Speak and Spell a fascinating gadget, and while playing with one on loan for a week discovered a delightful trick which you can play on it.

In order to expand the Speak and Spell's vocabulary, there is provision for an extra ROM in the form of a plug-in module. A "module" key on the keyboard makes the content of the new memory accessible to the synthesizer circuit.

If you press the "module" key, but fail to insert the module, the synthesizer circuitry makes its usual random search for instructions and will sooner or later try to delve into the non-existent ROM. When this happens the synthesizer goes haywire, asking the operator to spell non-existent words, phrases and sounds. So pathetic is the garbled sound that only the hardest heart can fail to feel sorry for the confused electronics burling as if in final, demented death throes.

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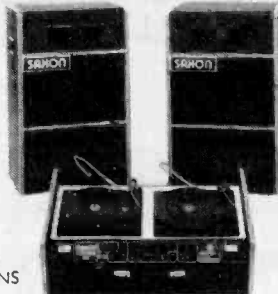
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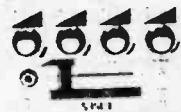
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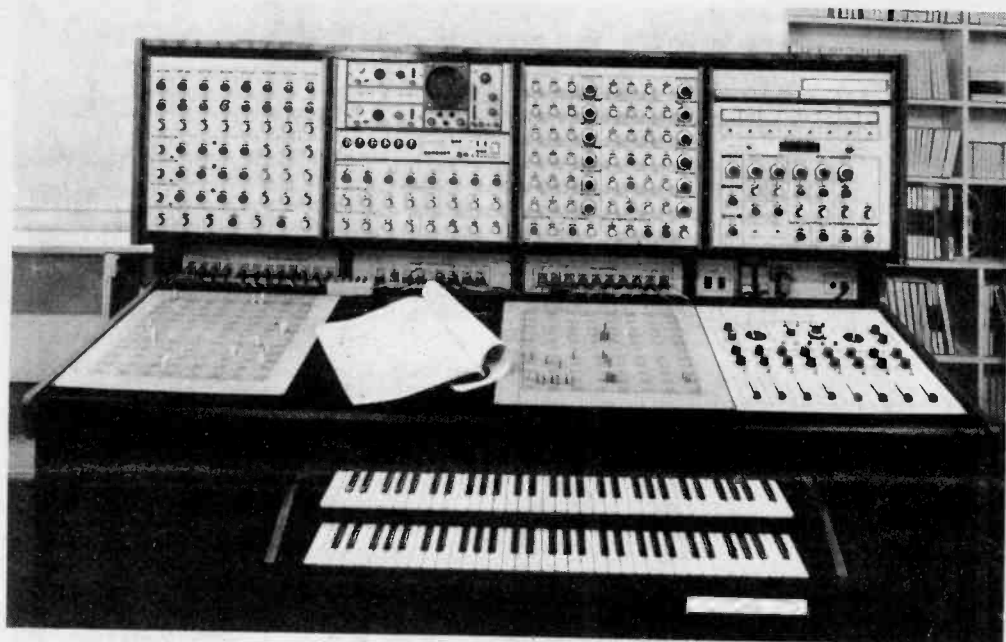
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By B. H. Bailly

SYNTHESISERS

EXPLAINED

PART 2

IN PART 1 we dealt with the basic principles of tone generation and envelope shaping in both electronic organs and synthesisers. We saw how the organ uses a set of oscillators and dividers to produce all the required notes or pitches for the entire organ, and the keyboard selects these when keys are pressed, but that in the monophonic synthesiser only one, two or three oscillators are normally used, and these are made such that each can produce a wide range of pitch, and can thus be called upon to produce any note over the whole keyboard, by applying a suitable voltage to its voltage control input.

We also saw how easy it is to memorise any such pitch by arranging for the voltage applied to be "stored" in a special sample/hold circuit, using a simple capacitor.

Already, the principle of voltage control has shown to be very valuable. But it does not stop at that. Just think of the numerous effects pedals you can now buy for guitars alone. Each of these contains a circuit which can be varied by mechanical means to give such effects as waa-waa, phase, etc. The circuits are designed such that the effect is modified by the rotation of a potentiometer, which changes the resistance in a

certain part of the circuit to give the change in effect. The rotation of the potentiometer is produced by movement up and down of the foot-operated pedal, and is what is termed manually operated.

Manual operation is all very well, and essential in some cases, but in a synthesiser it is often convenient that such changes in effect be done automatically, usually at a preset frequency of repetition. Of course, little motors could be devised to drive the shafts of potentiometers, but this has obvious disadvantages.

VOLTAGE VARIATION

Instead, the circuits which require a variable resistance to work them are modified so that they will produce the effect by a variation of voltage on a special voltage control input as with the voltage controlled oscillator mentioned earlier. The actual pattern of voltage applied to control such circuits can be generated internally in the synthesiser by other special circuits, or, where required, manually, by either the keyboard, as in tone generation using the v.c.o.s, or even by a special two-function voltage source potentiometer known as a joy-

stick. This device uses two potentiometers arranged such that the movement of a control stick in one direction produces a variable voltage output from one output terminal, whilst movement in a direction at 90 degrees to this, varies a second voltage output. In this way, two separate voltage controlled circuits may be varied using only one hand.

Another source of manually-operated voltage control is the ribbon controller which is rather like a long potentiometer operated by a finger pressed on to a foil strip which is pressed to make contact on a strip of resistive element underneath it. The output is taken from the foil, and a voltage is connected across the ends of the resistive element, so that the foil picks off whatever voltage is present at its point of contact with the element.

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A repetitively-changing voltage is relatively simple to produce. After all, this is what we have coming from our v.c.o.s, except that the repetition rate is too fast for most of our purposes. So, a slower oscillator is required, whose frequency can be

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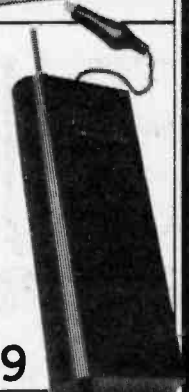
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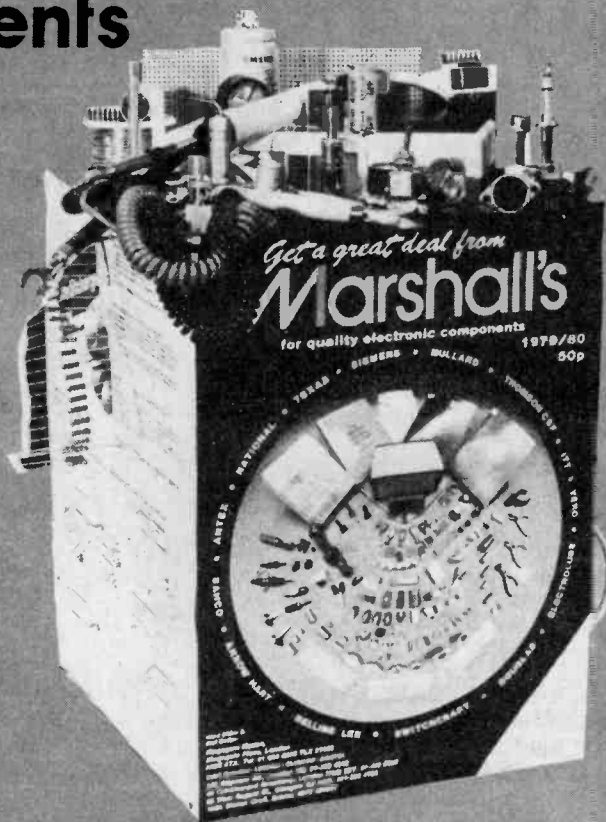
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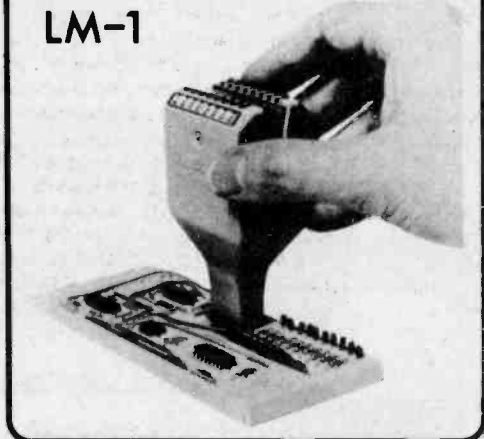
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varied at will to suit the type of music being played, and whose effect or intensity can also be varied.

A suitable frequency range would be from 1Hz (i.e. one cycle per second) to about 7Hz. Such an oscillator is termed a low-frequency oscillator (l.f.o.) to distinguish it from the v.c.o. used to produce the tones. Whilst the l.f.o. is used to vary voltage-controlled circuits, it is not normally itself voltage controlled, but is varied manually.

Similarly, its output is manually variable, by means of a potentiometer, which results in the change of intensity of the effect being controlled by the l.f.o.

VIBRATO

The vibrato effect is popular in organs and synthesisers. In both cases it is created by modifying the pitch of the tone generators slightly by applying a low-amplitude sinewave of about 6Hz to the tone generator(s) so that the pitch is varied about six times a second upwards and downwards around the natural frequency of the note(s) being sounded.

In the synthesiser there is no need to apply the l.f.o. signal to each v.c.o. separately, since each oscillator is controlled by the same source, i.e. the resistor ladder of the keyboard and the subsequent sample/hold circuit. So the l.f.o. signal may be applied to either of these.

If it was applied to the keyboard resistor ladder, however, it would be effective only while the keyboard was in actual use. Once a key was released, i.e. during the sustain period, the sample/hold circuit would be disconnected from the ladder, and, of course, the sample/hold could not memorise the changing voltage from the l.f.o.

The effect of vibrato during the held portion of a note, and not during the decay period of the sustain has its uses, but it is more common for the vibrato to be present throughout the entire length of a note. This can be done by applying the l.f.o. signal to the sample/hold circuit, where the stored voltage on its capacitor could be modified at the frequency of the l.f.o., 6Hz.

The variation that the l.f.o. produces in pitch of the v.c.o. is of the order of a quarter-tone in each direction for normal vibrato supplied on organs, but in the synthesiser we can vary our intensity control so that the l.f.o. sweeps the frequency over many full tones, or even a full octave! Such an effect is in great demand in space-type musical effects.

PRODUCING CHORDS

Before we drift too far away from the v.c.o. it is relevant to cover the use of more than one v.c.o.

As stated already, the monophonic synthesiser allows one key of the keyboard to be played at a time. So far, it is easy to understand how a single pitch can be created, as a single v.c.o. is scaled by the voltage control selection on its input. Imagine a second oscillator connected the same as the first. If this were identical, the two v.c.o.s would both produce the same pitch, e.g. middle C, when the keyboard key of middle C is pressed. But if we equip one oscillator with an independent pitch-modifying control, and turn this control on the second oscillator such that it changes the pitch of the second oscillator to, say, G below middle C, we find we have a chord of two notes.

The G is, in fact, five semitones below C. When the oscillator is so adjusted for G, and the key pressed is, say, D, the second oscillator sounds a note still five semitones below D, i.e. the note of A below middle C. So, although the secondary pitch control of the second v.c.o. has been changed, the change is constant, so that we can depend upon the fact that if we offset the second v.c.o. to produce a certain difference in pitch as measured on the musical scale, then that same difference in pitch will be maintained for whatever key is pressed on the keyboard. Where more than two v.c.o.s are used, the number of notes sounded in a single-key chord can be increased proportionally.

MULTIPLE-STRING EFFECT

It is not always to produce chords, however, that more than one v.c.o. may be used. You will remember that it was mentioned in Part 1 that a piano hammer strikes more than one string when a key is pressed. There is more than one reason for the use of multiple-strings, and increased volume of sound is only one.

In a piano, it is practically impossible to set two strings such that their frequencies are exactly identical, and certainly quite out of the question to rely on them staying in perfect tune with one another for any length of time afterwards. No, an integral part of the quality of a piano note is actually the very slight difference in pitch produced by the strings of any note played. In fact, the strings are sometimes deliberately offset by a noticeable degree to enhance the "honky-tonk" sound of a piano in a bar-room.

Similarly, in synthesisers, we can use more than one v.c.o., each set basically to the same pitch, yet not quite. The effect is a curious phasing quality as the pitches come together to reinforce one another and gradually drift out of phase so that one tends toward cancelling another out. The change may be very slow, taking

a second or two to repeat, or it may be faster, depending on the discrepancy of tuning between the v.c.o.s.

PHASING

The previous paragraphs have introduced an effect which can be produced by two oscillators slightly off-tune to one another; known as phasing. However, there is another way of producing this effect without resorting to two oscillators.

The reader will probably be familiar with the small units available for guitar use, which give a continuously varying phasing sound. The effect is created by selecting a narrow band of frequencies in the audio spectrum and suppressing these frequencies. The band selected is then slowly moved up and down the spectrum, so that it covers and re-covers the whole range of its ability. The result is the familiar effect known as phasing. It operates by suppressing the harmonics of the notes played.

So far, we have dealt with individual notes only, but now we shall look closer at such notes and see exactly what they consist of.

Many books have been written on this sort of study alone, so it must be understood that the look we take at it can only be very brief and basic, sufficient to understand the operation of the phaser and filters, to be described later.

HARMONIC CONTENT

In Fig. 1.2 there are three output waveforms available from the v.c.o. One is a truly wavelike form, smooth and flowing, with no sharp corners or points on it, shaped like the ripples on a pond when a stone is thrown into the water. The waveform is known as a sinewave. It is technically pure, i.e. it consists of one frequency, its natural frequency, or *fundamental*.

If we look at a sinewave of a note of say, middle C, on an oscilloscope, we are looking at the actual shape of the pure signal of middle C frequency. The straight portions and the rounded portions are all part of the pure and fundamental frequency. This means that any shape slightly different from the sine shape is impure, and contains an element of another frequency.

Difficult to understand? Well, consider the following.

If we take the sinewave of middle C, and modify its shape slightly, such that although its peaks are the same distance apart, the "bend" is made sharper instead of being so smooth. The bent portion will then be narrower, and the sharper law of bend will therefore correspond to the law of bend of a frequency whose peaks are closer together, i.e. a higher frequency. So our modified waveform

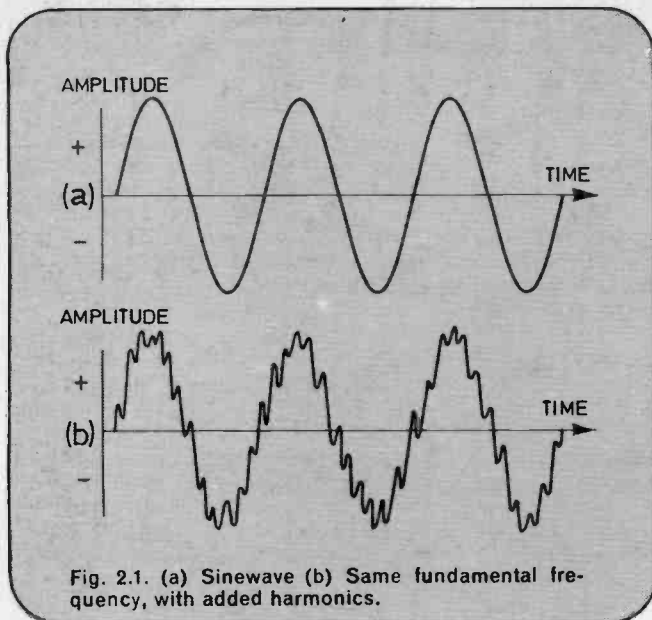


Fig. 2.1. (a) Sinewave (b) Same fundamental frequency, with added harmonics.

will still have the same fundamental, i.e. number of peaks per second, but will also contain a characteristic of another higher, frequency within it!

This second frequency content is termed a *harmonic*. The more a signal departs from the pure shape of a sinewave, the more harmonics it contains. In fact, the squarewave contains many harmonics, chiefly because its vertical edges are so sharp, but it has a clear-cut fundamental, i.e. repetition rate. Violin music is also rich in harmonics, and a single violin note has a host of harmonics (overtones) contained within it.

WHITE NOISE

A pure sinewave is shown in Fig. 2.1a, to be compared to Fig. 2.1b, a waveform very rich in harmonics, but having the same fundamental frequency as that in Fig. 2.1a.

It is these harmonics which the phaser and later-to-be-described filter operate upon. For this reason, the application of these circuits to pure sinewave signals is largely ineffective, and the more harmonics a signal has the more effective the phaser or filter is found to be.

Sometimes, a deliberate quantity of *white noise* is added to a signal to enrich it and make use of a filter or phaser more noticeable. White noise sounds like the rush of steam from a locomotive, or similar to waves breaking on a sea shore. It contains a vast number of harmonics, with no regular or constant fundamental to bias the sound. So, it is analogous to white light, and contains all the colours of the spectrum of sound within it. It is easy to see now why a signal containing white noise is so effectively phased.

FILTERS

Filters take three main forms, bandpass, highpass and lowpass. Like the phaser, filters in synthesisers are made voltage controlled for full flexibility.

The bandpass filter is basically opposite in function to the phaser. Instead of suppressing a narrow band of frequencies or harmonics it is designed to suppress all but this narrow band. The effect is as if it were amplifying the narrow band over all other frequencies.

As in the phaser, the narrow band is moveable, up and down the audio spectrum by means of a voltage control frequency. On some filters, the actual band is adjustable by means of a panel control, so that the band may be narrowed or broadened at will.

The effect of a simple bandpass filter is that of the familiar waa-waa circuit which is really a simple form of bandpass filter.

The highpass filter suppresses frequencies below a certain threshold and this threshold is adjustable by voltage control. The lowpass filter works in reverse, by suppressing frequencies above a threshold, which again can be moved up and down the spectrum by voltage control.

The effects differ in practice between the three types of filter, but their basic operation is that of filtering certain harmonic contents in composite waveforms. The actual effect of filters on specific waveforms is not easily shown in diagrammatic form, so no attempt is made here to illustrate filtered and unfiltered waveforms, mainly because filtering is not a present/absent effect, but is more a gradual onset as the threshold level is met, and changes as the voltage

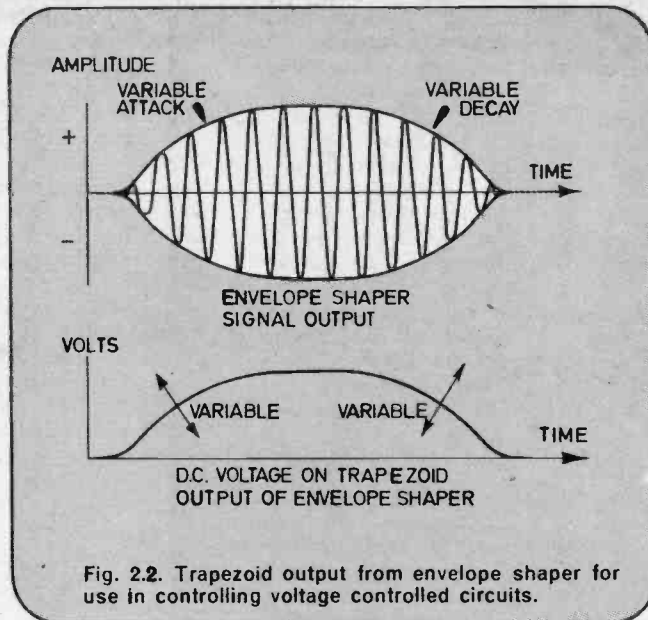


Fig. 2.2. Trapezoid output from envelope shaper for use in controlling voltage controlled circuits.

control is varied, and two dimensions would prove inadequate to illustrate the whole overall picture. However, it is hoped the above description will give the reader a good idea as to the principles involved.

VOLTAGE CONTROL FROM ENVELOPE

A useful source of voltage control signal is derived from the envelope shaper circuit. Unlike the signal output, which contains the signal shaped into an envelope of variable attack and variable decay, this second output is simply a d.c. voltage, which varies in direct proportion to the form of the actual envelope at any given time. This output is known as the trapezoid output, and it can be used to control other circuits by changing the voltage on their voltage control inputs, see Fig 2.2.

If it were applied to a bandpass filter (giving waa-waa sound), through which the final synthesiser signal is passed, the sound produced would be, perhaps, "oowwhaah". The "oow" portion being produced as the attack portion was covered, and the "whaah" part during the decay period. This effect is particularly useful when it is required to give waa-waa effects which are synchronised with the playing of the tunes.

If the waa-waa was produced by driving the filter from a l.f.o., it would be self-repetitive at the frequency of the l.f.o., and the player would have to set this frequency to synchronise with the music beat, whereas with envelope control, the envelope automatically follows the music beat, as it follows the playing of the keys themselves.

To be continued

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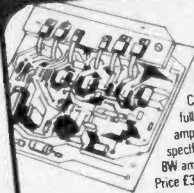
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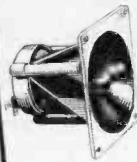
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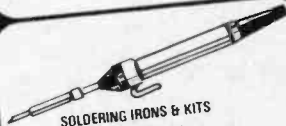
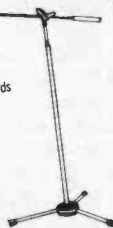


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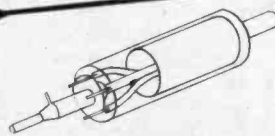
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LETTERS

No Entry

May I endorse what Pat Hawker had to say concerning the delay in the Radio Amateurs Examination, see *Radio World* November 1979 issue.

Having studied for a year I applied to the R.S.G.B. last August to sit the exam in December. I received no entry form from them and on checking in October found I was too late for the December exam and would have to wait until May 1980, with no results until September. I am considering giving it up especially as I am no youngster but an elderly gent.

G. J. Abrahams
Birchington,
Kent.

Fading Display

I am writing to correct a statement that appeared in *For Your Entertainment* October 1979 issue. Mr. Adrian Hope quotes that liquid crystal displays fade after about five years. In fact this is only true of the cholesteric type, the fading being caused by ultraviolet light. The cyano-biphenyl type of display is immune to this fading.

It is possible to tell the difference between the cholesteric and cyano-biphenyl

types of display. Look at the display, while it is running, with your eye almost on a level with it. A cholesteric display will show a greenish tint to the characters.

A more general criterion is that cholesteric displays are fitted mainly to Casio calculators. Sharp calculators, and most modern l.c.d. watches, have cyano-biphenyl displays.

I hope this will prove helpful to readers.
C. G. Bulman
Worcester.

Light Resistance

Recently, I was in need of a photo transistor OCP71 for a simple alarm circuit. I solved this problem by converting an old OC71 transistor to an OCP71 by scraping off some of the black paint on the outside of the case, Fig. 1.

To test, set a multimeter to the resistance range, connect the common or black test lead to the emitter and the red (+) lead to the collector. By covering the clear area with your fingers the resistance should increase substantially. Connect the other way round and this will not be effected by light. You can use the OCP71 as a light dependent resistor (l.d.r.) as long as the collector is supplied with a positive voltage and emitter a negative voltage, disregarding the base.

David Elwin (age 13),
Kings Lynn,
Norfolk

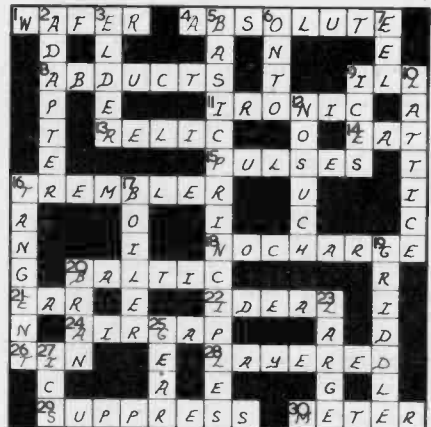
Ideas Wanted

As I have just arrived in England to work, I am a keen electronics enthusiast, I feel I have no friends to talk about electronics or to exchange ideas and get help in constructing circuits etc.

I am from Mauritius, and speak the English, and the French language. I would be very glad if you would kindly insert my address in your *Letters* page—about me wishing to write and exchange ideas with other electronics enthusiasts.

Sam Hosenbocus,
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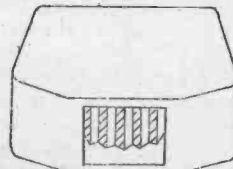
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FOR BEGINNERS

THE COMPONENT LIST

EACH constructional article featured in *EVERYDAY ELECTRONICS* contains a comprehensive and detailed component list. This lists all the electronic components and various pieces of hardware, sometimes to the last nut and bolt to complete the project. A typical list is seen on page 31.

Each component is specified in detail and this stringent specification can cause headaches for some constructors, especially the newcomers to electronics.

For convenience (yours and ours) the list has several headings under which like components are grouped in numerical order as per the circuit diagram.

RESISTORS

All fixed-value resistors will be found under the heading of resistors. In the majority of cases they will be collectively specified as " $\frac{1}{4}$ watt carbon ± 5 or 10 per cent". Any special types will be indicated appropriately after the value. Many newcomers can be excused for thinking that this particular type is vital for successful operation of the circuit. It is not!

A metal film, metal oxide and in some cases wirewound types may be readily substituted for just as good, if not better overall performance. Wirewound types however should be substituted with caution, their relatively high inductance could interfere with the operation of some circuits.

Carbon types are chosen for their availability and low relative cost.

WATTAGE

Now a few words on wattage. As previously said most resistors in these pages are specified as $\frac{1}{4}$ watt types. This does not exclude the use of $\frac{1}{3}$, $\frac{1}{2}$, $\frac{3}{4}$, 1 watt and even higher, except where available "board space" is limited, or on a p.c.b. design where component hole spacings have been decided with a particular component in mind.

The $\frac{1}{4}$ watt resistor is probably chosen by designers for its small, but still easy to handle size, availability

and cheapness. They are more than adequate for low-voltage, low-power battery circuits, as many of our projects are.

If someone took the time and trouble to calculate the required wattages in a circuit, it would be found that in many cases $\frac{1}{10}$, $\frac{1}{20}$ watt and less are all that are necessary. (Divide the square of the maximum possible voltage across the resistor by the resistance value. $W = V^2/R$.)

But for those not sufficiently experienced, the specified rating should be regarded as the minimum required for the circuit, allowing higher wattages to be used if at hand.

TOLERANCE

The " ± 5 or 10 per cent" seen in component lists refers to the resistor tolerance, its maximum deviation from its nominal value. For $\frac{1}{4}$ watt carbon types the constructor these days has little choice. It appears that only 5 per cent types are available. A closer tolerance type can be employed if that is all you can obtain at the time with no adverse effects on operation. Also a 10 per cent can replace a 5 per cent and in a lot of cases an even looser tolerance. Some parts of circuits will still operate in a fashion even if the value is widely different.

CAPACITORS

Both fixed-value and variable capacitors (including preset-types usually called trimmers) are found under the heading capacitors.

With variable types, their maximum value is given. For example, a variable capacitor specified as 365pF is continuously variable from 0pF to 365pF. A lower value than specified, e.g. 208pF if at hand could be used to initially test the circuit operation but would give reduced coverage or range. A higher value variable capacitor (e.g. 500pF) can also be used for testing purposes. The range or coverage would be increased, but the intended coverage would be cramped at one end. Similarly with trimmers.

Fixed value capacitors fall into two categories — polarised (electrolytic)

and non-polarised. The latter can be connected in circuit either way round but the former can only be connected one way.

Non-polarised capacitors are specified as value and dielectric. In many cases the latter reads "ceramic or plastic". The constructor then has a free choice from what is available to him since plastic includes polycarbonate, polyester, polystyrene and polypropylene. Polyester is the most common and cheapest.

If a particular dielectric is specified it is wise to obtain this type, as it may have been chosen for its particular properties and optimum performance. For example, a silvered mica capacitor would be chosen for its close tolerance and high stability. A particular dielectric may also be specified if it is to be mounted on a p.c.b. where the lead fixing holes have been accurately dimensioned to suit the specified type.

WORKING VOLTAGE

Working voltages of non-polarised capacitors tend to be high, certainly higher in nearly all cases than 9V which is the most popular supply voltage in our battery operated projects. If the working voltage requires mention, when it is used, say, for example, in a mains filter, it is clearly specified after the value— $0.01\mu\text{F}$ 400V a.c. The capacitor can have a higher working voltage but should never, in any circumstances, be less.

This is true also for electrolytic capacitors where the working voltage is always specified. With such capacitors, the physical size for a given value increases with working voltage.

In particular applications, a higher working voltage type than required may be called up. In timing circuits, where capacitors are being charged with minute currents, the leakage through the capacitors may become significant.

The leakage effect is reduced by using a higher working voltage type of the same value.

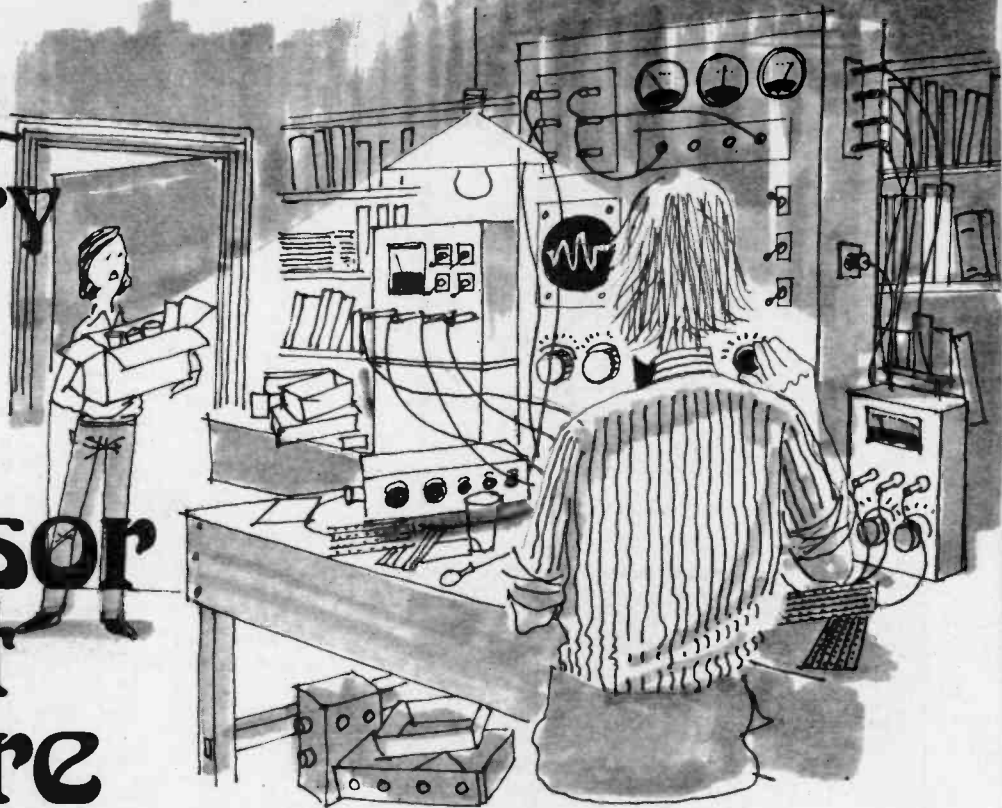
The working voltage specified for electrolytic capacitors is usually that used in the prototype and may considerably exceed the maximum requirement.

This may be due to the fact that this is the lowest working voltage available to meet the voltage requirement.

SHOP TALK

A reference to our *Shop Talk* feature appears alongside most components lists and is often overlooked by constructors. If you are building a project, it is wise to read this page. Here, among other items, any components thought likely to be difficult to get, special components, substitutions etc. are discussed, and where appropriate sources of supply and cost are given.

The Extraordinary Experiments of Professor Ernest Eversure



by Anthony John Bassett

Bob, Tom and Maurice watched as the Prof. fed a few instructions into a computer which promptly printed out a large bundle of fuzz box circuits, which were simultaneously displayed on one of his large computer viewscreens. "I know you will want to take these and study them." He handed the bundle to Bob.

"Thanks, Prof. These look really interesting. I know that fuzz boxes produce their effects by various changes in the musical waveform of the instrument and it will be interesting to study a few of the different circuits and their effects. I am amazed that there are so many!"

"Yes—but although the large number of circuits may seem bewildering, they can mostly be fitted into a number of small groups according to the various principles of operation."

As the Prof. spoke his young friends saw the diagrams rearrange themselves into groups on the large computer viewscreen.

"In this group (Figs. 1-6) the fuzz is produced by operating transistors as non-linear amplifiers, which adds harmonic distortion, and intermodulation effects. An extra bonus of fuzz effects is also produced by overloading the circuit.

"Notice how in this early design fuzz circuit (Fig. 1) using germanium pnp transistors, the input transistor TR1 is not forward biased at all and relies upon a combination of transistor leakage together with the guitar signal itself, to bias it into conduc-

tion. This results in a highly-distorted signal at the collector, which is fed through a $0.1\mu\text{F}$ capacitor (sometimes $0.047\mu\text{F}$ or smaller) to the other two transistors where further distortion and amplification occurs. The effect is modified by adjusting VR1 'Fuzz Filter' control.

"Here is a very similar circuit using silicon transistors (Fig. 2). Because these transistors do not 'leak' as much as the older germanium types and the guitar signal itself cannot be relied upon to bias the input transistor to conduction, a bias circuit (R1, R2, R3) is used and this is decoupled by a $10\mu\text{F}$ capacitor to prevent negative feedback from correcting distortion introduced by the transistor.

"I will not comment on every circuit. You can learn a lot for yourself by studying them all and by doing a few experiments. In Fig. 4 the fuzz effect is varied by changing the bias on a transistor, whilst this circuit, Fig. 5, uses a transistor, TR3, which has been deliberately reverse-biased. This technique can be useful in reducing low-level noise and interference which is a problem with many other fuzz box designs.

"The 'overdriver' (Fig. 6) is basically a fuzz circuit which incorporates tone-controls."

DIODES IN FUZZ BOXES

"Here are some more fuzz-box circuits which use diodes to distort the waveform and produce fuzz effects,

but these circuits, unlike earlier ones which used heavy duty power diodes connected to the speaker outlet of the amplifier, use miniature diodes to distort the signal before it reaches the input of the guitar amplifier.

"Either silicon or germanium diodes may be used to produce the fuzz effects, and although the principles are the same, the effects produced are not identical and may sound different. In the first of these diode fuzz circuits (Fig. 7) an integrated-circuit pre-amplifier is used to raise the voltage level of the input signal to a value which will cause the diodes to conduct, alternately clipping away the upper parts of the signal waveform, when the fuzz control is at minimum resistance.

"As the fuzz control is adjusted to higher resistance, the clipping is reduced to give less harsh effects."

"What happens if you use germanium diodes instead of silicon ones in this circuit, Prof?" Bob enquired.

"Due to the lower forward voltage drop of the germanium diodes, they would clip at a lower voltage level, giving a lower output level which would be especially noticeable when the fuzz depth control was set to low resistance. This lower amplitude can easily be compensated by means of extra amplification. So the circuit will work equally effectively with either germanium or silicon diodes!"

To be continued

FUZZ CIRCUITS

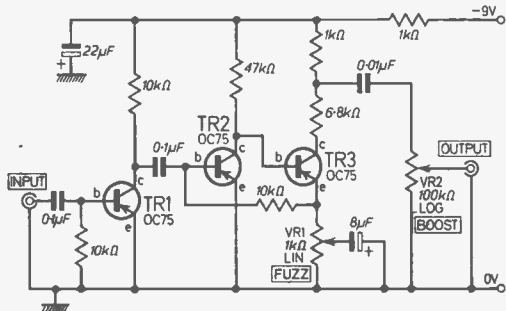


Fig. 1. Germanium pnp fuzz circuit.

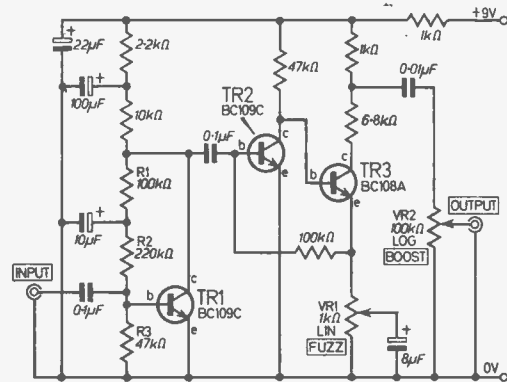


Fig. 2. Silicon npn fuzz circuit.

DISTORTION BOOSTER

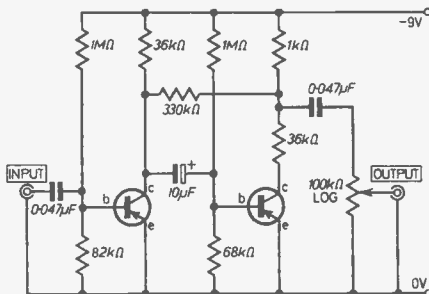


Fig. 3. Distortion Booster circuit diagram. Note that any high gain pnp transistor can be used here.

FUZZ CIRCUIT

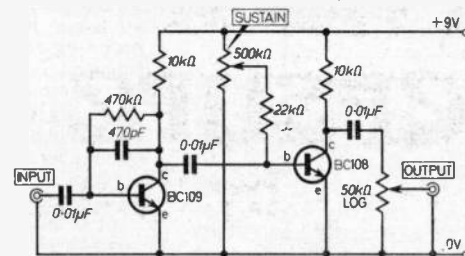


Fig. 4. Another simple fuzz circuit.

FUZZ & TREBLE BOOSTER

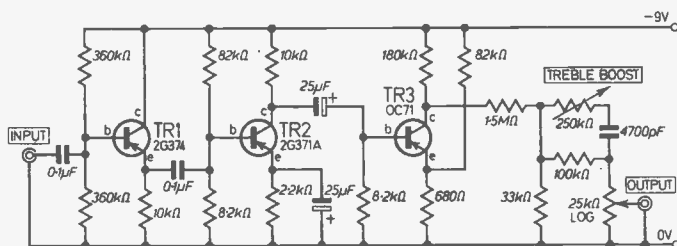


Fig. 5. Circuit diagram for the fuzz box with treble boost.

DIODE FUZZ

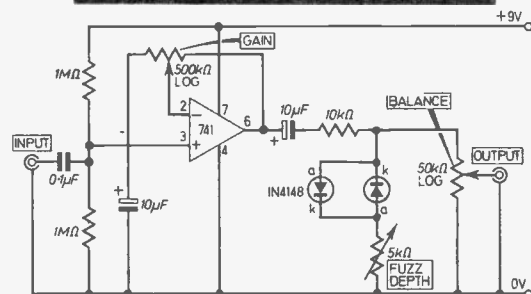


Fig. 7. Simple i.c. fuzz box circuit diagram. Note the use of diodes to produce distortion by clipping the output waveform.

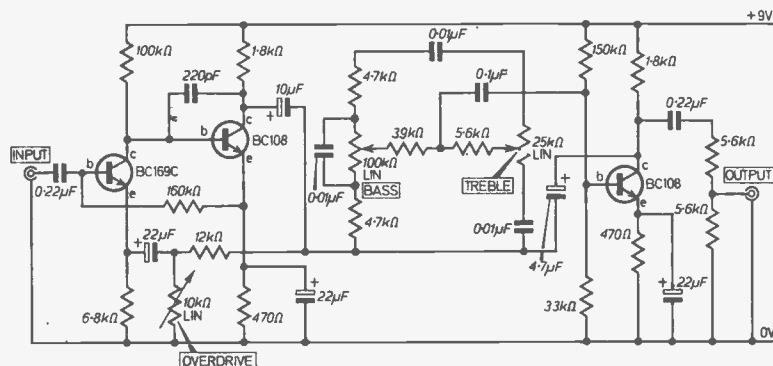


Fig. 6. "Overdriver" effect circuit diagram.

OVERDRIVER CIRCUIT

RADIO WORLD

By Pat Hawker, G3VA

Down to earth?

In announcing the engineering plans for the fourth British TV programme channel, Lady Plowden, chairman of the IBA, pointed out recently that many people think that transmitter networks on the ground are about to be overtaken by direct broadcasting to the home from space, adding: "If we were starting all over again, and there were no u.h.f. networks in the country, there might be reason to do this—always assuming that we were not working to a fixed launch date." This confirms, once again, the view that the question of broadcasting from spacecraft is now increasingly one of need, desire or choice rather than technological feasibility (which indeed is now virtually proven).

In practice, for the Fourth Channel, there could be no question of using direct broadcasting satellites, with the u.h.f. networks now firmly established and with so many viewers already having receivers and aerials and just waiting to touch or push the channel-selection button. For 12GHz transmissions from space they would need at least a new "electronic aerial" comprising a parabolic dish aerial of up to one-metre in diameter together with the circuitry of a receiver or adaptor capable of dealing with 12GHz frequency-modulated signals. Because of the electrical power limitations on spacecraft (the idea of putting a nuclear generator into space is now virtually ruled out) it is necessary for direct-broadcast satellites to use f.m. for vision as well as sound.

I would estimate that it would be some considerable time, if ever, before the extra cost to a viewer for watching programmes coming directly from a space satellite would fall below about £100-£200. This might be well worth paying for say five additional programme channels (the UK allocation) or if you are located in one of the "impossible" places for u.h.f. reception, but otherwise would not appeal to many viewers.

While France, West Germany and Luxembourg all seem anxious to push ahead with direct-broadcast satellites (the first two with an eye on industrial opportunities in those countries where the advantages of satellite systems are more real than in Europe) the major need at present would seem to be for "distribution satellites" akin to those which are already proving useful and profitable for so many American cable "subscription TV" services, for the Canadian CBC and American PBS broadcast networks.

The intention in this case is to provide a low-cost "programme feed" for transmitters spread over large areas or for small, medium and large cable networks. Currently over 1500 TV receiving terminals (mostly working on about 4GHz) are in use or being planned in North America,

and all the major American sound radio networks now distribute their programmes to affiliated transmitters by means of satellite distribution circuits (which allow improved audio up to 15kHz compared with the 5kHz of most long-haul terrestrial links).

Europe at present has only the OTS experimental satellite, apart from the high-cost *Intelsat* global system. But at least this has enabled the IBA to make some interesting use of their transportable up-link terminal, including the first space relays from the Channel Islands and Eire (for the Pope's visit).

Since most European countries operate a telecommunications monopoly, one suspects that there will be less rapid progress towards low-cost satellite distribution circuits in Europe than in the fiercely competitive situation in the USA where RCA, Western Union and now AT & T are all in the business of providing circuits in space.

What a novice needs to know

At a time when there is renewed discussion about the possibility of "novice" amateur licences in the UK, based on an appreciably simpler technical examination and a Morse test of only 5 or 6 words per minute, Graeme Scott, an Australian amateur with the call sign VK3ZR has formulated what appear to be some guidelines on the minimum technical/operating knowledge suitable for a novice examination. He considers that the candidate should be expected to show knowledge of the legal conditions imposed by the amateur licence he is seeking (i.e. how to operate legally); how to tune a transmitter; how to carry on a contact in Morse; how to put together a simple station; show an understanding of common problems (including the causes of television interference, key clicks etc); and have some basic familiarity with the terminology and equipment commonly used in radio.

These guidelines differ from the standard Radio Amateur's Examination in placing much less emphasis on the design of equipment and would limit the mathematics to such basic formulae as Ohm's Law; resistance-capacitance-inductance-frequency-wavelength relationships; value of parallel/series resistors, watts input and so on. The emphasis would be on the information needed in practice to ensure the radiation of satisfactory signals.

Interference

Recently, I was speaking to someone concerned with interference complaints in South Africa (where this is primarily the responsibility of the broadcasters rather than the Post Office). He reported that there had been a very significant increase in complaints of television interference since the start of Citizens Band radio there a couple of years ago.

Tests showed that often the CB rig when correctly tuned and operated gave no problem, even when placed on a bench beside the TV receiver. However, when used over a period of time by people with very little technical knowledge, the same rig tended to drift out of adjustment and to cause severe interference.

The most recent figures from the USA also underline the problem of the inexperienced operator: in the first quarter of 1979, the FCC received 16,401 complaints of alleged radio-frequency interference to TV reception: 13,894 related to CB stations; only 519 to amateur radio stations.

Young Ladies

A very marked change has come over the electronics trade and technical press during the past decade: today one finds that the industry's press conferences are very far from being the all-male affairs they tended to be not so many years ago. A large number of talented young ladies are now writing regularly on electronics.

Does this mean, one wonders, whether the readership is similarly changing? Mr Editor may correct me, but I would hazard the guess that the overwhelming majority of readers are still male.

This certainly applies to the field of amateur radio, where at a guess not more than about 0.25 per cent of British amateurs are "YLs" (young ladies) or "XYLs" (wives)—the former expression "OW" comparable to "OM" (old man) is never used today. Of course, even 0.25 per cent represents several hundred and this is a vast increase since the early days of amateur radio.

I was reminded of this by learning of the death a few months ago of Miss Barbara Dunn, G6YL who for five years (1927-1932) had the distinction of being Britain's first and only YL operator. Altogether she held her amateur licence for more than 50 years and, particularly in the 1930s was an extremely active and able operator.

She taught herself 20 words-per-minute operating by listening on a crystal set to the old FL time signals on 2600 metres from Paris and by listening to ships working on 600 metres and (as they did in the early days) around 2100 metres. She also had to cope with the problem, common to many of the early amateurs, of having no a.c. mains supply and having to depend on a rotary converter running from accumulators charged from 100-volt d.c. mains. Even now, it is well within memory of many of us when quite large areas of London had nothing but d.c. mains.

In 1932 Barbara Dunn was joined by another YL colleague, the late Miss Nell Cory, G2YL who also achieved great distinction in the amateur world by her work on 28MHz—on which band she became the first British amateur to work all continents in October 1935.

In fact, although the number of YLs has always been small in the UK they have contributed much to the hobby. These days I find quite a few American amateurs and also the operators on the Russian club stations turn out to be "YLs".

With my name I also encounter the problem that a number of the people I work on c.w. imagine that I am a "YL" operator and insist on sending me "88" (love and kisses)!

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(* Yes, we still haven't learnt how to spell.)

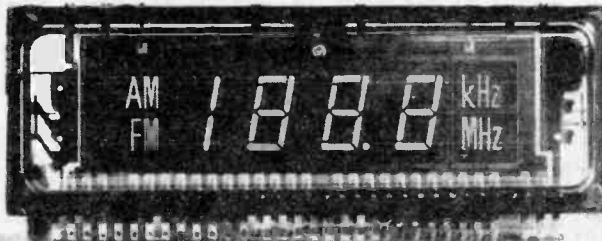
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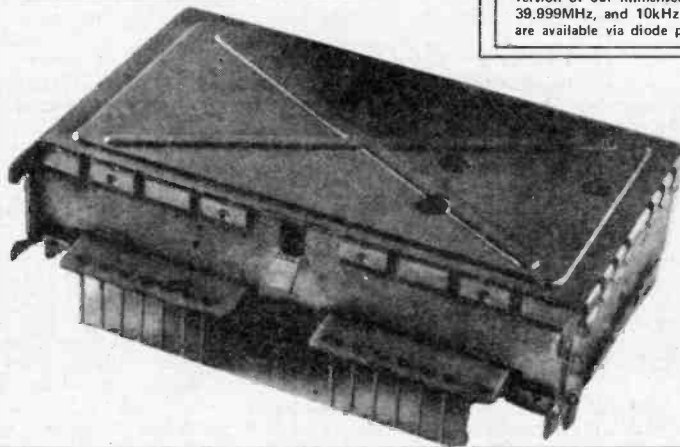
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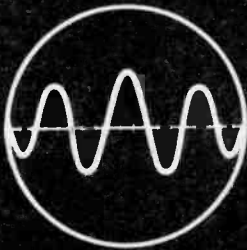
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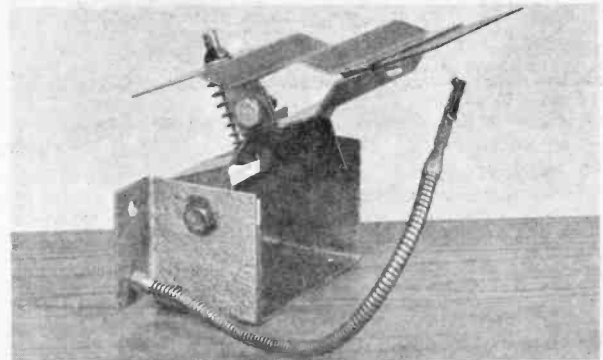
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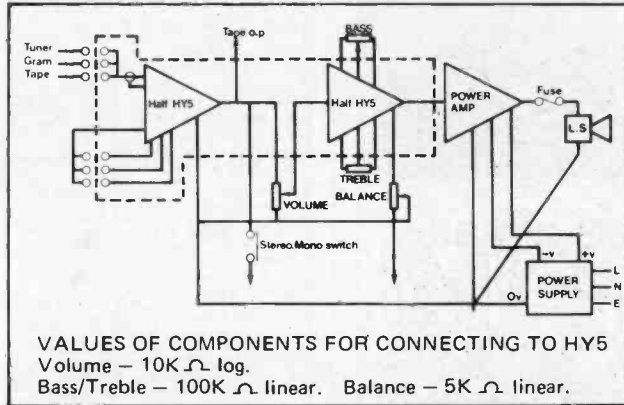
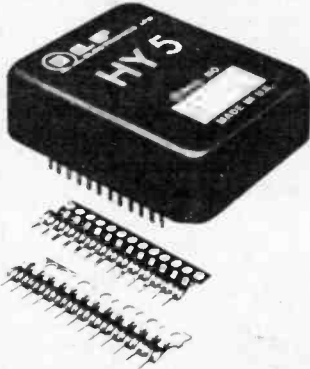
With I.L.P. performance standards and quality already so well established, any advances in I.L.P. design are bound to be of outstanding importance – and this is exactly what we have achieved in our new generation of modular units. I.L.P. professional design principles remain – the completely adequate heatsinks, protected sealed circuitry, rugged construction and excellent performance. These have stood the test of time far longer than normally expected from ordinary commercial modules. So we have concentrated our improvements whereby our products will meet even more stringent demands such, for example, as those revealed by vastly improved pick-ups, tuners, loudspeakers, etc., all of which can prove merciless to an indifferent amplifier system. I.L.P. modules are for laboratory and other specialised applications too.

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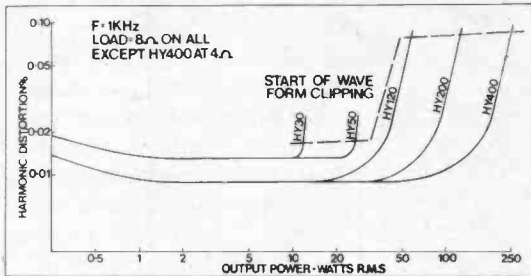


VALUES OF COMPONENTS FOR CONNECTING TO HY5
 Volume - 10K Ω log.
 Bass/Treble - 100K Ω linear. Balance - 5K Ω linear.

The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm, and provides multi-function equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits; 500 mV out, Distortion at 1KHz-0.01%. Special strips are provided for connecting external pots and switching systems as required. Two HY5's connect easily in stereo. With easy to follow instructions.

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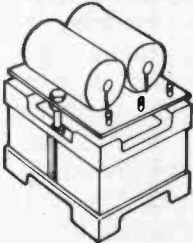
THE POWER AMPLIFIERS



Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0 +20	105x50x25	155	£6.34 + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0 +25	105x50x25	155	£7.24 + £1.09
HY120	60 W into 8 Ω	0.01%	100dB	-35 -0 +35	114x50x85	575	£15.20 + £2.28
HY200	120 W into 8 Ω	0.01%	100dB	-45 -0 +45	114x50x85	575	£18.44 + £2.77
HY400	240 W into 4 Ω	0.01%	100dB	-45 -0 +45	114x100x85	1.15Kg	£27.68 + £4.15

Load impedance - all models 4 - 16 Ω
 Input sensitivity - all models 500 mV
 Input impedance - all models 100K Ω
 Frequency response - all models 10Hz - 45Hz - 3dB

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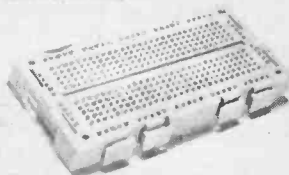
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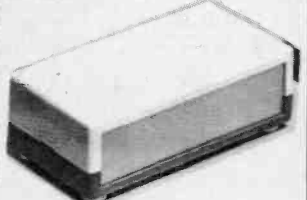
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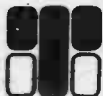
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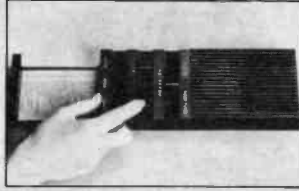
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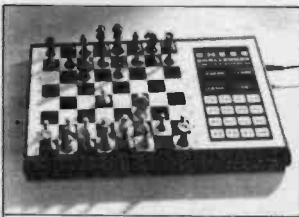
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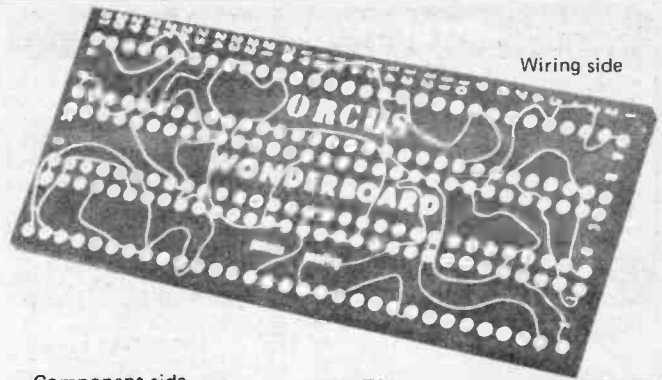
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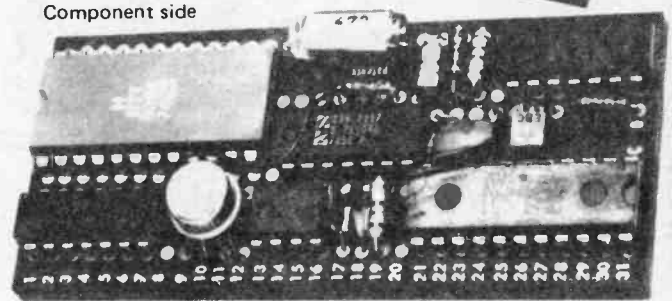
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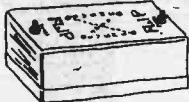
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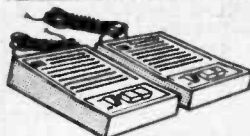


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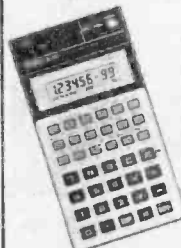
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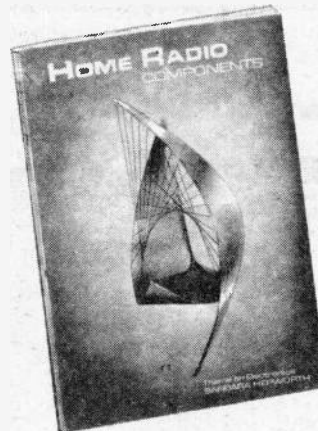
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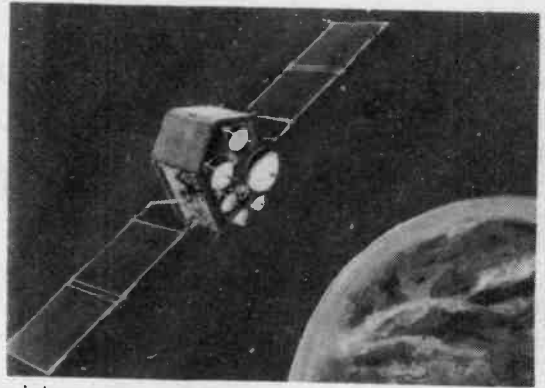
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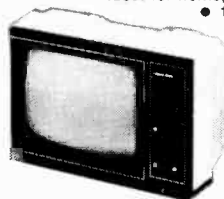
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