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ELECTRONICS PROJECTS

VOL. 12

A Compilation of 102 tested Electronic Construction Projects and Circuit Ideas for Professionals and Enthusiasts

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Electronics Projects
Vol. 12

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FOR YOU

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FOREWORD

This volume of Electronics Projects is the twenty second in the series published by EFY Enterprises Pvt Ltd. It is a compilation of 25 construction projects and 77 circuit ideas published in 'Electronics For You' magazine during 1991.

In keeping with the past trend, all relevant modifications, corrections and additions sent by the readers and authors have been incorporated in the articles. Queries from readers along with the replies from authors/ EFY have also been published towards the end of relevant articles. It is a sincere endeavour on our part to make each project as error-free and comprehensive as possible. However, EFY cannot resume any responsibility if readers are unable to make a circuit successfully, for whatever reason.

This collection of a large number of tested circuit ideas and construction projects in a handy volume would provide all classes of electronics enthusiasts—be they students, teachers, hobbyists or professionals—with a valuable source of electronic circuits, which can be fabricated using readily-available and reasonably-priced components. These circuits could either be used independently or in combination with other circuits, described in this and other volumes. We are sure that this volume, like its predecessors, will generate tremendous interest among its readers.

Contents

Section A: Construction Projects

Section B: Circuit Ideas

SECTION A:
CONSTRUCTION PROJECTS

DYNAMIC DISPLAY

K.P. Viswanathan

Several circuits for displays using different integrated circuits have been published earlier in EFY. This advertising display (mainly for name board) uses the popular IC 555. The display has only one mode, i.e. the characters light up one by one and go off one by one from left to right giving a writing and wiping effect. Each letter is lit up by ordinary 230V AC bulbs controlled by triacs. LEDs can also be used with proper driving circuits.

In the circuit diagram and PCB layout, seven ICs are used to display the word 'WELCOME'. One can increase or decrease the number of ICs according to the number of letters to be displayed.

Control circuit

All ICs, except IC1, work as schmitt triggers. All ICs are connected in cascade. Understanding the first two stages and how they initiate the operation of the next stage helps in understanding the operation of complete circuit.

When the supply is switched on, IC1 is triggered as its trigger terminal pin 2 and threshold terminal pin 6 are below 1/3 Vcc. The output at pin 3 goes to high state, thus triggering the triac connected to it for lighting up the first letter.

Apart from providing the drive to the triac gate, the output of IC1 is also connected to the control voltage terminal pin 5 of IC2 through a delay circuit consisting of a resistor and a capacitor. This will change both trigger and threshold voltage levels otherwise provided by internal voltage divider as 1/3 Vcc and 2/3 Vcc respectively.

When the capacitor gets charged and exceeds the voltage by twice the voltage set by the variable resistor connected to pin 2 of IC2, its output goes to high state and thus the second letter is also lit up through the second triac. This process continues in sequence from second to third letter and so on, lighting up all the letters.

The output of the last IC is also connected to the threshold terminal pin 6 of IC1 through a delay circuit consisting of a resistor and a capacitor. When the capacitor charge exceeds 2/3 Vcc, output of IC1 goes to low state, removing the necessary drive given to the triac gate and thus the first bulb goes off.

At the same time, control voltage of IC2 is also pulled to negative, discharging the capacitor. When it goes below the threshold voltage level set by the variable resistor connected to pin 6, its output also goes to low state switching off the second bulb. This process continues in sequence and all the bulbs go off one by one. When the last bulb goes off, the first bulb is switched on as the trigger terminal of IC1 is pulled below 1/3 Vcc. This makes a continuous loop and the timer operates endlessly.

Setting

Keep all the presets connected to trigger terminals (pin 2) of ICs at maxi-

PARTS LIST

Semiconductors:

IC1-IC7	--	NE555 timers
TR1-TR7	--	1-amp, 400PIV triacs
D1-D4	--	1N4001 diodes

Resistors (all 1/4-watt, ±5% carbon, unless stated otherwise):

R1-R7	—	330-ohm
R8-R15	—	4.7-kilohm
VR1-VR12	—	100-kilohm presets

Capacitors:

C1	—	0.01µF ceramic
C2-C7	—	47µF, 16V electrolytic
C8	—	100µF, 16V electrolytic
C9	—	1000µF, 25V electrolytic

Miscellaneous:

X1	—	230V AC primary to 12V, 500mA secondary

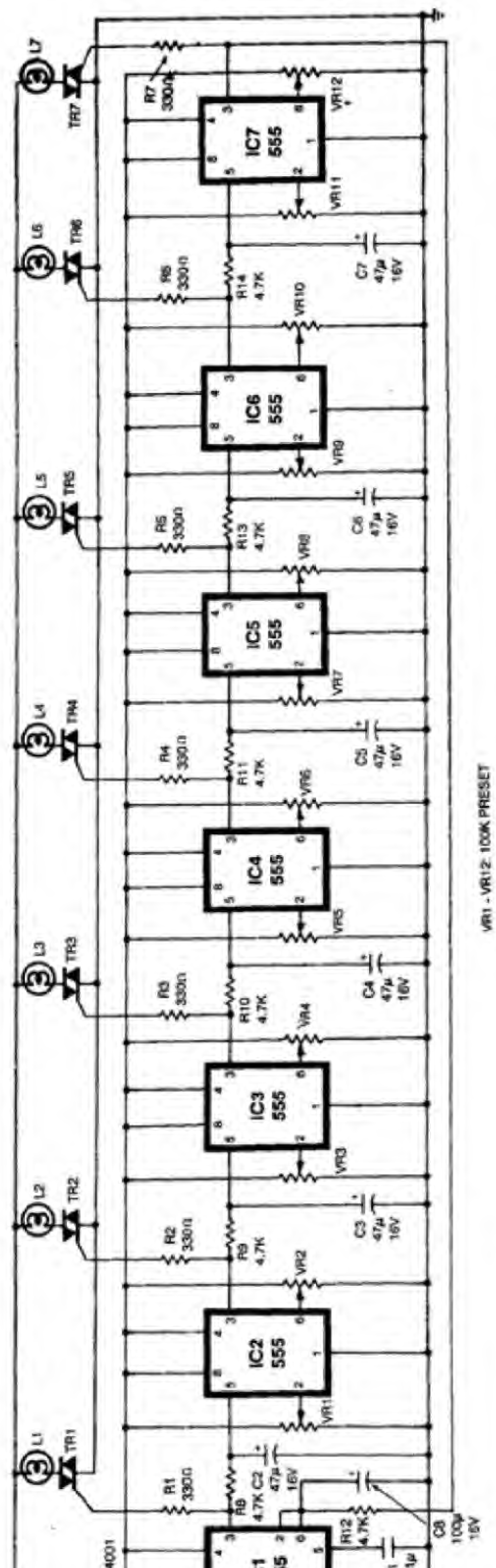


Fig. 1: Circuit diagram of the dynamic display.

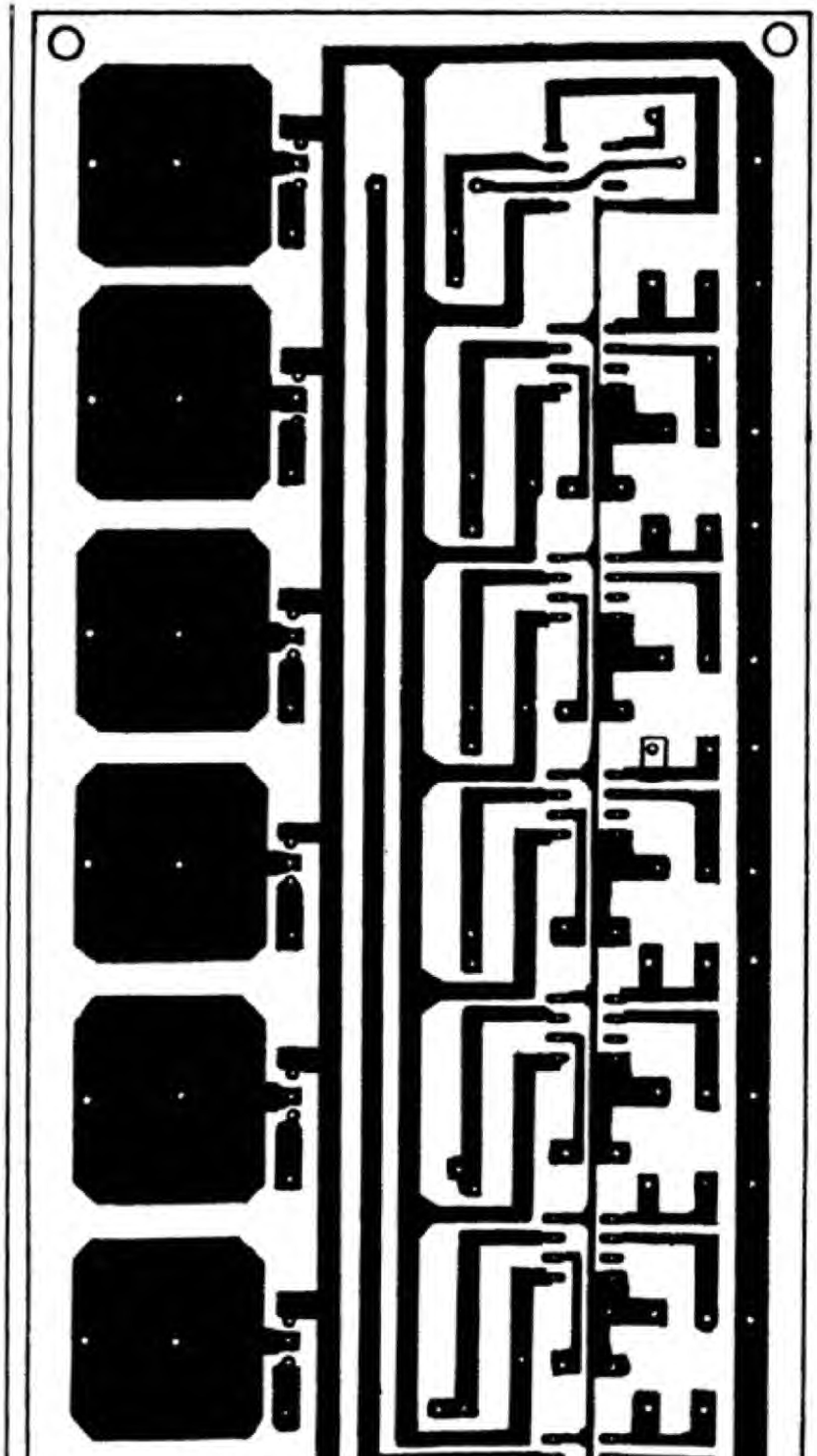


Fig. 2: Actual-size PCB layout for the dynamic display circuit.

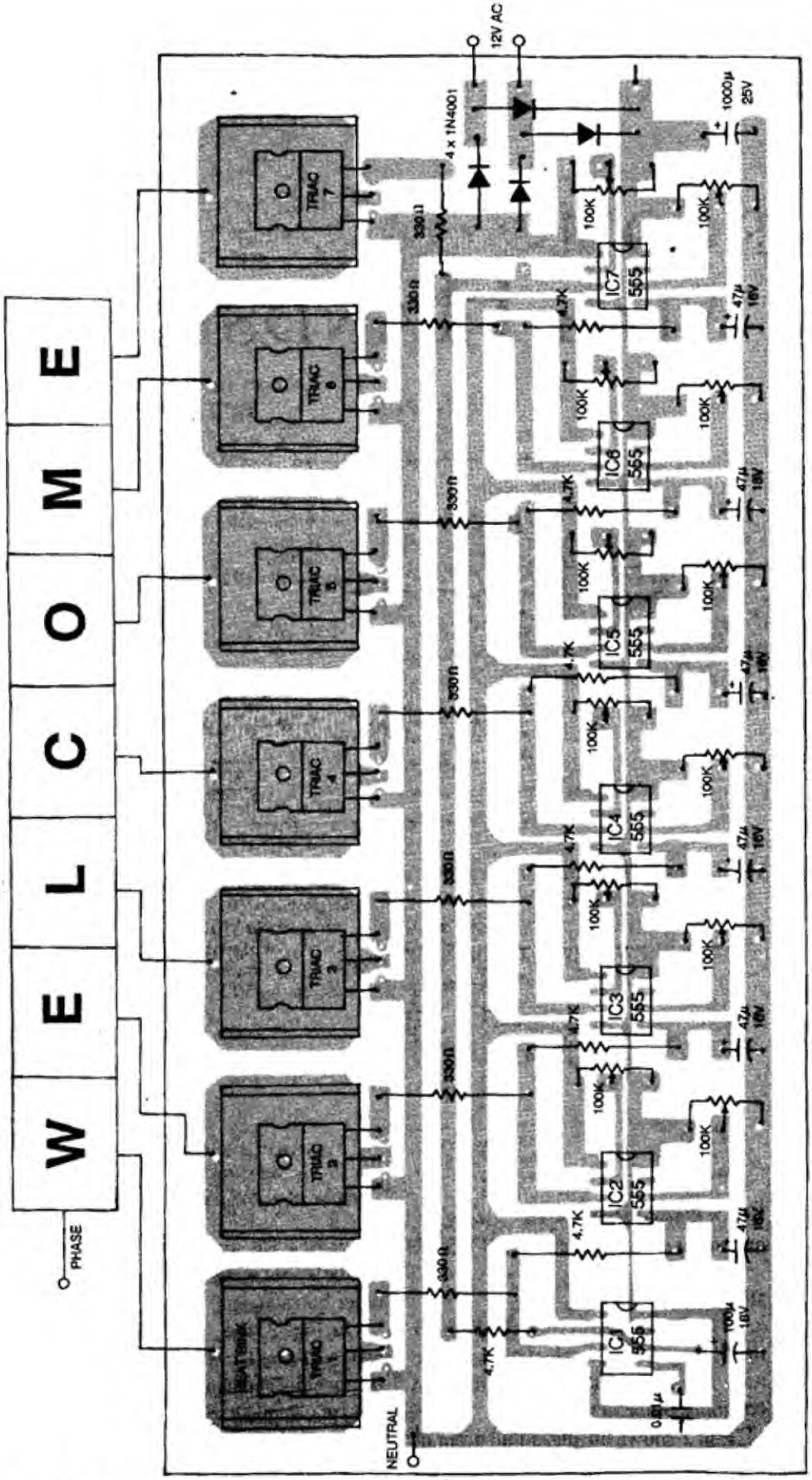


Fig. 3: Components layout for the PCB shown in Fig. 2 .

mum voltage position and to threshold terminals (pin 6) at minimum voltage position. Switch on the power. Only the first bulb gets lit up. Adjust the preset connected to the trigger terminal of IC2 to reduce the trigger voltage level.

At a critical voltage, IC2 gets triggered for lighting the second bulb. In this way all the presets connected to the second terminal can be adjusted and all the bulbs switched on one by one. Switch off the power for a few seconds and switch on again for rechecking the sequence. Most of the presets have to be readjusted because even touching the preset may trigger the IC.

When the output of the last IC goes to high state, IC1 goes to low state. So the first bulb is switched off. Adjust the preset connected to the threshold terminal pin 6 of IC2 for increasing the threshold voltage level. At a critical voltage, the second bulb also goes off. Thus all the presets connected to pin 6 can be adjusted and all the bulbs go off one by one. This cycle is repeated endlessly. A final setting is required for making the delay time equal in the sequence.

All precautions must be taken against electrical shock as the circuit works on AC mains.

Power supply taken from 12V, 500mA step-down transformer, full-wave rectifier and a 1000µF filter capacitor is enough for the given circuit. When more letters are to be displayed, current rating of transformer may also be increased. Triacs of rating 1-amp, 400PIV are used so that 100W, 230V AC bulbs may be used safely with heatsinks.

Stencil-cut letters fixed on box having separate compartments for each letter are easy to make. Bulbs fitted on holders in each compartment light up the letters. □

AN INTERCOM WITH HANDSET

Sakthidharan K.A.

The intercom system described here has all the facilities of a commercially available 2-station system. It has advantages like low voltage operation, ring and ring-back functions, free from feedback howling and talk-listen changeover. The sound quality is superb. It covers wide frequency range.

The transmitter

The transmitter comprises a condenser mic. and an audio amplifier using IC BEL1895. It is a low power, 8-pin audio amplifier IC, intended for use in portable radio receivers. It works on very low voltage, viz, 2.5V DC onwards.

The sensitivity of the transmitter is enhanced by the use of the condenser mic. If the system is intended for use in a noisy location, the sensitivity of the mic. has to be reduced by increasing the value of R1.

The gain of the amplifier can be adjusted with the help of preset *VR1*. However, a 100k resistor can be used in place of *VR1*

The output of the transmitter is sent to the receiver of the other station. The amplifier circuit is shown in Fig. 1.

The receiver

An earphone of a stereo headphone set is used here as the receiver. By selecting this earphone, the problem of feedback howling is almost totally eliminated and the frequency response is extented to maximum levels.

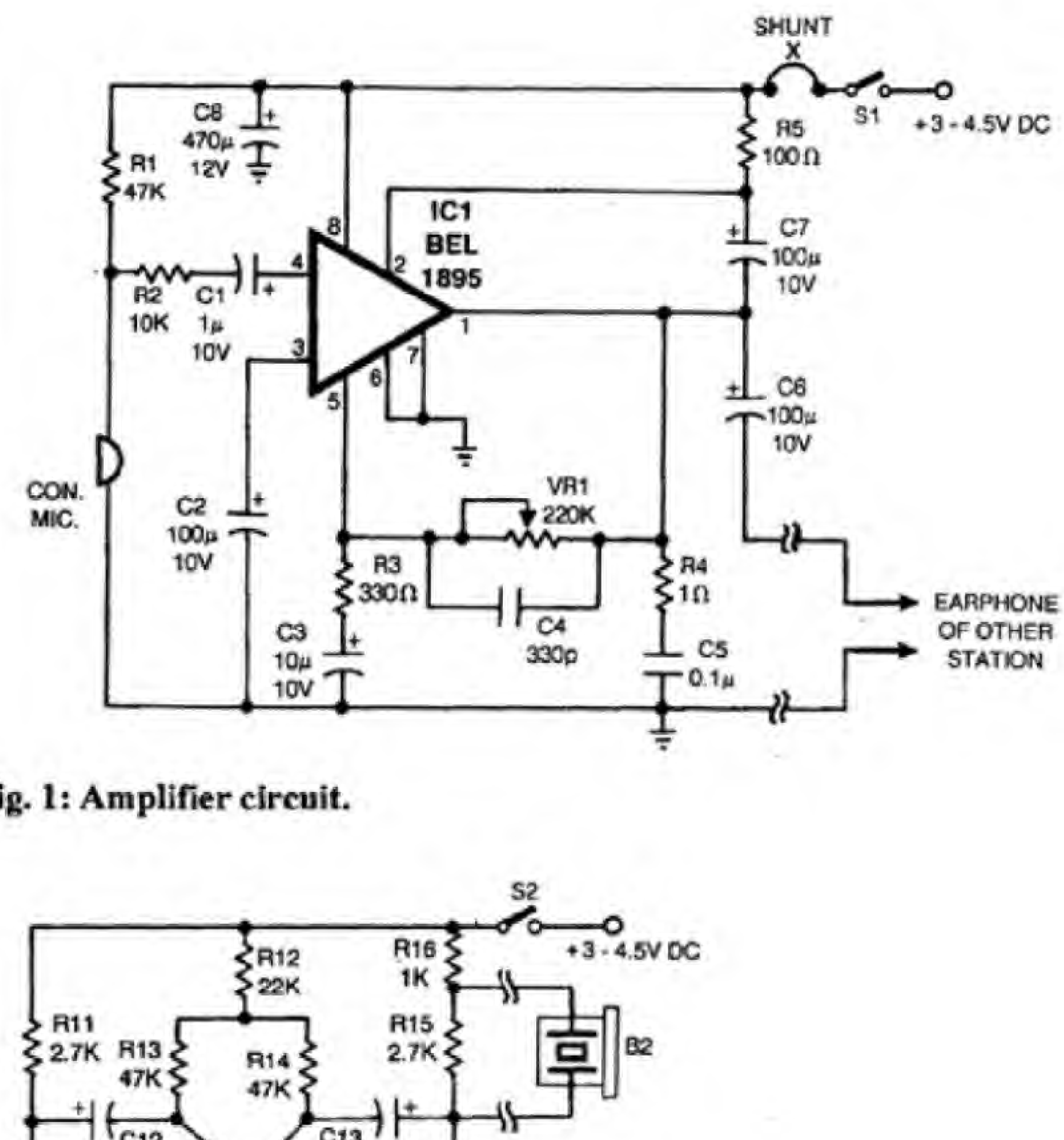


Fig. 1: Amplifier circuit.

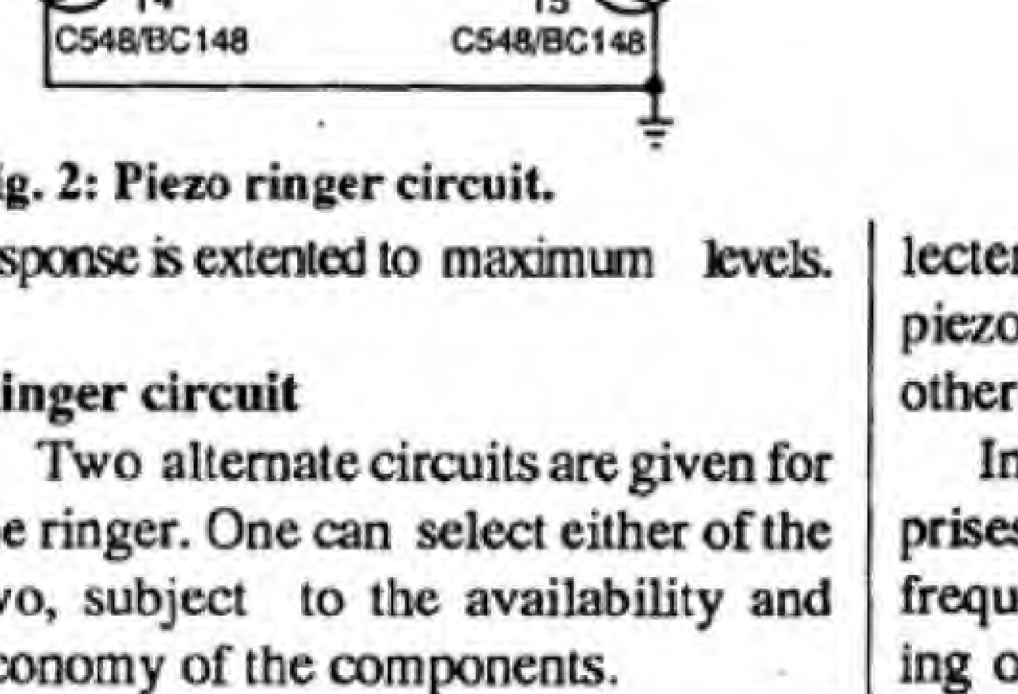


Fig. 2: Piezo ringer circuit.

Ringer circuit

Two alternate circuits are given for the ringer. One can select either of the two, subject to the availability and economy of the components.

Fig. 2 shows the circuit diagram of a conventional multivibrator. The negative-going pulses available at the collecter of T2 are used to drive a piezoelectric buzzer placed inside the other handset.

In Fig. 3, the multivibrator comprises T1 and T2, which produce audio frequency. The charging and discharging of C9 make interruptions in the audio frequency. This is amplified by T3 and its output is sent to a small loudspeaker placed in the handset of

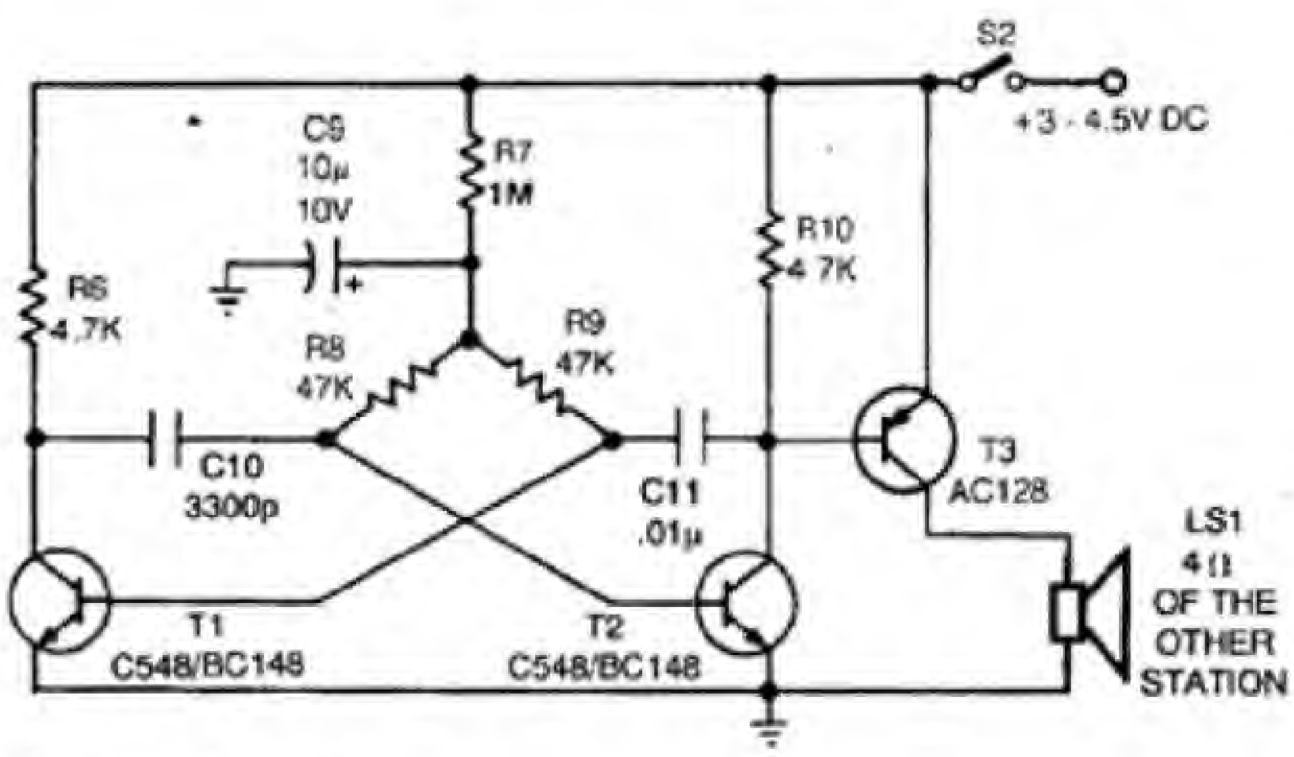


Fig. 3: Bird sound ringer circuit.

PARTS LIST

Semiconductors:

IC	— BE1 1895
T1, T2, T4, T5	— C548/BC148
T3	— AC128 (optional)
D2	— OA79

***Resistors:** (All 1/4-watt ±5% carbon, unless stated otherwise):*

R1, R8, R9, R13, R14	— 47-kilohm
R2	— 10-kilohm
R3	— 330-ohm
R4	— 1-ohm
R5	— 100-ohm
R6, R10,	— 4.7k
R11, R15	— 2.7-kilohm
R7, R12	— 22-kilohm
R16	— 1-kilohm
VR1	— 220-kilohm, preset

Capacitors:

C1	— 1µF, 10V electrolytic
C2, C7, C6	— 100µF, 10V electrolytic
C3, C9, C13	— 10µF, 10V electrolytic
C4	— 330pf ceramic
C5	— 0.1µF ceramic
C8	— 470µF, 12V electrolytic
C10	— 3300p
C11	— .01µ

Miscellaneous

Condenser mike	— 1 no.
Earphone	— 1 no.
B1, B2	— Piezoelectric buzzers
S1, S2	— DPDT swithes

other station. This produces an attractive bird sound.

The ring pulse will come back to the receiver of the calling person so that he can know if someone has attended the other station. This provision is made simply by connecting the incoming line with the outgoing line through a diode. This diode should have extremely low leakage current. Otherwise it will cause problems like oscillations, motor-boating etc.

Power supply

The whole circuit works on 3V DC. If the distance between two stations is more than 30 metres, the voltage should be raised to 4.5V or 6V. If 6V supply is used, a 56-ohm resistor should be connected in place of the shunt marked 'X' in Fig. 1.

Dry battery is recommended. If penlight cells are used, they can be housed inside the handset. If separate power supply units are used for each station, the connection wires between two stations can be limited to three. However, a central power supply system can also be used as shown in Fig. 4(b).

Control switches and operation

Two DPDT slide switches are used in each station to select on/off and call/talk positions. Normally, switches S1 at both stations are kept in 'off'

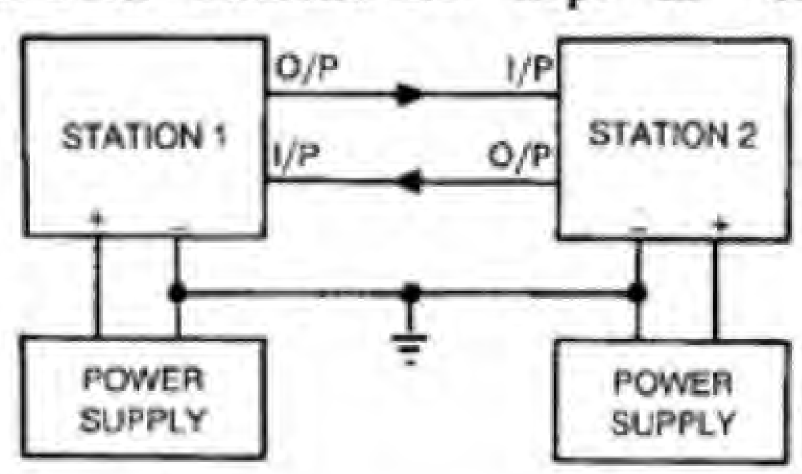


Fig. 4 (a): Connection diagram of a separate power supply.

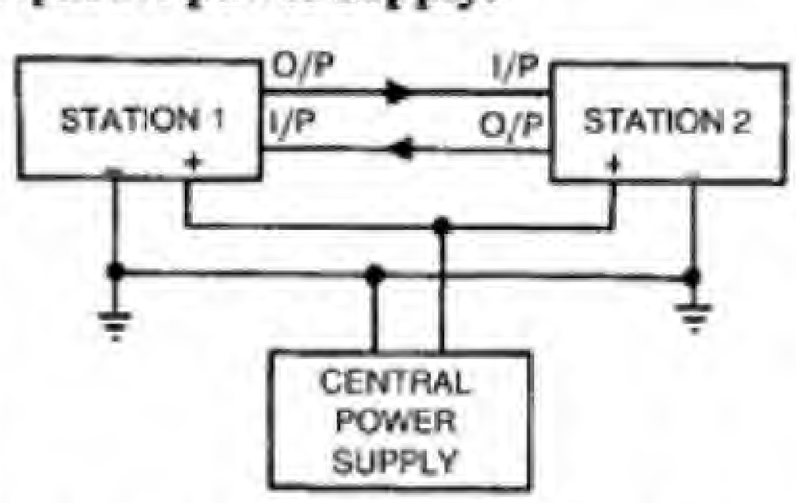


Fig. 4 (b): Connection diagram of central power supply.

position. Now no power is applied to any circuit and the incoming line is connected to the buzzer or loudspeaker in both stations.

If one wants to call the other station, S1 is set to 'on' and S2 to 'call' position.

This provides power to the ringer circuit and its output is connected to the outgoing line. This produces ringing at the other station.

If someone attends the other station, he turns S1 of his set to 'on' position which stops the ringing and then S2 is set to talk position. The first person receives these changes in his receiver and he too turns S2 to 'talk' position. Now both persons can talk to each other. At the end of the conversation, both sets have to be set to 'off' position. The connection diagram for the intercom is given in Fig. 5.

Construction of handset

An average hobbyist may find it difficult to obtain handsets for intercom projects. This problem is solved by selecting the low-cost and easily available students'plastic pencil boxes. These are available in various shapes and attractive colours. It should have minimum size of 20cm x 3cm x 6cm. Some holes have to be drilled on the box for clear sound reproduction. The earphone should be placed in such a way as to get close coupling to the ear. Figs 6 and 7 show the PCB and components layout for the intercom.

The PCB, loudspeaker, buzzer, switches and battery holder must be fixed in the handset by using rubber based adhesive (Fig. 8). Avoid nuts, bolts or screws. A 3-core shielded wire should be used to connect the handset with the main lines.

Since all parts of the intercom can be housed inside the handset, the need for a tableset or speaker box is eliminated. The handset can either be hung on the wall or kept on a table.

Coiling of cord

The shielded wire emerging from the handset may be coiled permanently for convenience (as in com-

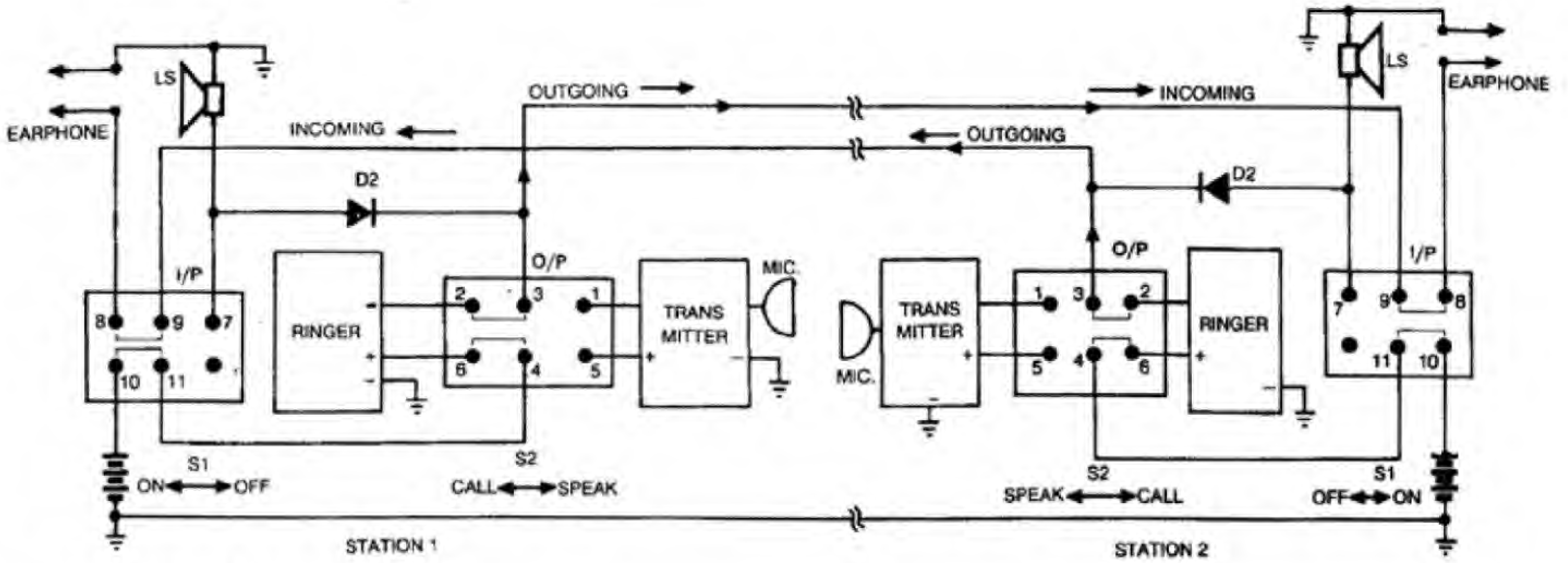


Fig. 5: Connection diagram.

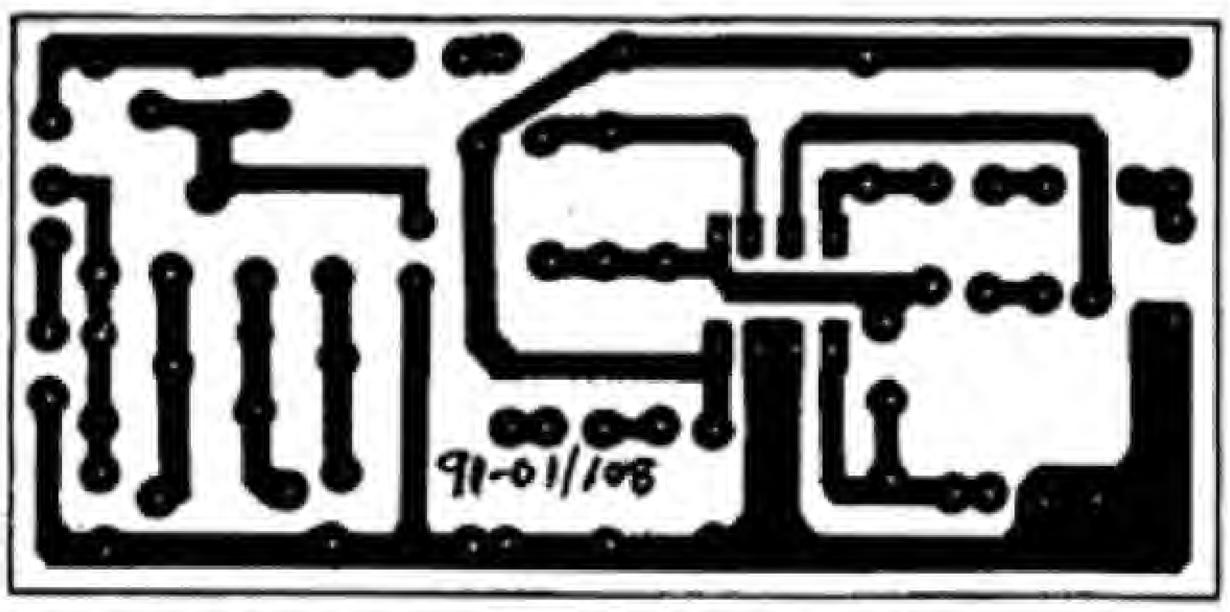


Fig. 6: Actual size PCB layout for the intercom.

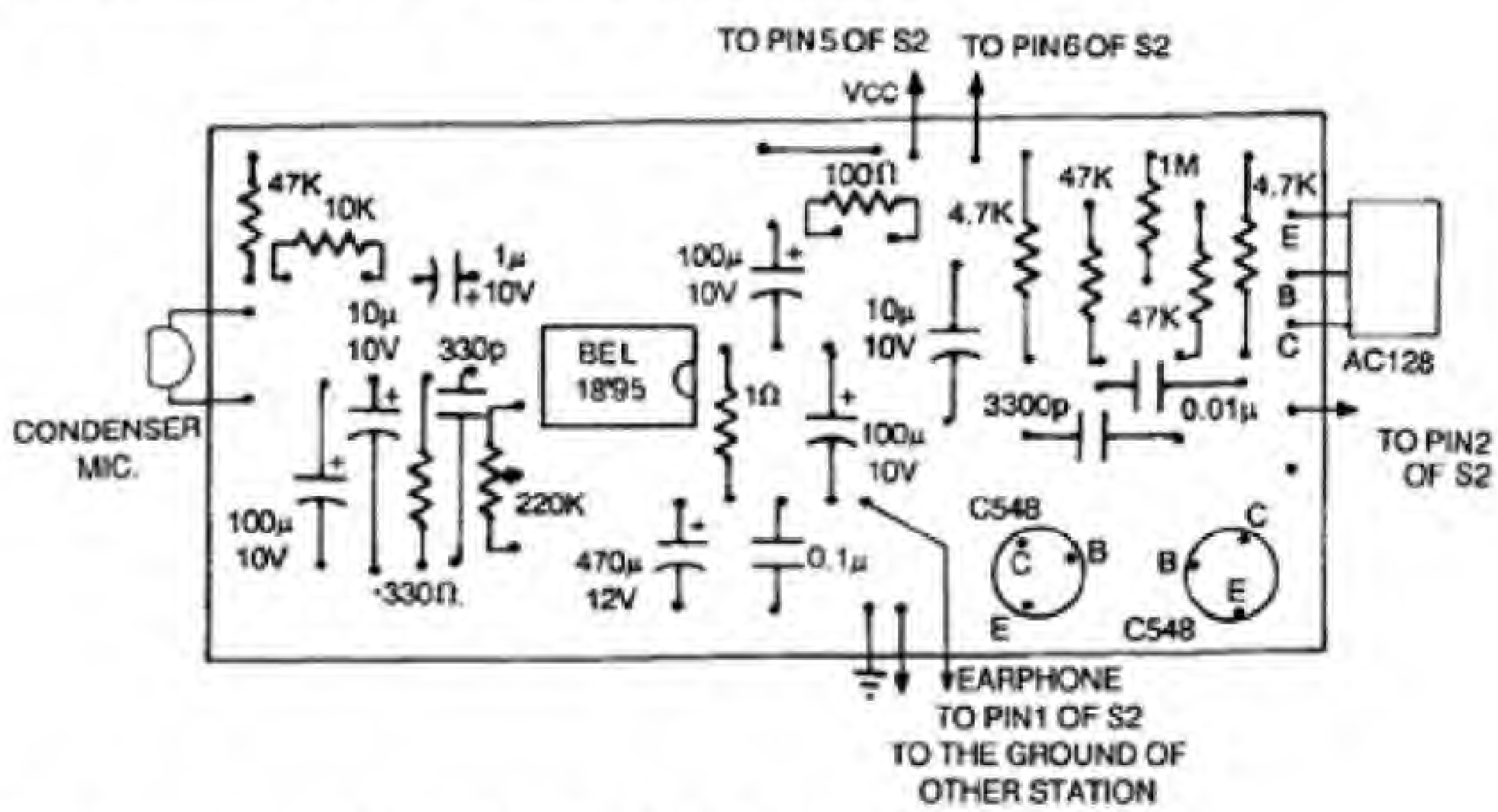


Fig. 7: Components layout for the PCB shown in Fig. 6.

mercially available systems). An indigenous method is explained here. Clean the surface of the cylinderical heating portion of a 10W soldering iron and apply a thin coat of grease over it. Coil the cord closely over it.

Connect the iron to AC mains through diode BY127 or 1N4007. By applying the rectified half-wave current to the iron, its temperature can be kept within reasonable limits. Keep it heating for about 10 minutes. Then switch off the mains and let it cool down. A wet rag may be used for cooling. When thoroughly cooled, loosen the cord from the iron. A sample test with a piece of waste cord will give exact information about temperature and duration of heating.

Note: If the power supply is increased above 6V, feedback howling may occur. This can be reduced by adjusting preset VR1.

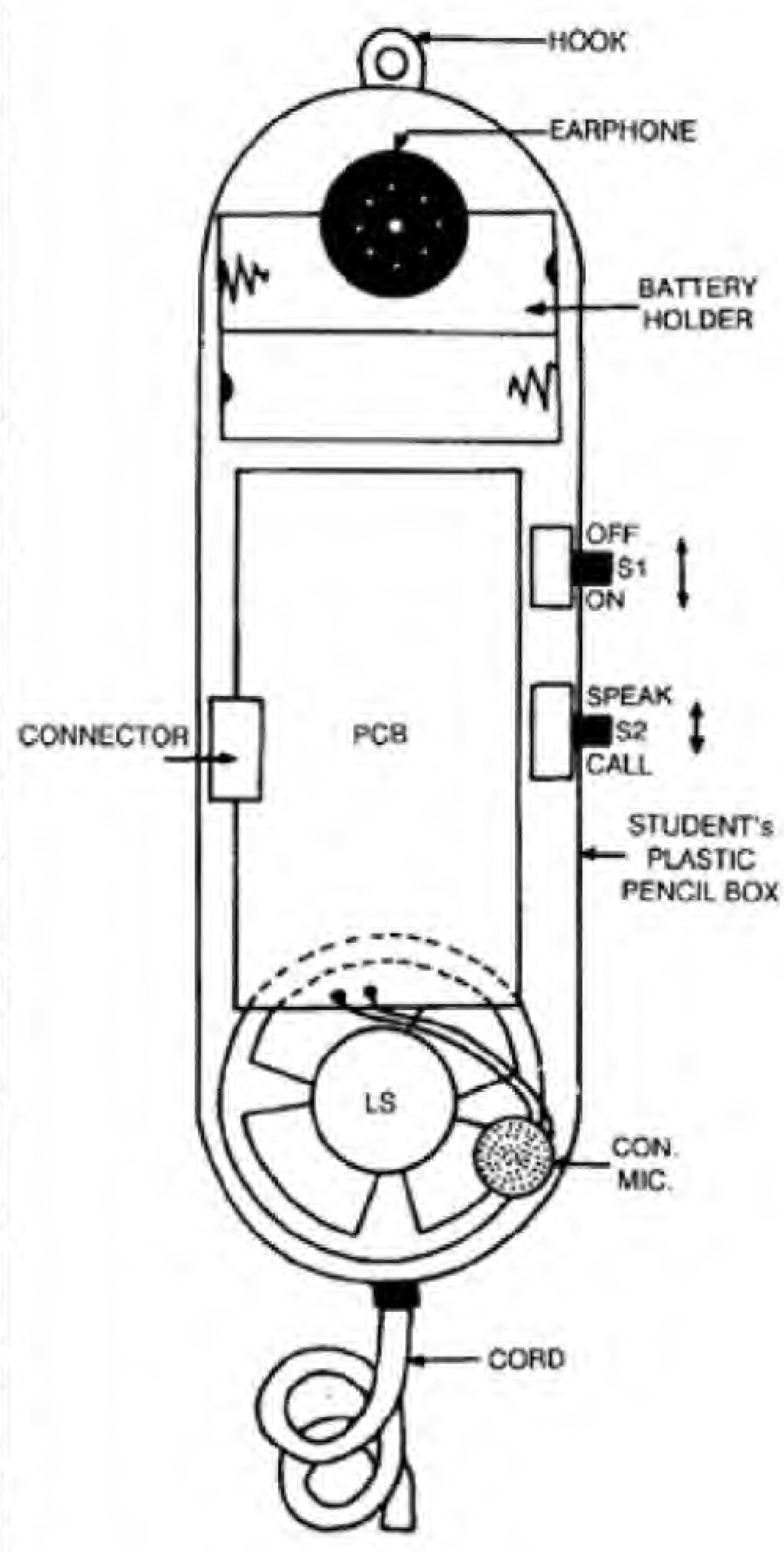


Fig. 8: Handset layout.

All joints of connecting wires must be soldered to reduce line resistance and transmission losses.

□

Readers' comments:

The project is very interesting. But I can't find IC BEL1895 here. So kindly give the circuit which is based on IC TDA7205 or TDA2020 or any other IC.

If I want to use a dynamic mic. instead of condenser type, kindly tell me the changes required.

You have shown both earphone and loudspeaker in handset layout diagram. Please tell me why two sound producing components are used? Is it possible to use either loudspeaker or earphone?

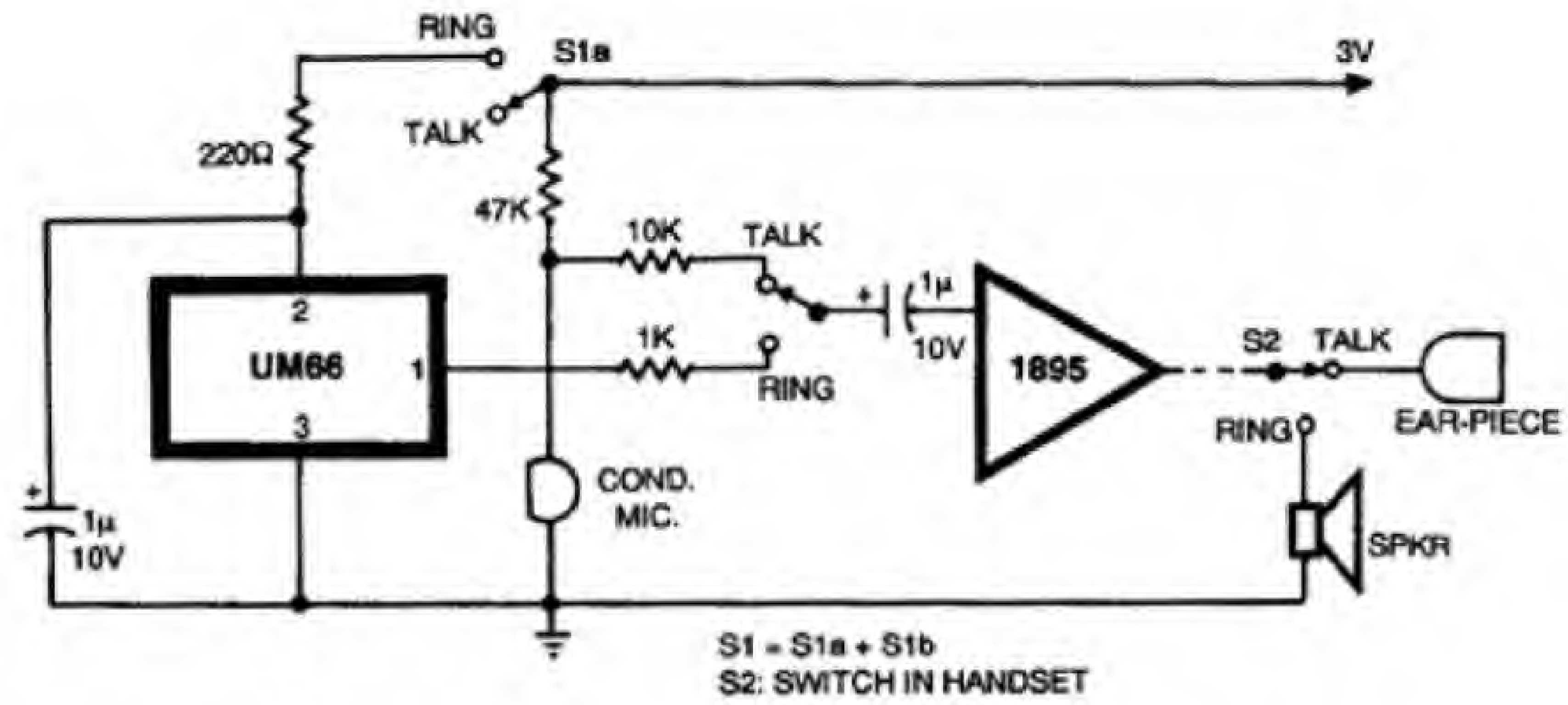
ANAND BALLABH
Mehsana

❐ In Fig. 8, does 'LS' stand for station 1 or station 2? You have given details for only 2-station intercom; can I increase the number of stations?

A. NAGA BABU
Karapa

❐ As power supply for the circuit is 3 volts only, we can use a UM66 IC instead of the buzzer. It needs no extra components for generating music. Then size of the PCB can be reduced to half as shown here.

Pradeep G.
Alappuzha



Using IC UM66 in place of buzzer.

The author, Mr K.A. Sakthidharan, replies:

IC BEL1895 has become very popular. If it is not available, an amplifier circuit using TBA810 can be used with a power supply of 4.5 or 6 volts. Since IC TDA7205 and TDA2020 are both high-volt, high-power ICs they are not suitable for this project.

If a dynamic mic. is used, a 1-transistor preamplifier has to be added.

A loudspeaker cannot be used in place of an earphone. If done so the sound waves from the loudspeaker will reach the mic. through air causing unbearable feedback noises. At the same time a loudspeaker is necessary for producing loud ringing.

The circle marked as 'LS' in the handset layout figure is a small 5cm loudspeaker. In both stations there should be one speaker each. Three or four wires are necessary for connecting one station with another. Bulky wiring and complicated switching will be required for increasing the number of stations.

The idea of using IC UM66 for ringer does reduce components and size of the PCB. But as shown in Mr Pradeep's diagram, if output of UM66 is given through the main amplifier the following changes should be made: (a) replace C6 with 470µF and C7 with 220µF capacitors; (b) volume setting for LS and earphone will be different; and (c) a current limiting resistor should be connected in series with the earphone.

But remember, the melody produced by UM66 has now become very popular as it is widely used in doorbells, quartz clocks etc. Imagine the confusion created by the melody of an intercom placed in a room where a clock or doorbell having the similar tune already exists!

R4 should be read as VR1 wherever mentioned in the text (not in the Fig.) of the article.

Finally, for improvement of the project, only earphone and mic. may be fitted inside the handset. Other parts, viz, switches, battery, loudspeaker and PCB etc can be housed in a separate box which also acts as a rest for the handset. A larger speaker may be used in this case.

Build Your Own
30W+30W Stereo Hi-Fi Double Cassette Recorder

T.S. Shankar

Several circuits on cassette players and a few circuits on recorders have been published in EFY, but none of them provide recording quality equal to that of professional recorders. This is because of their simplicity and low-cost orientation. With a little more expense you can make yourself a high quality recorder with double cassette deck facility.

Three factors make this circuit superior to the other circuits:

1. While recording, the circuit provides AC bias instead of DC bias to the recording head. AC bias increases the recording level and greatly increases the S/N ratio. Further, it leaves the tape in demagnetised condition when there is no signal. This reduces tape hiss to a large extent.

2. The circuit uses AC bias to the erase head also. In conventional circuits, a resistor in series with the erase head is used for erasing. In this process the tape is saturated magnetically instead of demagnetising. But saturated tape produces too much hiss which is simply not bearable in multiple speaker systems. On the other hand, AC bias completely demagnetises the tape which is a superior method of erasing.

3. The circuit uses variable monitoring system with peak level indicator so that the record level can be adjusted manually to an exact value the tape is meant for. Too much recording level increases distortion and too low recording level increases noise. So an optimum level has to be chosen which is achieved through the peak level indicator.

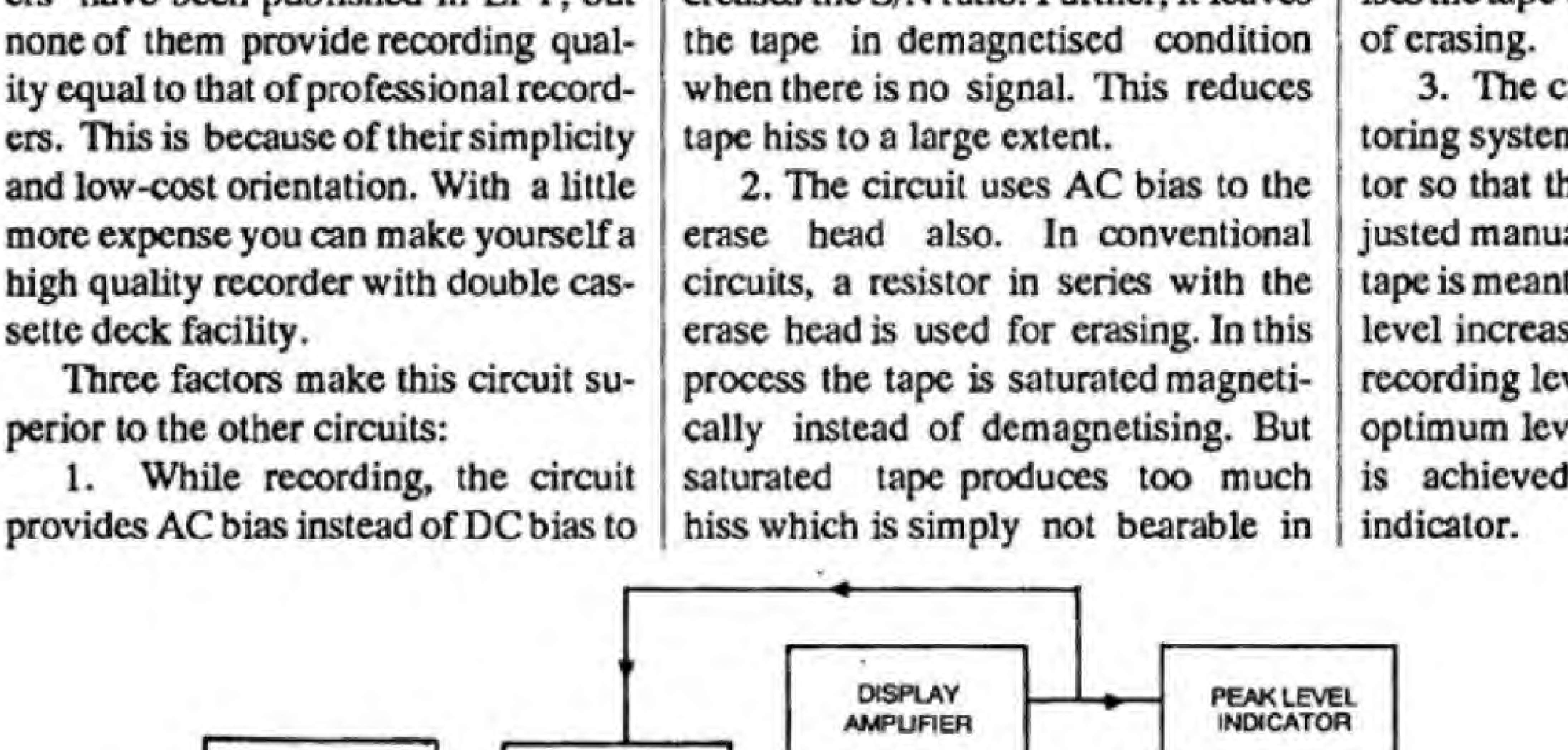


Fig. 1: Block diagram of the 30W + 30W stereo double cassette recorder.

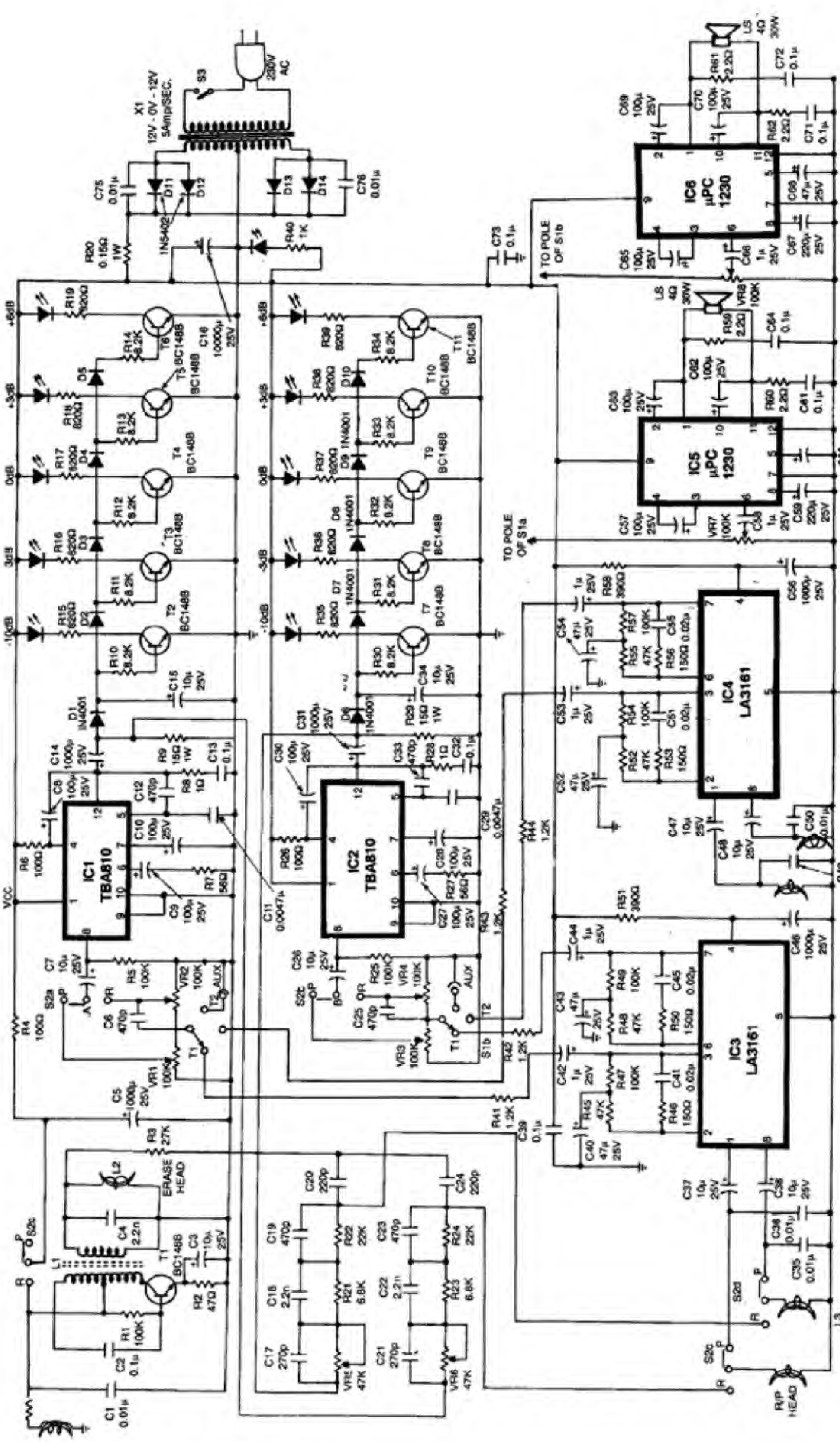


Fig. 2: Circuit diagram for the 30W + 30W stereo double cassette recorder.

PARTS LIST

Semiconductors:

IC1, IC2	— TBA810S, 7-watt amplifiers
IC3, IC4	— LA3161 stereo preamplifiers
IC5, IC6	— µPC1230, 40W amplifiers
T1-T11	— BC148B silicon transistors
D1-D10	— 1N4001 silicon diodes
D11-D14	— 1N5402, 3-amp diodes

Resistors (All 1/4-watt, ±5% carbon unless stated otherwise):

R1, R5, R25, R47, R49, R54, R57	— 100-kilohm
R2	— 47-ohm
R3	— 27-kilohm
R4, R6, R26	— 100-ohm
R7, R27	— 56-ohm
R8, R28	— 1-ohm, 1/2W
R9, R29	— 15-ohm, 1W
R10-R14, R30-R34	— 8.2-kilohm
R15-R19, R35-R39	— 820-ohm
R21, R23	— 6.8-kilohm
R22, R24	— 22-kilohm
R40	— 1-kilohm
R41-R44	— 1.2-kilohm
R45, R48, R52, R55	— 47-kilohm
R46, R50, R53, R56	— 150-ohm
R51, R58	— 390-ohm
R59, R60, R61, R62	— 2.2-ohm, 1/2W
VR1, VR3	— 100-kilohm preset
VR2, VR4	— 100-kilohm pot.
VR7, VR8	— 100-kilohm, trimpots
VR5, VR6	— 47-kilohm preset

Capacitors:

C17, C21	— 270pF ceramic disc
C20, C24	— 220pF ceramic disc
C6, C12, C19, C23, C25, C33	— 470pF ceramic disc
C35, C36, C49, C50	— 0.01µF ceramic disc
C4, C18, C22	— 2.2nF ceramic disc
C1, C75, C76	— 0.01µF ceramic disc
C2, C13, C32, C39, C61, C64, C71, C72	— 0.1µF ceramic disc
C42, C44, C53, C58, C66	— 1µF, 25V electrolytic
C3, C7, C15, C26, C34, C37, C38, C47, C48	— 10µF, 25V electrolytic
C40, C43, C52, C54, C60	— 47µF, 25V electrolytic
C8, C9, C10, C27, C28, C30, C57, C62, C63, C65, C69, C70	— 10µF, 2.5V electrolytic
C59, C67	— 220µF, 25V electrolytic
C41, C45, C51, C55	— 0.02µF ceramic disc
C11, C29	— 0.0047µF ceramic disc
C5, C14, C31, C46, C56, C74	— 1000µF, 25V electrolytic
C16	— 10000µF, 25V electrolytic

Mechanical:

L1	— Detector IFT
L2	— Erase head
L3, L4	— Stereo record/play heads
L5	— Motor choke
X1	— 12-0-12V, 5-amp secondary transformer

Miscellaneous:

LEDs	— 11 nos.
S1	— 2-pole, 3-way switches
S2	— 6-pole record-play switch
S3	— 250V, 2-amp toggle switch
LS1, LS2	— 4-ohm, 30W speakers
Leaf switch	— 1 nos.
	— Tape deck mechanism
	— Heatsinks

The circuit

The circuit can be divided into seven important parts, viz, playback preamplifier decks 1 and 2, power amplifiers (30W+30W), display amplifiers, peak level indicators, bias oscillator and frequency pre-emphasis network (Fig. 1).

ICs LA3161 are used as tape preamplifiers for both decks. The outputs of the preamplifiers are given to a 2-pole, 3-way switch. This switch selects the input to the power amplifiers as well as display amplifiers.

In one position the output of tape 1 is selected, in the mid position output of tape 2 is selected and in the third position aux or line-in terminals are selected. One may use 2-pole, 4-way switch if mic. jacks are also required and 5-way switch if tuner or turntable is also used.

The selected input is fed simultaneously to the display amplifiers and power amplifiers. The selected input goes to volume control pots at power amplifier side and record level presets at display amplifier side. The inputs of display are connected to 100k presets during playback and to 100k pots during recording. These pots act as record level control during recording. The presetting of the pots is explained later.

The display amplifier is used not only to drive the display but also for recording through record/play heads. Note that the record level indicator (or peak level indicator) is a must and should not be dispensed with to make the circuit simpler or low-cost. The detailed circuit diagram is shown in Fig. 2.

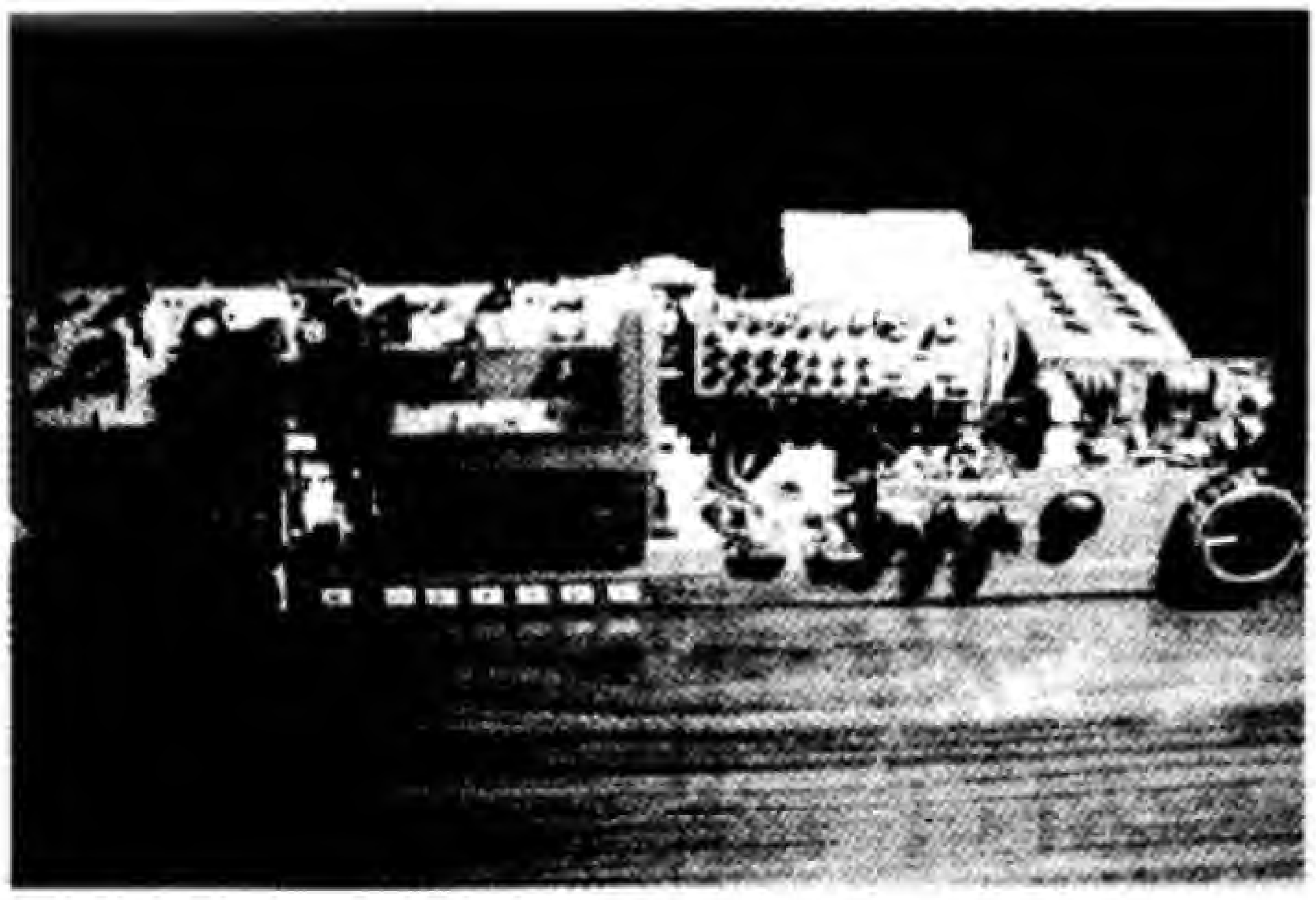
Recording

During recording, the outputs of display amplifiers are connected to the recording heads through a frequency pre-emphasis network and bias oscillator circuit.

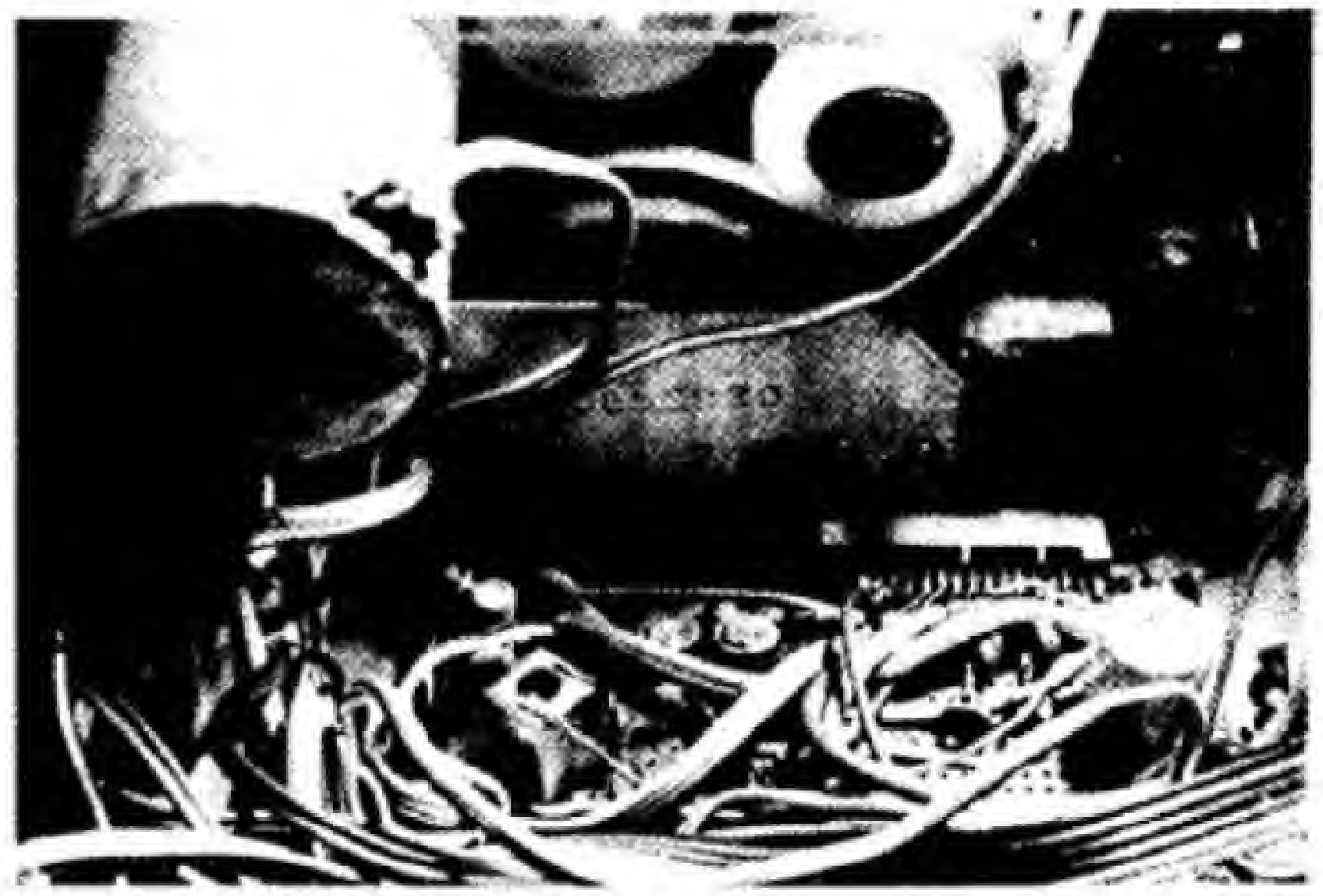
As stated earlier, the circuit uses AC bias for recording as well as erasing. Hence an oscillator is required to bias the recording and erasing heads. This is a hartley oscillator wired around transistor BC148B. The tuned secondary causes the transistor to oscillate at frequencies higher than 80 kHz.

C4 is a 2.2nF tuning capacitor whose value can be changed to obtain the specified frequency with any coil used. The transformer may be any IFT used in radio receivers. The output of bias oscillator is mixed with the audio signal from display amplifier and pre-emphasis network through a 27k resistor and 220pF capacitors.

The pre-emphasis network comprises VR5, R21, R22, C17, C18 and C19 for left channel and VR6, R23, R24, C21, C22 and C23 for right channel. These boost the high frequency components of the audio so as to meet the requirement of oxide tape. Do not alter the values of these components. Adjustments of VR6 and VR7 are explained later.



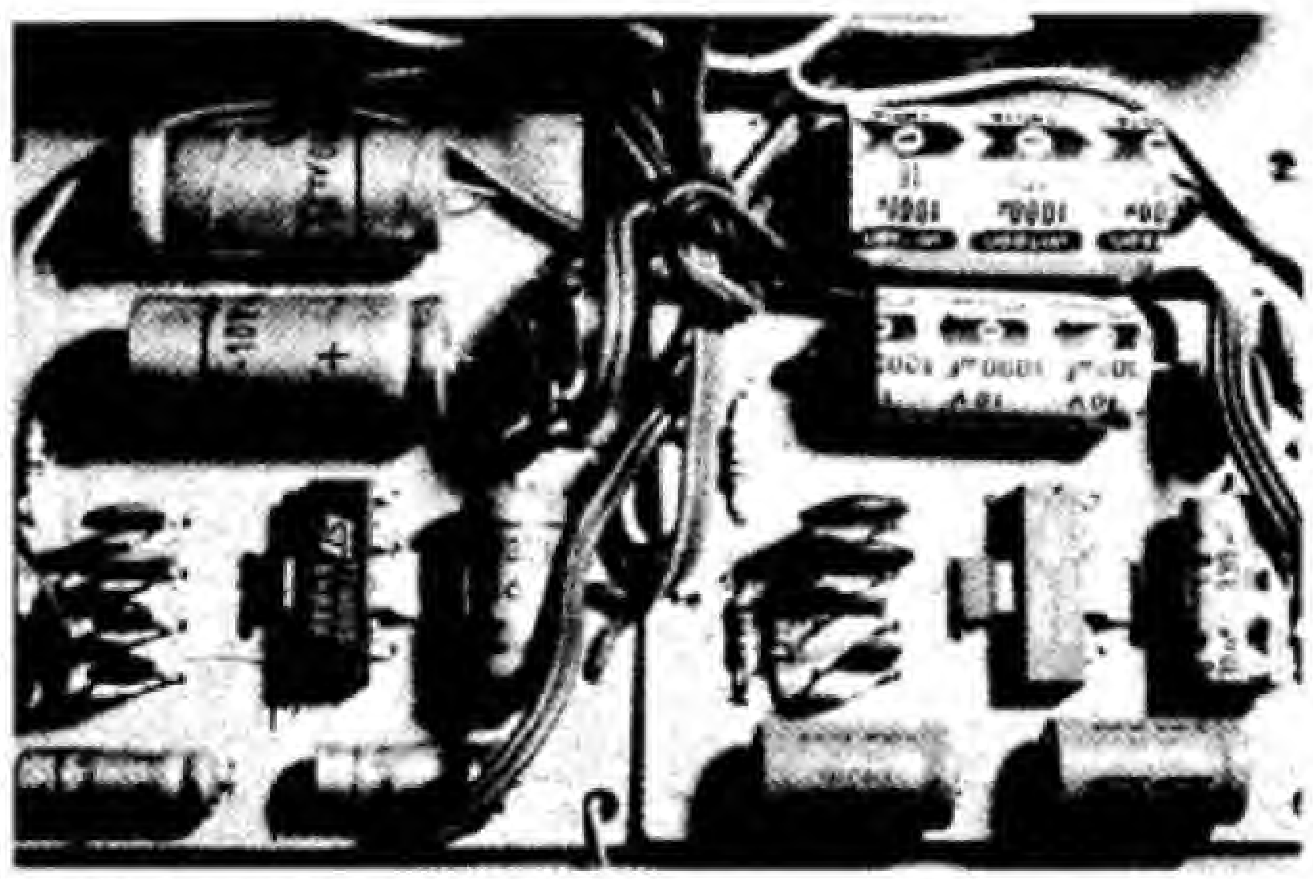
Author's prototype of the stereo double cassette recorder.



The recording module of the author's prototype.

Display amplifiers

The display amplifiers are wired around ICs TBA810. Display amplifiers may be wired on ready-made PCBs available in the market, so as to minimise ground loops and hum. The same amplifiers are used for recording also and hence only new components or PCB should be used.



The display and recording amplifier.

Display

It is a 5+5-segment display wired around ten BC148B transistors. Each transistor is biased through a diode which causes the transistors to saturate at different levels. One may cascade the transistor stages to obtain better resolution by using more LEDs.

It is necessary to calibrate the display properly before it is used for recording. For calibration, one may need a calibrated deck or any other means. Here is a method for calibration.

Record a tone of 1kHz on a pre-calibrated cassette deck at 0dB level. Play that tone in one of the decks, adjusting VR1 and VR3 so that first three green LEDs are lit. The calibration for playback is over.

Calibration for recording is a bit tedious. But once adjusted, the presets need not be touched again.

Record a tone of 1kHz and adjust the record level control pots so that the indicator shows 0dB. Now play back the recorded tone. If the indicator shows more or less than 0dB, turn VR5 and VR6 accordingly and test once again. By means of this method of trial and error, one can calibrate it in four or five trials.

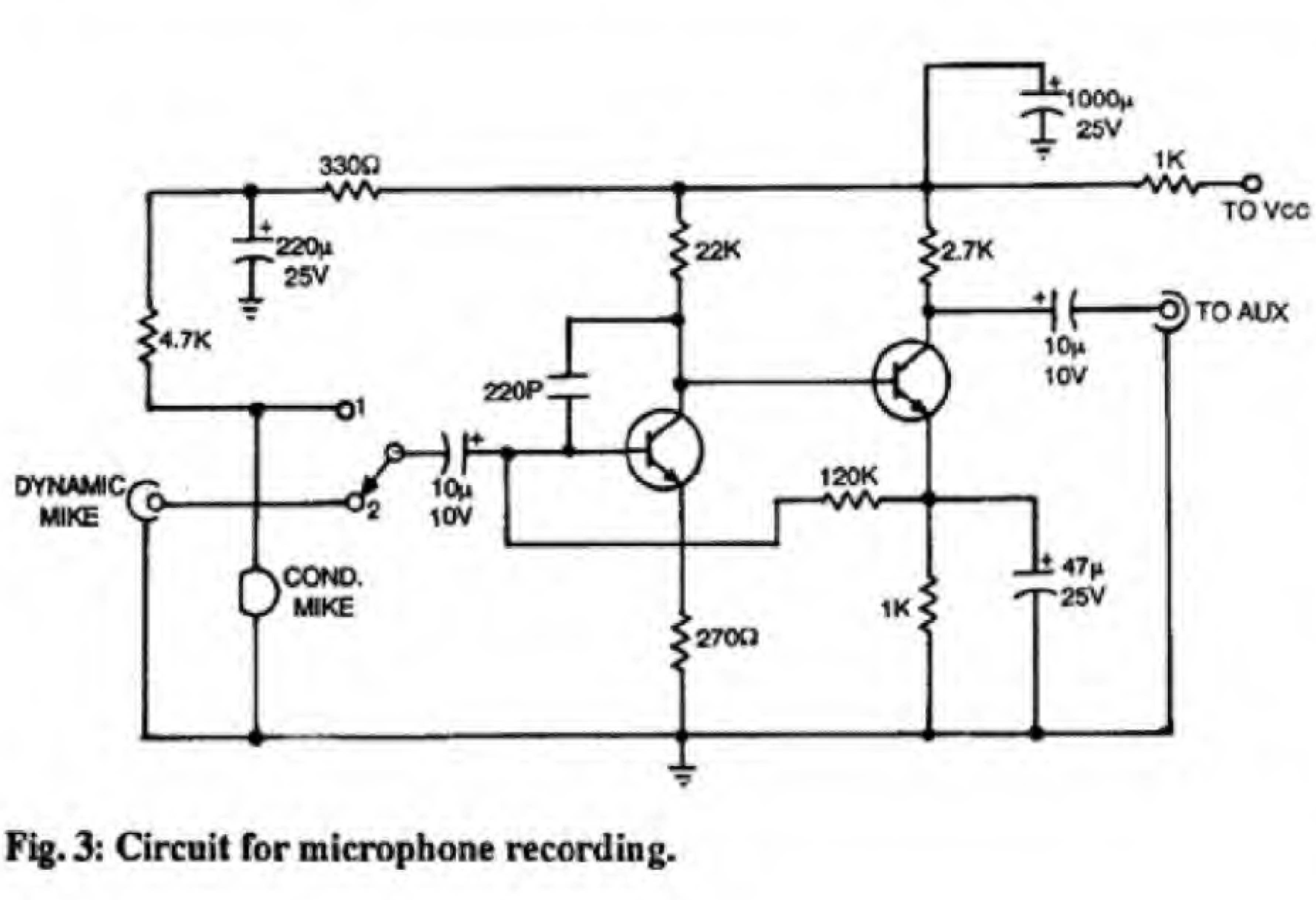


Fig. 3: Circuit for microphone recording.

Power amplifiers

Power amplifiers are wired around ICs µPC1230. It is a single-in-line IC with 12 pins on one side. It requires a

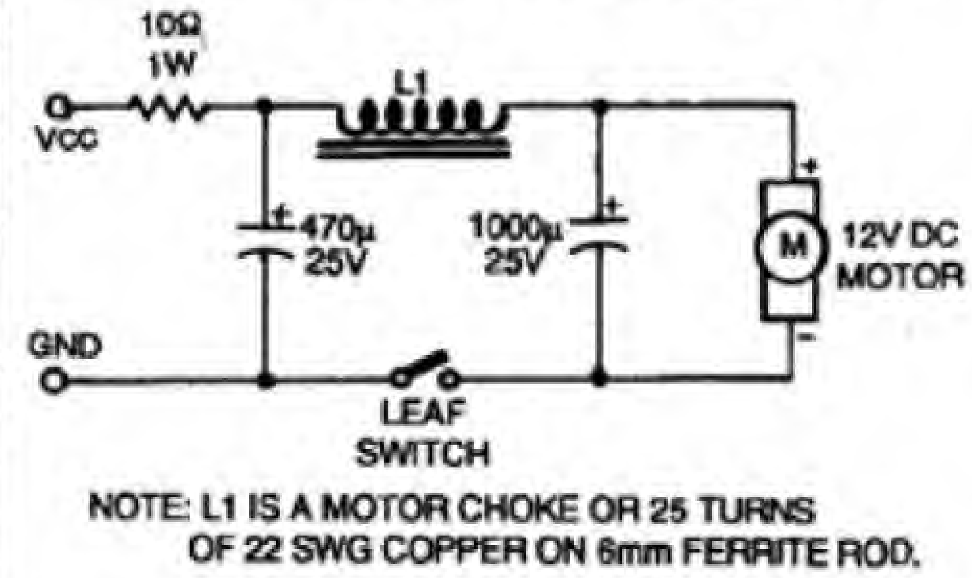


Fig. 4: The motor circuit.

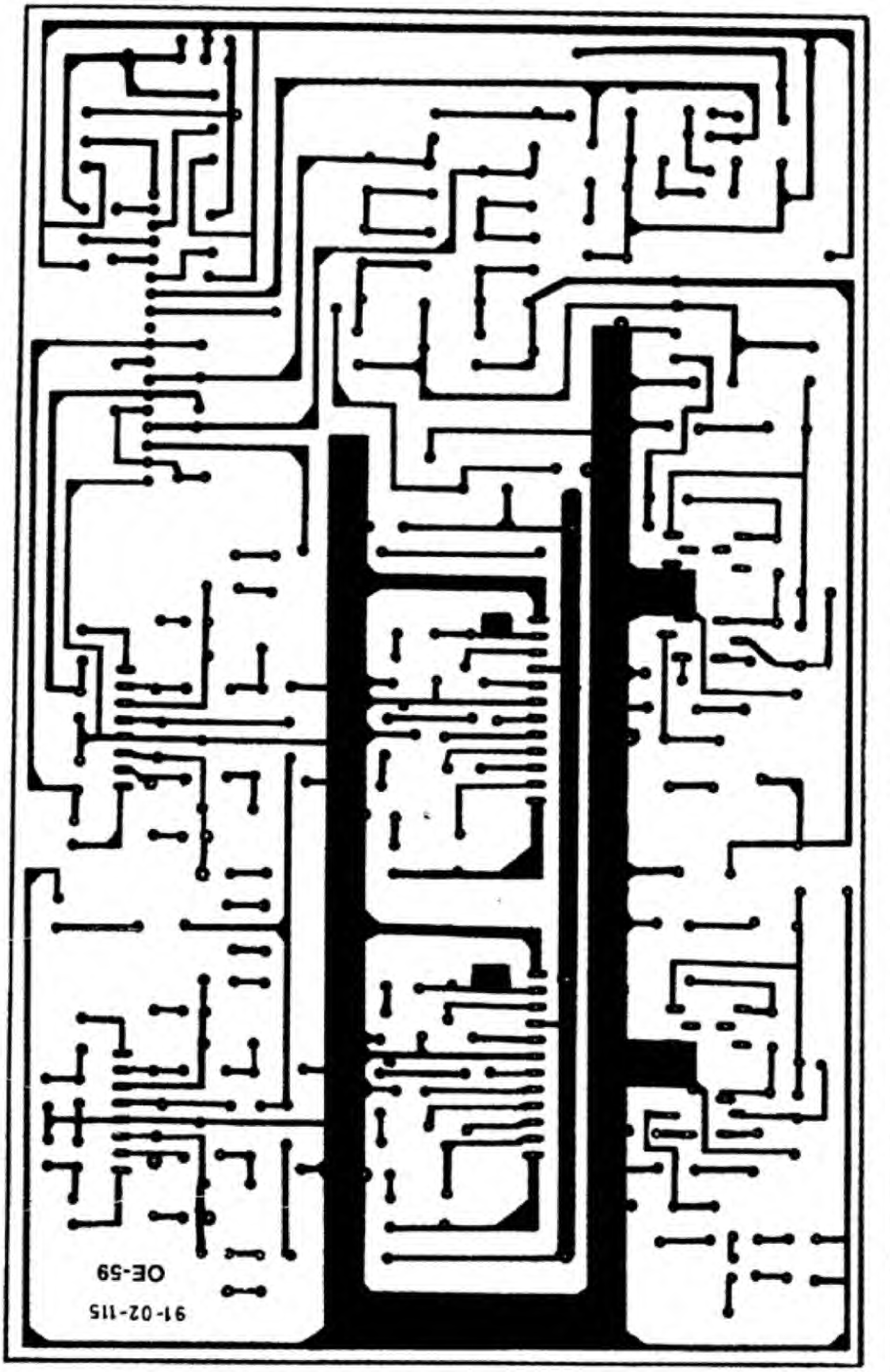


Fig. 5: Actual-size PCB layout for the cassette recorder.

heatsink of about 500 gms. The output is double ended without any output capacitor. Such configuration is common in most power ICs. It delivers 30W power into a 4-ohm load.

Power supply

Since amplifiers are of high wattage, adequate power supply should be used. Use a 12-0-12V transformer with 5-amp continuous rating. Two diodes are connected in parallel to increase the current capacity of the rectifier. A filter capacitor of 10,000µF should be used for better hum rejection. A 0.15-ohm resistor is introduced to limit the surge current at the time of power on.

Construction

Most of the circuit modules can be assembled on general-purpose PCBs. Both preamplifiers should be wired on a single PCB and care must be taken to avoid ground loops. The record-play switch, pre-emphasis circuit and bias oscillator should be assembled on a single board. Shielded wires should be used for connecting head to record-bias PCB, record-bias PCB to preamp PCB and at places wherever low level signals are to be transmitted.

It is better to ground the common point of record/play head through one section of record-play switch, i.e. during playback the common point is connected to the ground of preamplifier and during recording, the common point is connected to the ground of display amplifier. This removes ground loops in the circuit and prevents the circuit from oscillating. (This is not shown in the circuit diagram.) Avoid using too long wires. Ground the chassis of both the decks as well as the volume control, record-level control, and transformer bodies.

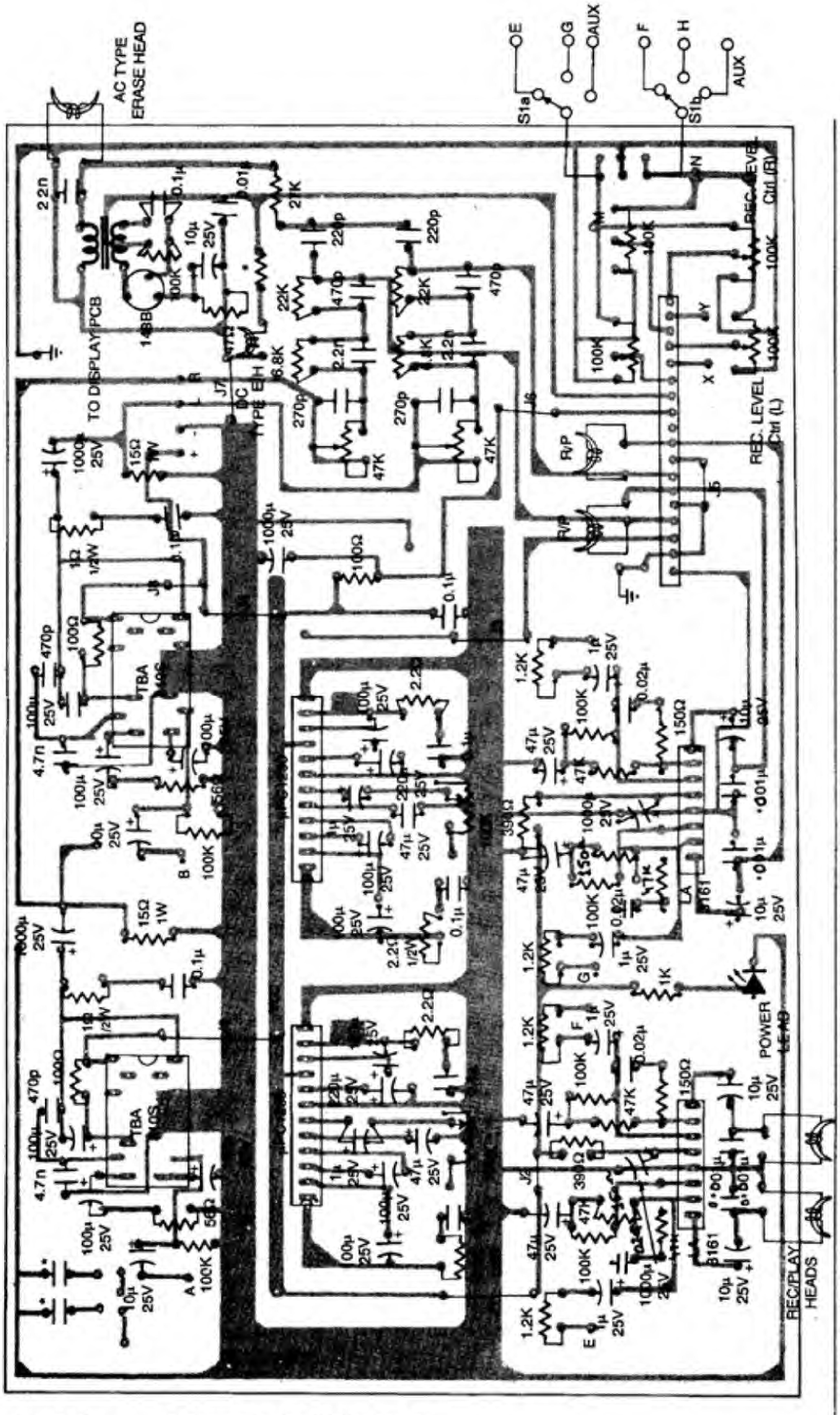


Fig. 6: Components layout for the PCB in Fig. 5.

If you want to use microphones for recording, the circuit is shown in Fig. 3. Fig. 4 shows the motor circuit. For 6V motor, use a suitable resistor of adequate power rating in place of L1.

Construction and testing

A suitable PCB for the circuit is shown in Fig. 5. The components layout is shown in Fig. 6. A separate PCB is used for display module. The main PCB incorporates power amplifiers, preamplifiers, display cum recording amplifiers, bias oscillator, frequency pre-emphasis network and rec/play switching circuit. The assembling should be done as explained here.

The power amplifiers should be assembled first. The power ICs must be soldered directly on the PCB. After assembling all the components (power amp), apply around 6V to the Vcc track and ground. Connect the speakers and keep the volume control at minimum. The output should be absolutely silent.

The volume control wiring should be done with 2-core shielded wire at exactly the same points as shown in Fig. 7. Otherwise ground loops will be formed causing hum and distortion. Now raise the volume and apply signal to the power amplifiers. Test for the output. The IC should get slightly warm.

After testing the power amplifiers, solder the preamplifier section. The LA3161 ICs are delicate and hence should be soldered in shortest time possible. After assembling, connect (temporary connections) the output of preamp and the input of power amp through the volume control. Connect the input of the preamp to the record/play head with two double-core shielded wires. Do not use the shield as common ground for both channels.

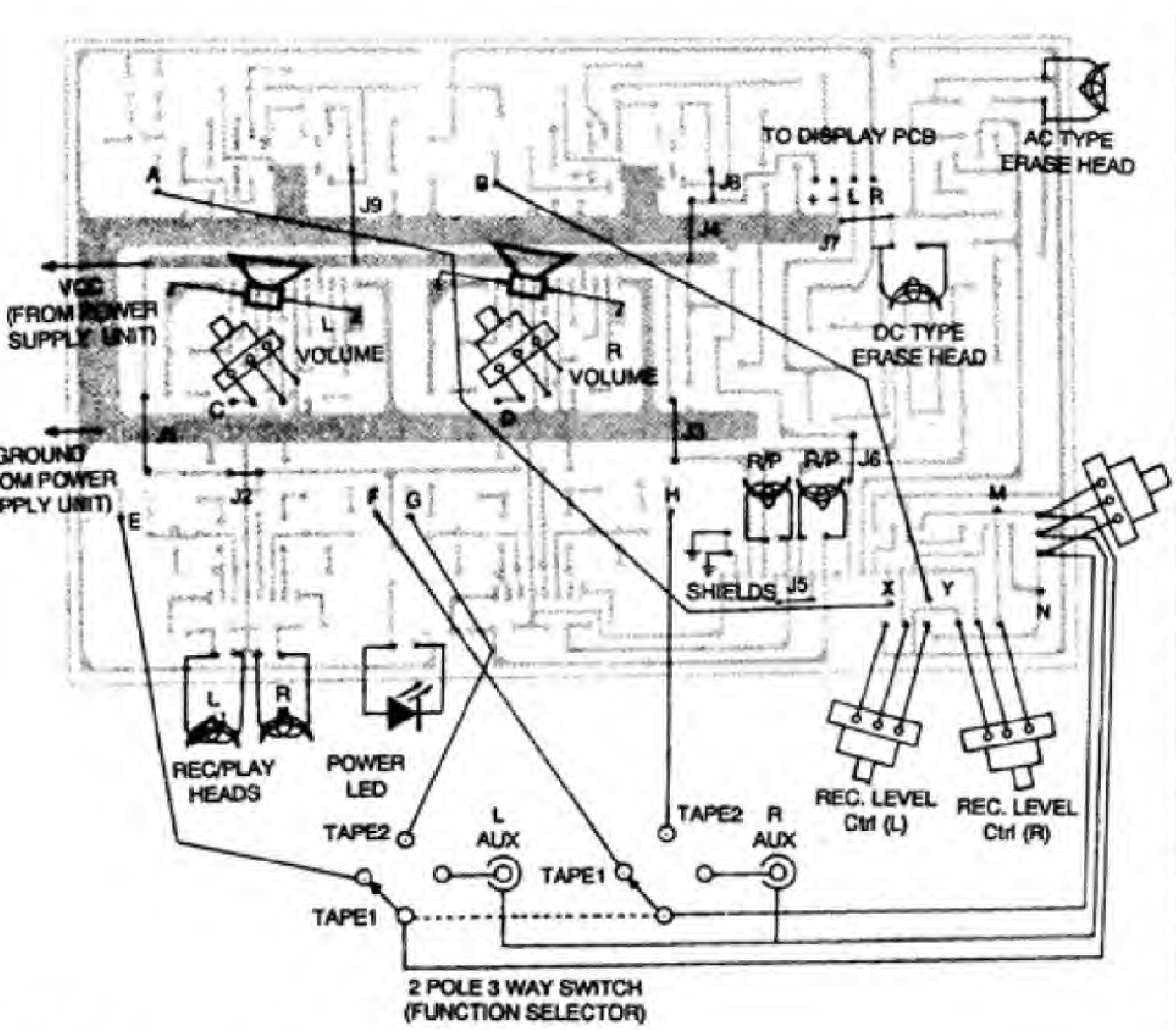


Fig. 7: The wiring diagram for the circuit.

Solder the shields to the point 'shield' in Fig. 7.

Now play some music and check the output. If it is not proper, refer the troubleshooting section given later. (The motor should be the given supply.) If the working is satisfactory, the display amplifiers are to be soldered next. For TBA810 ICs, no holes are provided for heatsinks. Hence it is required to bend the heatsinks carefully before soldering.

The display amplifiers can be tested by connecting speakers at their outputs (instead of 15-ohm, 1W resistors) and applying input. If distortion is noticed (as rarely it does), increase the value of R7 (and R27) to 100 ohms. The output should then be absolutely distortion-free.

The bias oscillator and frequency pre-emphasis circuits are to be soldered next. The body of the IFT may be grounded to avoid radiation. Erase heads are available as AC type and DC type. If DC type is used, its wires must be soldered to the tracks provided below R2 and C3 and a 820-ohm resistor is to be soldered in the place provided. If AC type erase head is used, these components may be omitted.

For testing, play some useless recording and short the tracks connected to jumper J6 as well as that connectnend to the centre tap of the IFT. The recording should be completely erased. If a beeping sound is produced, reduce the value of C4 until the output is absolutely noiseless. In case of DC type of erase heads, the erase current should be 15 mA for good erasing.

After testing, solder record/play switch and associated components. During recording, the connection of heads is reversed (not shown in Fig. 2). The ground is also changed from preamplifier to power amplifier ground to completely avoid ground loops and oscillation (also not shown in Fig. 2). Two-core shielded wires should be used for connecting the record/play head. The shields are to be soldered to the tracks provided.

The commonly available record/play switch does not fit into the PCB. For that reason, a flat-ribbon cable may be

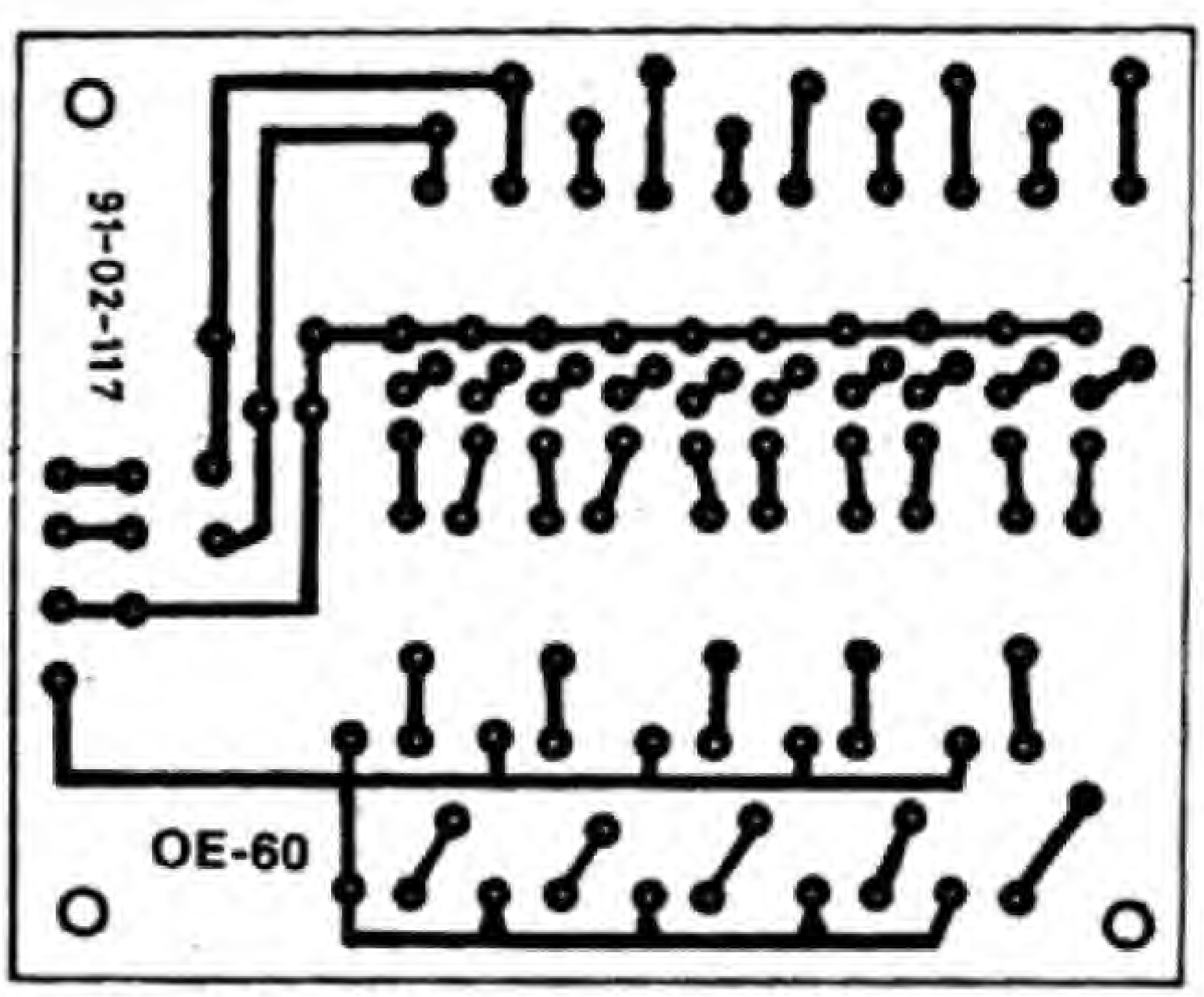


Fig. 8: Actual-size PCB layout for the record level indicator (display).

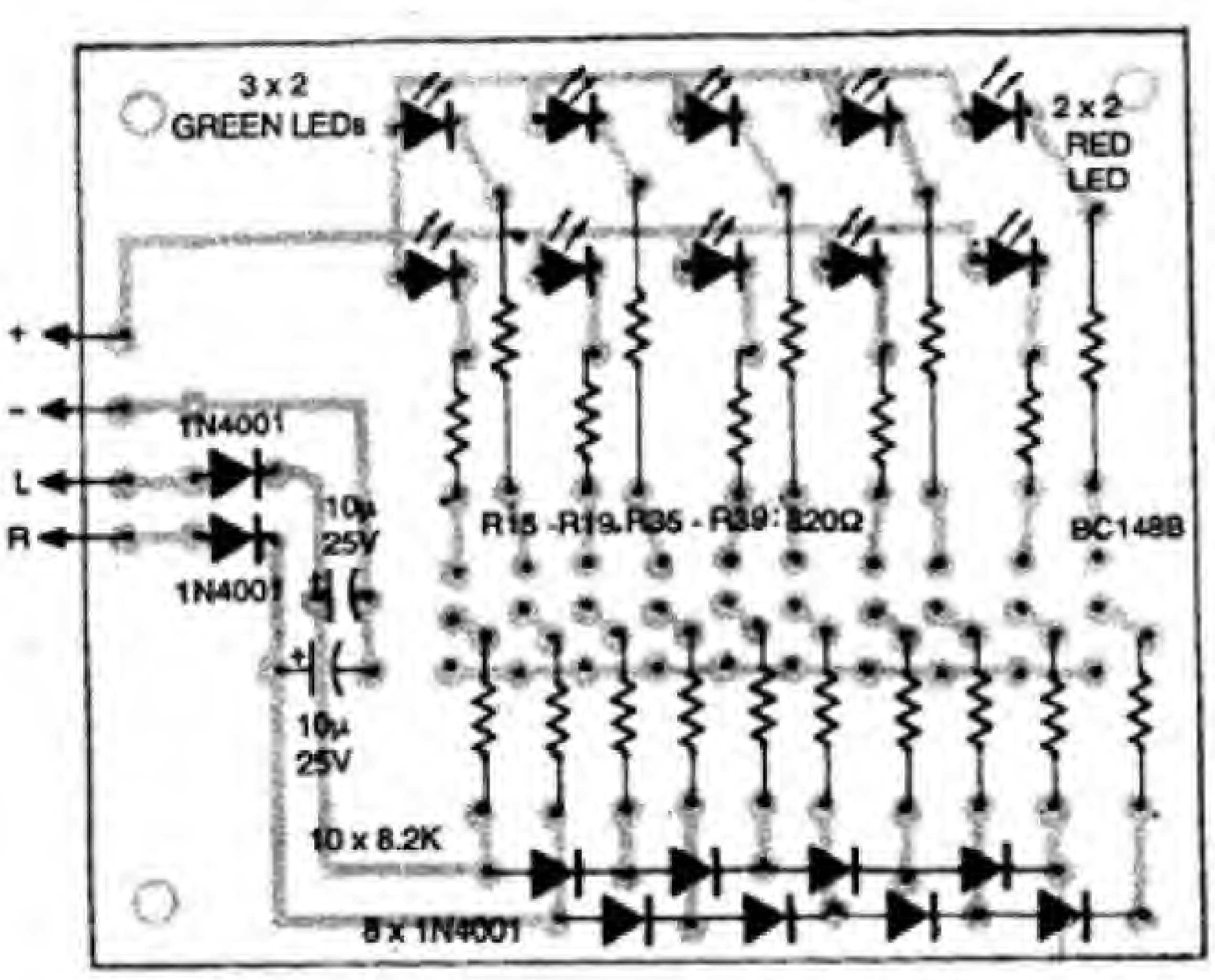


Fig. 9: Components layout for the PCB shown in Fig. 8.

used for connecting the switch to the PCB. In this case, the record/play switch may be conveniently fitted to any type of deck mechanism. But ensure that the wire length does not exceed 5 cms. The record-level control pots may be preferably dual pot type for convenience. A 47k LIN potentiometer may be used as balance control, but this effects the display also.

The display module is very easy to assemble as the circuit is very simple. The first three LEDs are to be green, while the last two should preferably be red. The transistors should be soldered quickly to avoid any damage due to heat. The leads may be held with nose-pliers while soldering, to dissipate the heat. The PCB and components layout for the record level indicator (display) are shown in Figs 8 and 9 respectively.

The tracks are in line for transistor leads and not in triangle as in case of most circuits. This is so designed to minimise space consumption. The terminals +, -, L and R are to be connected to the corresponding points on the main PCB with a flat ribbon wire not more than half a metre long.

There are nine jumper connections on the PCB. These are to be soldered first before soldering any component. Otherwise it may lead to confusion.

The body of tape decks, transformer, volume and record-level controls, record/play switch and heatsinks should be earthed properly.

There are a few large jumpers to be made. In Fig. 7, points A and X, B and Y, L and N as well as D and M are to be linked. Points E, F, G and H are to be linked to S1 (2-pole, 3-way function selector switch) as shown.

A good quality CRGO core transformer should be used for power supply. The diodes, capacitors and the filter capacitor should be directly soldered to the transformer terminals. Use high-current capacity stranded copper wires for power supply and speaker connections. Use more solder for soldering the high-current tracks.

Use RCA sockets and pins for aux and mic inputs. A few tracks are provided with C78 and C79 (0.1μ) for optional tone control.

After assembling all the components and making all connections, fix suggested heatsink to the power ICs with heatsink compound and provide proper ventilation.

TABLE I

Troubleshooting Check List

	Troubles	Possible Causes
1.	No output	Check the power supply. Check for voltage at pin 9 of power IC.
2.	Too much hum	Check the ground connection of volume control. It should be on track of pin 7 only.
3.	IC getting too hot without signal	Check for shorts; if not replace the IC.
4.	Output is clipped	The filter capacitor is faulty.
5.	No output from preamplifiers	Touch the inputs of preamp. If there is no loud hum, check for voltage (supply). If not, replace the IC.
6.	Sharp background noise	Check the shielding and grounding.
7.	Not recording	Check the record/play switch and bias oscillator circuit.
8.	Distorted recording	The bias oscillator is not working.
9.	No erasing	The bias oscillator is not working or erase head is faulty.
10.	Hum is produced when the balance is turned to one side completely	Connect a 220-ohm resistor in series with the centre tap.
11.	Poor high frequency response	Align the record/play head.
12.	Insufficient record level in spite of adjustment of presets	Try different values of R3 to suit your record/play head.
13.	Sound without depth	Speaker polarity is reversed (one of them).
14.	Sound clipped and too loud with aux	Divide the incoming signal by a 47k and 2.2k resistor divider.
15.	ICs TBA810 getting hot	Check the ICs. If no fault, replace R9 and R29 by 22-ohm resistors.
16.	Only one channel	Compare voltages at different points with the working channel and identify the fault.

Troubleshooting

If you want to avoid troubleshooting, use new and good quality components only. Use good quality 60/40 type solder for soldering. The soldering should be neat and done quickly. Do not apply too much solder. The polarity of components should be strictly observed. A list of possible troubles and their causes is shown in Table I.

Good quality speaker systems and a graphic equaliser are recommended for superb hi-fi reproduction with excellent bass. □

Readers' comments:

The article captioned 'Stereo Double Cassette Recorder' is working well. I have a few doubts regarding this circuit.The author has stated in the article that no suitable record/play switch is available in the market to suit the requirement. But 27-pin record/play switches are freely available in the market which are being used in the PCBs of front loaded deck mechanisms. The incorporation of this switch will be helpful, if the same has been used in the PCB. It would have further helped if the PCB could have been divided into three parts: Recording/play PCB, Recording level indicator PCB along with IC, and Power amplifier PCB.

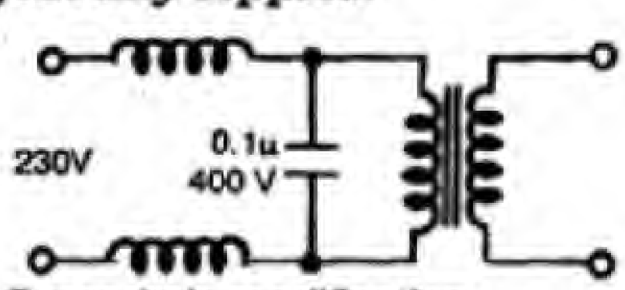
The above division would have facilitated the use of these PCBs for single and double cassette recorders.

V.V.V.S.N. MURTY
Bhilai

❑ The IC µPC1230 has the capacity of delivering 40W on each side. Please clarify how the wattage per channel can be increased up to 40 watts?

PRITPAL SINGH
Aurangabad

❑ I have assembled the circuit and its sound, especially recording, is excellent. But during recording, there are small disturbances due to ripples in the mains. I connected a capacitor (0.1µF, 400V) as shown in the figure, to reject any ripples.



Mr T. Surendra's modification.

How to change DC type of erasing to AC type erasing to avoid hiss in the commercial tape recorder circuit?

T. SURENDRA
Hyderabad

❑ The construction article is excellent and interesting. I have following doubts regarding the circuit:

Wattage value 30W+30W is RMS value or PMPO value?

Can this double cassette recorder be modified for high speed dubbing with excellent recording quality? How can it be done?

How can I modify the circuit to use in a separate high power amplifier? How to use a 10+10 band equaliser in the circuit?

VEEKY DATTA
Malda

❑ The article is very useful for me. But there are some doubts which I hope the author will clarify.

I have with me an assembled 50W+50W amplifier (24V-0-24V, 3A supply) with a predeck around 'Philips Universal Preamp' (30V, 14mA supply). Is 5A current necessary for LA3161 and TBA810? If not, please give me the modified power supply.

Two condensers are shown with asterisk (*) in the left bottom of the 'component layout'. Nothing is mentioned about it. What is its value?

How to ground the common point of the R/P head?

It is written in the text to connect the shield of the wire from head to 'shields'. But in Fig. 7 the head is connected from two other points. How should it be modified?

Recommend a suitable head for the LA3161 preamp.

ANILRAJ.K.G.
Alwaye

❑ Please clarify following doubts:

I had assembled the circuit and it is performing well. But its recording section has some distortion. Is it because of the IFT used?

Please suggest a circuit for bass and treble controls and its connections.

RAJU PAULOSE
Manjapara

❑ Please clarify the following doubts: The VR connection of the power amplifier shown in Fig. 7 and Fig. 6 are different.

The connection of the detector is not shown in Fig. 6.

The IC pin numbers are also not shown in Fig. 6.

I could not understand the connection of heads.

There are two erase heads, AC type and DC type in the component layout. Which mechanism would you suggest to use?

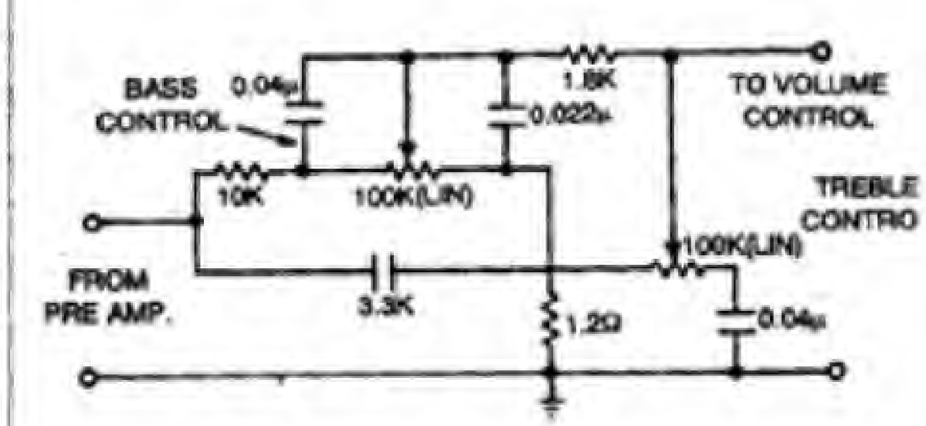
What is the meaning of ground loops?

KISHOR E. SOMWANSHI
Nasik

❑ I am very thankful to the author for interesting and detailed information about the construction and working principle of the circuit. I want to know what is high speed dubbing? Can I do high speed dubbing in this recorder by increasing the speed of motors only?

ARUN KUMAR
Lucknow

❑ The article published in Feb.'91 was long awaited one. Does the display indicator show standard decibel level? Can I add any equaliser or tone control? Can I use the circuit given below for this purpose? Can we connect any other audio power amplifier like 40W+40W (IC 7205) instead of using the circuit's own amplifier? Only 5 poles of the R/P switch have been utilised, so what is 6th pole meant for. The R/P has been printed twice!



Mr Mahesh Gurung's tone-control circuit.

MAHESH GURUNG
New Delhi

❑ There were some mistakes in the circuit. In the component layout (Fig. 6); all electrolytic capacitors are shown without any polarity. It may be cumbersome to see polarity of each capacitor from circuit diagram (Fig. 2). Therefore, I request you to publish your component layout again (Fig.6) with polarity of electrolytic capacitors shown.

RAKESH PUSHKARNA
New Delhi

❑ Please convey my thanks to the author for the construction article.

On page 113, in last paragraph's second last line the variable resistors should be VR5 and VR6 instead of VR6 and VR7.

C6, C25 and oscillator coils are not shown in components layout. Which of the two variable resistors are recording level controls, VR5 and VR6 or VR2 and VR4? VR5 and VR6 are presets or manually adjustable potentiometers? TBA810 is to be mounted with heatsink or without?

If R2 and C3 are omitted (with AC type erase head) as given in the text, emitter of the transistor BC148B becomes open. Once the deck is adjusted we will get a low output recorded cassette if recorded from a low-output or old cassette. Please explain how we can get better recorded cassette? How to use the circuit (using IC LB1405) of 9 LED peak level indicator in place of transistorised 5 LED indicator?

µPC 1230 is a 40W amplifier. Can we increase the output of the circuit to 40W?

Please give a circuit for 1kHz frequency at 0 dB.

AZEET KUMAR
Patna

❑ I would request Mr Shankar to pass on idea for biasing chrome tapes in addition to the normal ferric oxide tapes. What modifications will be required for using VU meter in place of LEDs. Noise limiter circuit is lacking in the schematic.

SUDIPTO GHOSE
Calcutta

❑ In the circuit, what is the speaker polarity. How to differentiate between AC/DC type of eraser?

B. MOMIN
Meghalaya

The author, Mr T.S. Shankar, replies: I am very pleased to see the interest taken by EFY readers in my article on Stereo Double Cassette Recorder. The doubts raised by the readers are clarified here.

In Fig. 6 (component layout) at top right corner, the switch S2 is shown as a rectangular box. Points C, D, M and N, connections are explained on page 118 (Feb '91).

For connecting a motor of different voltage one should use a resistor in place of L1. Value of the resistor is given by

$R = (13-V_m)/I_m$ and $P = (13-V_m)I_m$

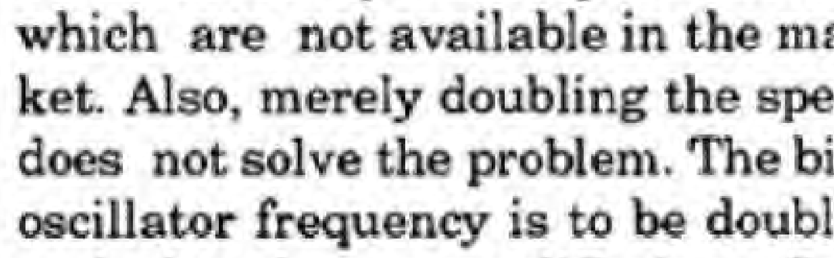
where R is the resistance, V_m the motor's rated voltage, I_m the motor's rated current and P is the power dissipated in the resistor in watts.

The low record level and distorted recording may be due to several reasons. Firstly, the rec-amplifiers may be over driven. One may try different values of R3 which may be of any value from 0 to 100k. But the prototype uses 27k resistor.

The wattage of the amplifiers is in rms value. Due to obvious reasons, the circuit was never tried as a high speed recorder. The high speed can be achieved by dual speed motors, which are not available in the market. Also, merely doubling the speed does not solve the problem. The bias oscillator frequency is to be doubled and also the rec-amplifier's configuration must be changed to increase their bandwidth to up to 35 kHz.

If the circuit is to be used with separate power amplifier, output from the circuit may be taken from the poles of S1a and S1b and fed to the power amplifier. In that case, IC5, IC6 and associated components may be omitted. Without power amplifiers the transformer of 750mA rating would be adequate.

Two capacitors with asterisks in Fig. 6 are meant for optional tone control. The tracks provided may be utilised for tone control pots. The tone control circuit is given below.



T.S. Shankaran's tone-control circuit.

Shields for the rec/play heads may be soldered to the nearest ground track.

For LA3161 preamp, a head of 250Ω may be used.

In Fig. 6 the directions of ICs on the PCB are not given. Please refer the circuit diagram for the same. An extra jumper joining the top track of J3 and top ground is missing.

Mr Murty's idea of dividing the PCB into individual modules is good. But having a single PCB would be convenient and easy to assemble. If anyone wants to have a mono cassette recorder, one preamplifier may be simply ignored and the function selector switch modified accordingly.

The PCB was designed for front load mechanisms, but it can very well be used with other mechanisms with simple mechanical modifications.

Power can be raised to 40W+40W by using 16V, 7A sec. transformer for power supply. I have seen some commercial kits of 1230 IC but they seldom work for 40W+40W as their capacitor voltage ratings are inadequate and heatsinks insufficiently provided. Change the capacitors to minimum value of 25V and use a good heatsink of 500 gms aluminium.

I am happy to know that Mr Surendra had successfully attempted the project. The circuit given by Mr Surendra can be used if the environment is noisy. But my prototype worked without such a circuit. DC type erase head cannot be replaced by AC type, unless the circuit has bias oscillator facility. The secondary of the bias oscillator circuit can be paralleled to the AC type erase head.

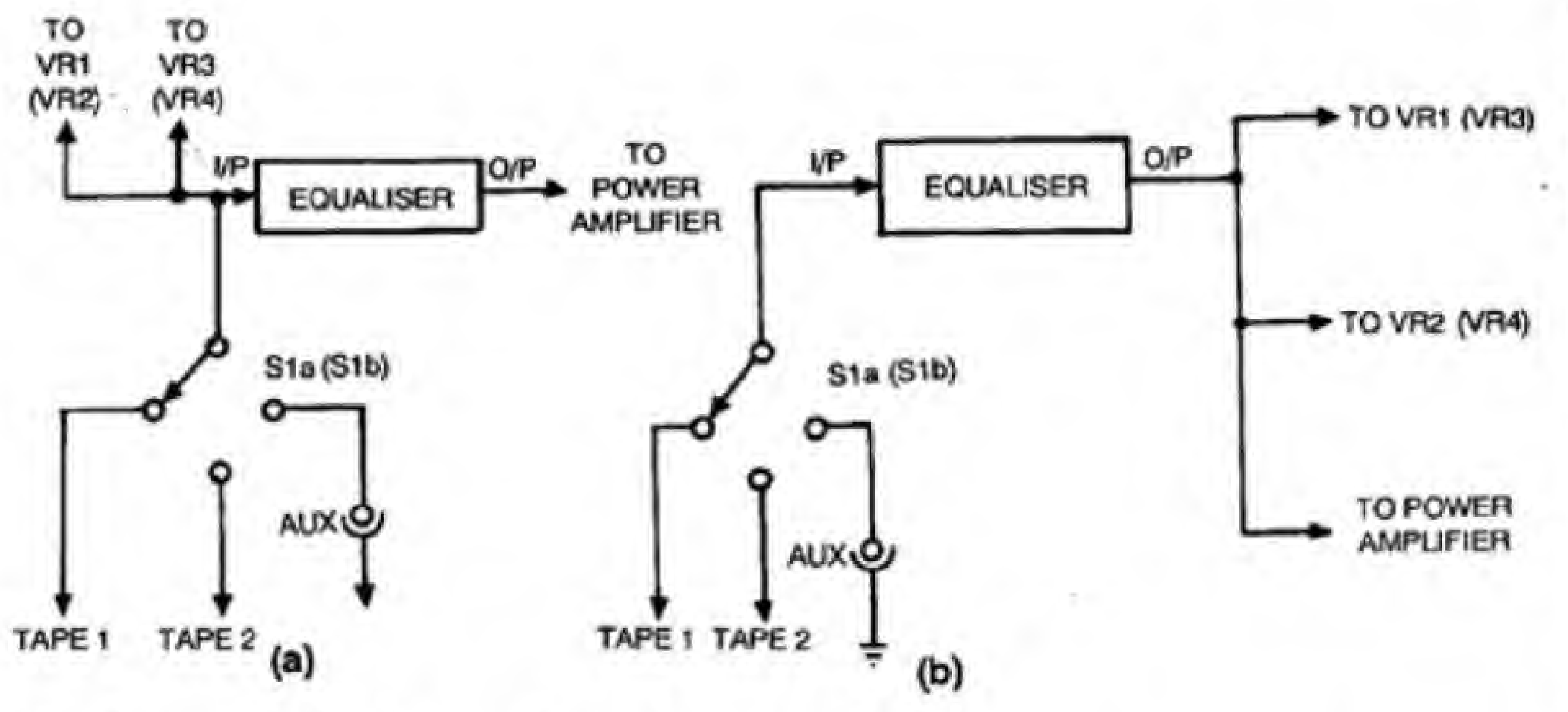
Mr Mahesh's tone control circuit can very well be used in the main circuit.

The polarity of eletrolytic capacitors is not marked in components layout, which I regret. Please refer to circuit diagram for the polarities. It is not 'that' necessary to reprint the component layout.

The display shows the standard decibel value, roughly only, as we are interested in '0' decibel level only. Addition of an equaliser is suggested as it would increase the performance greatly. The output from the poles of function selector switch should be given to the equaliser input and the output of equaliser to the power amplifier input. Any type of equaliser may be used. The following figure shows the equaliser connections. Any other type of amplifier may be used, but the PCB was designed for IC µPC 1230 only.

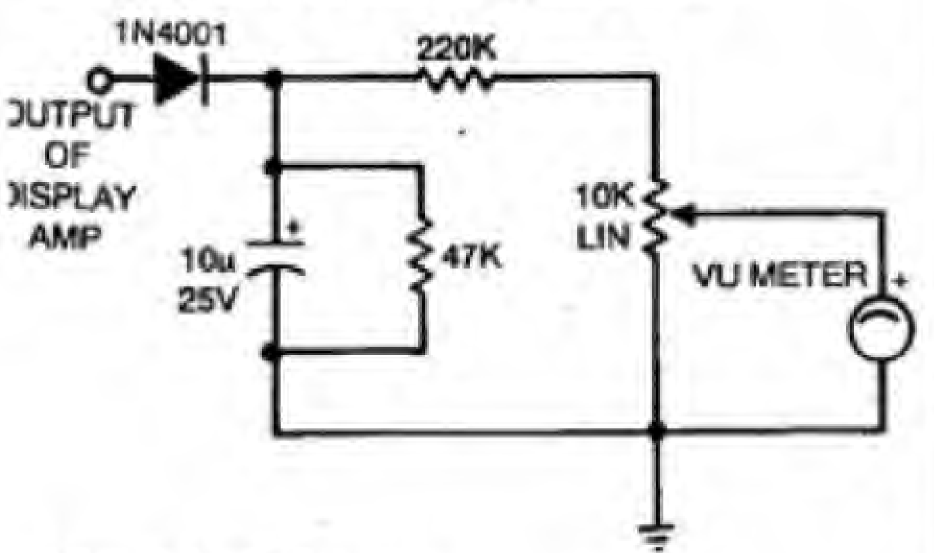
As is clear from the PCB layout, sixth pole of rec/play switch is used for changing power-amplifier ground to preamplifier ground.

The transistors of Fig. 3 are BC149C and BC149B respectively.



Equaliser connection for recording and power amplifier.

Noise limiters and tape selector circuits are beyond the scope of the article. However, efforts will be made to include them in one of the future issues of EFY. VU meters may be used in place of LED circuits with the help of the following circuit.



Circuit for VU meter.

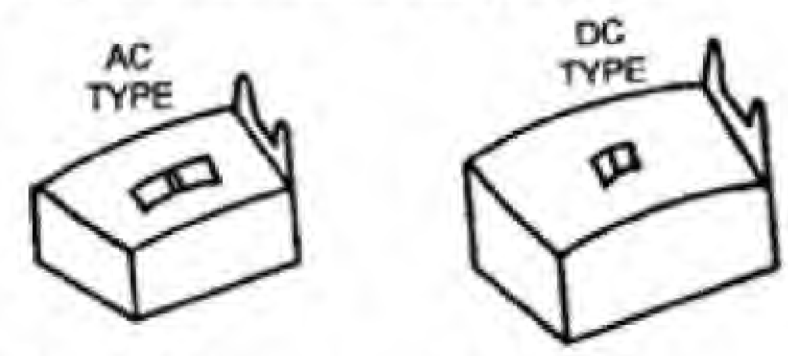
Indeed the last line of page 113 should read VR5 and VR6. C6 and C25 should be soldered directly on the potentiometers. VR2 and VR4 are rec-level control pots and VR5 and VR6 are rec-level presets. No heatsink is required for TBA 810 ICs. In case of AC type erase head, only 820-ohm resistor is to be omitted not R2 and R3. Points C and N are to be connected (not L and N).

As the gain of display amplifiers is sufficiently high, dubbing can be made from old cassettes by raising the rec-level control. IC LB1405 circuit can be used in place of transistorised circuit by feeding the input of the circuit from the output of display amplifier after attenuating with a 100k trim pot.

We can very well use μPC1230 for 40W+40W by using 16V-0-16V, 7-amp sec. transformer. No further modifications are necessary.

'0' dB level is only relative level and can only be obtained by calibrating the circuit with standard instruments. Absolute '0' level cannot be obtained and hence no such circuit can be designed.

AC and DC type erase heads can be differentiated by their head gaps. AC type will have larger gaps.



AC and DC type erase heads.

Speaker polarity:
Pin 1 of IC μPC1230 — Negative
Pin 11 of IC μPC1230— Positive

The volume control connection shown in Fig. 6 is wrong. Please refer Fig. 7 for correct connection.

The position of L1 is at the top right of transistor T1. For IC pin identification on PCB, please refer the circuit diagram. Each head of R/P type has four leads which are to be linked to the points shown on PCB layout through two core shielded wires per head. The shields should be soldered to the points marked 'shields' or to the nearest ground track.

The component layout shows both AC and DC type erase heads. However, only one of them is to be used. Any type of mechanism can be used. The prototype used vertical type soft touch mechanism which cost me Rs 425 per deck (in Hyderabad).

Ground loops are formed whenever a small part of supply voltage or output is fed back to the input due to drop across ground tracks or wires. This results in lot of hum and distortion.

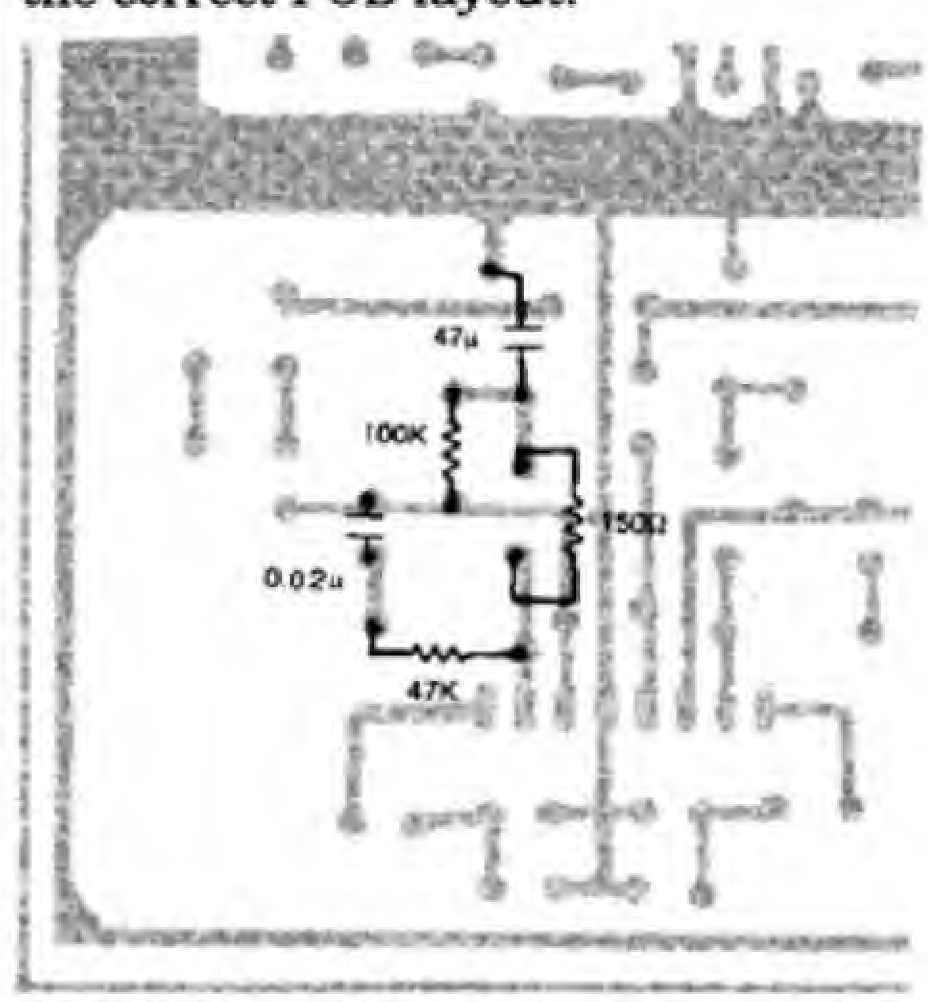
High speed dubbing is a special feature by which audio from one cassette can be dubbed or copied to another cassette at twice the normal speed. This cannot be achieved by merely doubling motor speed. One has to increase the bandwidth of all amplifiers to 36 kHz and change the bias oscillator frequency to 170 kHz. This is all complicated and beyond the scope of the article.

The background noise may be due to the use of some power supply. Try using separate power supply. Also use best quality shielded wires for interconnections.

A R/P head of 250-ohm impedance would be suitable.

Besides following corrections need to be made:

The tracks of preamplifier section of the PCB layout are wrong. Here is the correct PCB layout.



Mr T.S. Shankar's corrections in preamplifier section.

The figure shown in Fig.5 is component side. Pins 6 and 7 of IC3 and IC4 (LA3161) are to be interchanged. R45, R48, R52 and R55 are 150Ω. R46, R50, R53 and R56 are 47k. C35, C36, C49 and C50 are 0.001μF.

Multirange Adjustable Timer

Dinesh Kumar Raheja

An electronic timer is often used for delayed and precise switching in various industrial as well as domestic equipments. Generally, three methods are used to construct an electronic timer.

The first method is to use a monostable multivibrator, but for large time delays, the components become bulky, which is its major drawback. Thus such a circuit is not useful if longer time delay is required.

The second method is to employ microprocessor for the extremely precise control and switching. Although a very advanced method, it is extremely expensive and complicated.

The third method which is applied in this circuit employs an astable multivibrator cascaded with counters and driver circuit for the relay.

The characteristic feature of this circuit is its extremely wide range. This timer can be suitably adjusted for a time delay of 10 seconds to 100,000 seconds (more than 27 hours), in four suitable ranges. Moreover, CMOS ICs are used as counters, which eliminate the requirement of a regulated power supply, reducing the cost of the system considerably.

Working

The circuit diagram of the complete system is shown in Fig. 1. Here IC1 is used in astable mutivibrator mode to generate clock pulses. The time period of these clock pulses can be suitably adjusted with potentiometer VR1. The range select switch S2 enables selection of the required time range.

The clock pulses are fed serially to the cascaded counters formed by IC2 and IC3. These ICs are wired as divide-by-10 and divide-by-9 counters, respectively. So the last output of IC3 goes high at the generation of 90th clock pulse, after a time delay, given by the equation :

$$Td = (0.693\,(R1+2VR1+2R2)\,C')\times 90 \text{ sec.}$$

where C' is the effective capacitance, selected by the range select switch S2.

The delay period can be set in the following ranges:

Range	Delay Period	
	Min.	Max.
A	10 sec	100 sec
B	100 sec	1000 sec
C	1000 sec	10,000 sec
D	10,000 sec	100,000 sec

The instantaneous state of the timer

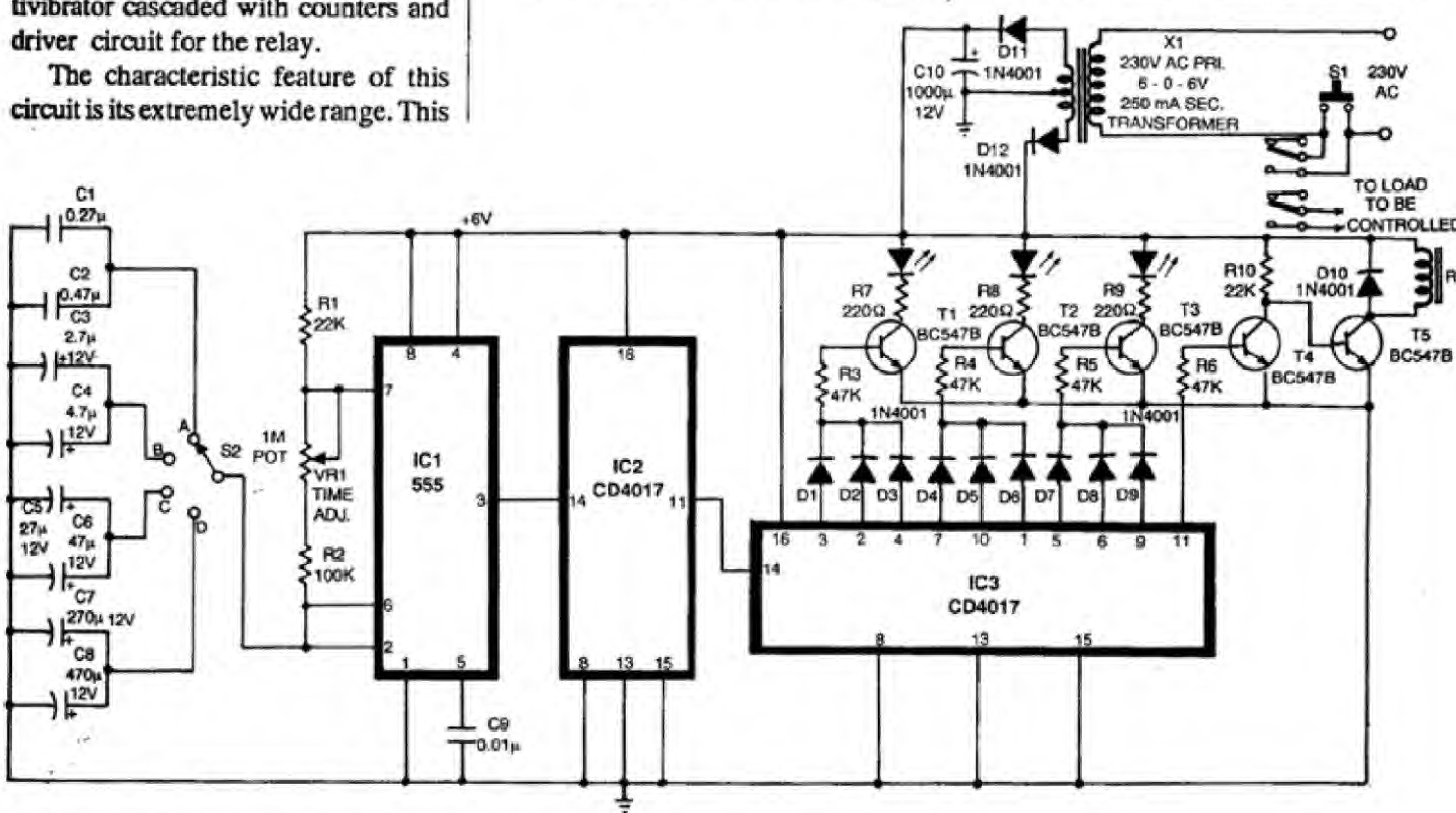


Fig. 1: Circuit diagram for multirange adjustable timer.

PARTS LIST

Semiconductors:

IC1	— LM555 timer
IC2, IC3	— CD4017 decade counter
T1-T5	— BC547B transistors
D1-D12	— 1N4001 diodes

Resistors (all 1/4-watt, ±5% carbon, unless stated otherwise):

R1, R10	— 22-kilohm
R2	— 100-kilohm
R3-R6	— 47-kilohm
R7-R9	— 220-ohm
VR1	— 1-megohm potentiometer

Capacitors:

C1	— 0.27µF ceramic disc
C2	— 0.47µF ceramic disc
C3	— 2.7µF, 12V tantalum
C4	— 4.7µF, 12V tantalum
C5	— 27µF, 12V tantalum
C6	— 47µF, 12V tantalum
C7	— 270µF, 12V tantalum
C8	— 470µF, 12V tantalum
C9	— 0.01µF ceramic disc
C10	— 1000µF, 12V tantalum

Miscellaneous:

S1	— Push-to-on switch
S2	— Single-pole 4-way rotary switch
RL1	— 6V, 100-ohm relay.
X1	— Transformer

is indicated by the LEDs. If the timer is in the initial one-third stage of the adjusted delay, the first LED glows. As soon as the timer reaches the middle one-third stage, the first LED goes off and the second LED glows automatically. Progressively, when the two-third delay time is over the second LED goes off and the third LED glows, indicating the timer in final state.

Transistors T1, T2 and T3 drive the LED indicators, while transitors T4 and T5 drive the relay. If the base of T4 is low, it remains the cut-off state, keeping T5 in saturation, which in turn keeps the relay on. As soon as the base of T4 goes high, it saturates and T5 goes into the cut-off state, driving off the relay.

First, the range and time delay should be adjusted properly with the help of potentiometer VR1 and range select swtich S2. Then switch S1 should be pressed to start the timer.

To make the system auto power off, a double pole 6V, 100-ohm relay is used. One pole is used to switch the desired load and the other to switch off the whole system, after the delay time is over.

The actual size PCB layout is shown in Fig. 2 with the components layout in Fig. 3. As the circuit consists of CMOS ICs, use of IC sockets is recommended. Tantalum capacitors are preferred to get better accuracy. As the system requires very little power, there is no need of using heatsinks for either transistors or ICs. The relay and transformer (X1) should be separately mounted.

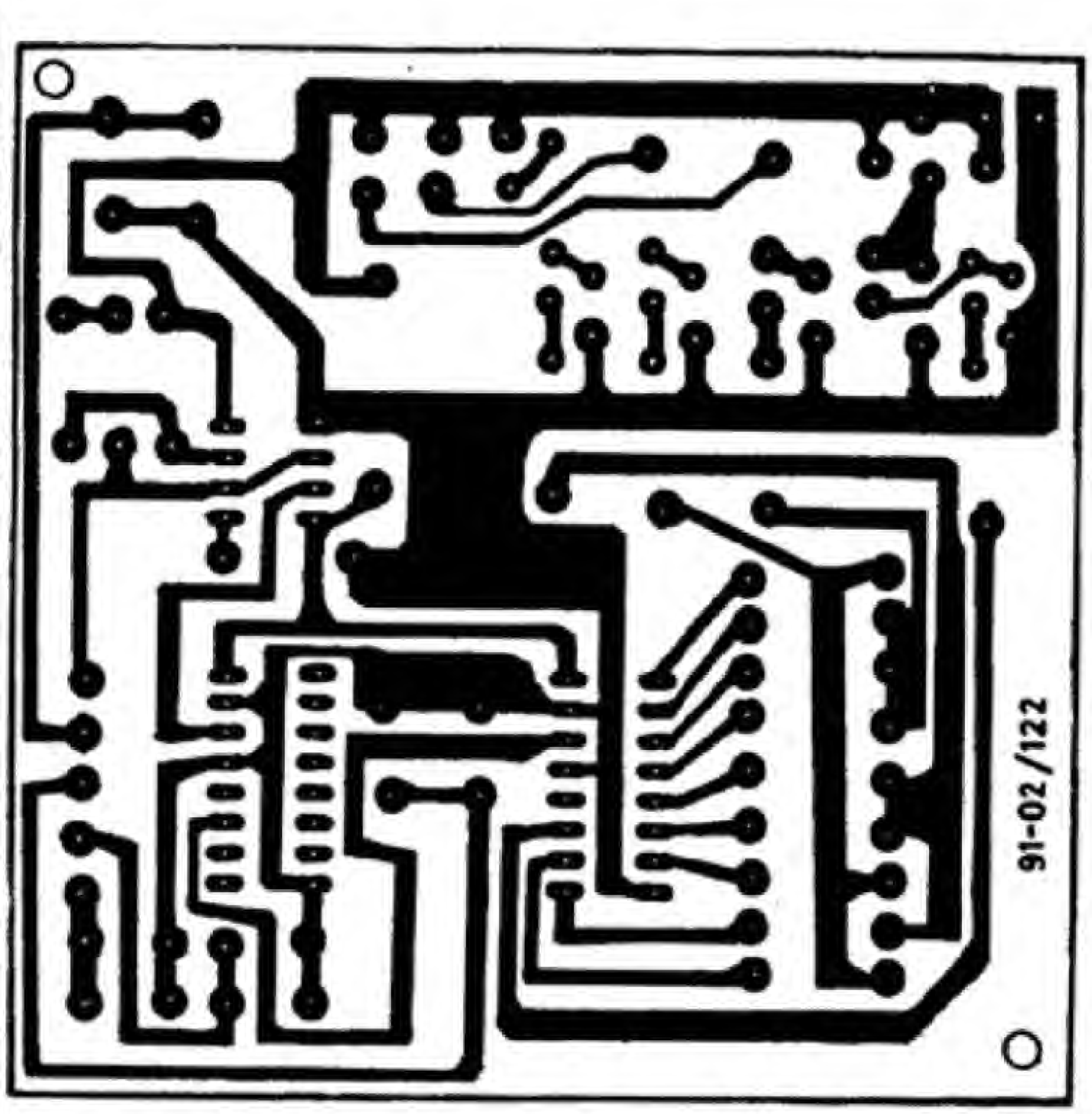


Fig. 2: PCB layout for multirange adjustable timer.

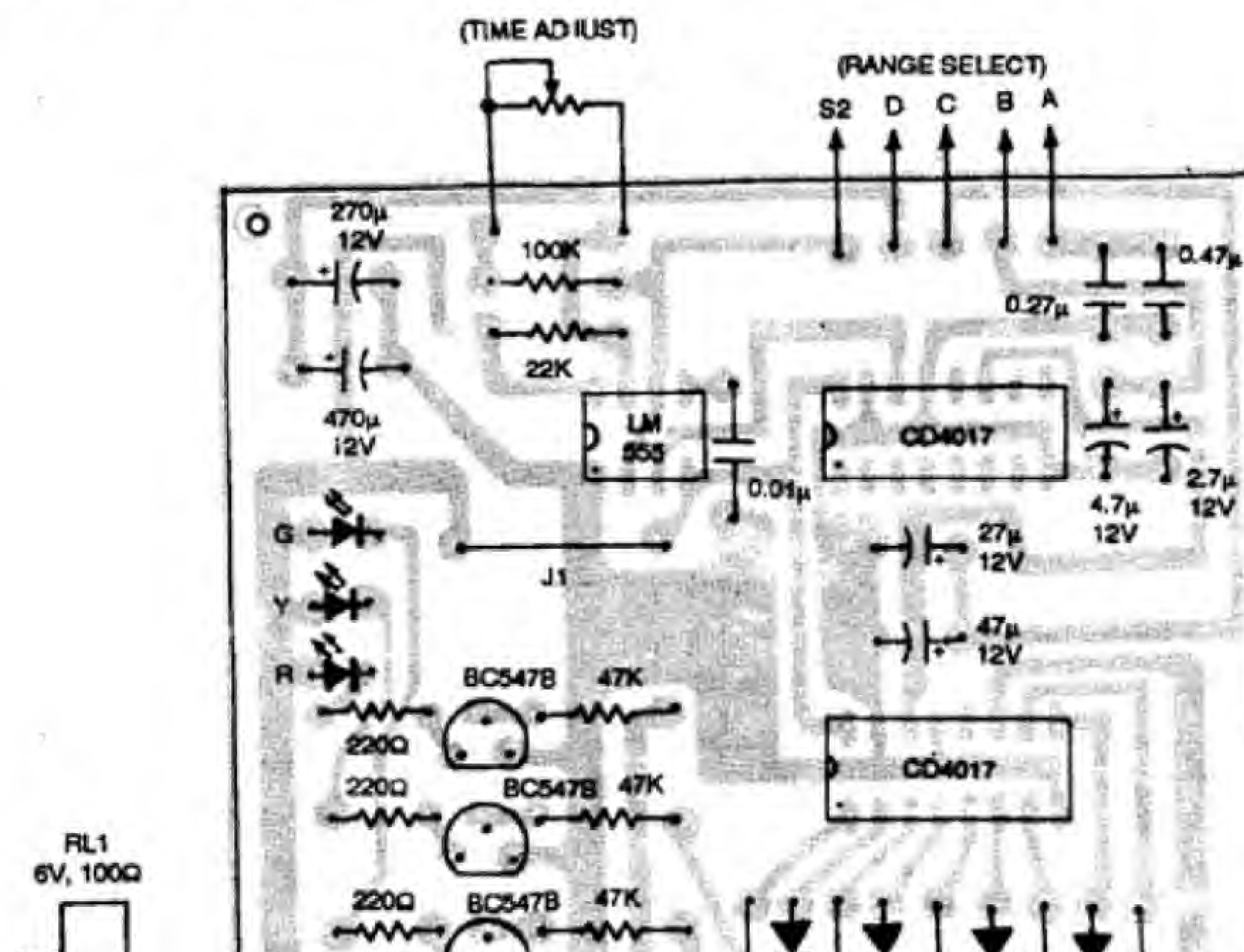
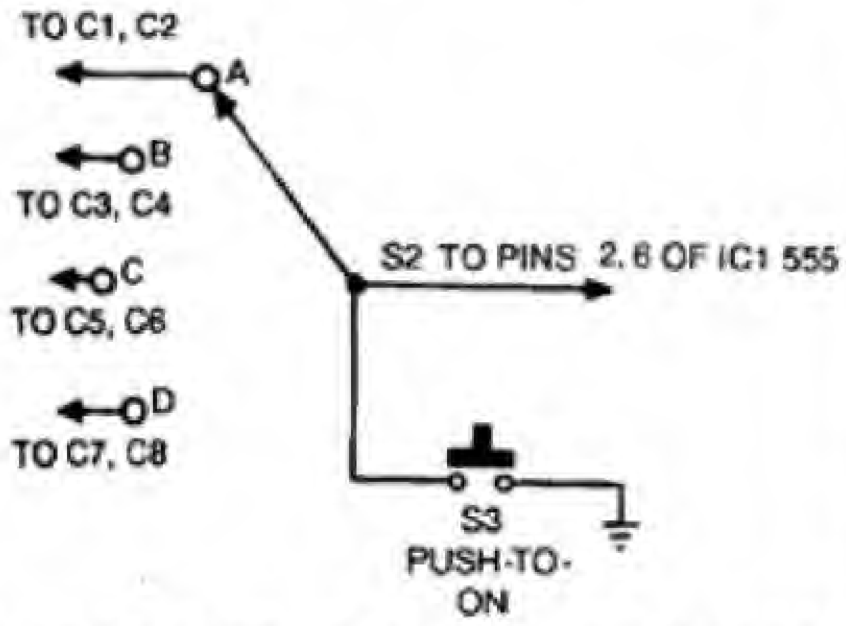


Fig. 3: Components layout for the PCB shown in Fig. 3.

This circuit can be suitably modified to get time delay out of the given range by using different combinations of capacitors and inserting more counters. □

Readers' comments:

The 'Multirange Adjustable Timer' project is good. The circuit is working quite well, but I would like to make the following addition to the circuit.



Modification for the multirange adjustable timer.

The circuit will indicate a false timing if it is switched off and then started, say within next few seconds or minutes. This is because of the slow decay of charges from capacitors C1 through C8 once they are charged. So to prevent this, the following modification may be done.

S3 has to be pressed each time before a new operation is started. This helps in preventing false timing.

Also I want to know what will happen to the relay contacts if the load to be controlled is a 1000W immension heater. Will the contacts be damaged because of excessive current flow drawn by the heater?

S.S. MANI
Madras

❒ Please clear my doubts regarding the Multirange Adjustable Timer circuit: (a) will the circuit work without LED indicator, (b) can I omit IC2, and (c) what if I use only one capacitor instead of the two connected in parallel?

A.N. BABU
Rajahmundry

The author, Mr Dinesh Kumar Raheja, replies:

Mr Mani has suggested a simple but very effective modification, using a simple push-to-on switch. This modification surely enhances accuracy of the timer. Now, if he wishes to control 1kW immersion heater using the timer, it is not possible with an ordinary relay. Because the peak current for 1kW heater is approximately 6.15 amperes, it will surely cause damage to the relay contacts. He should use the relay whose rated contact current is more than 6.15 amperes (say 10 amperes or so). If Mr A.N. Babu does not wish to use LED indicators, it is not going to affect the working of the timer in any case. He can use one capacitor instead of the parallel combinations of the capacitors, but the delay time will be affected.

If Mr A.N. Babu just omits IC2, the timer will work but all the ranges will be reduced to one-tenth of the given values.

Automatic Brightness Controller For TVs

Amrit Bir Tiwana

If you are making a TV receiver, or already have one, here is a sophisticated feature you can add to make its performance comparable to the most advanced television receivers available today.

This article describes the functional and constructional details of an automatic TV picture brightness controller, which 'sees' the brightness level of the room where it is being operated, and then, automatically selects one out of the eight possible TV picture brightness levels, thus ensuring the viewer a perfectly blended and clear picture with an optimum level of brightness. The circuit is compatible with almost all types of black-and-white or colour TVs.

Circuit description

The main control circuit of the automatic brightness controller is described in Fig. 1. The PCB and components layout are shown in Figs 2 and 3 respectively. Eight op-amp comparators (IC1 and IC2) form the heart of the circuit. Resistors R1-R7 along with presets VR1 and VR2 provide a reference voltage to the non-inverting input of each comparator.

The inverting inputs of all the comparators are connected together. Presets VR11 and VR12 along with resistors R16 and R17 tap the input voltage. The voltage obtained from this tap is fed to the inverting inputs of all comparators through the LDR.

Resistors R8-R15 are connected between the positive supply line and the output of each comparator to avoid any stray pickups. The outputs of the comparators are converted into a "sequential dot output" by the exclusive-OR gates, a1-h1 (contained in IC3 and IC4).

The outputs of these gates control bilateral static switches S1 - S8 (contained in IC5 and IC6), which automatically connect one out of the eight possible resistances between points X and Y (Fig. 4). This resistance in turn controls the brightness of the picture.

Principle of operation

Normally a TV set has a panel mounted brightness control potentiometer. The brightness of the TV picture has to be kept low under bright operating conditions and vice versa.

The brightness of the TV picture is dependent upon the value of resistance between points X and Y as shown in Fig. 4. Automatic brightness control is achieved by replacing the original brightness controlling potentiometer by a set of eight presets, each of which is set for a particular brightness level.

An LDR senses the room brightness level and automatically selects the most suitable preset (with the help of the circuit given in Fig. 1), and connects it between points Y and X thus stabilising the TV picture brightness to a suitable level.

Working

When the LDR is exposed to light, its resistance changes with the light. As resistance of the LDR (between points A and B) decreases, the voltage level at point B increases.

When the voltage level at the non-inverting input (point B) exceeds the reference voltage at the non-inverting input of the comparator, its output, which is initially high, goes low. When the output of the comparator goes low, the output of the corresponding EX-OR gate goes high, activating the corresponding bilateral static switch. This is turn connects the corresponding preset between points X and Y, which determines the TV picture brightness.

When the output of the next comparator goes low, the output of the corresponding EX-OR gate goes high, while that of the preceeding one goes low. Thus the next bilateral switch is

PARTS LIST

Semiconductors:

IC1, IC2	-	LM324, quad comparator
IC3, IC4	-	CD4030, quad EX-OR gate
IC5, IC6	-	CD4016, quad bilateral switch
IC7	-	7805, 5V regulator
D1	-	1N4002 diode

Resistors (all 1/4W, ±5% carbon, unless stated otherwise):

R1-R7, R16, R17	-	1-kilohm
R8-R15	-	1.5-kilohm
R18	-	330-ohm
VR1, VR2	-	22-kilohm preset
VR3-VR10, VR12	-	100-kilohm preset
VR11	-	47-kilohm preset

Capacitors:

C1	-	1000μF, 16V electrolytic
C2, C3	-	0.1μF ceramic
C4	-	220μF, 10V electrolytic

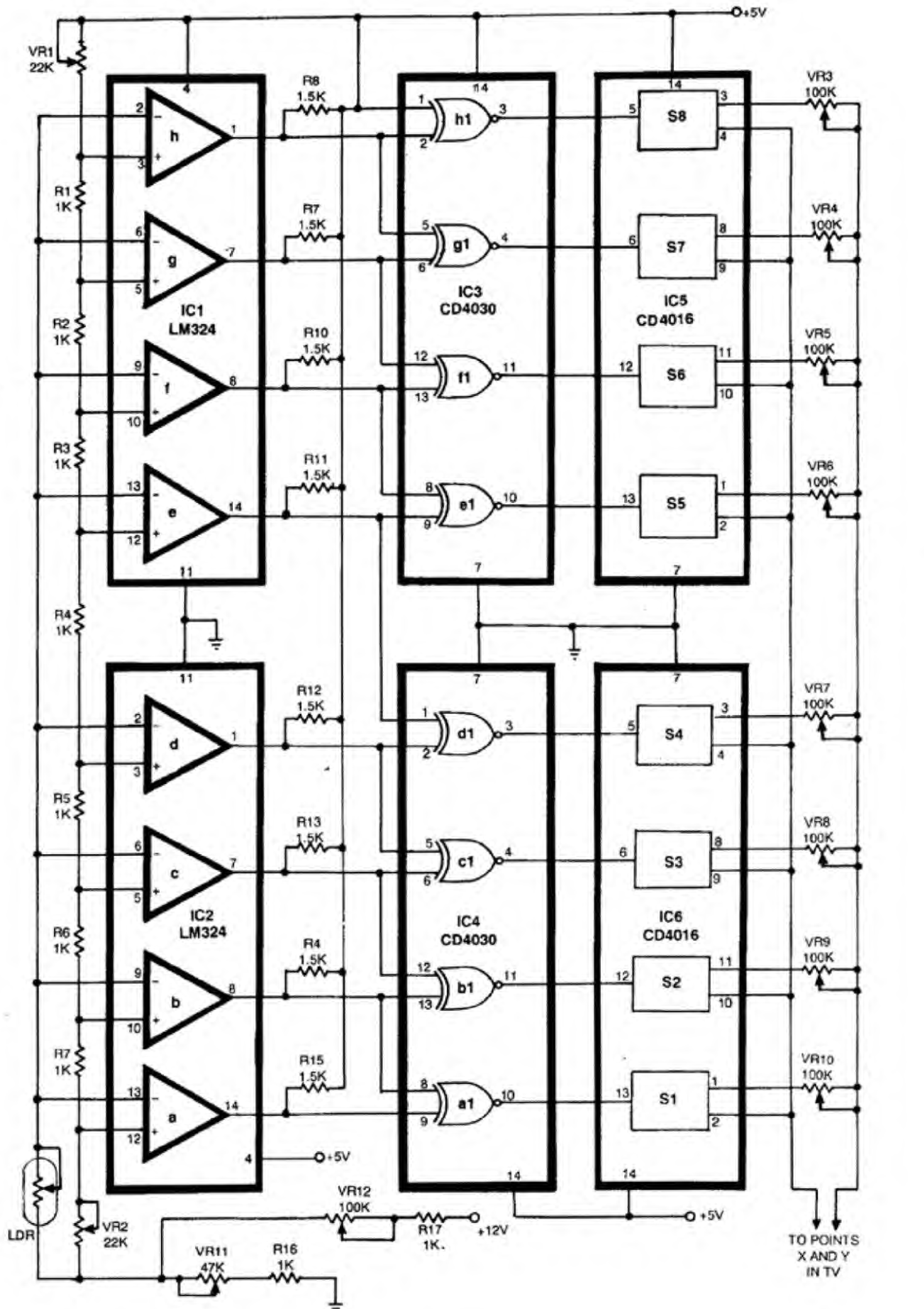
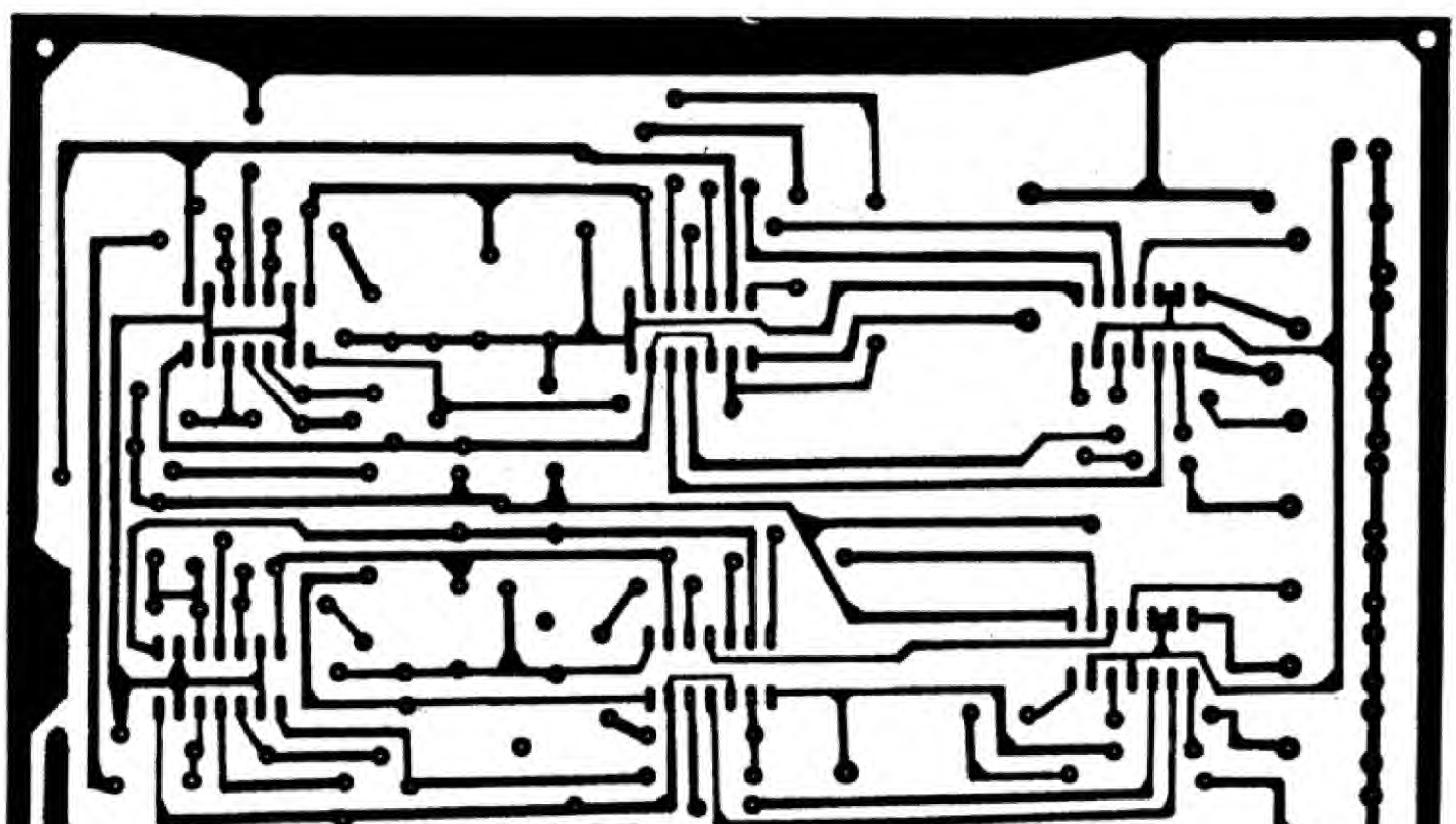
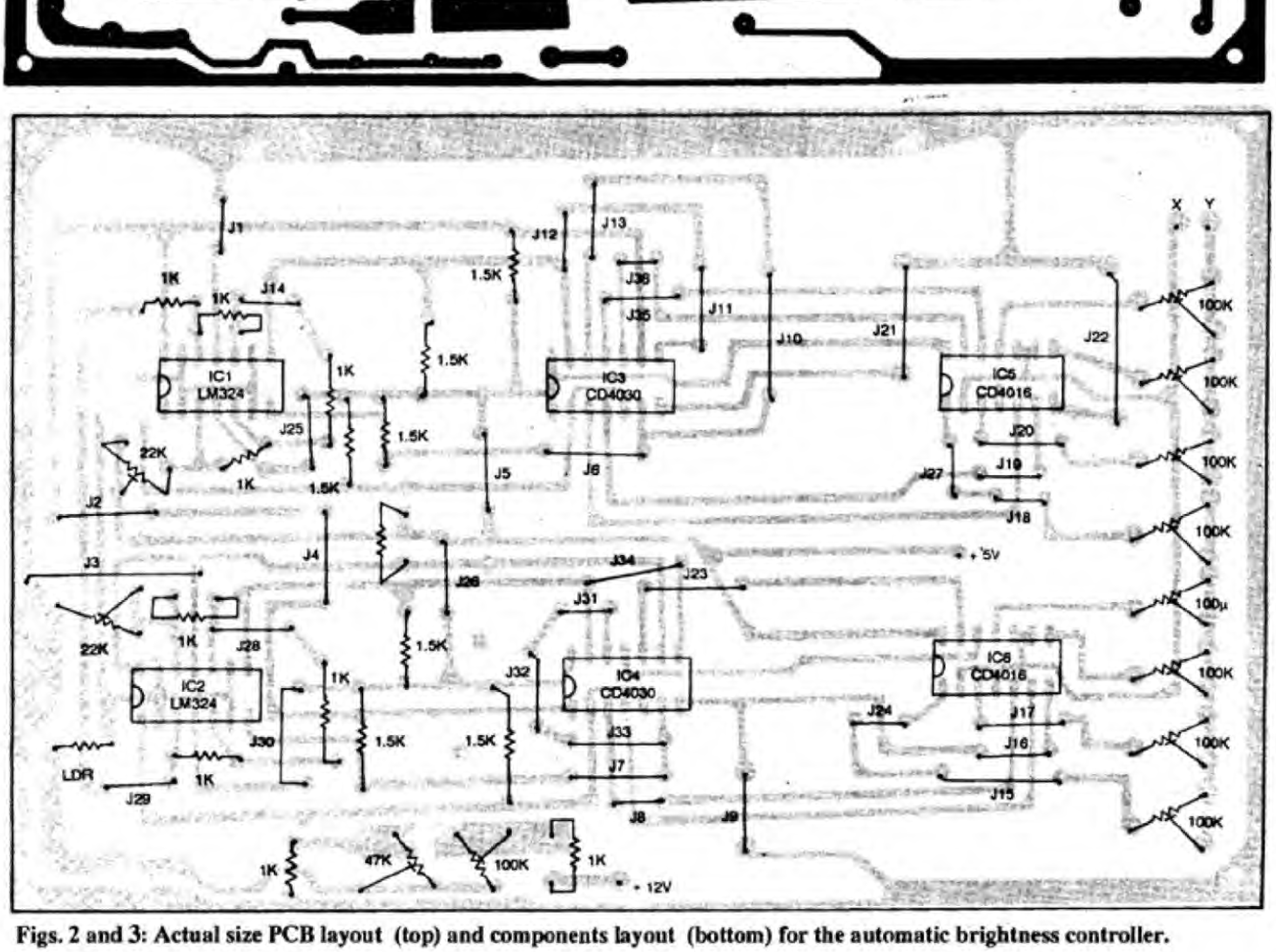


Fig. 1: Control circuit for the automatic brightness controller for TVs.





Figs. 2 and 3: Actual size PCB layout (top) and components layout (bottom) for the automatic brightness controller.

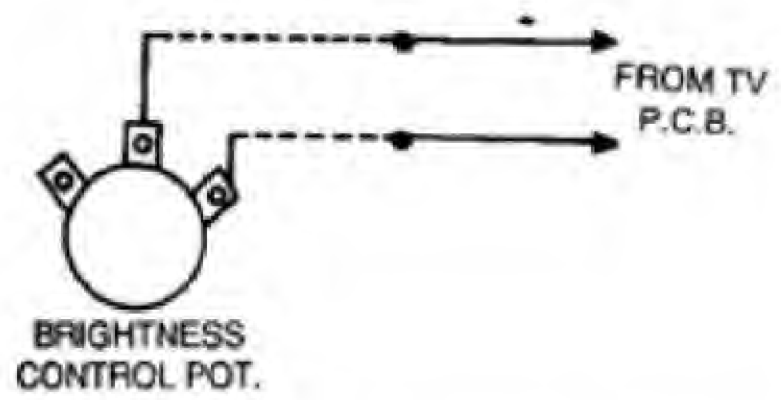


Fig. 4: Connections between automatic brightness controller and the TV.

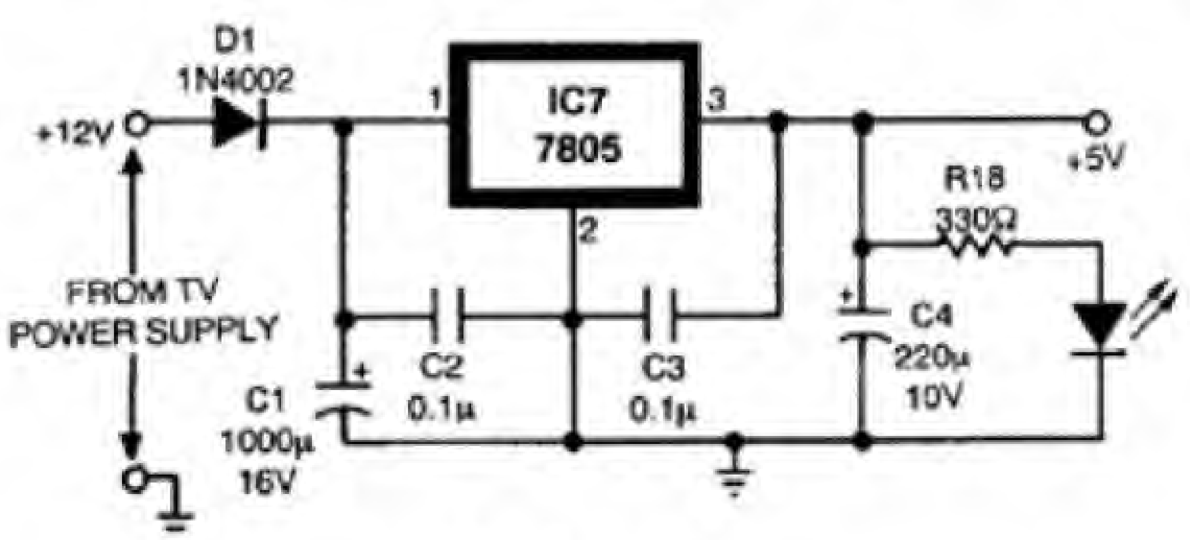


Fig. 5: Power supply arrangement for the circuit.

activated and another value of resistance is inserted between points X and Y. Similarly, the other six resistors are also selected.

Power supply

The circuit requires a regulated power supply of 5V which may be obtained from the TV circuit itself. The circuit shown in Fig. 5 converts the 12V power supply obtained from the TV into 5V DC for this purpose. D1 protects the circuit from reverse polarity connection, while D2 serves as a pilot indicator when the circuit is working and protects IC7 by discharging C4 when the circuit is switched off.

Construction

The circuit can also be assembled on a general-purpose PCB. Care should be taken while soldering the ICs. The use of IC sockets is recommended. All connections should be made using flat colour-coded multiway ribbon cables. After soldering, the circuit should be thoroughly checked for loose or dry solder joints.

Installation

The circuit should be installed in the TV as shown in Fig. 4. First, the brightness control potentiometer should be disconnected and removed from the front panel. The wires disconnected from the potentiometer should be connected to the automatic brightness controller.

A small circular piece of transparent acrylic sheet should be glued behind the potentiometer's panel mounting hole, using a strong rubber-based adhesive. The LDR should then be fixed behind the sheet and connected to the circuit using a shielded cable. Now the circuit should be adjusted, after which, the circuit can be enclosed in the TV cabinet itself.

Adjustments

After the circuit has been successfully constructed, it should be adjusted for optimum control at different levels of brightness.

Place the TV set (i.e. LDR) in very bright room conditions and adjust VR1, VR2, VR11 and VR12 such that the output of h1 just goes high. Now adjust VR3 so that the brightness level of the picture obtained is sufficiently low. Now expose the TV to lesser bright conditions, so that the output of g1 goes high.

Next, adjust VR4 for an optimum level of brightness. Similarly, adjust presets VR5-VR10 for a suitable level of brightness. Finally readjust VR1 and VR2 for optimum sensitivity. The unit is now ready for use.

Under bright operating conditions, the TV picture brightness will now remain adequately low and as the room brightness decreases the TV picture brightness will increase in eight steps to ensure the user a well-blended and clear picture, automatically.

The complete automatic brightness controller would cost less than Rs 100.

□

A High Impedance Adapter For a Multimeter

R. Shankar

Here is a project for a high impedance adapter which can be added to a multimeter to provide the function of a sophisticated voltmeter having an input impedance of 11 megohms. The circuit could be used with any analogue multimeter having a DC current range of 250 μA or less. The circuit given here is a complete voltmeter by itself except for the indicating portion, i.e. the micro-ammeter.

The circuit does not interfere with the normal operations of the multimeter since it is a separate unit. It can be connected to the multimeter by its test probes.

Table I shows the specifications of the high impedance adapter. As in the case of DVMs and DMMs, the input impedance (viz, 11 megohms) is the same for all ranges. This is quite contrary to conventional analogue multimeters in which the input impedance is directly proportional to the voltage range selected. It should be noted that this circuit would be superfluous in the 1000V range for 20k/volt models.

The circuit diagram for the adapter is given in Fig. 1. The voltage to be measured is applied to the dividing network comprising R1 through R11. The voltage range is selected by S1 and the corresponding fraction of the

TABLE I
Specifications

Voltage ranges	: 2V, 10V, 50V, 200V, 500V, 1000V AC and DC
Input impedance	: 11 megohms on all ranges
Accuracy (excluding that of the meter)	: DC—1% on all ranges AC (50Hz)-1.5% on all ranges
AC bandwidth (-3dB)	: DC to 30kHz
Input overload protection	: Up to 1000V DC continuous on all ranges
Output short-circuit protection	: Indefinite

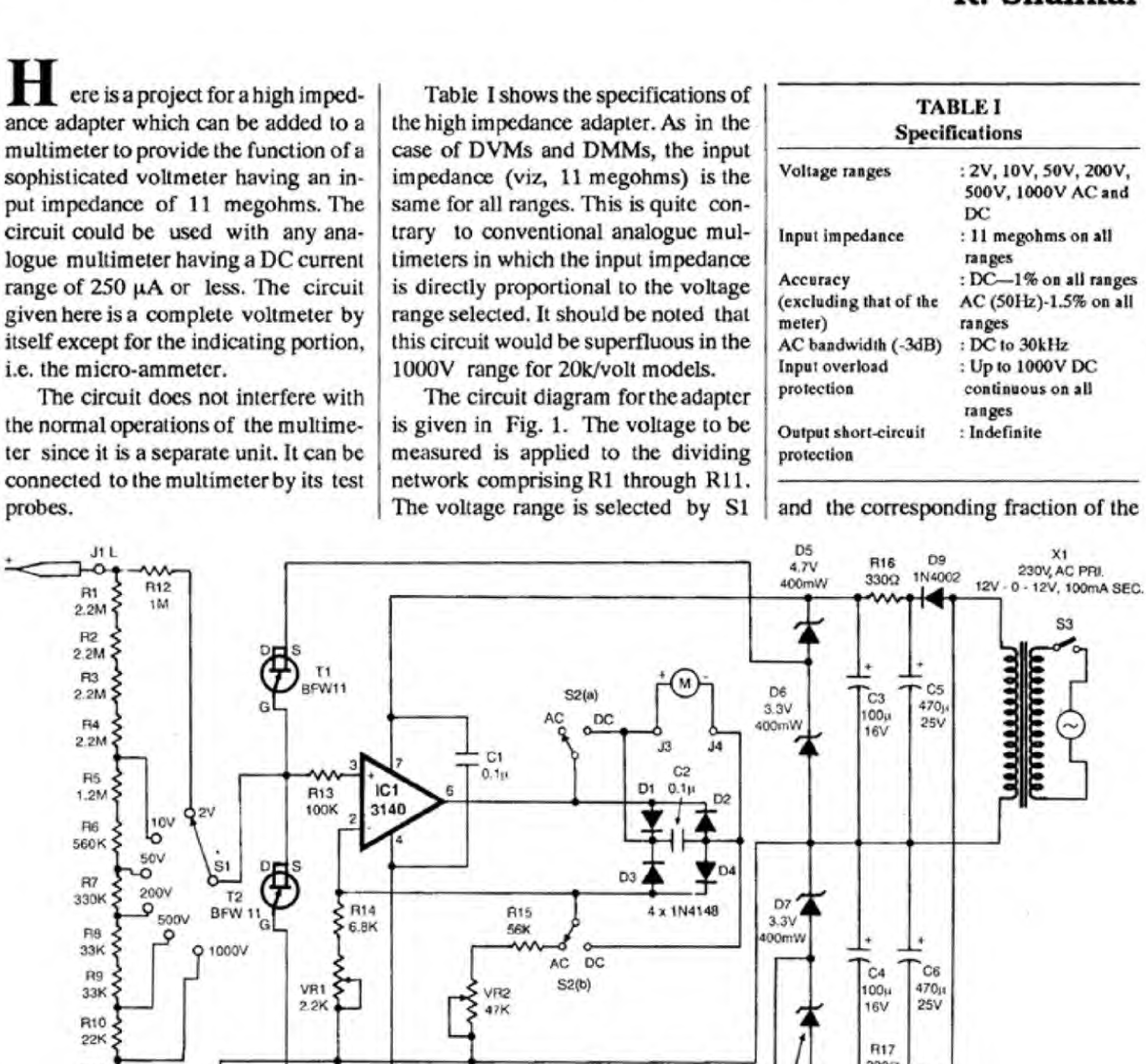


Fig. 1: Circuit diagram of the high impedance adapter for multimeter.

PARTS LIST

Semiconductors:

IC1	-	CA3140, Bi-MOS op-amp
T1, T2	-	BFW11 n-channel FET
D1-D4	-	1N4148 silicon switching diode
D5, D8	-	4.7V, 400mW zener diode
D6, D7	-	3.3V, 400mW zener diode
D9, D10	-	1N4002 silicon rectifier diode

Resistors (all 1/4W, +5% carbon, unless stated otherwise):

R1-R4	-	2.2-megohm, 1/2W, 1% metal film
R5	-	1.2-megohm, 1/2W, 1% metal film
R6	-	560-kilohm, 1% metal film
R7	-	330-kilohm, 1% metal film
R8, R9	-	33-kilohm, 1% metal film
R10, R11	-	22-kilohm, 1% metal film
R12	-	1-megohm, 1W
R13	-	100-kilohm
R14	-	6.8-kilohm
R15	-	56-kilohm
R16, R17	-	330-ohm, 1/2W
VR1	-	2.2-kilohm variable resistor
VR2	-	47-kilohm variable resistor

Capacitors:

C1, C2	-	0.1μF ceramic
C3, C4	-	100μF, 16V electrolytic
C5, C6	-	470μF, 25V electrolytic

Miscellaneous:

S1	-	Single-pole, 6-way rotary switch
S2	-	DPDT switch
S3	-	SPST switch
X1	-	230V AC primary to 12V-0-12V, 100mA secondary transformer

input voltage is applied to IC1 via R13. IC1 is a Bi-MOS op-amp which has an extremely high input impedance of 1.5 million megohms (1,500,000 times that of a 741). So the impedance of the meter is practically determined by R1-R11 which is 11 megohms.

The multimeter is included in the feedback loop of IC1 via bridge rectifier comprising D1-D4. The current through the multimeter is directly proportional to the input voltage, the actual value for a given input voltage being determined by R14, R15, VR1 and VR2.

TABLE II

Meter FSD	R14	R15	VR1	VR2
50μA	33k	270k	22k	220k
60μA	27k	270k	22k	100k
100μA	18k	150k	4.7k	100k
150μA	12k	100k	2.2k	47k
250μA	6.8k	56k	2.2k	47k

The values of the above components depend on the lowest current range in your multimeter. For the sake of convenience, these have been calculated and enumerated in Table II.

The voltage at pin 3 of IC1 required for full scale division (FSD) of the multimeter is 2V. This rather high value eliminates the need for an offset-eliminating potentiometer. The offset voltage of IC1 (2 mV maximum) would cause less than 0.1 per cent error which

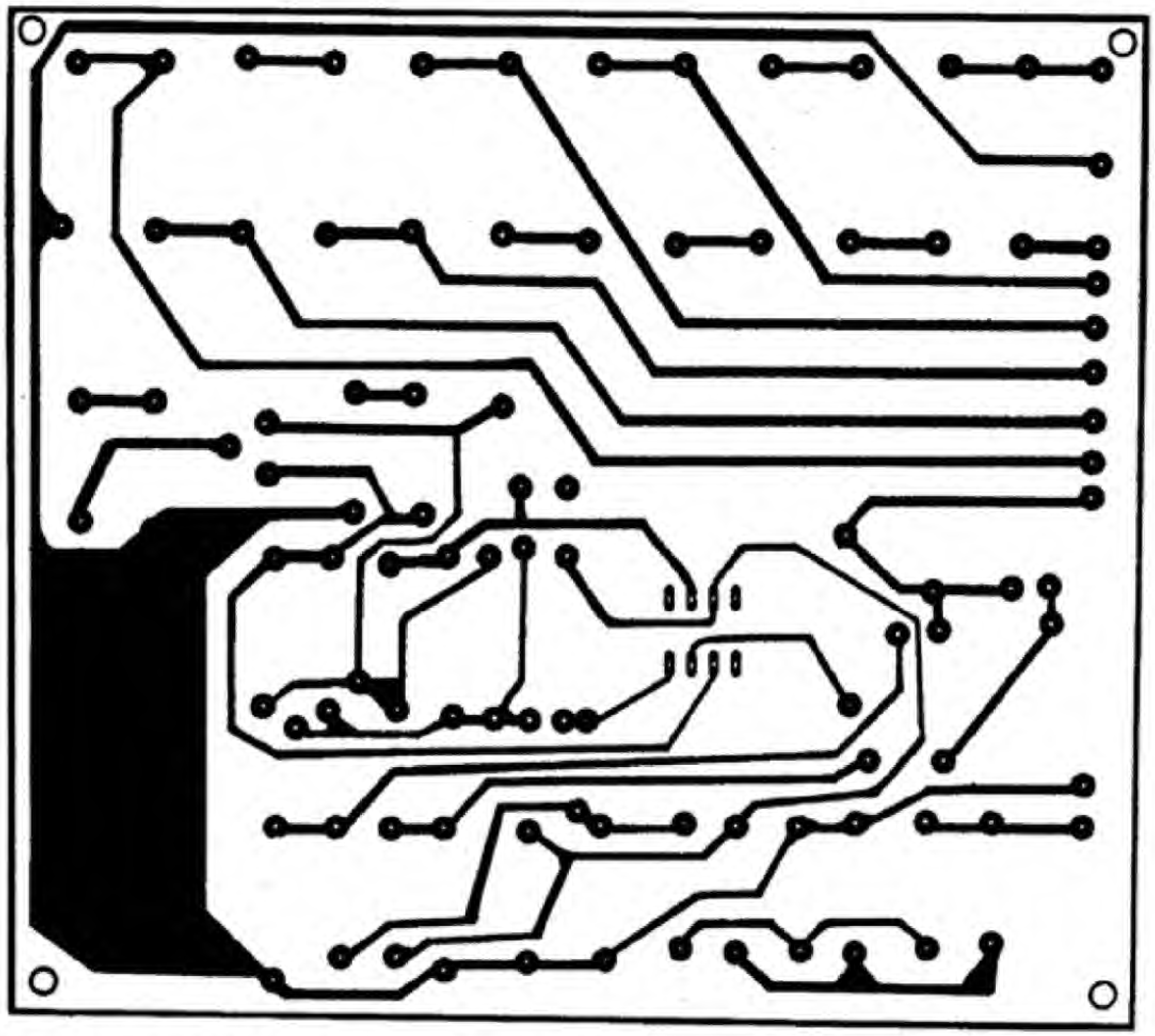


Fig. 2: Actual-size PCB layout for the high impedance adapter.

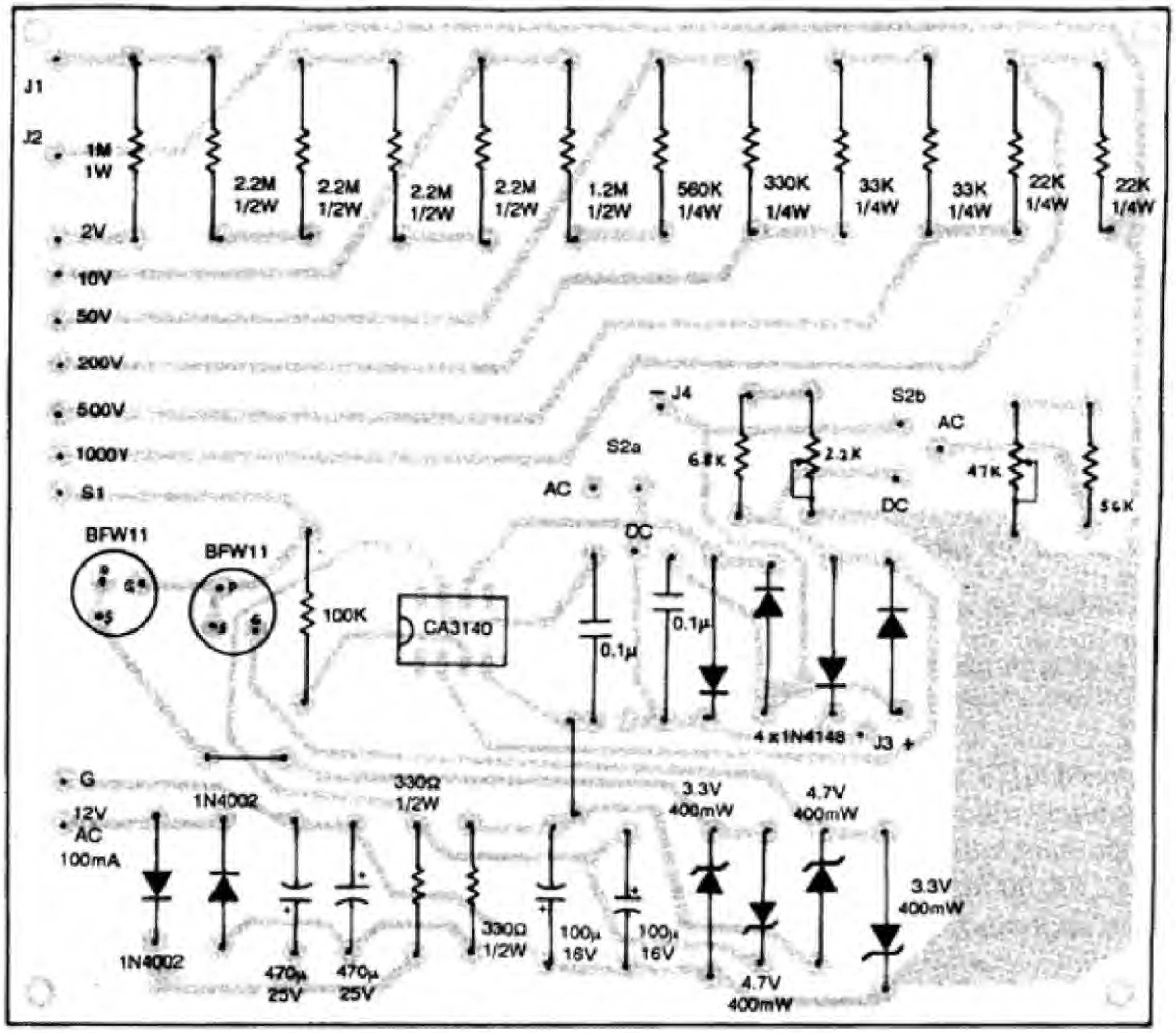


Fig. 3: Components layout for the PCB shown in Fig. 2.

is hardly detectable. S2 is used to select AC or DC voltage to be measured.

In the AC position, S2 increases the transconductance by a factor of 1.11. This increment is necessary for the multimeter to show the RMS voltage.

In the DC position, R15 and VR2 are removed from the feedback loop while diodes D1 and D4 are shorted. This arrangement is necessary. It is otherwise be difficult to determine the polarity of the input voltage due to the presence of the bridge rectifier.

The advantage of using a multimeter in the feedback loop is that the meter reading is virtually unaffected by stray fields picked up by the wires. IC1 forces a constant current through the multimeter regardless of induced voltages in the feedback loop. C2 improves the stability and high frequency response of the circuit.

Overload protection circuit consists of FETs T1 and T2 connected as very low leakage diodes with a reverse leakage current of 10pA at 25°C. These effectively chop off input transients which exceed ±4V.

The power supply is simple and straightforward. The combination of zener diodes D5-D8 provides ±8V supply to IC1 while D6 and D7 provide ±3.3V for the protection circuitry.

Construction

The PCB pattern and its components layout are given in Figs 2 and 3. The values of R14, R15, VR1 and VR2 depend upon the value of the lowest current range in the multimeter. These can be selected from Table II.

Since IC1 has MOS inputs, a low profile IC socket is strongly recommended. Do not use soldering flux while soldering pins 2 and 3 of the IC socket as the leakage would cause deterioration in performance. The same applies to FETs T1 and T2.

The inputs and outputs are brought out as sockets similar to those found in multimeters. The test probes are inserted into jumpers J1 and J2, while the probes of the multimeter are inserted into J3 and J4.

Calibration

After checking the circuit, adjust VR1 and VR2 to their maximum position. Keep S1 in 2V position and S2 in DC position. Measure its voltage using a DMM. Now adjust VR1 to give the same reading on the multimeter. DC calibration is complete.

For AC calibration, keep S1 in 500V position and S2 in AC position. Test the AC mains voltage keeping both the DMM and this circuit across the L and N terminals simultaneously. Now adjust VR2 to get concurrent readings.

This project is now ready to be enclosed in a cabinet. The circuit costs less than Rs 150.

□

Neo Digital Clock
Part I

Amarjeet Singh Bajwa

Although several circuits for digital clocks have already been published in EFY earlier, here is a new digital clock which is most modern and has all the qualities generally incorporated in Japanese watches/clocks. This neo digital clock has the following features:

1. Displays time (hour, minute and seconds), calendar (month and date), and day on alphanumeric display, continuously on different display.

2. Hourly chime with volume control (hour counter type).

3. Alarm with auto-snooze (with different music at every snooze).

4. Very easy to set (very few control switches like mode switch).

5. Very little consumption of power (due to multiplexing of display).

6. Large display of time, so easy to

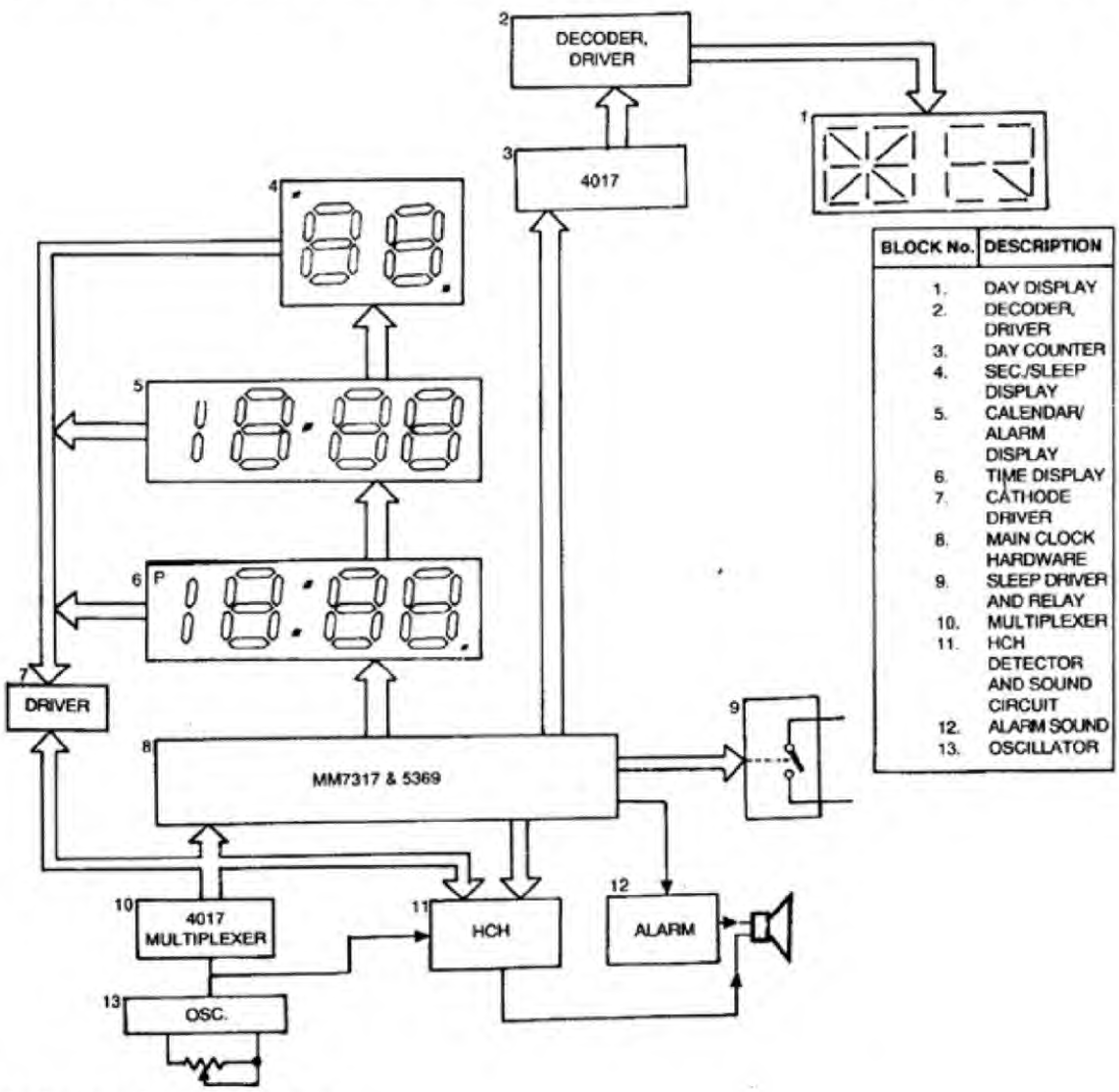


Fig. 1: Block diagram of neo digital clock.

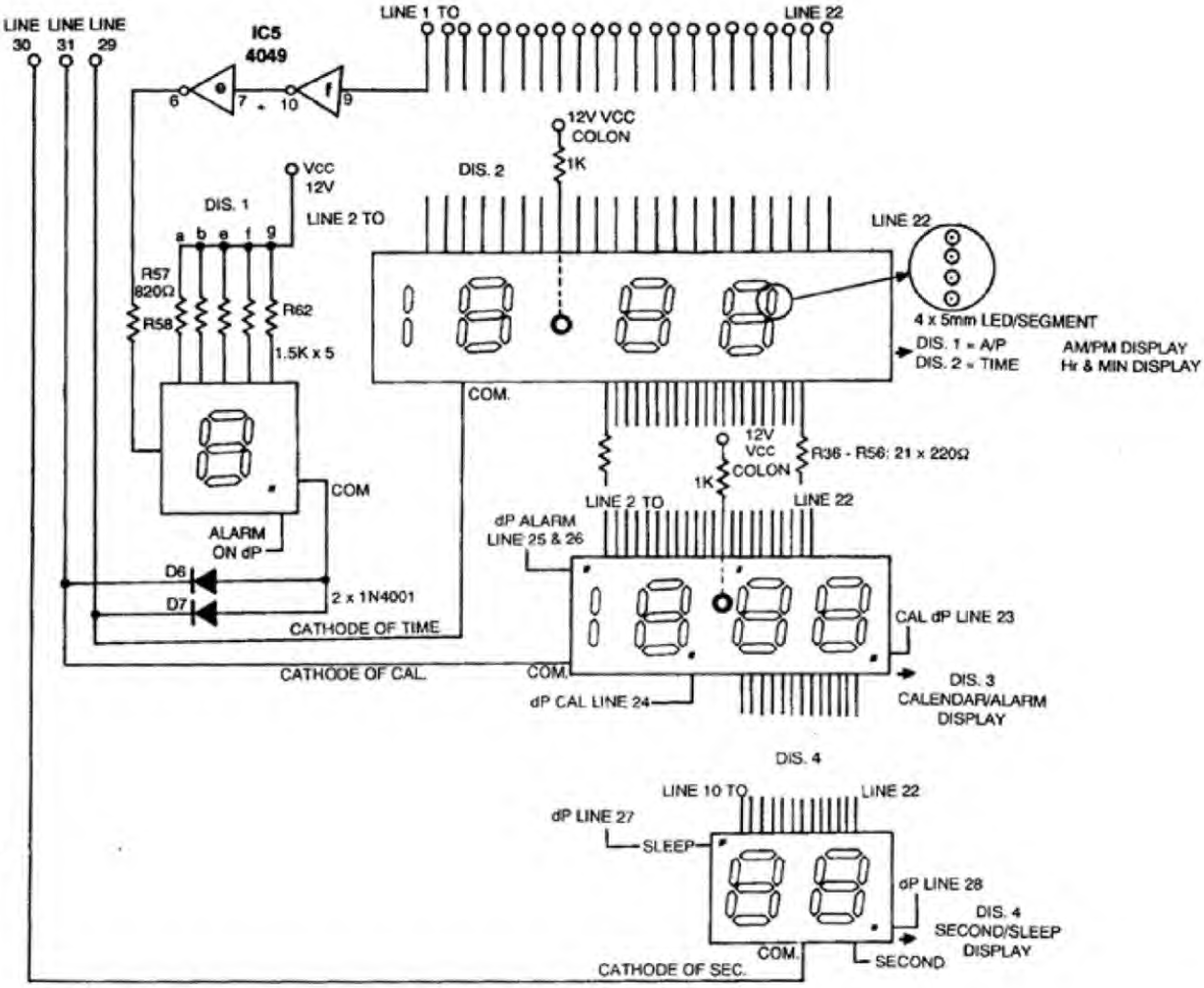


Fig. 2: Display circuit.

read even at long distances.

7. Sleep facility to turn any appliance on/off as a switch.

8. Indication of mode during setting, e.g. calendar or alarm, seconds or sleep, alarm and hourly chime on/off etc with simple circuit and easily available components.

Description

From the block diagram in Fig. 1, the circuit can be easily understood. Block 1 is the day display which shows day in two letters of English, e.g. Sunday will be displayed as "SU". AM pulse of IC 7317 (block 8) forces the decade counter (block 3) to count next day. Diode ROM (block 2) decodes that day and also drives the day display.

As already experienced with previous circuits of digital clocks, if we want to see the display for 'seconds' or 'alarm', then the input switch has to be pressed. If three displays are connected in this manner to the same circuit, then by pressing one button time display shows time; pressing the second button displays the seconds and by pressing next button, the alarm display shows the alarm time.

If we now increase the speed of pressing the button to about 200 depressions/sec (200 Hz) by some automatic means, then we will see that time, seconds and alarm time are all displayed continuously, without a flicker. This is the main principle behind this neo digital clock. The primary problem in the designing of the circuit was how to make the hourly chime circuit (HCH) to know that the minutes on the time display are zero-zero since the signals of clock ICs are changing rapidly.

Display circuit

The neo digital circuit has five different displays as shown in Fig. 2:

1. Time, hour and minute on display 2.
2. Calendar (month date)/alarm (hour, minute) on display 3.
3. Seconds/sleep on display 4.
4. AM/PM on display.
5. Day display.

All dp's of FND500 displays show mode of various displays. The time display consists of 94 LEDs (including two for colon). Each segment has four LEDs connected in series and all segments of time display have common cathode. The AM/PM display comprises only one FND, which shows A for "AM" and P for "PM". The same display also indicates whether the alarm of HCH is on or off.

For the second display, two FNDs have been used. Their dp's show the

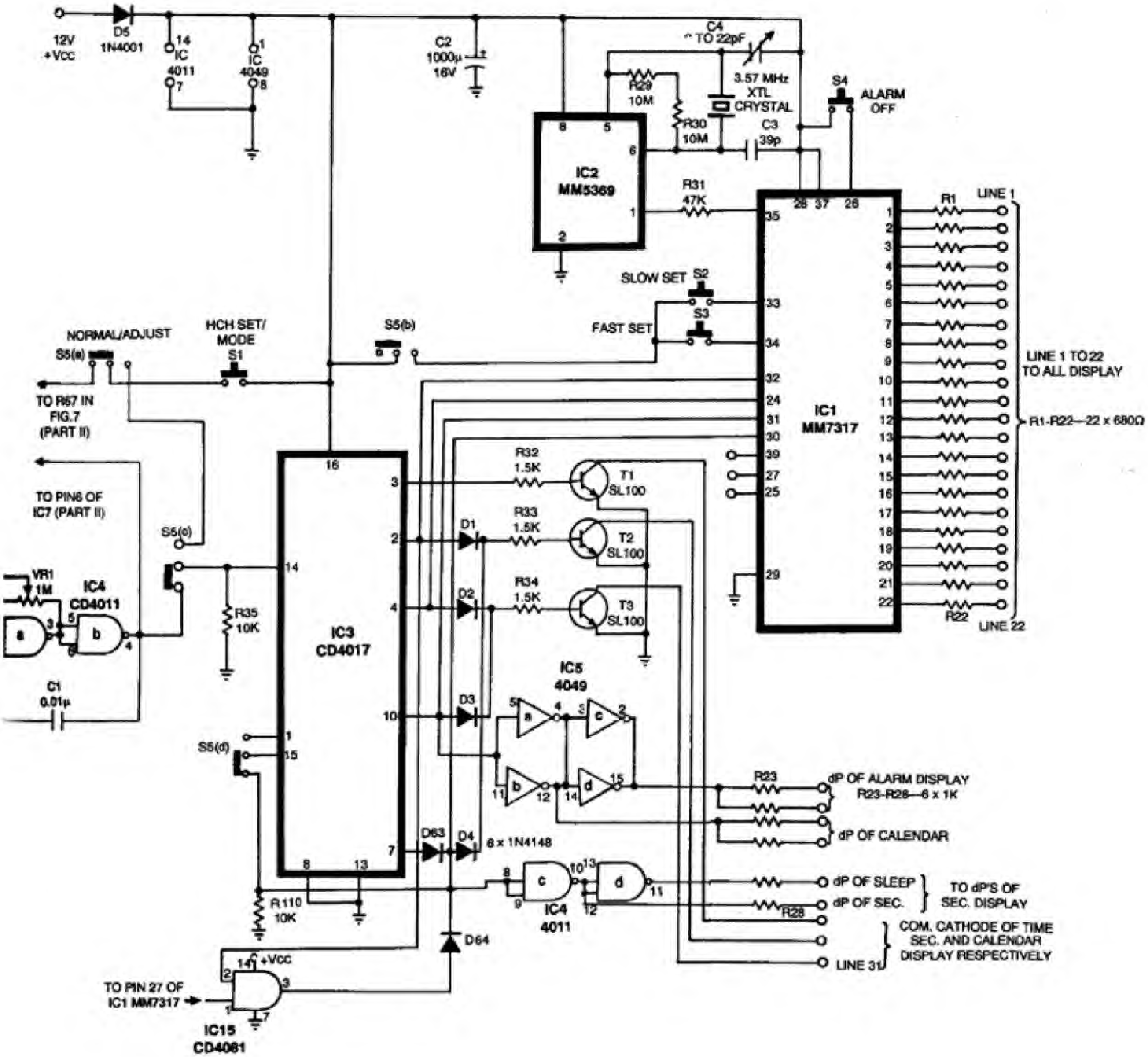


Fig. 3: Main Circuit for neo digital clock.

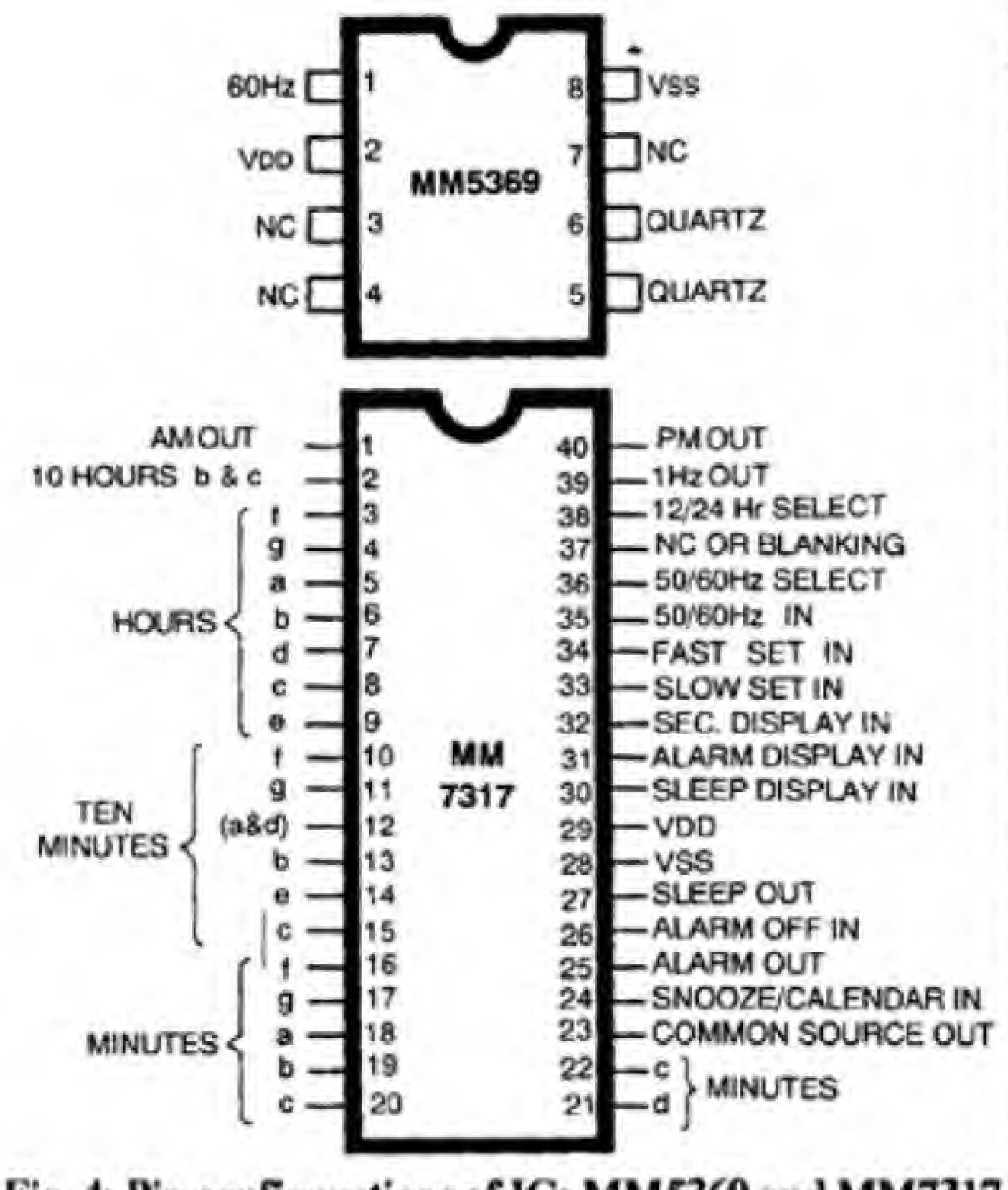


Fig. 4: Pin configurations of ICs MM5369 and MM7317.

mode of display, viz, whether it is showing seconds or sleep. Calendar display consists of four FNDs, the left two showing month and right two showing date. Their dp's show the mode of calendar display, viz, whether it is calendar or alarm.

AM/PM display cathode has been connected to the cathode of both time and calendar display through two diodes, so that it also shows AM/PM during alarm mode. All three displays (time, seconds and calendar) are connected in parallel to IC 7317.

A current limiting resistor of 680 ohms is used for time display. For both calendar and seconds display 680+220-ohm resistor is used because the current requirement of FND display is low as compared to discrete LED display (time display). FND of seconds display is connected to pins 10 to 22 of IC 7317 because only these pins give the signal for seconds.

In the centre of both the calendar and time displays, two LEDs are connected in series to Vcc to indicate a colon. The segments of a,b,g,e and f of AM/PM display are permanently connected to Vcc through a limiting resistor so that it always show "P". When AM is high, gates e and f will pass the current to segment "c" so that the display will show AM.

Main circuit

The heart of the main circuit is IC 7317 (Fig. 3). (Details of IC 7317 and IC 5369 are shown in Fig. 4.) IC 7317 is a clock IC with an extra calendar facility. The output of IC 7317 (IC1) from pins 1 to 22 is connected to the displays. Pin 35 of this IC is connected to IC 5369 (IC2) oscillator which gives 60 Hz to IC1. It consits of crystal, trimmer and other associated components which also stabilise its oscillation. The frequency of this oscillator can be adjusted by trimmer C4. The PCB and components layout for the main circuit are given in Figs 5 and 6 respectively.

To display time, seconds and calendar on different displays connected in parallel, IC1 is connected to a multiplexer comprising IC3 (4017) and its oscillator gates a and b of IC4. Its frequency can be adjusted with a 1-megohm preset (VR1).

If the HCH circuit is also connected to the same oscillator, the frequency can be adjusted according to the required pitch of sound. Otherwise it should be so high that the display does not flicker. This oscillator is connected to pin 14 of IC 4017 (IC4) through switch S5(c) and forces the decade counter IC 4017 to give high pulses number wise at pins 3, 2, 4, 7, 10 and 1, respectively.

When pin 3 is high, transistor T1 conducts, connecting the cathode of time display to earth to display the time. When pin 2 of IC3 is high, transistor T2 will conduct, connecting the cathode of seconds display to earth. As pin 2 of IC3 is also connected to input seconds (pin 32) of IC1, seconds will be displayed.

Similarly, when pin 4 of IC3 is high, it will connect the cathode of calendar display to earth and force IC1 to display the calendar signal. Again when pin 7 of IC3 is high, it will reset IC3 because pin 7 is connected to pin 15 (reset) through switch S5(d) (normal position). So the multiplexer will force IC1 to display time, seconds and calendar on different displays at high speed.

To adjust the clock, it is needed to change the position of switch S5 from normal to adjust. This will disconnect pin 14 of IC3 from oscillator (a, b) and connects it to mode switch. It will also connect pin 15 of IC3 to pin 1 as well as switches S2 and S3 (fast and slow set switches) to Vcc. By pressing mode switch momentarily again and again, IC3 will count from Q0 to Q4, because the reset pin is connected to Q5 (pin 1) instead of Q3 (pin 7) of IC3.

When pin 3 of IC3 is high, time display shows the time along with AM/PM display, so it can be adjusted by slow/fast switch. When pin 2 is high, it will force IC1 to display seconds which can be adjusted by switches S2 and S3. Similarly when pin 4 of IC3 is high, calendar can be adjusted.

As already described, pins 1 and 15 of IC3 are connected together, so that when pin 7 is high it will not reset IC3 but will force transistor T2 to conduct and IC1 to show sleep on seconds display. Pin 7 of IC3 is also connected to gates c and d of IC4 which provide indication of sleep on dp of seconds display. Otherwise, normally it will indicate "sec" on seconds display.

When pin 10 of IC3 is high, it forces T3 to conduct and IC1 to show alarm on calendar display because this pin has also been connected to input calendar/snooze (pin 31) of IC1. Pin 10 of IC3 is also connected to four gates of IC 4049 (IC5), which will indicate alarm on calendar display. Otherwise it will indicate only calendar.

All mode indicator (display) indicates mode only when that display is on. Pressing of mode switch again will reset IC3 because pin 15 is now connected to pin 1 and clock can be adjusted once again. When switch S5 is in normal position, it connects the mode switch to HCH circuit. So the same switch will set the HCH. If switch S5 is replaced with a 6-pole, 2-

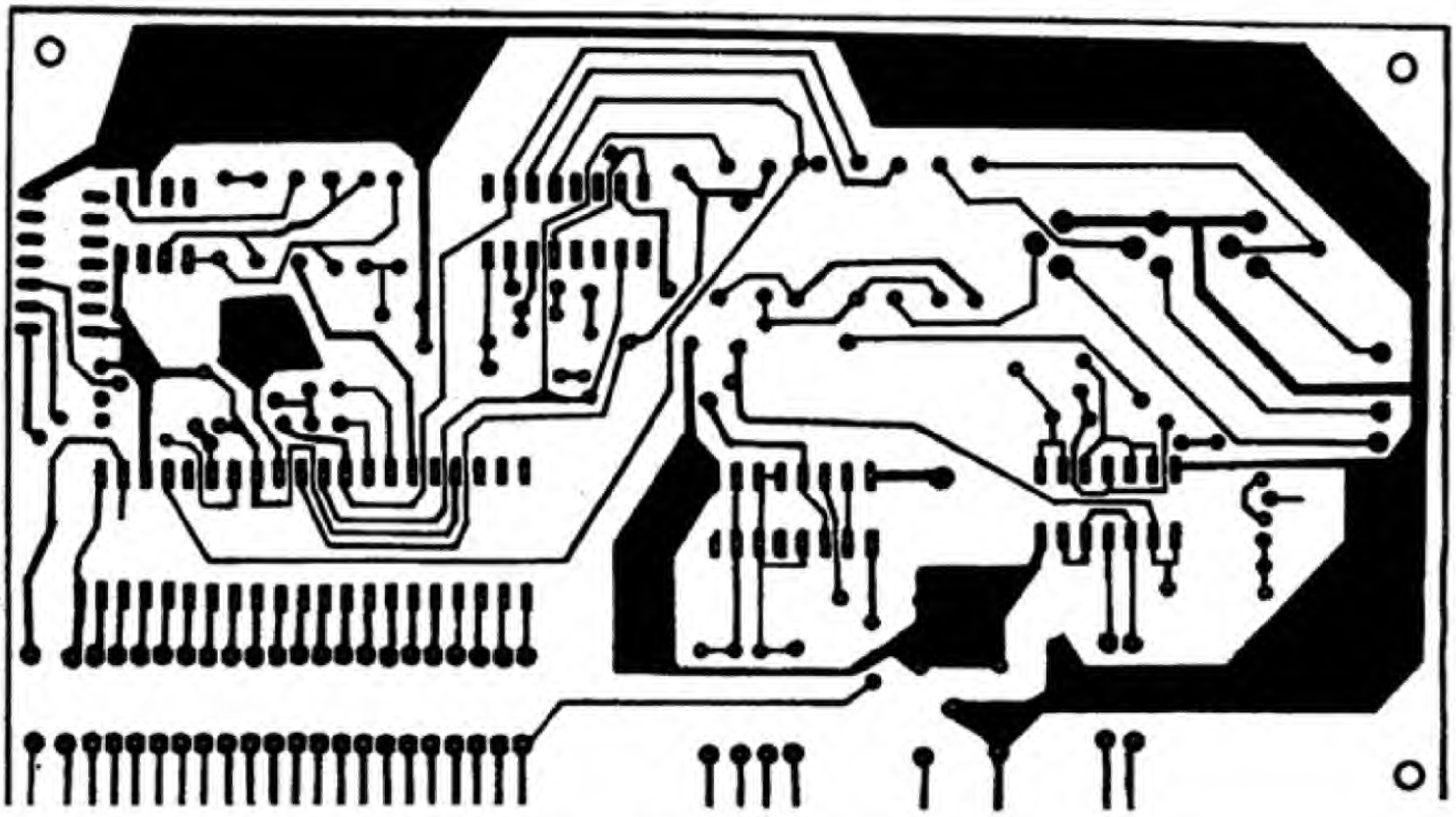


Fig. 5: Actual-size PCB layout for main circuit of neo digital clock.

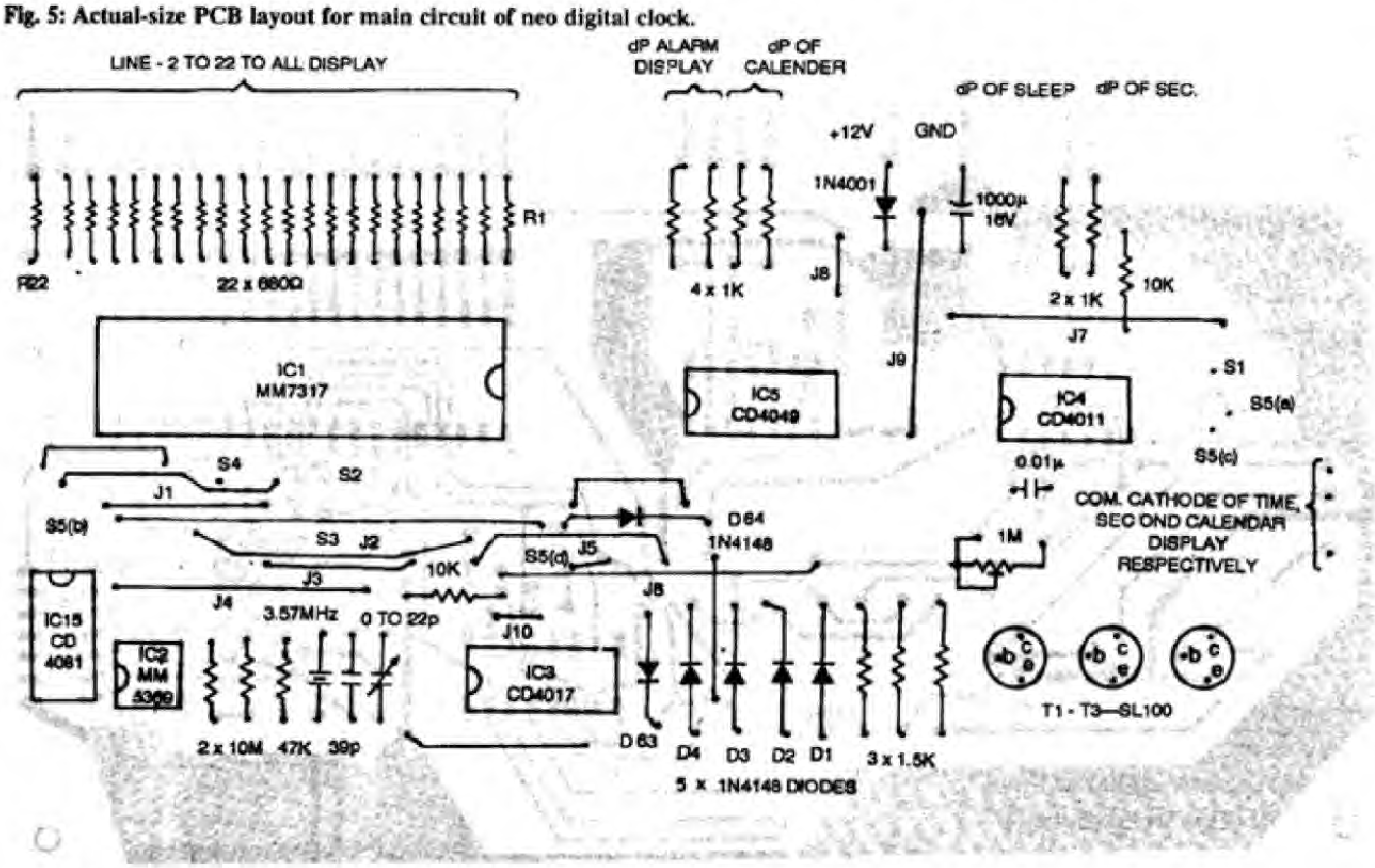


Fig. 6: Components layout for the PCB shwon in Fig. 5.

way switch, another set switch can be eliminated, e.g. fast/slow set switch can be used as alarm off and day set switch. (The 6-pole, 2-way switch is much longer than a 4-pole, 2-way type so it has not been used.)

Fast and slow set switch will be active only when switch S5 is in adjust position. So an unauthorised person cannot adjust the clock. Pin 14 of IC3 is connected to earth through 10k resistor so that when mode switch is off during adjust position, it would remain at low position.

Sleep Display

In this circuit (Fig. 3) one AND gate of IC15 is used. Its one input is connected to pin 27 of IC1. When sleep output is high and pin 2 of IC3 is also high, high pulse will go to pin 30 and 32 of IC1. Since sleep has higher priority, seconds display will show sleep only. D63 and D64 diodes are connected to prevent reverse current and R110 is to stop false signals.

Part II

The hourly chime (HCH) circuit can be divided into two parts: one is the detector and timer circuit, while other is the sound producing circuit.

HCH detector and timer circuit consists of five gates of two ICs (IC 4001 and IC 4049). Gate a of IC6 (4001) receives the signal from two sides: from 'g' segment of minutes (pin 11 of IC1) and from pin 3 of IC3 (multiplexer) through inverter gate a of IC8 (4049).

nected to input c of IC6, which gives a high pulse because capacitor C6 takes some time to charge. So gate d of IC6 will receive low signal from both its inputs. It will give high signal for some time (according to the value of 1-megohm preset VR2) at its output pin 11 of IC6.

Now when segment "g" of minutes is high gate a of IC6 will give low output which will discharge capacitor C5 through a 22k resistor R64. Similarly C6 will also discharge through preset VR2. So the circuit will be ready for next hourly chime. Input pin 1 of IC6 is also connected to earth through a 10k resistor to stop false signal of HCH.

Sound producing circuits are also of two types. Two gates of IC4081 are used in circuit 1 (Fig. 7). Input 1 of gate a of IC7 is connected to output of gate d (IC6), while the other input is connected to pin 39 of IC1 (1Hz fre-

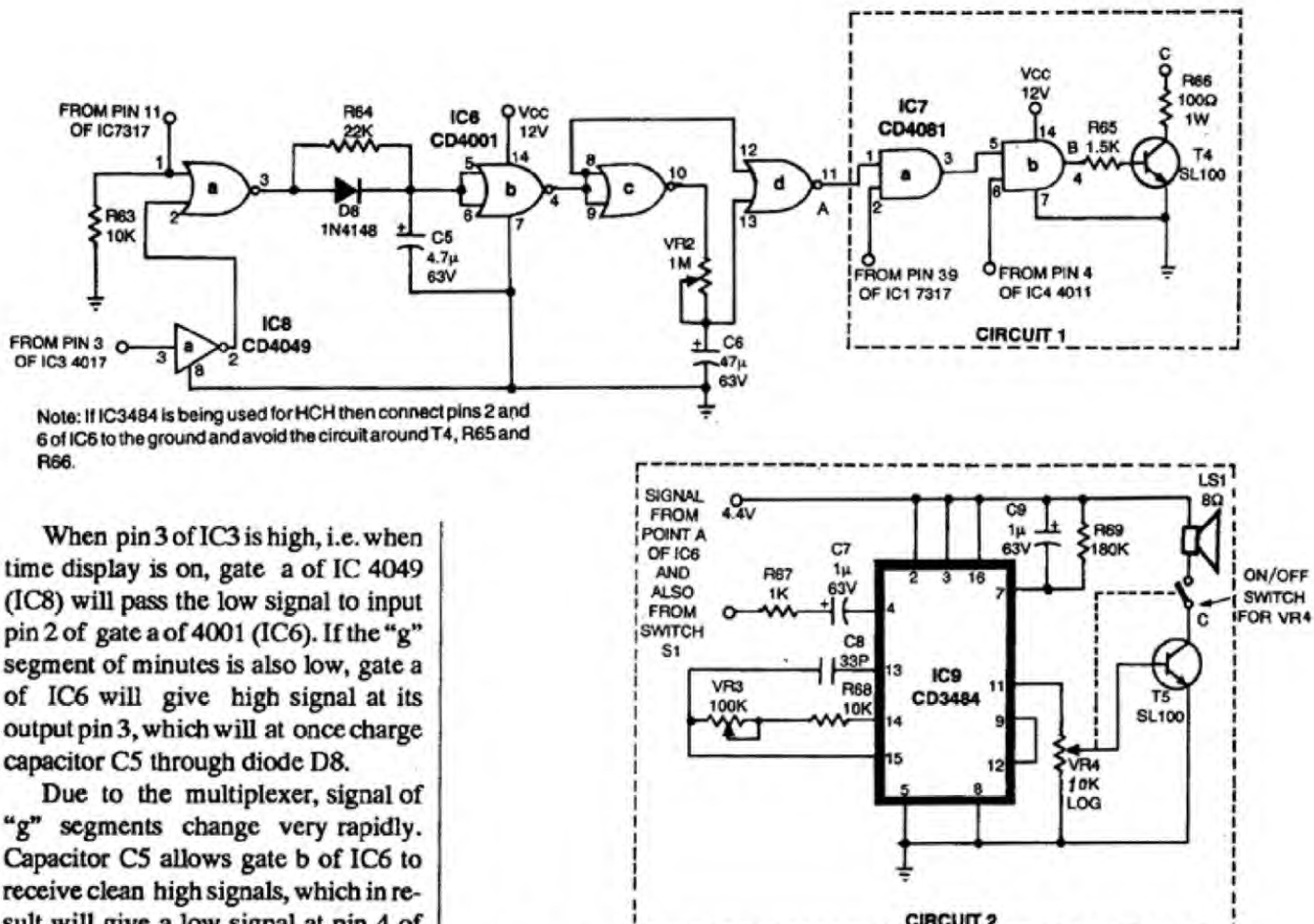


Fig. 7: The hourly chime circuit.

When pin 3 of IC3 is high, i.e. when time display is on, gate a of IC 4049 (IC8) will pass the low signal to input pin 2 of gate a of 4001 (IC6). If the "g" segment of minutes is also low, gate a of IC6 will give high signal at its output pin 3, which will at once charge capacitor C5 through diode D8.

Due to the multiplexer, signal of "g" segments change very rapidly. Capacitor C5 allows gate b of IC6 to receive clean high signals, which in result will give a low signal at pin 4 of IC6. Output of gate b of IC6 is con-

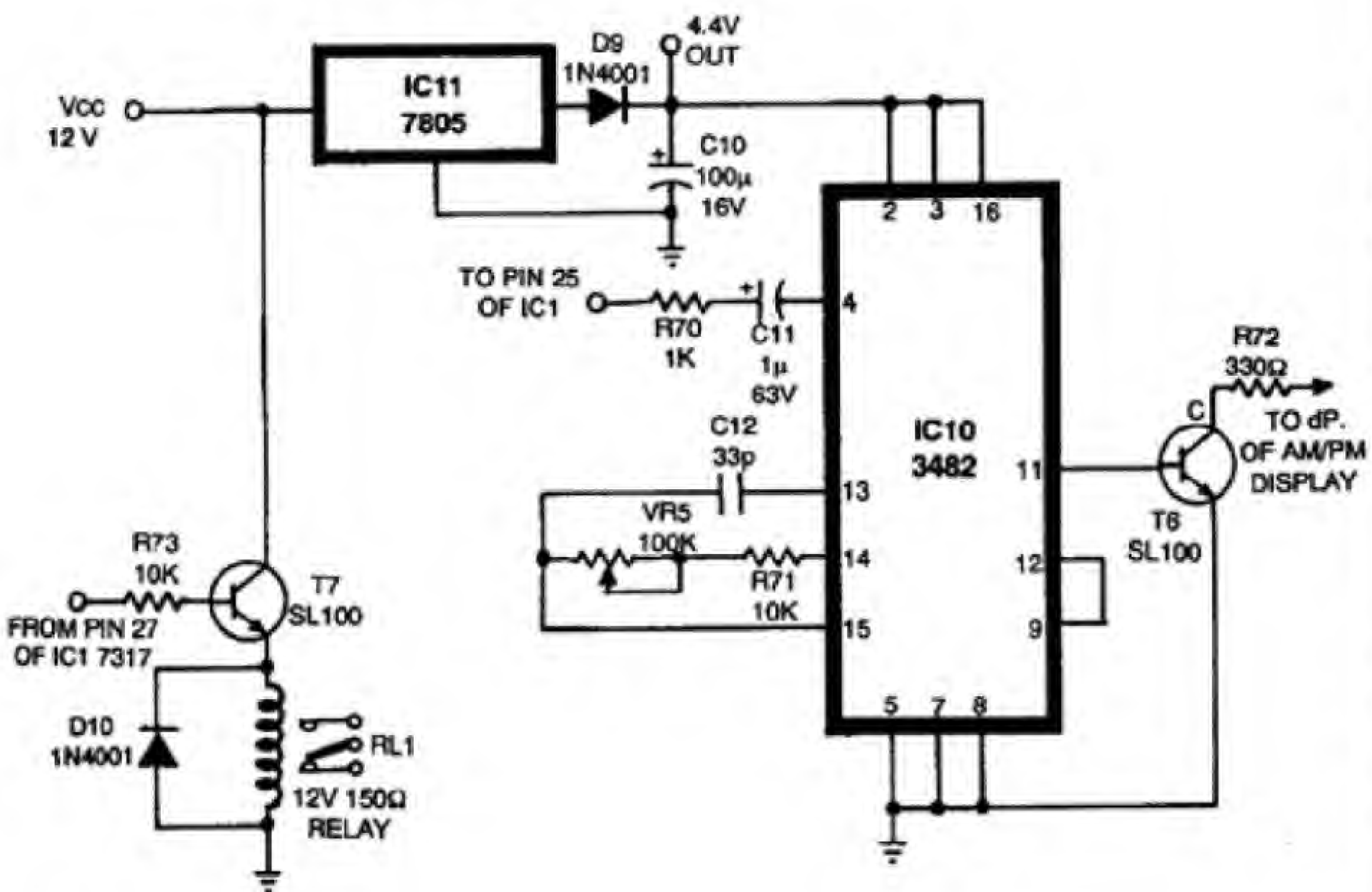


Fig. 8: Alarm and sleep circuit.

quency). So when d (IC6) is high, a (IC7) will give 1Hz oscillation at its output which is connected to gate b (IC7) input pin 5, while pin 6 is connected to oscillator of multiplexer. As a result, gate b (IC7) will give oscillator frequency at its output with 0.5-sec intervals.

The output of gate b (IC7) is connected to a SL100 transistor (T4) through limiting resistor R65. This transistor drives the speaker through resistor R66.

Circuit 1 emits beeps of 0.5-sec intervals, while circuit 2 is an hour counter type. IC 3484 has been used in this circuit. Capacitor C9 and resistor R69 are important for its internal circuit. The speed and pitch of tunes can be changed by preset VR3. Pin 11 of this IC is connected to volume control switch so that the volume of HCH can be adjusted as required. C7 will resist DC current (12V) to pass through IC 3484.

Alarm and sleep circuit

Musical IC 3482 has been used in this circuit (Fig. 8) so that its tunes are different from the HCH circuit. Both HCH and alarm circuits will receive 4.4V power supply from IC 7805 (IC11). The duration of tunes and pitch can be adjusted by preset VR5.

Volume switch also incorporates an on/off switch, which disconnects the speaker from both HCH and alarm circuits. The collector of SL100 transistor T6 is also connected to AM/PM display which indicates whether the HCH and alarm are on or off.

Since the multiplexer output has also been connected to snooze input of IC1, the alarm output would be high only for a millisecond. This is why the alarm will sound with auto snooze, such that only six of the 12 tunes of IC 3482 will be played with each snooze.

The alarm may be stopped with the alarm-off switch S4, but it will not stop the alarm permanently. So to

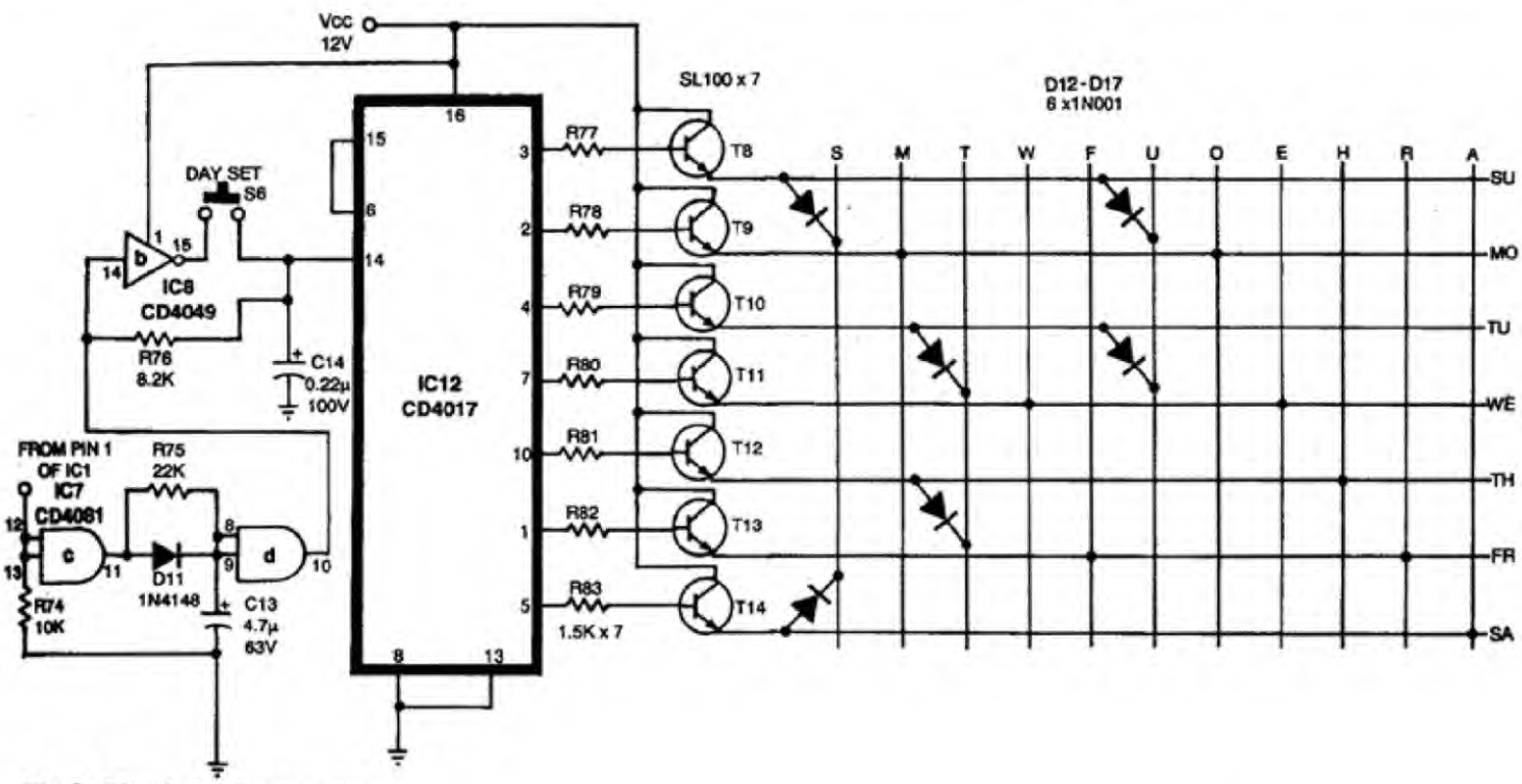


Fig. 9: Circuit for day counter.

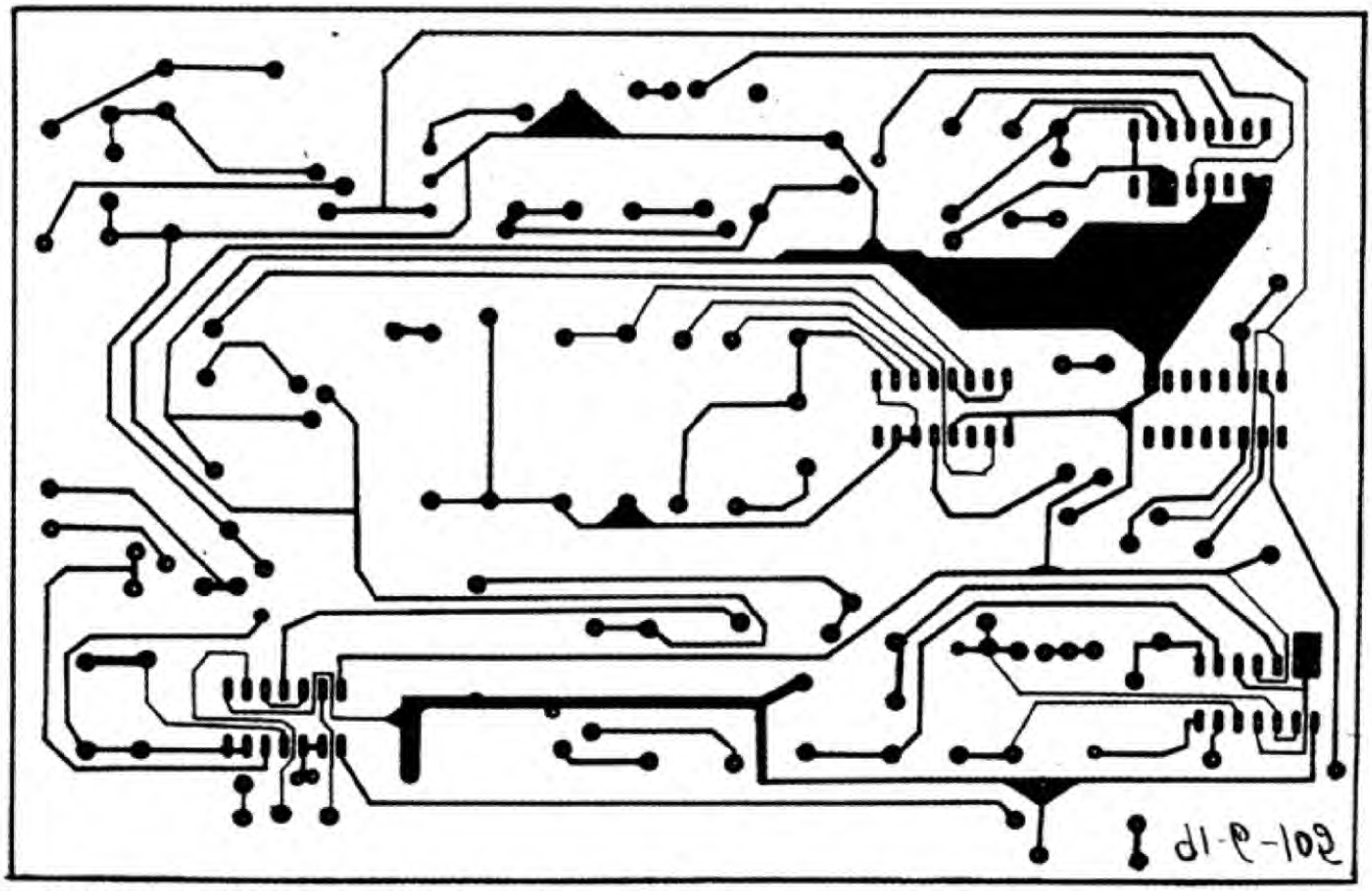


Fig. 10: Actual size PCB layout for HCH, alarm and sleep circuit and part of day counter circuit.

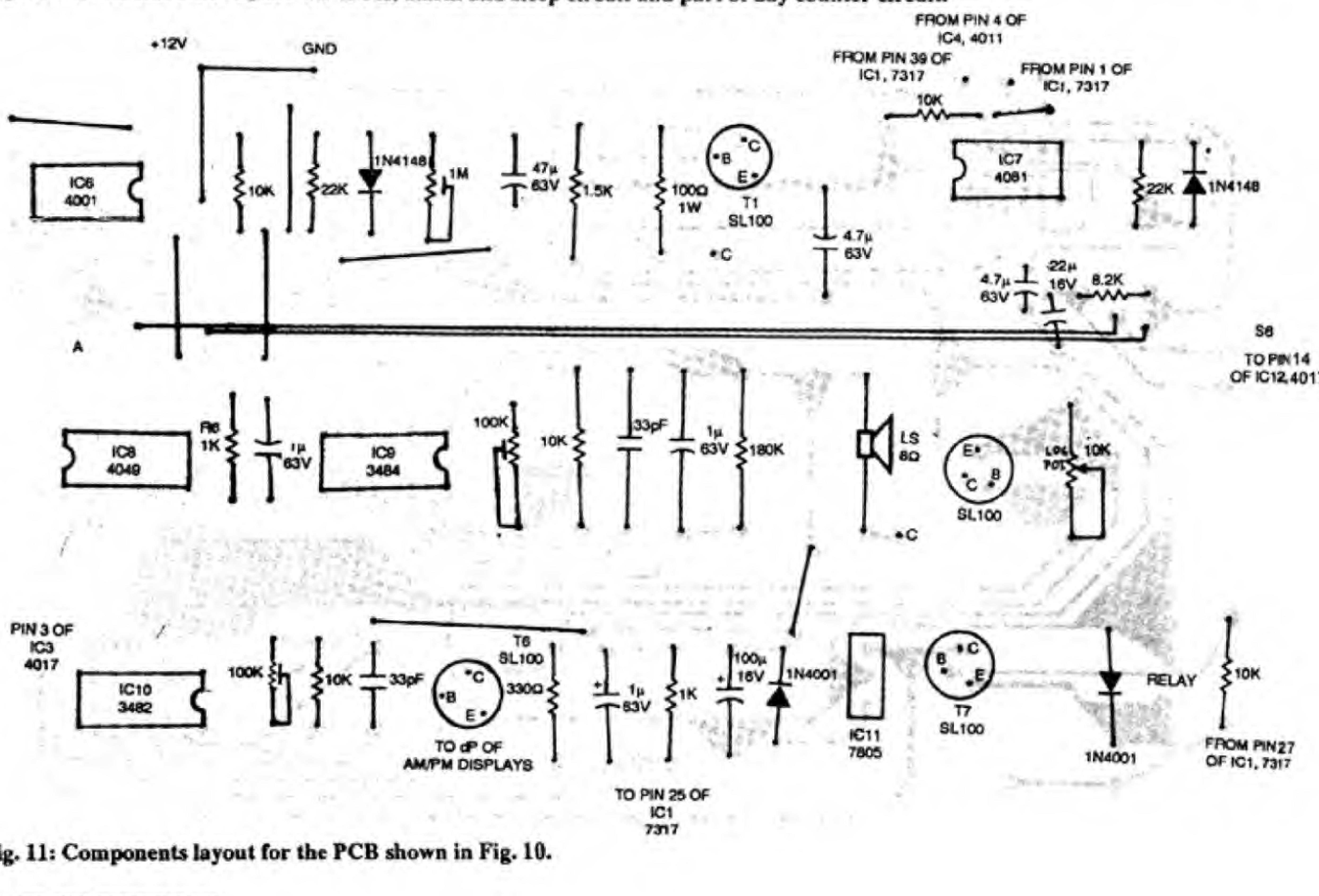


Fig. 11: Components layout for the PCB shown in Fig. 10.

TABLE I
Setting the Neo Digital Clock

Adjustment of	Position of set switch (S5) (normal/adjust)	Press mode switch (S1) repeatedly so that	Display of mode as indicated on dp's of displays	Press fast (S3), slow (S1) or both switches	Reaction at display	Remarks
Time	Adjust	Time displays with AM/PM	NA discrete LED	Fast or both Slow	Hours advance at 1Hz rate Minutes advance at 2Hz rate	Use this switch for setting only hours, also see AM/PM Use this switch for minutes only [do not bother about HCH or alarm]
Calendar	Adjust	Calendar display shows month and date	Calendar	Fast or both Slow	Day advances at 60Hz and month according to days in the month Day advances at 2Hz rate	Use this switch for setting month only [do not bother about AM/PM] Use this switch for setting day and month [do not bother about AM/PM]
Alarm	Adjust	Calendar display shows alarm	Alarm	Fast Slow Both	Hours advance at 1Hz rate Alarm minutes advance at 2Hz rate Alarm reset to 12.00 AM	Alarm hours can be adjusted this way (also see AM/PM) Alarm minutes can be adjusted this way
Seconds	Adjust	Seconds display shows seconds	Seconds	Slow Fast Both	Hold on the seconds and time Reset the second to 00 Time reset to 12.00 AM	
Sleep	Adjust	Seconds display shows sleep time	Sleep	Fast or both Slow	Subtract sleep min. at 60Hz rate Subtract sleep min. at 2Hz rate	
Day set	Normal	Day display shows day name —any from days of week	NA	Press day set (S6) momentarily	Day advances according to number of presses of day set switch (S6)	Set days only when time, seconds, calendar etc have been adjusted
HCH set	Normal	—	See which AM/PM display is on/off. Keep it on.	Press mode switch (S1)	By pressing mode switch (S1) again and again HCH (hour counter type) can be adjusted according to time	
Alarm off and HCH off	Normal	—	—	Press alarm off, turn off volume switch (S4) of alarm	By pressing alarm-off switch (S4) the alarm will be turned off but it will trigger next day again. So for permanent switching off of the alarm and HCH, use volume switch of alarm	

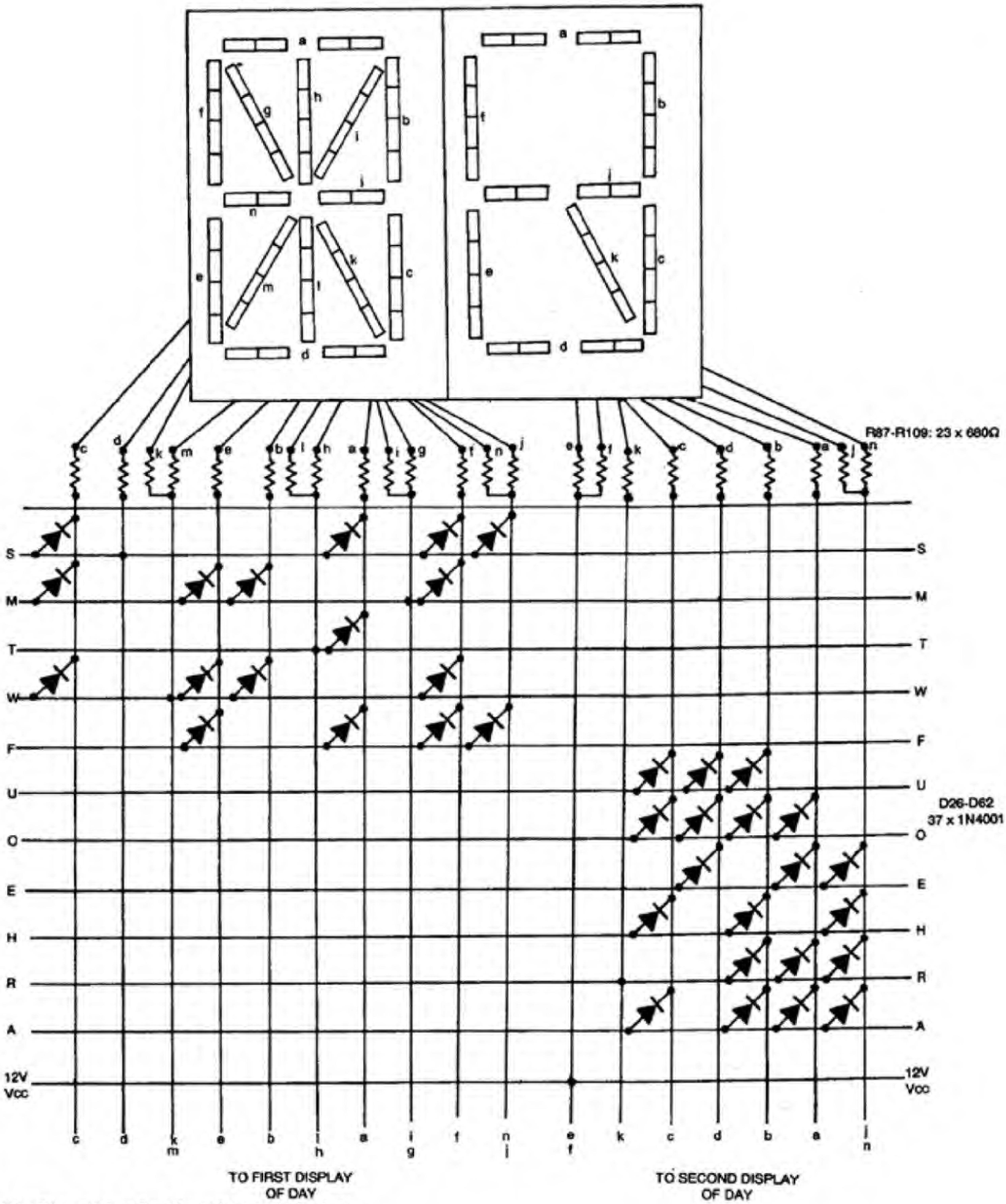


Fig. 12: Circuit for day decoder and display.

stop alarm and HCH permanently, volume switch of alarm can be used. Sleep output of IC1 is connected to relay through driver transistor SL100 (T7), which can be used as required like a switch. To set sleep, see Table I.

Day indicator circuit

This circuit has already been published in a previous project, "Alphanumeric Display" (EFY March '89). So no detailed description is required here. But its IC 4017 cannot receive signal directly from AM output of IC 7317.

Due to the multiplexer, AM output cannot give clean high, signal. In the circuit of Fig. 9, gate c of IC 4081 (IC7) is connected to AM output of IC1. Input of gate c (IC7) also earthed through a 10k resistor (R74) to restrict pulse

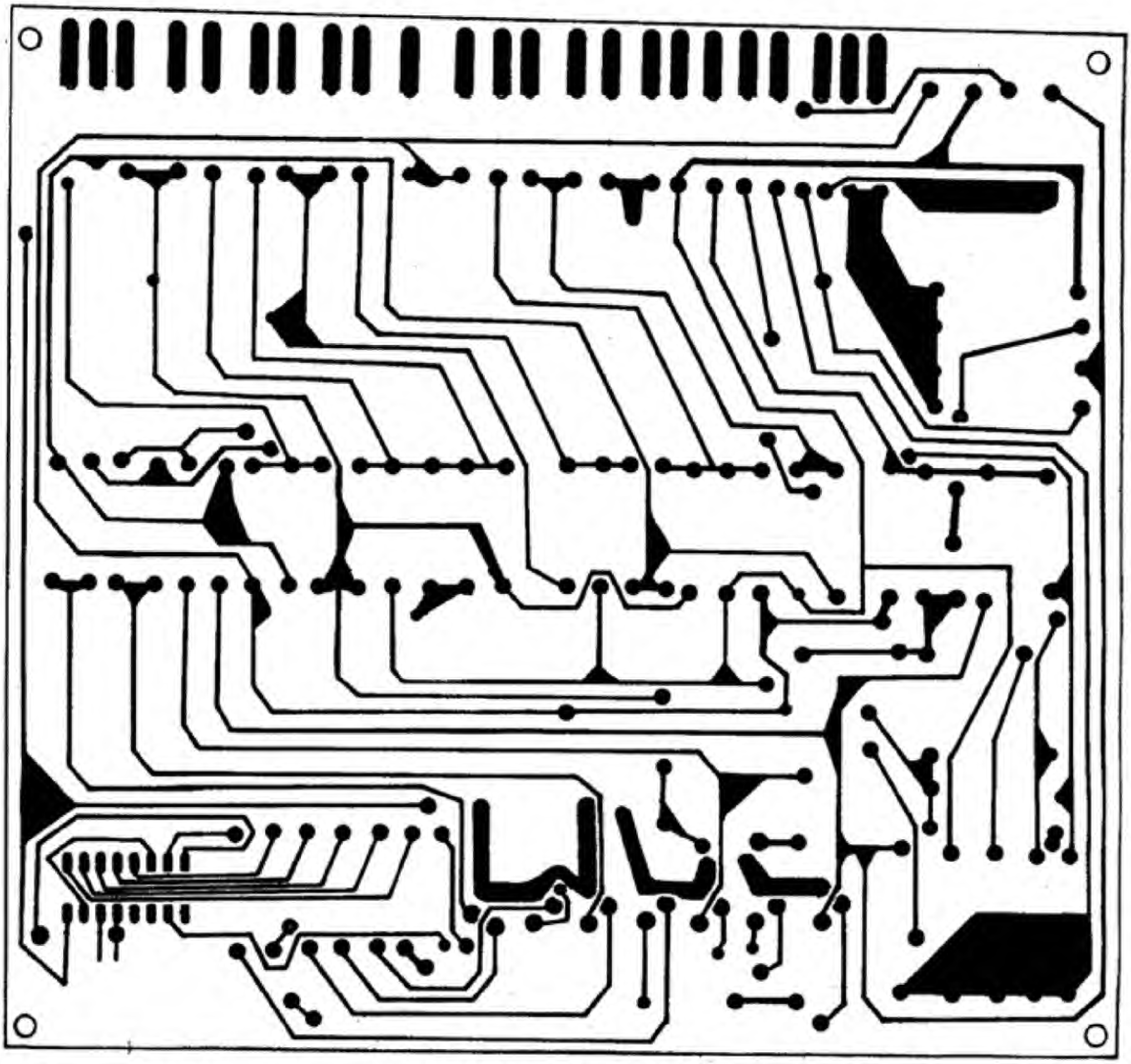


Fig. 13: Actual size PCB layout for day counter, day decoder and display circuit.

signals.

When the AM output of IC1 is high, the output of c (IC7) will also be high, charging capacitor C13 immediately. Input of gate d (IC7) will receive clean, high signal, also giving a high signal to pin 14 of IC12 through a 8.2k resistor R76. The output of gate d (IC7) is also connected to inverter gate b (IC8).

So day can be adjusted with the help of day set switch (S7) since the output of gate b (IC8) will always be inverted. C14 is used here to smoothen the effect of day set switch S7 so that at a time only one day advances.

The PCB layout for the HCH circuit, alarm and sleep circuit as well as part of the day indicator circuit is given in Fig. 10. Its corresponding components layout is shown in Fig. 11. The day decoder and display circuit is given in Fig. 12. The PCB and components layout for day counter, day decoder and display circuit is shown in Figs 13 and 14 respectively.

Power supply

The power supply of this circuit (Fig. 15) is somewhat different from that of usual digital clocks. Multiplexing of display and varying of load results in varying of voltage. AC current from 1.5-amp, 18V transformer is rectified through bridge rectifier (D18-D21) which is then filtered by capacitor C15.

This DC filtered current is regulated by two 7815 regulator ICs because the peak current consumption of clock and battery is more than 1 amp. Regulated 15V power supply is further dropped to 13V by diodes D22, D23 and D24. This is then used to charge the lead-acid battery through current limiting resistor R85.

The clock receives power supply from two sides, one from output of D23 and other from the battery through diode D25 and fuse. Since during mains supply, output voltage at D23 will always be more than battery, the clock will

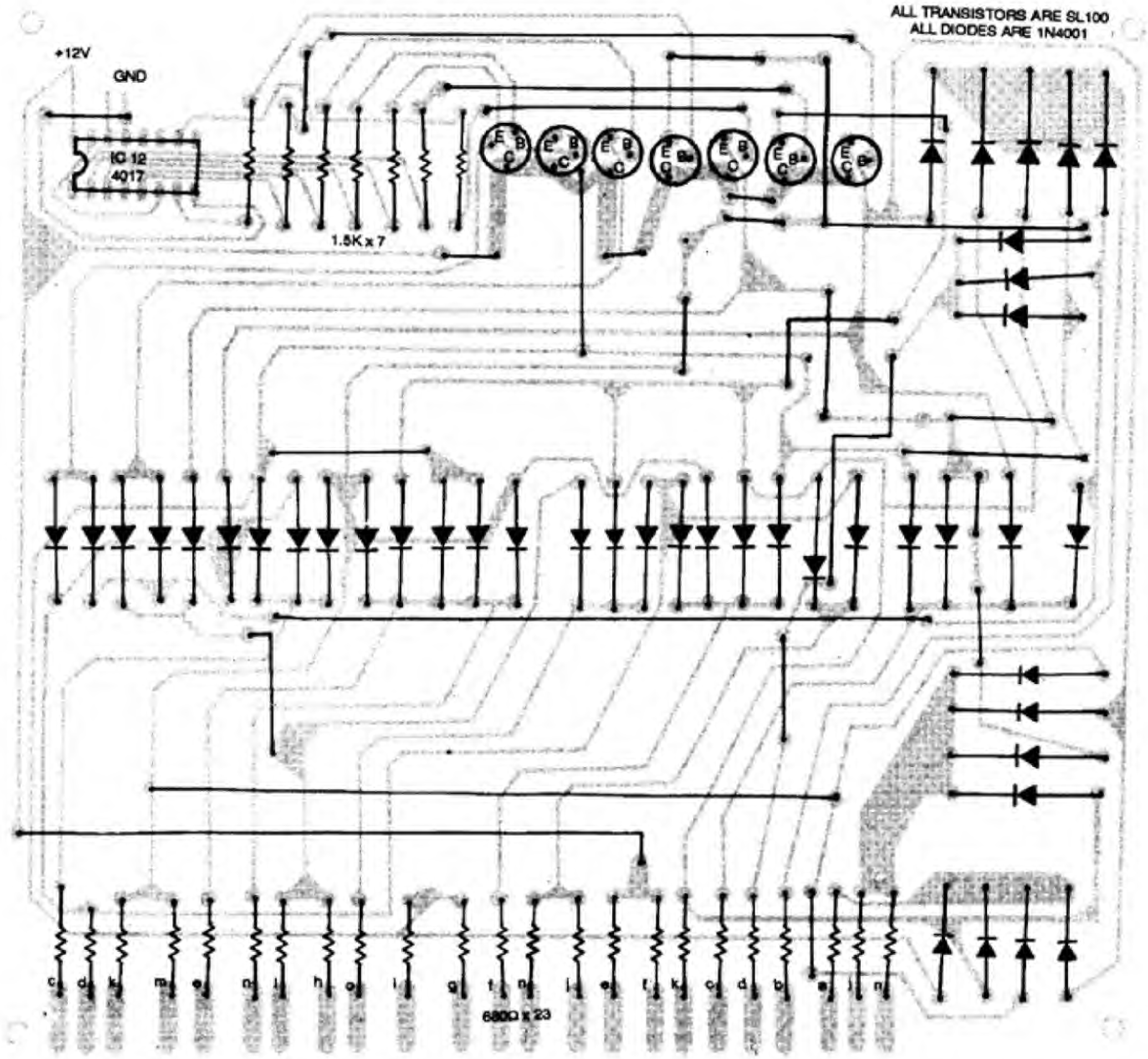


Fig. 14: Components layout for the PCB shown in Fig. 13.

receive power supply only from the mains. Otherwise (during main failure) supply will be from battery without any interruption. Dry battery is not used here as back up since current consumption of day indicator circuit is high.

All precaution and care should be taken for the long life of lead-acid

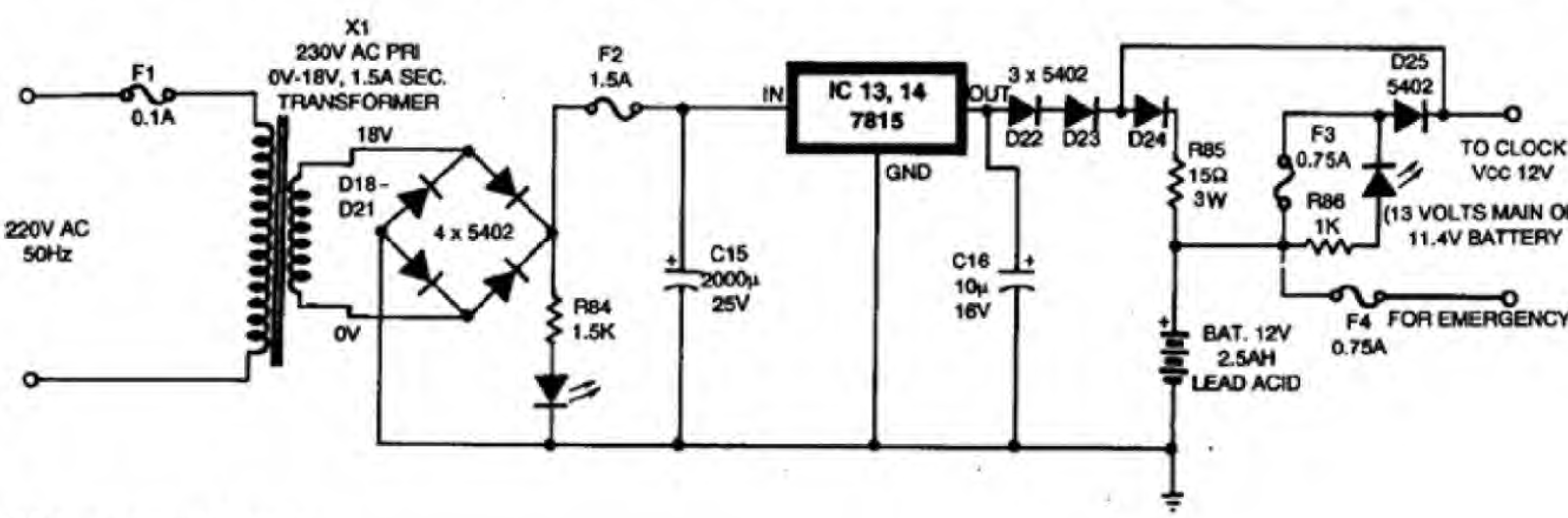


Fig. 15: Power supply circuit.

PARTS LIST

Semiconductors:

IC1 — 7317
IC2 — MM5369 ·
IC3, IC12 — CD4017, decade counter
IC4 — CD4011 quad 2-input NAND gate
IC6 — CD4011, quad 2-input NOR gate
IC7, IC15 — CD4081, quad 2-input AND gate
IC5, IC8 — CD4049, hex inverter
IC9 — 3484
IC10 — 3482
IC11 — 7805, +5V voltage regulator
IC13, IC14 — 7815, +15V voltage regulator
T1-T3, T4, T5, T6, T7-T14 — SL100 transistor
D1-D4, D8 — 1N4148 diode
D5, D9, D10, D11, D12-D17, D26-D62, D6, D7 — 1N4001, diode
D18-D25 — 5402, diode

Resistors: (all 1/4W, ±5% carbon, unless stated otherwise):

R87-R109, R1-R22 — 680-ohm
R67, R70, R86, R23-R28 — 1-kilohm
VR1, VR2 — 1-megohm
R29, R30 — 10-megohm
R31 — 47 kilohm
R65, R32-R34 — 1.5-kilohm
R74, R71, R68, R63, R35, R73 — 10-kilohm
R36-R56 — 220-ohm
R57 — 820-ohm
R77-R84, R58-R62 — 1.5-kilohm
R64 — 22-kilohm
R66 — 100-ohm, 1W
R69 — 180-kilohm
VR5, VR3 — 100-kilohm
VR4 — 10K log with on/off
R72 — 330-ohm
R75 — 22k
R76 — 8.2k
R85 — 15-ohm, 3W

Capacitors:

C1 — .01μF ceramic
C2 — 1000μ, 16V electrolytic
C3 — 39pF ceramic
C4 — 0-22pF
C13, C5 — 4.7μF, 63V electrolytic
C6 — 47μF, 63V electrolytic
C11, C7, C9 — 1μF, 63V electrolytic
C12, C8 — 33pF electrolytic
C10 — 100μF, 16V electrolytic
C14 — 0.22μF, 100V electrolytic
C15 — 2000μF, 25V electrolytic
C16 — 10μF, 16V electrolytic

Miscellaneous:

XTL — 3.57MHz
S7, S1-S7 — Push-to-on switch
S5 — 4-pole, 2-way switch
D15, 1, 3, 4 — 7xLTS543/FND500 common cathode type
DIS. 2 — 94 LEDs
LS1 — 8-ohm loudspeaker
RL1 — 12V, 150-ohm relay
F1 — 0.1-amp fuse
F2 — 1.5-amp fuse
F3, F4 — 0.75-amp fuse
X1 — 230V AC PRI. 18-0-18V, 1.5A, sec. transformer
— 12V battery
— LEDs

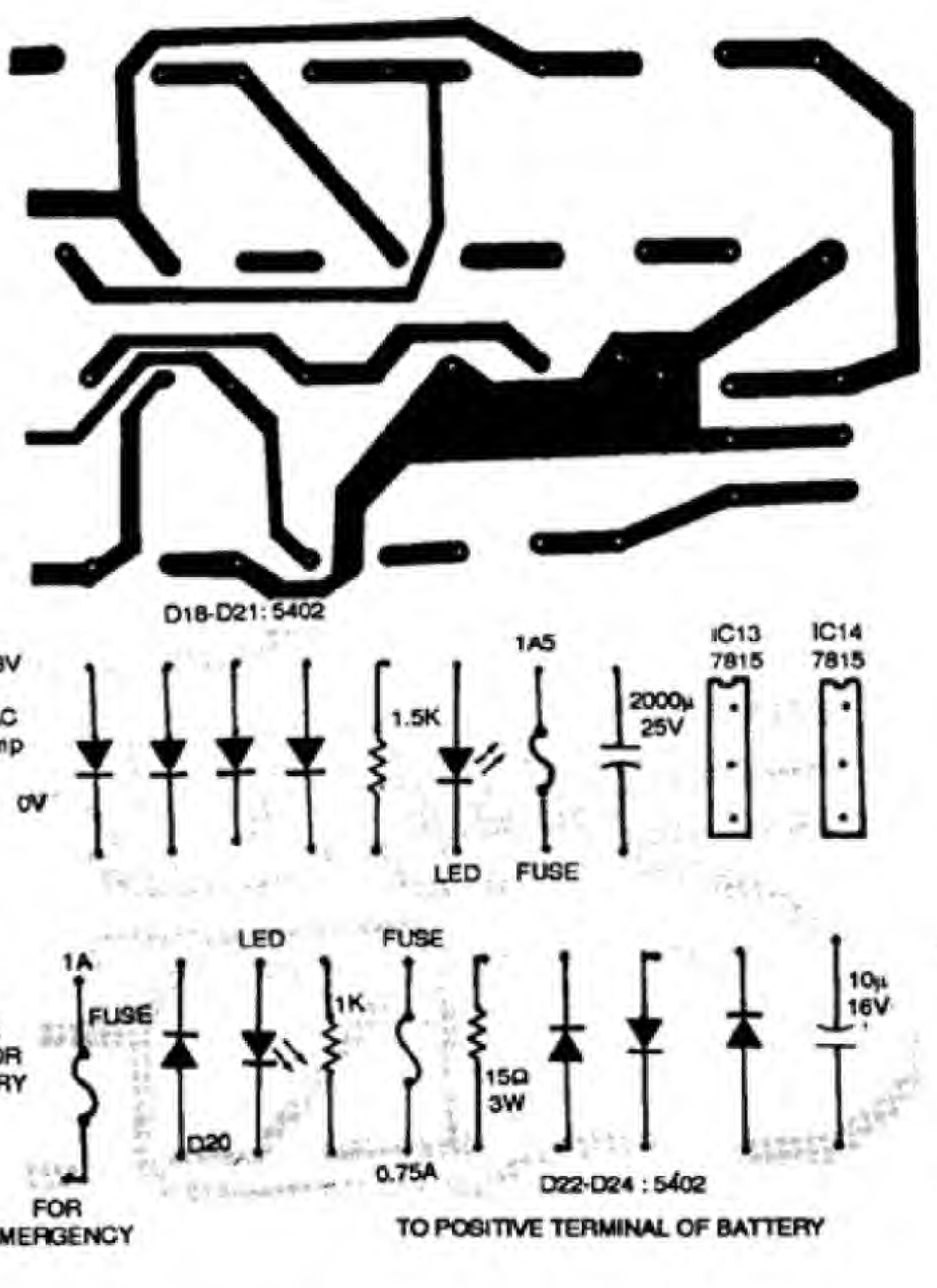


Fig. 17: Components layout for the PCB shown in Fig. 16.

battery. This battery may also be used as emergency, but such that it does not disturb the clock supply. Indicator and fuse are also used for the proper functioning of the circuit. Battery state indicator can also be used here.

The PCB and components layout for the power supply circuit are given in Figs 16 and 17 respectively.

Assembly

For the day display, all LEDs may joined together according to segments first before glueing it to the front panel. After glueing all displays, all LEDs should be joined in series with tinned copper wire according to circuit.

The advantage of this front panel is that only the front portion of LEDs can be viewed, besides minimising the scattering of light. Fabrication of front panel is somewhat difficult but die fitter may easily do this job. Ribbon wire should be used for connection of main PCB to front panel. If the front panel is earthed, multiplexer noise can be minimised.

Boolean Function Emulator

A. Jeyabal

An article of the same name which appeared in EFY August '89 gave the circuit and construction details along with wiring methods for Boolean operations, Boolean functions and utility circuit.

The present article deals with the full functional capabilities of the circuit. The power supply pins 12 and 24 of IC 74154 are connected to earth and positive 5V rail, respectively. (For easy understanding it is not shown in the illustrations.)

Reduced Boolean equation

To get the circuit for Boolean equation in the reduced form, the following method must be adopted:

$ABCD + A\bar{C} + AB\bar{D} + \bar{B}\bar{C}D = 0$ (arbitrarily taken)

In the above equation, two variables B and D in the second term and one variable each in the third and fourth terms (C and A) respectively

TABLE I

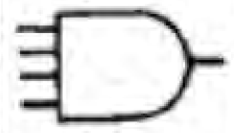
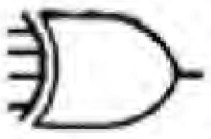
Decimal Equivalent	Inputs (Pin Nos 20, 21, 22 and 23) of IC1				AND Outputs No. of inputs			OR Outputs No. of inputs			EX-OR Outputs No. of inputs			Truth Table of IC74154 (Pin Number)															
														1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17
	D	C	B	A	2	3	4	2	3	4	2	3	4	Q0	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	0	0	0	1	0	0	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
3	0	0	1	1	1	0	0	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
4	0	1	0	0		0	0		1	1		1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
5	0	1	0	1		0	0		1	1		0	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
6	0	1	1	0		0	0		1	1		0	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
7	0	1	1	1		1	0		1	1		1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
8	1	0	0	0			0			1			1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
9	1	0	0	1			0			1			0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
10	1	0	1	0			0			1			0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
11	1	0	1	1			0			1			1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1
12	1	1	0	0			0			1			0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
13	1	1	0	1			0			1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
14	1	1	1	0			0			1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
15	1	1	1	1			1			1			0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Symbols					 (4-input)			 (4-input)			 (4-input)			Note: Both gates G1 and G2 (Pins 18 and 19) must be held low (ground). The IC is disabled when any one of the gates is high.															

TABLE II

Input D C B A	Required Output	Decimal Value of Input	'Q' Output of IC 74154	Pin No. of IC 74154
1 1 1 1	0	15	Q15	17
0 0 0 1	0	1	Q1	2
0 0 1 1	0	3	Q3	4
1 0 0 1	0	9	Q9	10
1 0 1 1	0	11	Q11	13
0 0 1 1	0	3	Q3	4
0 1 1 1	0	7	Q7	8
1 0 0 0	0	8	Q8	9
1 0 0 1	0	9	Q9	10

PARTS LIST

Semiconductors:

IC1	– 74LS154, 1-of-16 decoder/demultiplexer
D1-D70	– IN4148, diode
D71-D80	– Germanium diode

Resistors (All 1/4-watt, + 5% carbon, unless stated otherwise):

R1-R5	– 270-ohm
R6	– 300-ohm
R7	– 220-ohm

Miscellaneous:

S1-S2	– Single pole 3-way switch
S3-S6	– SPST switch
S7-S23, S25-S29	– Push-to-on switch.
24	Push-to-off switch

TABLE III

Input D* C B A	3-bit Full Adder Outputs: Carry	Sum	For LED Indication 'Q' Output of IC 74154: Carry	Sum	For LED Indication Pin Nos of IC 74154: Carry	Sum	For Positive Logic Output Pin Nos. of IC 74154: Carry	Sum
0 0 0	0	0					1	1
0 0 1	0	1		Q1		2	2	
0 1 0	0	1		Q2		3	3	
0 1 1	1	0	Q3		4			4
1 0 0	0	1		Q4		5	5	
1 0 1	1	0	Q5		6			6
1 1 0	1	0	Q6		7			7
1 1 1	1	1	Q7	Q7	8	8		

* is low (earthed)

are low (i.e. $\bar{E}$ and $\bar{F}$), we can easily connect it to the circuit and perform Boolean operation of six variables. For an instant take the equation:

$$ABCD\bar{E}\bar{F} + A\bar{C}\bar{E}\bar{F} + AB\bar{D}\bar{E}\bar{F} + \bar{B}\bar{C}D\bar{E}\bar{F} = 0$$

Each term contains variables $\bar{E}$ and $\bar{F}$. Use pins 18 and 19 of IC 74154 as inputs E and F. Note that whenever these pins are used, jumpers J1 and J2 should be removed. As mentioned earlier, find the pins to be connected for the rest of the inputs A, B, C and D. These will be as shown in Table II. Fig. 1 shows the circuit for this equation. Both variables E and F must be

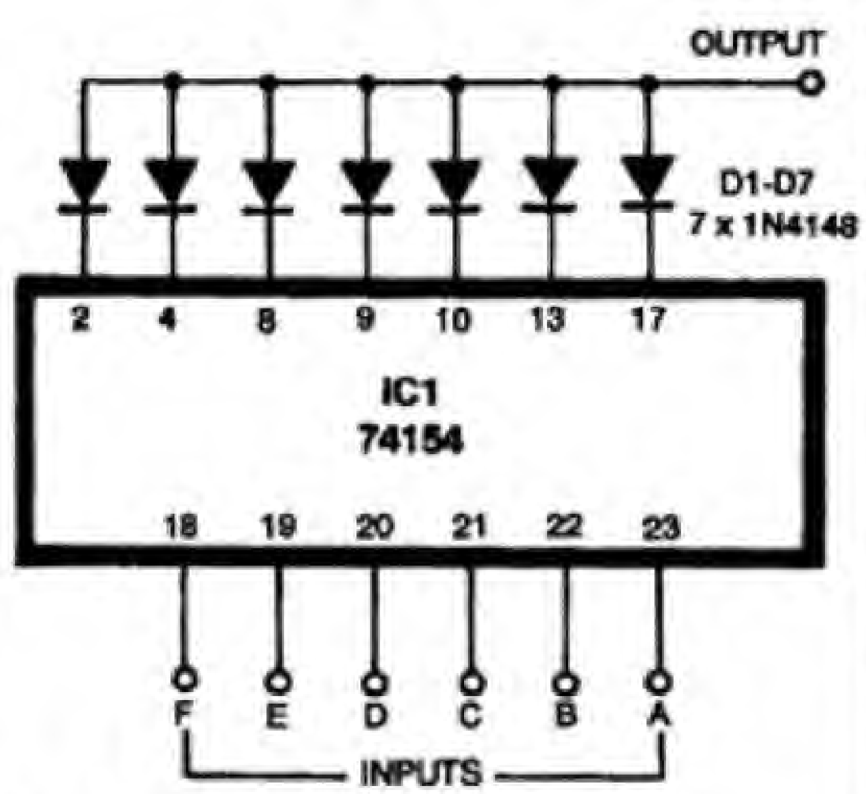


Fig. 1: Six-input circuit.

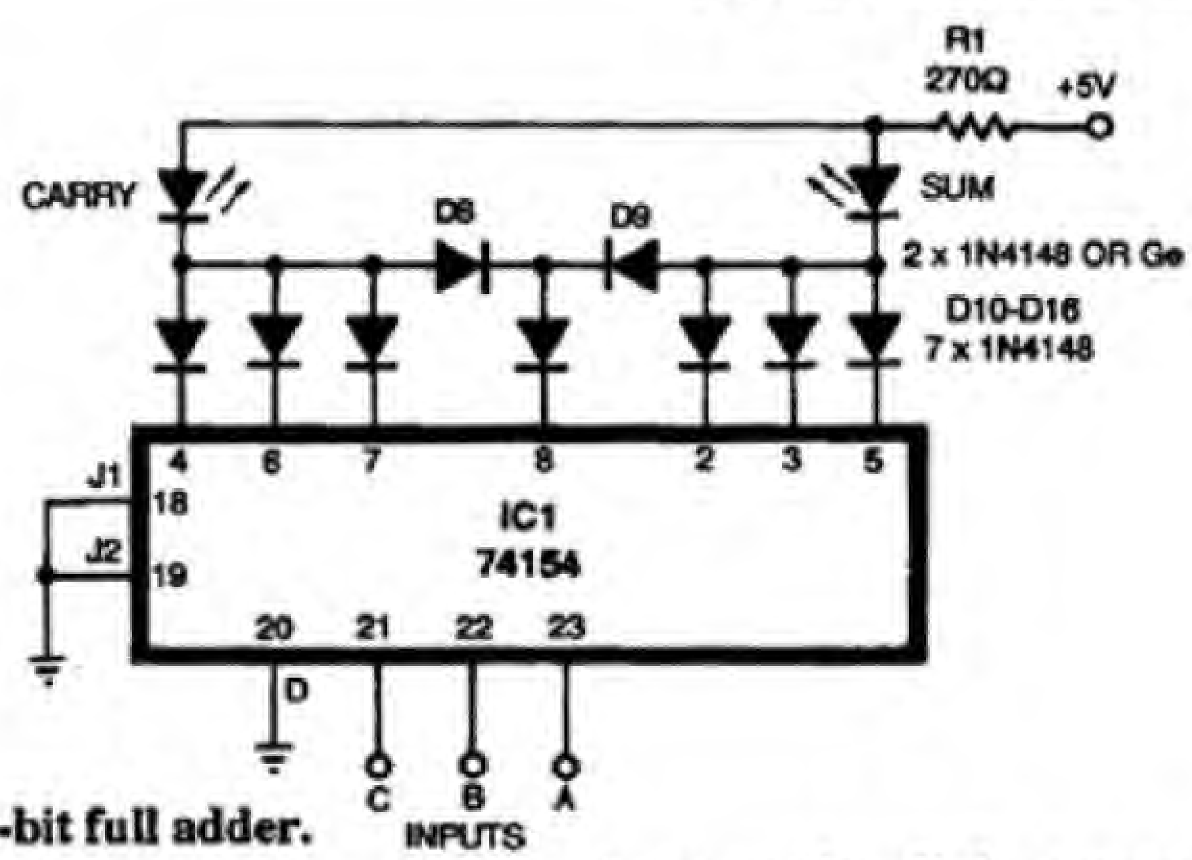


Fig. 2: Three-bit full adder.

are removed in the process of reduction. From Table I find which outputs of IC 74154 go low for the above inputs. (Assume the removed variables also present in the terms and take the values 0 and 1. For example, the fourth term will be $\bar{A}\bar{B}\bar{C}D$ and $A\bar{B}\bar{C}D$.)

Table II shows the pins to be connected together (anode side of diodes). The second term comes four times and the last two terms two times each in Table I.

Extending the number of inputs

The number of inputs can be extended (for two more variables) to six using pins 18 and 19 of IC 74154 with certain limitations. When any one of these pins is held high, the IC is disabled and all Q outputs go high. So in the equation if each term contains the extended variables (called E and F) and present in all the terms and both variables should be low.

$$A\bar{B}C\bar{D}E\bar{F} + \bar{B}C\bar{D}E + \bar{A}\bar{B}\bar{D}F + \bar{B}\bar{D}E\bar{F} = 0$$

In the above equation, variables E and F are not low in all terms and in the second and third term variables F and E are removed. Commutative law of Boolean algebra allows us to rearrange the variables in a term (i.e. $A\bar{B}C = C\bar{B}A = \bar{B}AC$ and so on). So find any two similar variables which are low in

TABLE IV

System Failed	Binary Value of Input D C B A	Output Pin Nos. of IC74154	Remarks	Colour of LED
Nil	0 0 0 0	1	System Alright	Green
A	0 0 0 1	2		
B	0 0 1 0	3	Warning	Yellow
C and D	1 1 0 0	14		
A and D	1 0 0 1	10		
C	0 1 0 0	5		
D	1 0 0 0	9		
A and B	0 0 1 1	4	Attention	Yellow
A and C	0 1 0 1	6		
A, B and C	0 1 1 1	8		
A, B and D	1 0 1 1	13	Immediate	Orange
B, C and D	1 1 1 0	16	Attention	
B and C	0 1 1 0	7		
B and D	1 0 1 0	11	Alarm	Red
A, C and D	1 1 0 1	15		
A, B, C and D	1 1 1 1	17	Total Destruction	Red

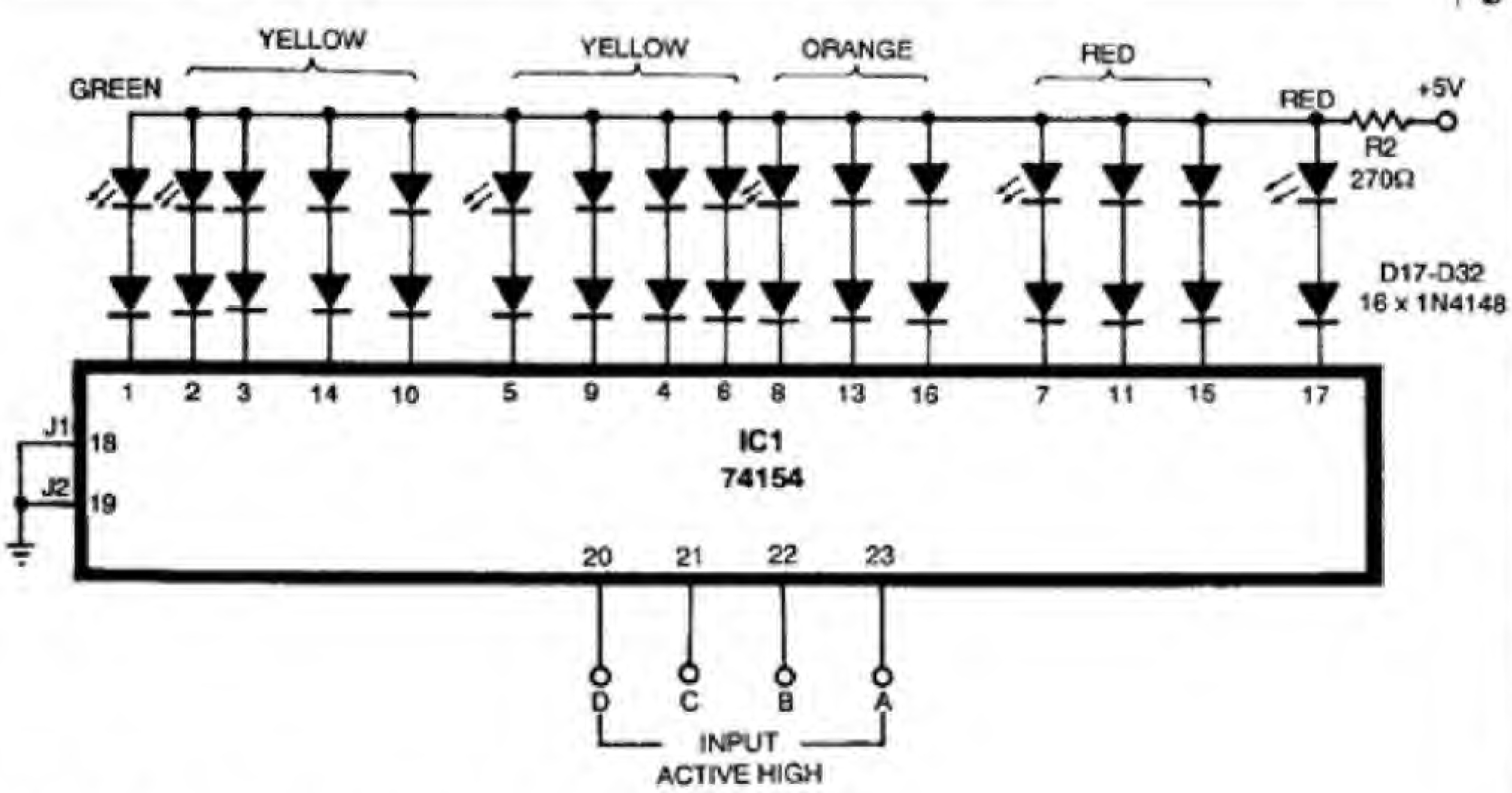


Fig. 3: System failure annunciator.

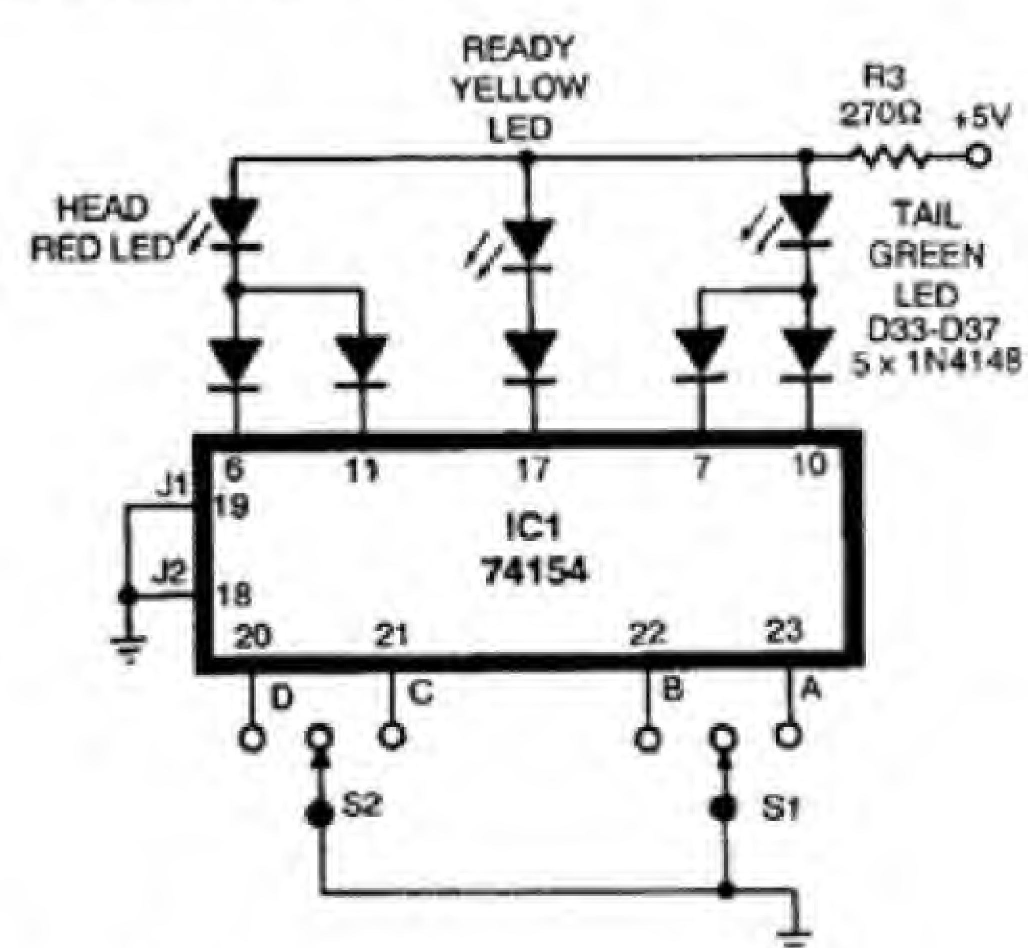


Fig. 4: Head or tail game circuit.

all the terms. Here B and D are low in all the terms. The above equation can thus be written as

$$AEC\bar{F}\bar{B}\bar{D} + EC\bar{B}\bar{D} + AF\bar{B}\bar{D} + E\bar{F}\bar{B}\bar{D} = 0$$

Connect variables B and D to inputs E and F (pins 18 and 19) and other variables A to A, C to C, E to B and F to D.

When consulting Table I, replace inputs B and D with variables E and F. Find output pin numbers to be connected as usual.

A word of caution: Once the circuit is wired, the inputs should not be interchanged. If the inputs are interchanged the truth table and pin connections should be modified accordingly.

So far we have assembled single output circuits. Now let us see how to wire multi-output circuits.

3-bit full adder, a 2-output circuit

A 3-bit full adder has two outputs, one for summed result and another for carry (Fig. 2). The required output levels and pin numbers are summarised in Table III. Positive logic indication is selected, i.e. for value '1' of sum or carry the LED should be lit. But IC 74154 cannot source that much current to drive the LED, although it can sink a maximum of 16mA current.

So the low Q output for the corresponding input is chosen, for which the sum or carry output is '1'.

If the output required is positive logic, the pins should be connected as shown in the last two columns.

System failure annunciator, a multi-output circuit

In any complex system or sophisticated machinery, there is a system failure annunciator to direct the authorities as to which part should be attended to when there is a failure or breakdown in that system.

Table IV shows pin numbers for getting one such a system failure annunciator. Four parts of a system can

TABLE V

Input D C B A	Required Output	'Q' Output of IC74154	Pin No. of IC74154	Colour of LED	Remarks
1 1 1 1	0	Q15	17	Yellow	Ready
1 0 1 0	0	Q10	11	Red	Head
0 1 0 1	0	Q5	6	Red	Head
0 1 1 0	0	Q6	7	Green	Tail
1 0 0 1	0	Q9	10	Green	Tail

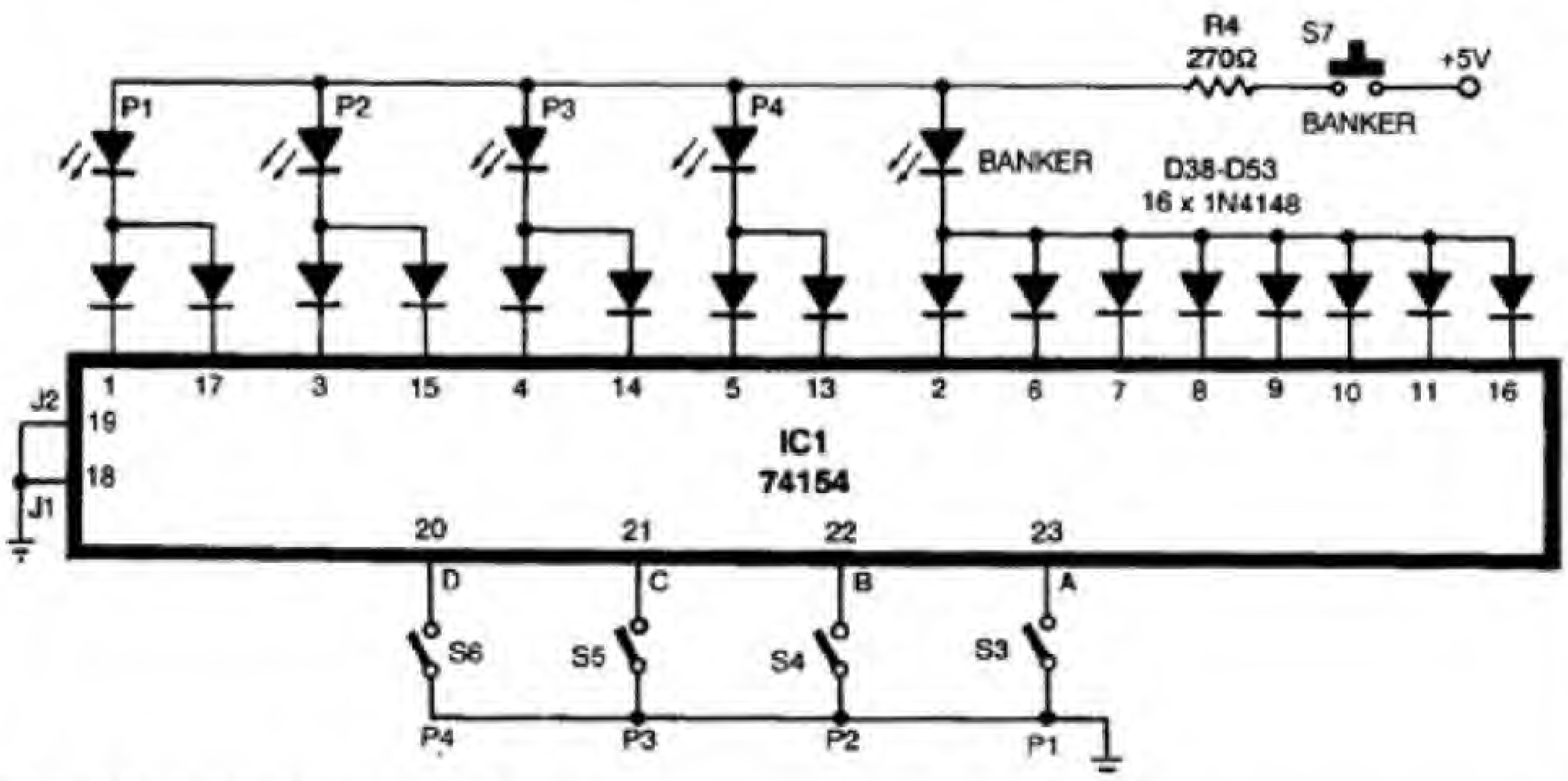


Fig. 5: Circuit for game of chance.

TABLE VI

Input D C B A	'Q' Output of IC 74154	Pin No. of IC 74154	Winner/Switch
0 0 0 0	Q0	1	P1 (S3)
1 1 1 1	Q15	17	
0 0 1 0	Q2	3	P2 (S4)
1 1 0 1	Q13	15	
0 0 1 1	Q3	4	P3 (S5)
1 1 0 0	Q12	14	
0 1 0 0	Q4	5	P4 (S6)
1 0 1 1	Q11	13	

All other pins viz. 2, 6, 7, 8, 9, 10, 11 and 16 are connected to the LED denoted banker.

TABLE VII

Order of Input held low	Input D C B A	Pin No. of IC74154	Colour of LED	Remarks
Stand by	1 1 1 1	17	Red	Pilot
First A	1 1 1 0	16	Orange	Optional
Second B (With A kept low)	1 1 0 0	14	Yellow	
Third C (With A, B kept low)	1 0 0 0	9	Yellow	
Fourth D (With A, B, C kept low)	0 0 0 0	1	Green	Win

All other 'Q' output pins 2, 3, 4, 5, 6, 7, 8, 10 11, 13 and 15 are connected to the buzzer or sound generator.

be monitored. Positive logic is used for inputs. In Fig. 3, TTL compatible outputs from the sensors monitoring the system are connected to the inputs.

It is a fool-proof method. If any input wire is broken, it responds as a system failure because floating inputs means logic '1' in TTL family ICs. In the annunciator, one of the LEDs must light in all cases. Otherwise a fault in the circuit is indicated.

GAME CIRCUITS

Head or tail/electronic toss

In every match, a coin is tossed to decide which team is to play first. Here an electronic coin tosser is described. Fig. 4 shows the circuit. Two switches S1 and S2 are in the mid position. The yellow LED lights up to imply that it is ready for tossing.

First, one player toggles or slides one switch, say S2, to one of the two positions. Then the second player slides switch S1. Now either head or tail LED lights according to the two switch positions.

Form a truth table as shown in Table V. The first column shows the possible input levels (according to the switch positions). The fourth column shows the pin numbers to be connected together. In the last two columns write for which input the LED should show head or tail (keeping in mind that both players should have equal chances and none of the switch positions should always show head or tail). Connect the LEDs to the respective pins as shown in Fig. 4.

A game of chance

Five persons can play this game. One should act as the banker so that four others can bet. The circuit is depicted in Fig. 5. A length of wire is connected to the four switches S3 to S6.

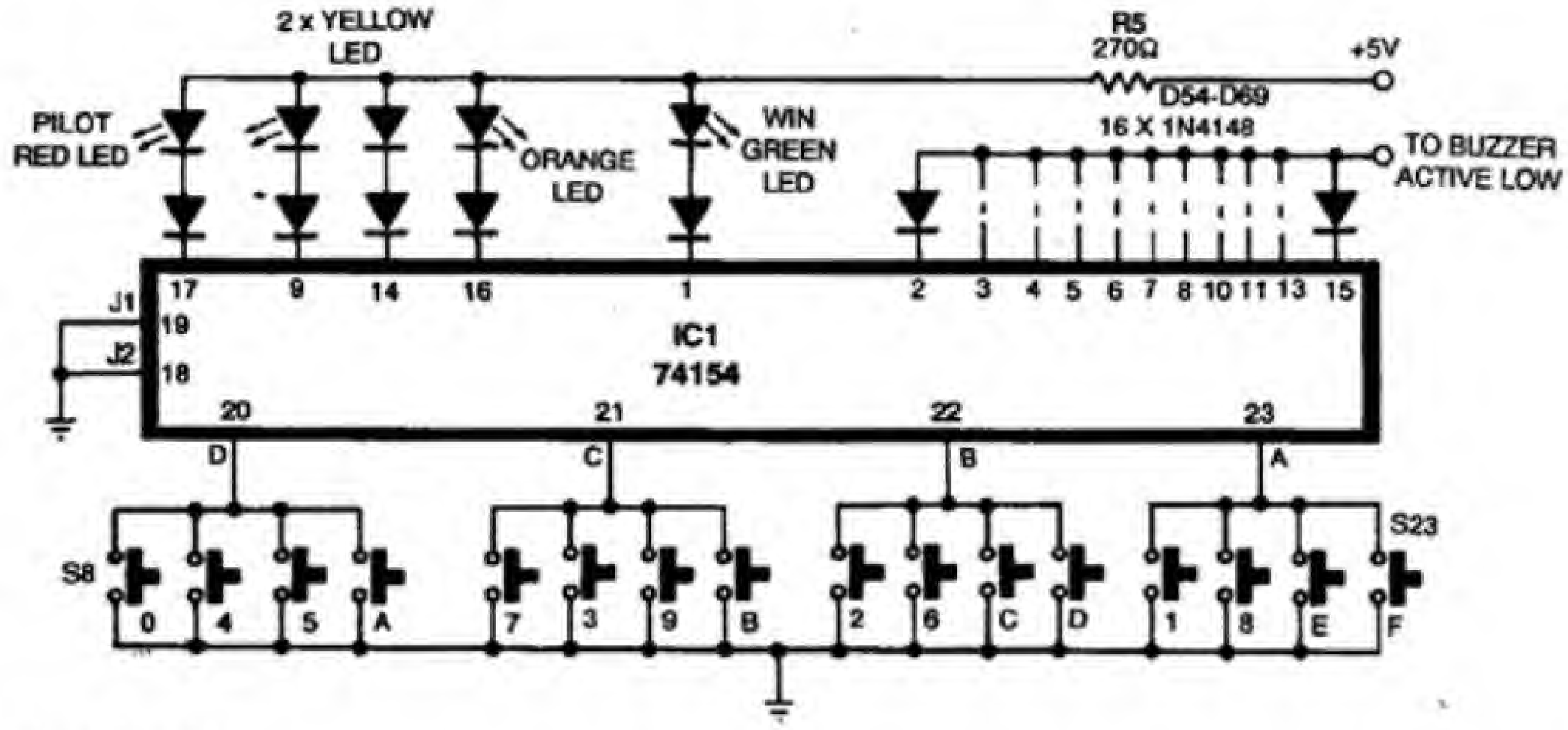


Fig. 6: Code breaking circuit.

TABLE VIII

No. of switches connected to inputs D C B A	Total No. of Codes
3 3 5 5	225
3 3 3 7	189
2 2 6 6	144
1 2 7 6	64
1 1 7 7	49
1 1 4 10	40
1 1 3 11	33
1 1 2 12	24
1 1 1 13	13

table and pins to be connected.

Game or code breaking

There are 16 switches numbered 0 through 9 and A through F. One has to find the 4-digit code by pressing the numbered switches one by one (keep pressing all the switches previously pressed) in the correct sequence. If any switch is pressed in the wrong sequence, a buzzer sounds. In five chances a player should find the correct code or he loses. The gadget is then passed to another player. You need not set another code as there are 256 codes in it. Out of 43680 (= 4P 16) numbers, 256 are codes. Form a truth table as shown in Table VII. The circuit is shown in Fig. 6. The orange and yellow LEDs (optional) intimate the progress of code breaking, i.e. numbers found out correctly in the correct order.

Those who think that the total number of codes are too many may reduce it to minimum 13 by adding several switches in one input taken from other inputs. Table VIII shows some such combinations.

TABLE IX

Input D C B A	'Q' Output of IC 74154	Pin No. of IC 74154	Remarks
1 1 1 1	0	17	Stand by state
1 1 1 0	0	16	Switch S26 pressed
0 1 1 0	0	7	Switch S29 pressed. Keep pressing Switch S26
0 0 1 0	0	3	Switch S28 pressed. Keep pressing Switch S26 and S29
0 0 0 0	0	1	Switch S27 also pressed
0 0 0 1	0	2	Switch S26 released
1 0 0 1	0	10	Switch S29 released

All other pins 4, 5, 6, 8, 9, 11, 13, 14 and 15 are connected together and to the alarm circuit.

Each player will to have play with one switch and he should not allow other players to see his switch position.

The banker permits the players to bet by closing or opening their switches. After the players make a bet, the banker presses his switch (S7) to see who won the bet. The winner is given 5 points. It is the banker's duty to check whether any player has tried foul play by changing his switch position when S7 is pressed. Table VI shows the truth

UTILITY CIRCUITS

Intruder alarm

If you like to protect some small area from trespasser, you may try the circuit shown in Fig. 7. Both break-contact and make-contact type sensing circuits are employed here.

An easily breakable very thin wire runs around the premises which is to be protected. This is connected to the circuit. When the trespasser breaks the wire, with or without his knowledge, the circuit senses it, sounds the alarm and is latched.

A pressure sensitive switch is concealed under the doormat or some other place where the culprit may most probably come in contact with it. When the culprit presses it, the alarm sounds and is latched.

In TTL ICS, input low means a current of 1.6 mA flow from that input pin. Up to 0.8V is taken as logic low. So resistor R6 is chosen (without any resistor or wire connected to it) such that the voltage drop across it does not exceed 0.8V. In the standby state, input A should be high. So R7 may be any value not exceeding the value of R6 as input high is from 2.5V to 5V.S24 is to reset the system.

Electronic lock

It is not an usual electronic lock but something different. Here, the four switches are pressed one by one in a se-

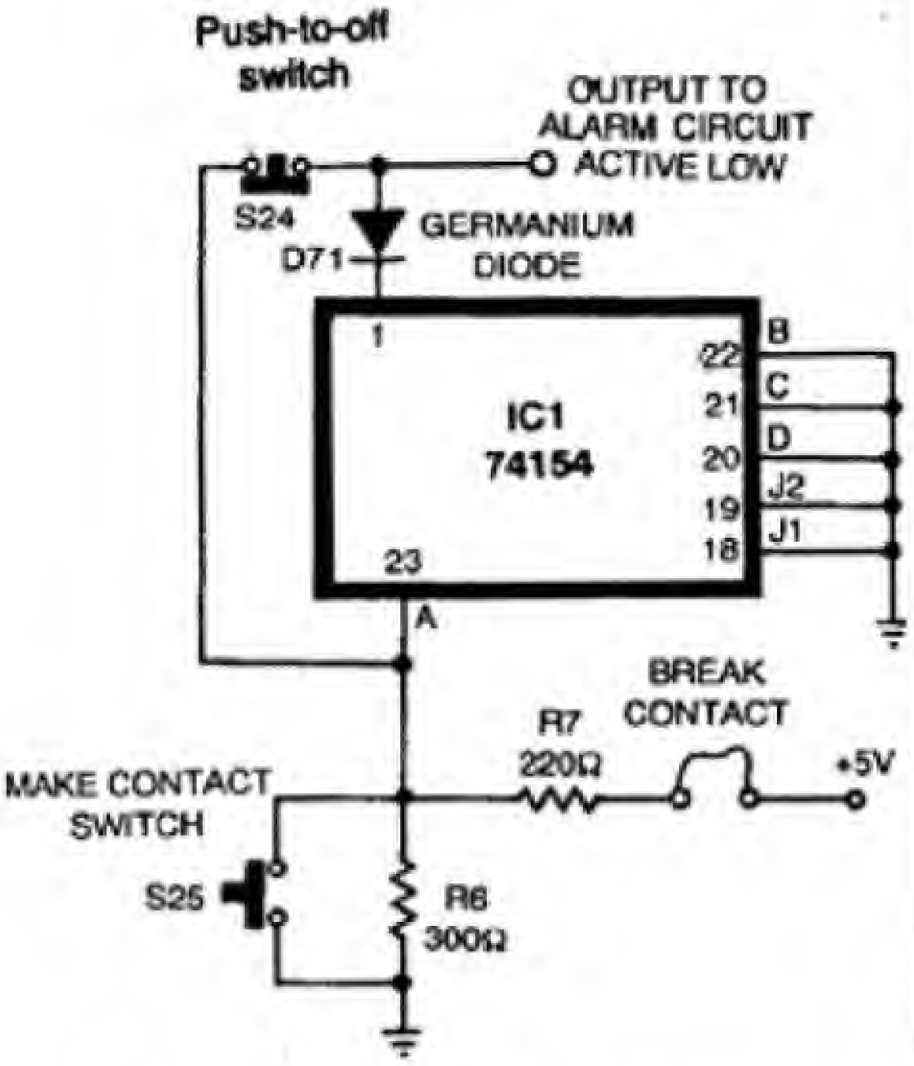


Fig. 7: Circuit for intruder alarm.

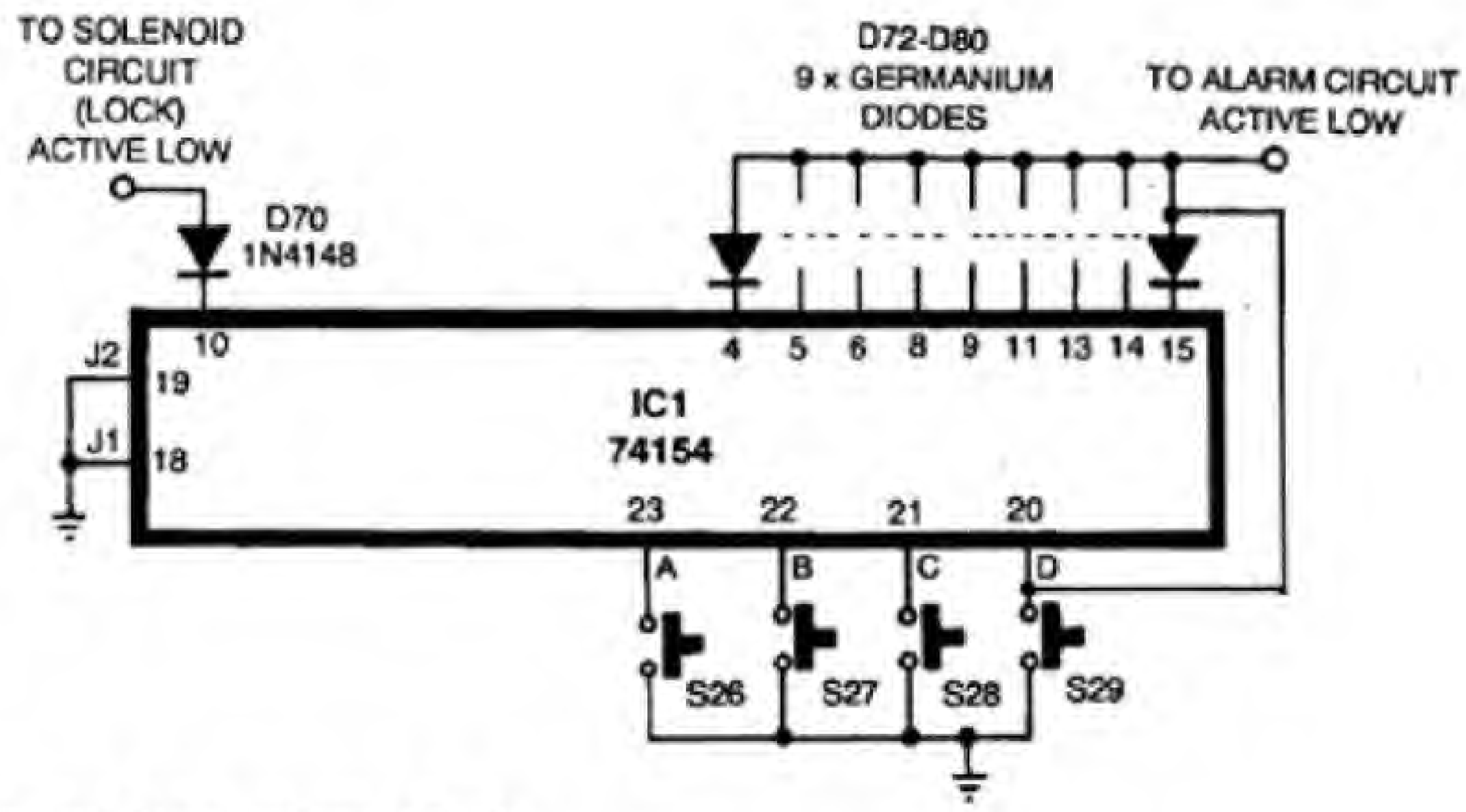


Fig. 8: Circuit for electronic lock.

quence. Keep pressing all the switches previously pressed. After all the four switches are pressed, release two switches one by one in a sequence. Now only two correct switches are kept pressed and the solenoid circuit is activated to release the latch mechanism of the lock.

If any switch is pressed or released in the wrong order, the alarm circuit is activated and the unit is latched as the D input is connected to the output. To reset the circuit, switch off the power and then switch on. Table IX shows the truth table and pin connections. Fig. 8 depicts the circuit.

Some of the other ideas an innovative hobbyist may try to assemble are wind direction indicator, reprogrammable array logic (RPAL), control changeover switch (16 gadgets can be controlled with only four switches), knight rider, and action game. □

Build Your Own Two-Stage UHF TV Booster

Ambur V. Guruprasad

The ultra high frequency (UHF) booster described in this project consists of two stages. It gives a gain of 24dB and operates from channel 21 to 34 on Band IV, i.e. from 470 MHz to 582 MHz. The UHF channels on Band IV have a bandwidth of 8 MHz, as well as a 5.5MHz difference between audio and video sub-carriers.

The impedance of the yagi antenna is 300 ohms balanced. However, the input of the booster is an unbalanced 75 ohms. So, a balun transformer with 4:1 ratio is used between the yagi antenna and booster amplifier.

Choke L1 and neon protect the

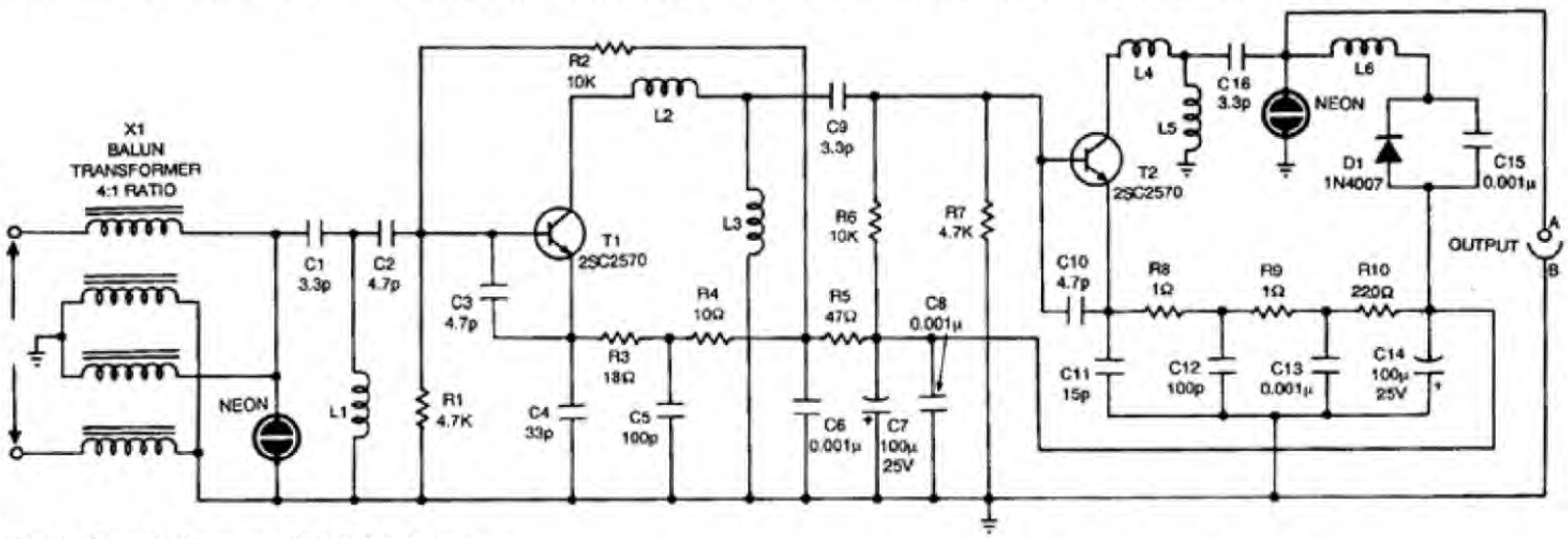
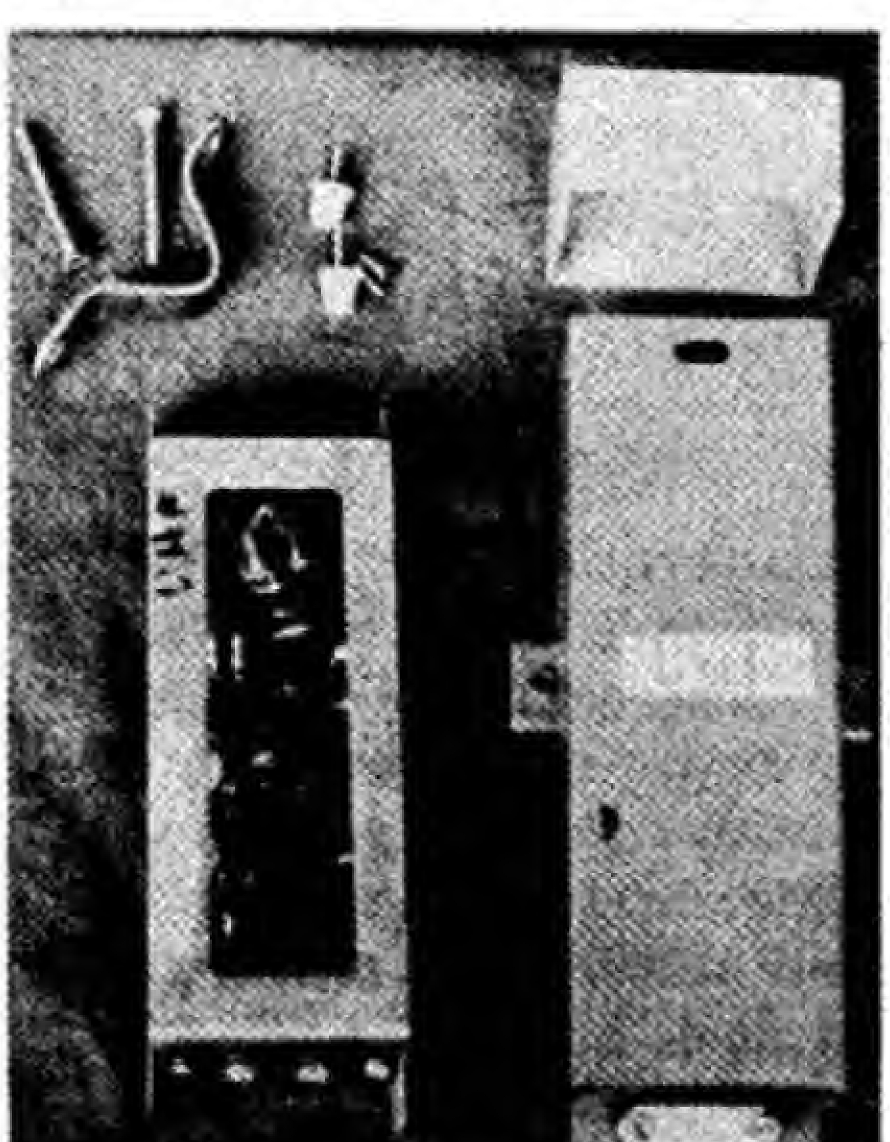
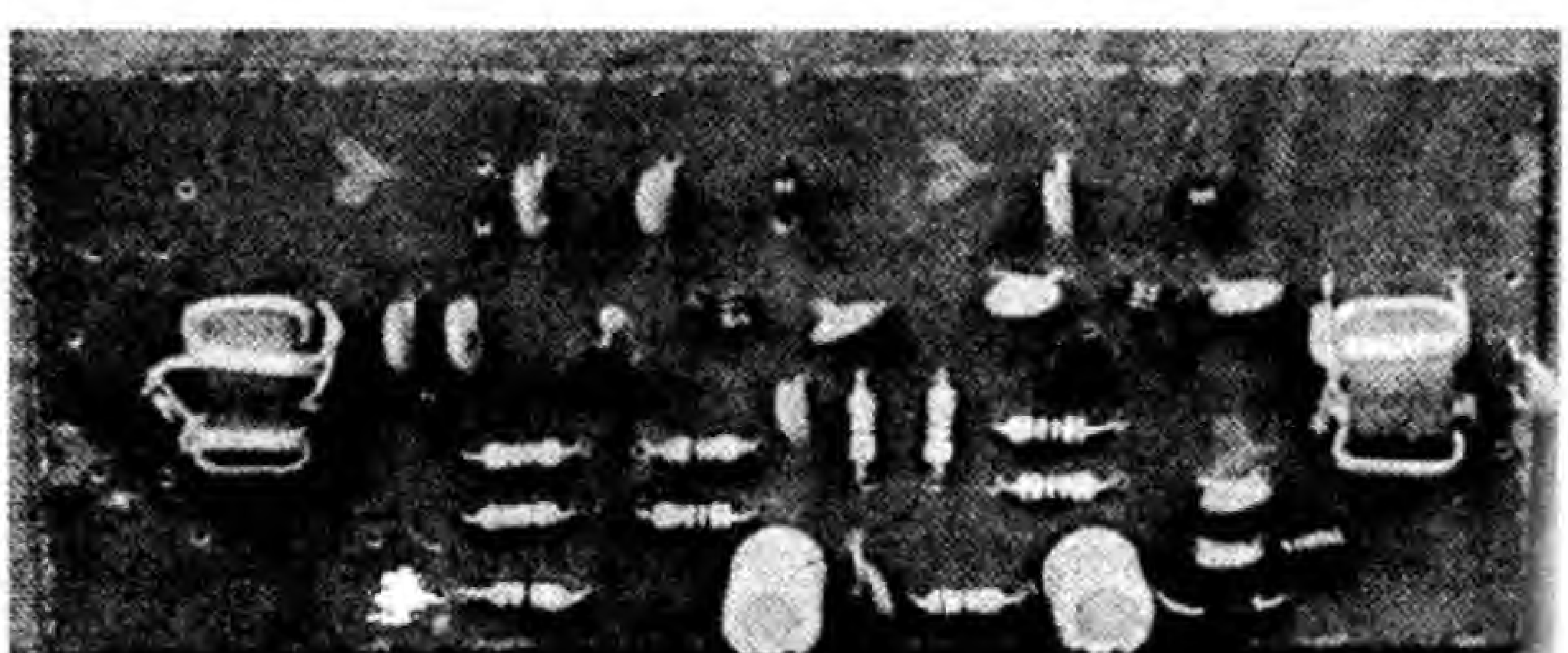


Fig. 1: Circuit diagram of UHF TV booster.



Author's prototype of UHF booster complete with cabinet.



Author's prototype

transistor from transient surges such as lightning. Also, coil L1 provides a bypass for unwanted low frequency signals to get grounded.

The circuit comprises two 2SC2570 transistors (Fig. 1). All the coils used in the booster, except those used in the power supply circuit, are made of 24 SWG wire and have 8mm dia.

The output can be taken directly if a coaxial connector and a coaxial cable of 75 ohms are used. If we want to take the output through ribbon feeder wire, the output is again taken through the balun transformer which is not recommended.

The booster works between 9V and 14V DC. For this, a 0-18V secondary winding is used through a 10k potentiometer (VR1) to the booster amplifier in series with 20 turns of 22SWG wire of 8mm dia.

The AC voltage from the power supply unit is fed through the feeder and rectified by diode D1 (1N4007). By varying the value of VR1 (Fig. 2), the DC voltage is varied, thereby vary-

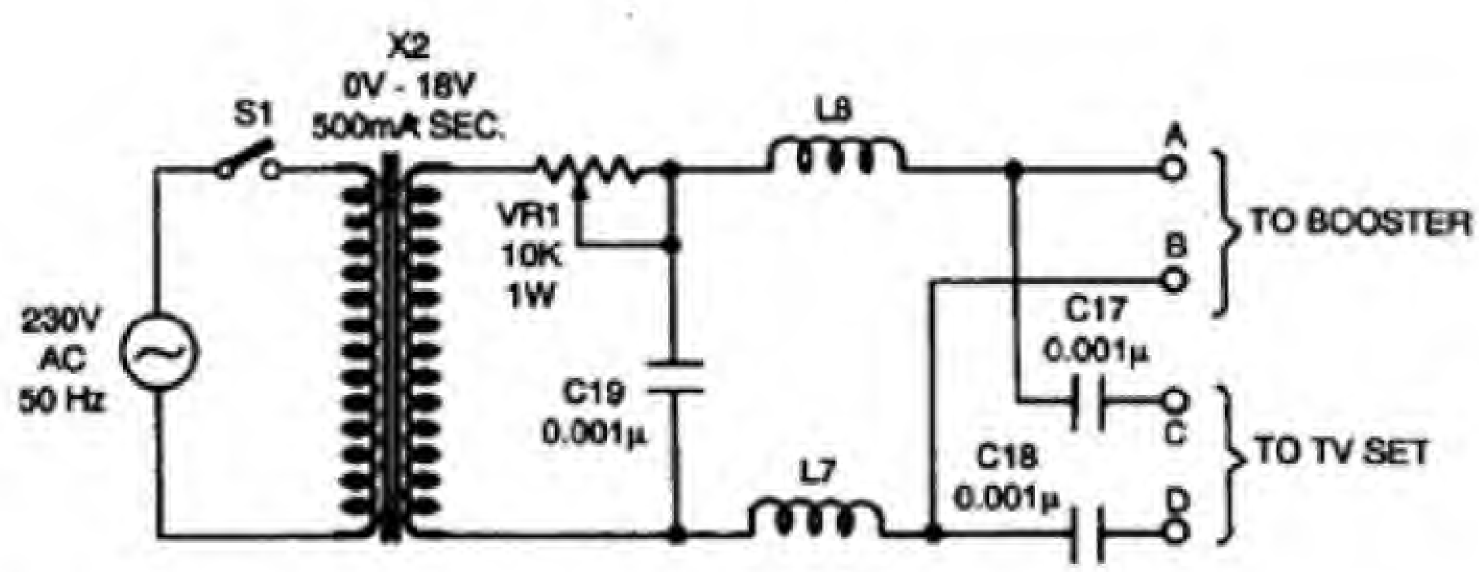


Fig. 2: Power supply circuit for UHF TV booster.

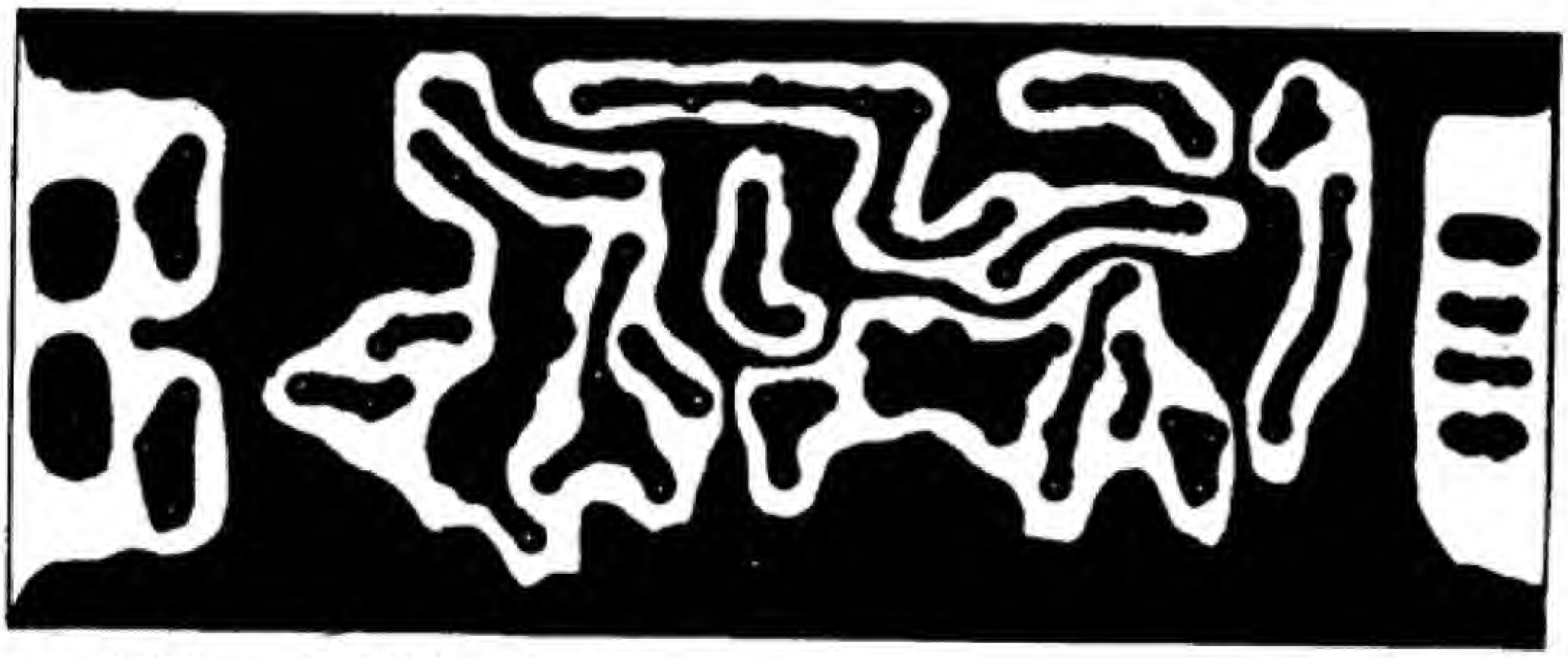


Fig. 3: Actual size PCB layout for UHF TV booster.

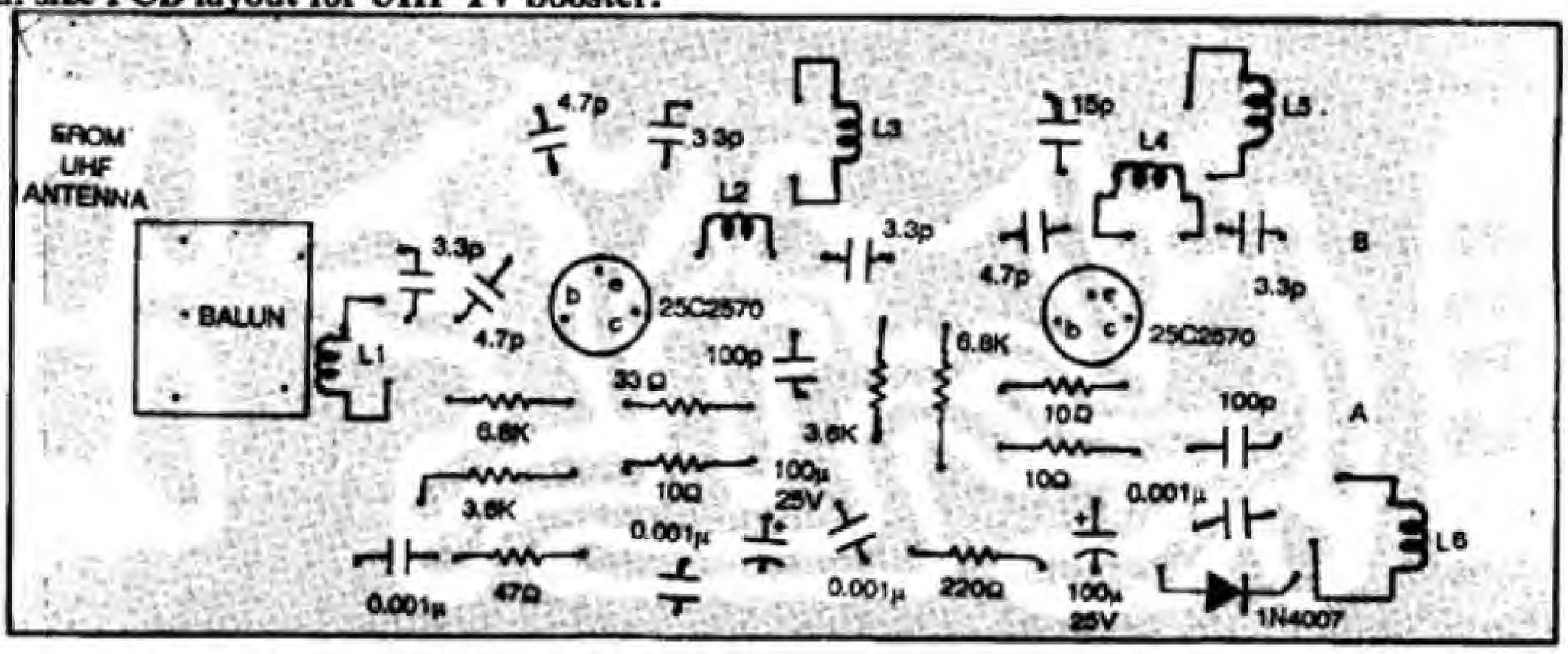


Fig. 4: Components layout for the PCB shown in Fig. 3.

TABLE I

Frequency and Audio/Video Carrier Frequencies for Different Channels

Channel Number	Frequency in MHz	Vision (MHz)	Sound (MHz)
21	470 - 478	471.25	476.75
22	478 - 486	479.25	484.75
23	486 - 494	487.25	492.75
24	494 - 502	495.25	500.75
25	502 - 510	503.25	508.75
26	510 - 518	511.25	516.75
27	518 - 526	519.25	524.75
28	526 - 534	527.25	532.75
29	534 - 542	535.25	540.75
30	542 - 550	543.25	548.75
31	550 - 558	551.25	556.75
32	558 - 566	559.25	564.75
33	566 - 574	567.25	572.75
34	574 - 582	575.25	580.75

PARTS LIST

Semiconductors:		C11	— 15 pF ceramic disc
T1, T2	— 2SC2570 transistor	C7, C14	— 100µF, 25V electrolytic
D1	— 1N4007 diode		
Resistors (all 1/4-watt, ±5% carbon, unless stated otherwise):		*Inductance:*	
R1, R7	— 4.7-kilohm	L1, L3	— 2 turns, 24SWG, 4mm dia. air core
R2, R6	— 10-kilohm	L2, L4, L5	— 3 turns, 24SWG, 4mm dia. air core
R3	— 18-ohm	L6	— 10 turns, 24SWG, 4mm dia. air core
R4,	— 10-ohm	L7, L8	— 20 turns, 20SWG, 4mm dia. air core
R8, R9	— 1-ohm	*Miscellaneous:*	
R5	— 47-ohm	S1	— On/off switch
R10	— 220-ohm	X1	— Balun transformer 4:1 ratio
VR1	— 10-kilohm, 1W potentiometer	X2	— 0-18V, 500mA secondary transformer
Capacitors:			
C1, C9, C16	— 3.3 pF ceramic disc		
C2, C3, C10	— 4.7 pF ceramic disc		
C4	— 33 pF ceramic disc		
C5, C12	— 100 pF ceramic disc		
C6, C8, C13, C15, C17, C18, C19	— 0.001µF ceramic disc		

ing the operations of the transistor.

The amplified signals are fed through the cable to the TV set by connecting capacitors C17 and C18 (0.001µF) at each end.

The PCB and components layout are given in Figs 3 and 4. Use of a glass epoxy PCB is recommended for better quality.

Great care should be taken in the construction, since extra load becomes a source of nuisance by serving as an inductance or capacitance. So keep all lead lengths as short as possible to avoid unwanted inductance or capacitance.

Use a good quality high gain UHF antenna. The design of the antenna will be dependent on the vision and sound carrier frequencies as well as channel frequencies given in Table I.

Avoid joints in the feeder wire. Use of coaxial wire is preferred. Use only coaxial feeders so as to minimise the loss in the cable since the UHF signals have a greater loss than VHF. □

Refrigerator Temperature Controller

C. Sanjay

All refrigerators are incorporated with a temperature controller which can be used to adjust its inside temperature. This device is usually complicated and cannot be repaired easily.

The electronic temperature controller given here is more accurate, cheaper, easily repairable and more effective. The temperature is easily set over a wide range, viz, 10°C to 30°C or 3°C to 25°C, since the range is adjustable. This increases the reliability and the wide range of temperature makes the device more versatile.

The temperature of a refrigerator is controlled by means of a compressor which sends pressurised freon gas inside the tubes through a small opening. The freon gas becomes cold after thus being passed through a small opening and absorbs the heat from the contents of the refrigerator.

The compressor must be switched on and off to maintain a constant

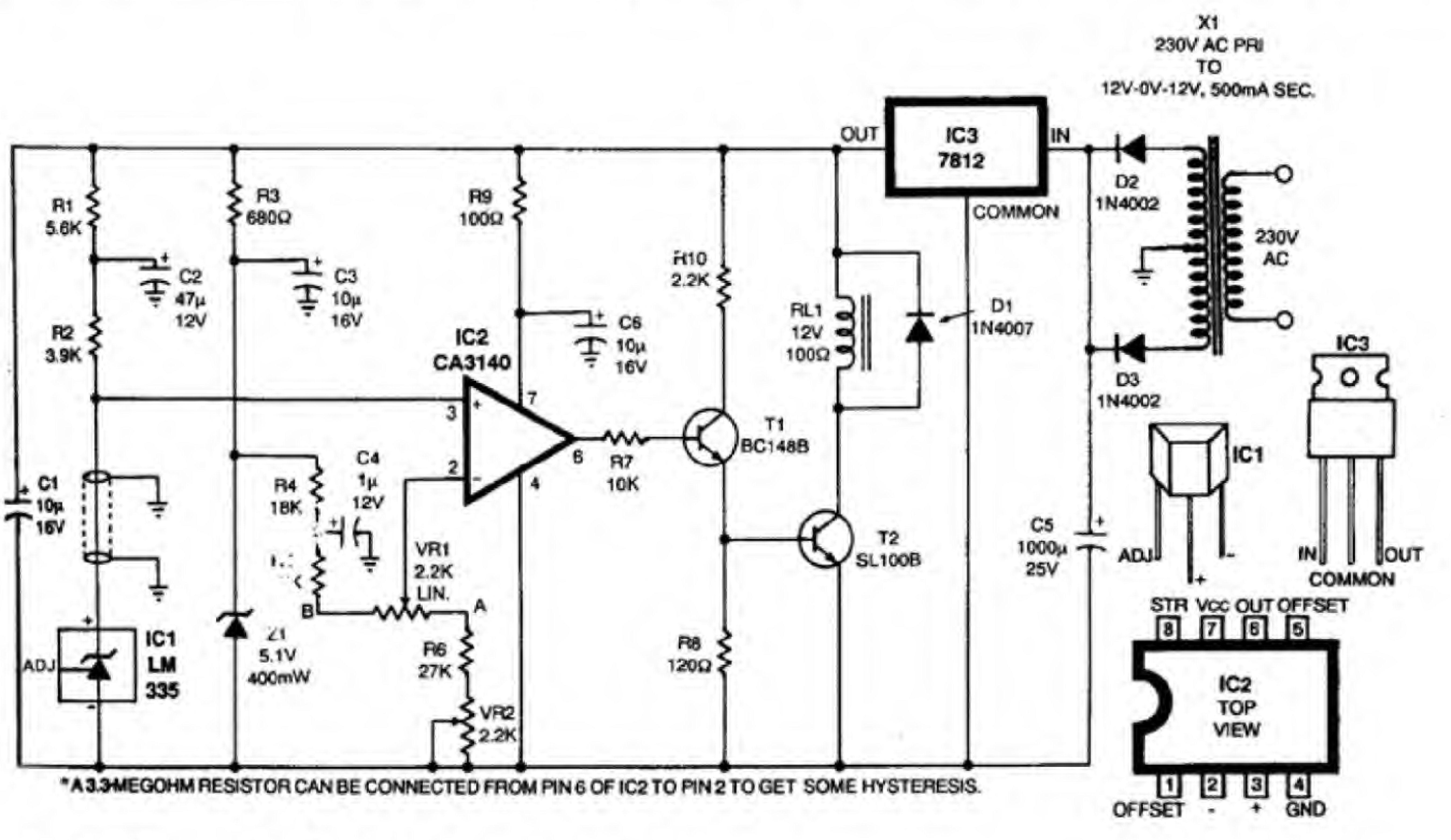


Fig. 1: **Circuit diagram of refrigerator temperature controller.**

PARTS LIST

Semiconductors:	
IC1	— LM335 zener diode
IC2	— CA3140, Bi-MOS op-amp (do not use 741)
IC3	— 7812, 12V regulator
D1	— 1N4007 silicon diode
D2, D3	— 1N4002 silicon diode
Z1	— 5.1V, 400mW zener diode
T1	— BC148B silicon transistor
T2	— SL100 silicon transistor with heatsink
Resistors (All 1/4-watt, ±5%, carbon unless stated otherwise):	
R1	— 5.6-kilohm
R2	— 3.9-kilohm
R3	— 680-ohm
R4	— 18-kilohm
R5	— 2.7-kilohm
R6	— 27-kilohm
R7	— 10-kilohm
R8	— 120-ohm
R9	— 100-ohm
R10	— 2.2-kilohm
VR1, VR2	— 2.2-kilohm potentiometer
Capacitors:	
C1, C3, C6	— 10µF, 16V electrolytic
C2	— 47µF, 12V electrolytic
C4	— 1µF, 12V electrolytic
C5	— 1000µF, 25V electrolytic
Miscellaneous:	
RL1	— 12V, 100-ohm relay
X1	— Transformer, 230V AC primary to 12V-0V-12V, 500mA secondary

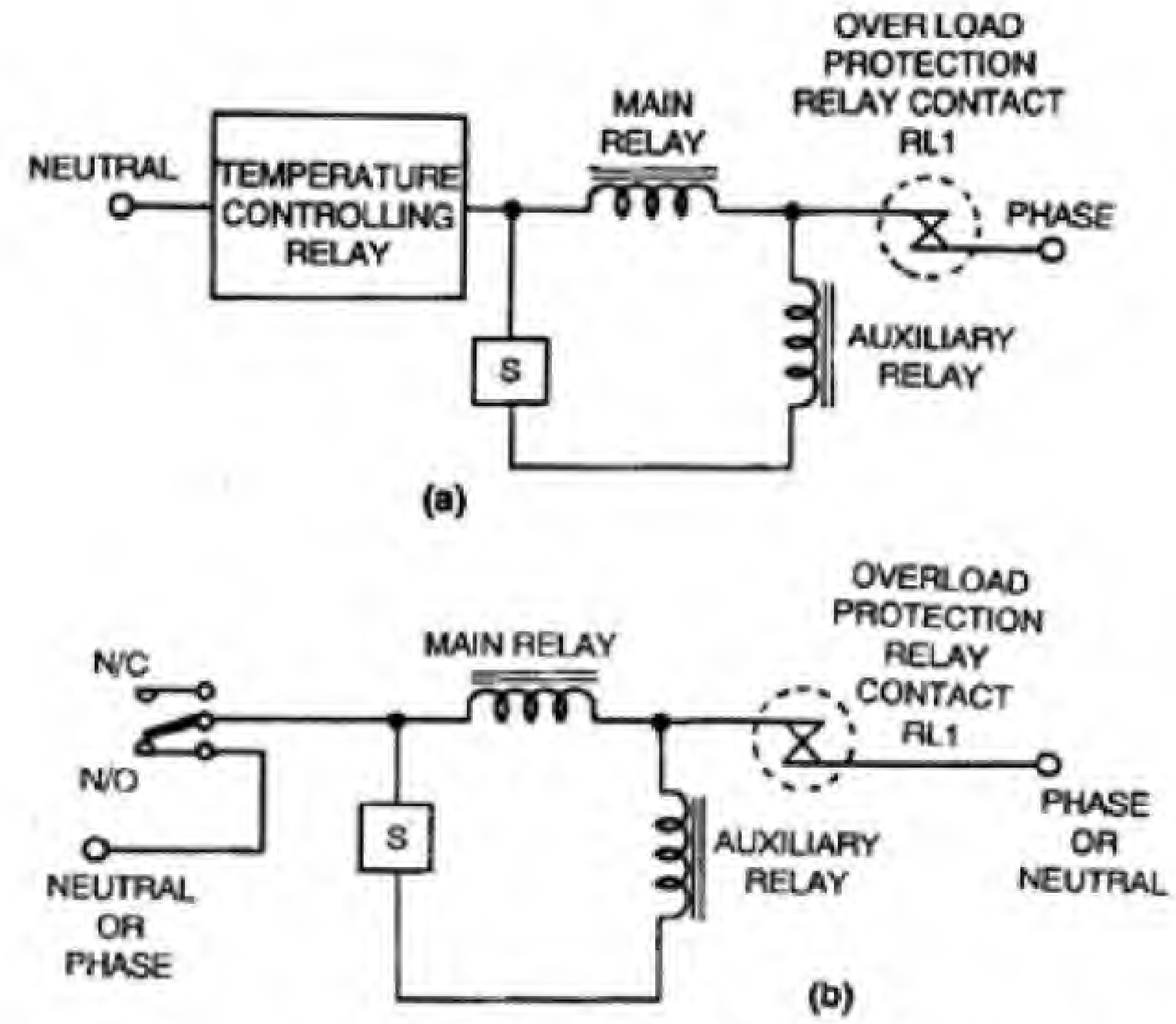


Fig. 2: Circuit for overload protection: (a) before connection; and (b) after connection.

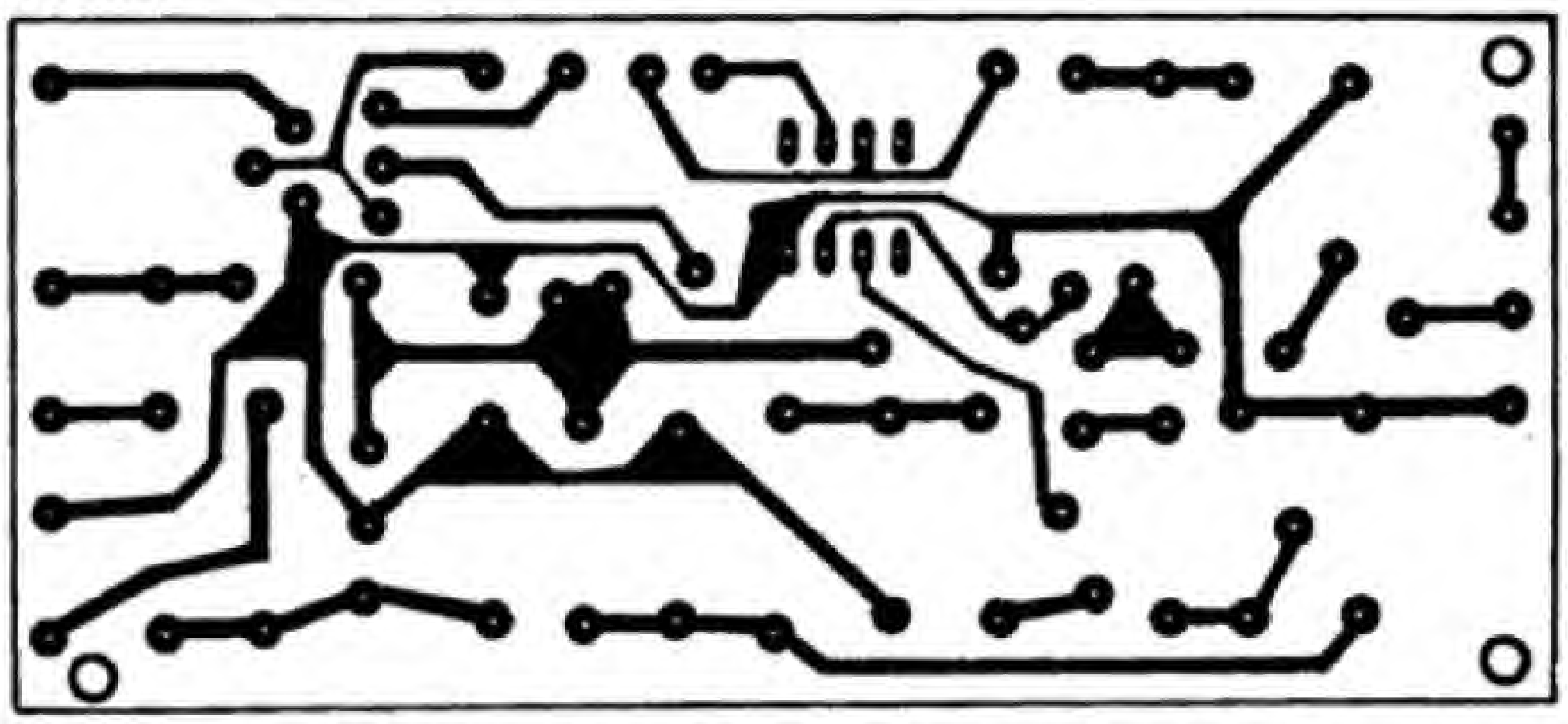


Fig. 3: Actual-size PCB layout for refrigerator temperature controller.

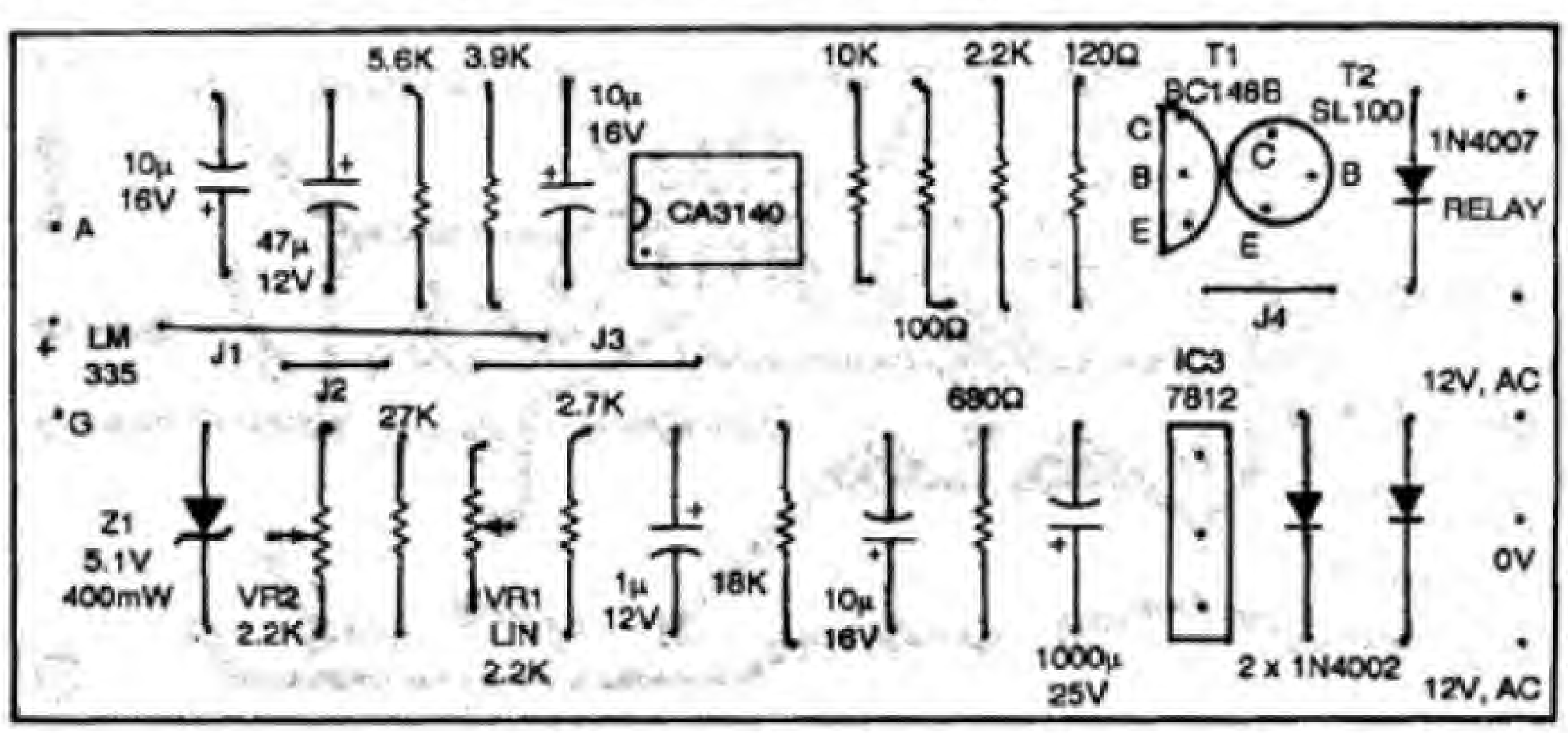


Fig. 4: Components layout for the PCB shown in Fig. 3.

temperature in the refrigerator. However, direct switch-on or switch-off of the compressor by a relay is not possible without an elaborate circuit to disconnect the auxiliary winding inside the compressor. The mechanical overload protection device must also be removed to achieve electronic control of the compressor.

Another alternative is to disconnect the temperature controlling portion alone and connect this new electronic controller. The only change required to be made is the disconnecting of the mechanical temperature controlling device.

The circuit

The temperature is converted into voltage by means of zener IC1 (LM335) which holds its voltage at 2.73V at 0°C (Fig. 1). When the temperature increases, the zener voltage increases linearly by 10mV/°C.

The current through this zener is set to a value of 1 mA. The current is almost constant since the circuit uses a regulated supply.

The voltage across this zener is given to the positive input of comparator IC2. The negative input is fed with a variable voltage which can be varied from 2.76V to 3.07V.

If the voltage is set to 2.78V, then the positive input of IC2 will become higher than the negative input whenever the voltage of positive input rises above 2.78V. This will happen when the temperature around IC1 is 5°C.

Immediately, the output of IC2 becomes high, driving transistor T1 into saturation, which in turn drives T2 into saturation. The relay is activated and the compressor starts operation.

Before connecting the circuit, assemble the circuit given in Fig. 2 for overload protection. Here S connects the auxiliary winding to the neutral when the refrigerator is switched on and disconnects after some time. The relay switches the refrigerator on or off after the connections are made to the starter and the overload protection circuits (Fig. 2). Thus the refrigerator can be switched on and off without tampering with the components around the compressor.

When the voltage at the positive input falls below 2.78V, the relay is switched off and the refrigerator is switched off. The relay has two contacts in parallel to handle the current easily. The supply to this circuit is given before it reaches the relay contacts. So the 230V portion of the transformer is connected to the mains directly and not where the refrigerator is connected.

The output of IC1 is brought to the circuit using a shielded cable to avoid pickups.

Construction

The components are assembled on a veroboard or the PCB layout shown in Fig. 3. The components layout for the PCB is given in Fig. 4.

The connections to LM335 are made using shielded wires as explained earlier. The IC is placed near the tubes behind the refrigerator's freezer compartment. The IC can also be made water tight by placing it inside a small plastic container and kept inside the freezer. But in this case, the temperature setting may not be so accurate.

The thin tube attached to the mechanical temperature controller in the regrigerator is disconnected along with the control mechanism. The switching terminals in the relay box near the compressor are shorted (Fig. 2). The PCB and its power supply can be fitted anywhere as its working is not affected by the ambient temperature.

Adjustments

Switch on the circuit and connect a multimeter to point A (Fig. 1). Now adjust VR2 to show a voltage of 2.81V if you wish the lower limit to be 8°C or a voltage of 2.76V if you wish the lower limit to be 5°C. This is the only adjustment to be made.

The voltage at point B will be about 2.98V when the voltage at point A is at 2.76V or about 3.03V when the voltage at point A is 2.81V. Transistor T2 must be provided with a heatsink.

☐

Heavy Duty Voltage Stabiliser

R.Shankar

The mains power supply in our country is subject to a lot of fluctuations which can considerably shorten the life of valuable equipment such as refrigerators and airconditioners. Therefore, a voltage stabiliser which reduces the degree of fluctuations is a worthwhile investment. Though such stabilisers are available from innumerable manufacturers, it is better to build one for yourself, from the point of view of both economy and reliability.

This voltage stabiliser delivers an output within the range of 200V to 240V for input voltages in the range of 170V to 270V. The power handling capacity was chosen to be 2.5 kVA which is sufficient for a 1-tonne airconditioner. However, it could be changed to higher or lower values by merely changing the transformer rating.

This circuit has several advantages as compared to commercial units. First, it is IC based. This ensures an overall long-term reliability and stability as compared to transistorised circuits.

Second, it features a time dependent hysteresis to avoid vibration of the relay contacts when the input voltage varies slowly near the trip point.

And last, but not the least, it provides an LED indication of the input voltage status, whether it is high (>240V) or low (<200V). Therefore, for most purposes an expensive moving iron voltmeter can be avoided, though this circuit includes it as an option.

The circuit

Fig. 1 shows the circuit diagram of the stabiliser. Let us first concentrate only on the input and output terminals, X1 and the relay contacts.

When the input voltage is between 200V and 240V, both RL1 and RL2 are open as shown. Therefore, the input voltage is passed on to the output without any step up or step down.

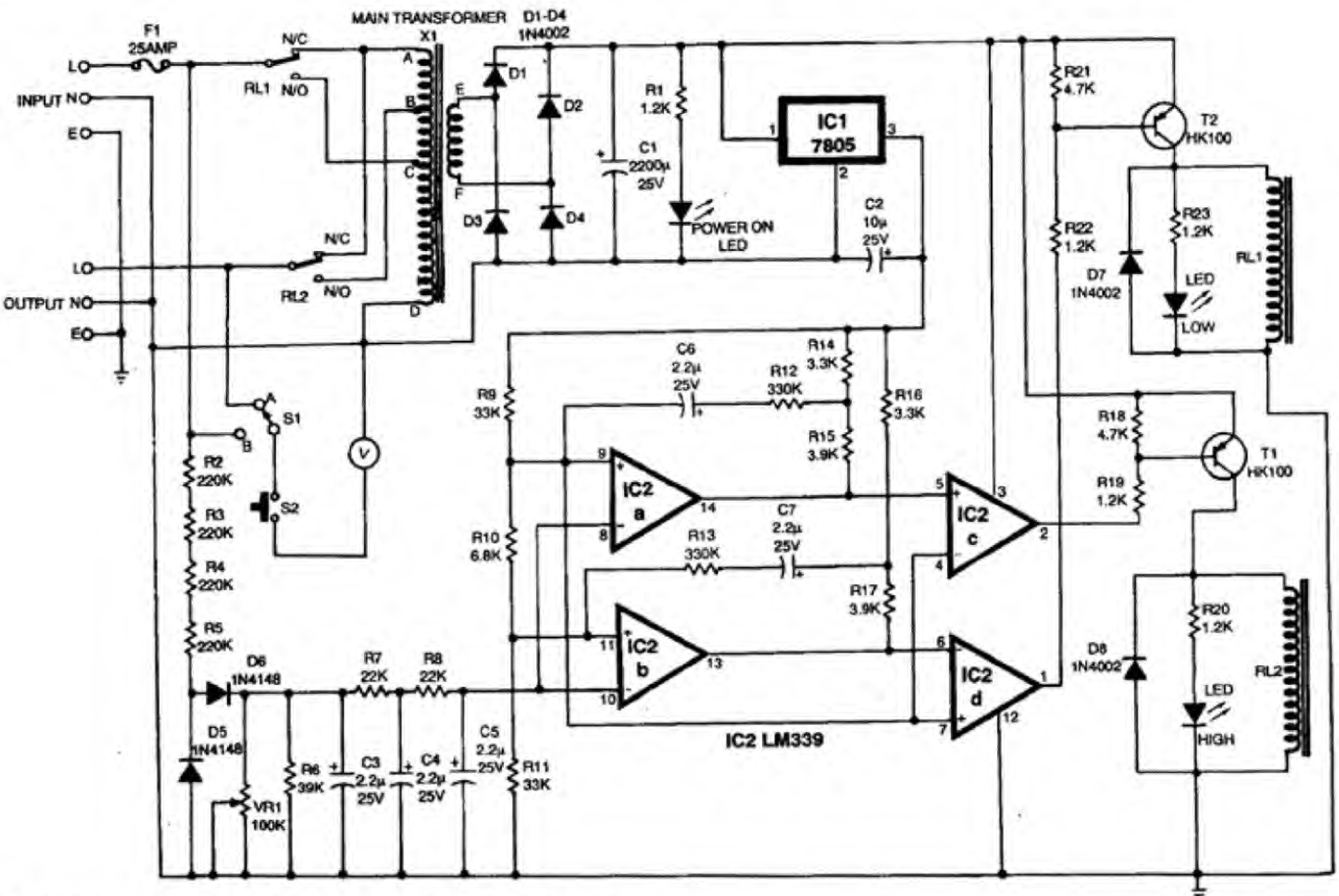


Fig. 1: Circuit diagram of the heavy duty voltage stabiliser.

PARTS LIST

Semiconductors:

IC1	— 7805 voltage regulator
IC2	— LM339 quad comparator
T1-T2	— HK100 pnp transistor
D1-D4, D7, D8	— 1N4002 diodes
D5-D6	— 1N4148 silicon diodes

Resistors (all 1/4W, ±5% carbon unless stated otherwise):

R1, R19-R23	— 1.2-kilohm
R2-R5	— 220-kilohm
R6	— 39-kilohm
R7, R8	— 22-kilohm
R9, R11	— 33-kilohm
R10	— 6.8-kilohm
R12, R13	— 330-kilohm
R14, R16	— 3.3-kilohm
R15, R17	— 3.9-kilohm
R18, R19	— 4.7-kilohm
VR1	— 100-kilohm preset

Capacitors:

C1	— 2200µF, 25V electrolytic
C2	— 10µF, 25V electrolytic
C3-C7	— 2.2µF, 25V electrolytic

Miscellaneous:

RL1, RL2	— 12V, 25 amp, ≥60-ohm relays
V	— 300V moving iron voltmeter (optional)
S1	— SPDT switch (optional)
S2	— Pushbutton switch (optional)
F1	— 25-amp fuse with holder
X1	— Transformer with 425VA core capacity with windings AB - 28V, 12.5-amp BC - 12V, 12.5-amp CD - 200V, 2.7-amp EF - 12V, 300mA

When the input voltage becomes less than 200V, RL1 closes and hence the input is fed to tap C of X1. This leads to step up of the output voltage. Similarly, when the input exceeds 240V, RL1 remains open while RL2 closes. This leads to step down of the output voltage.

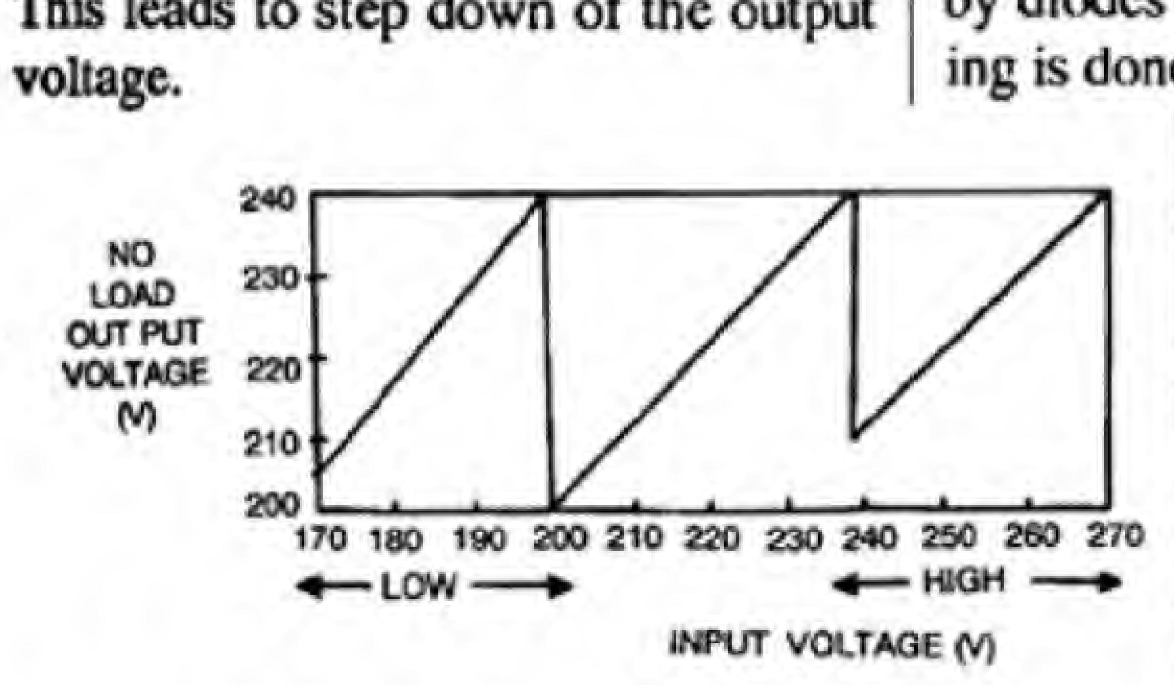


Fig. 2: Output vs input characteristics.

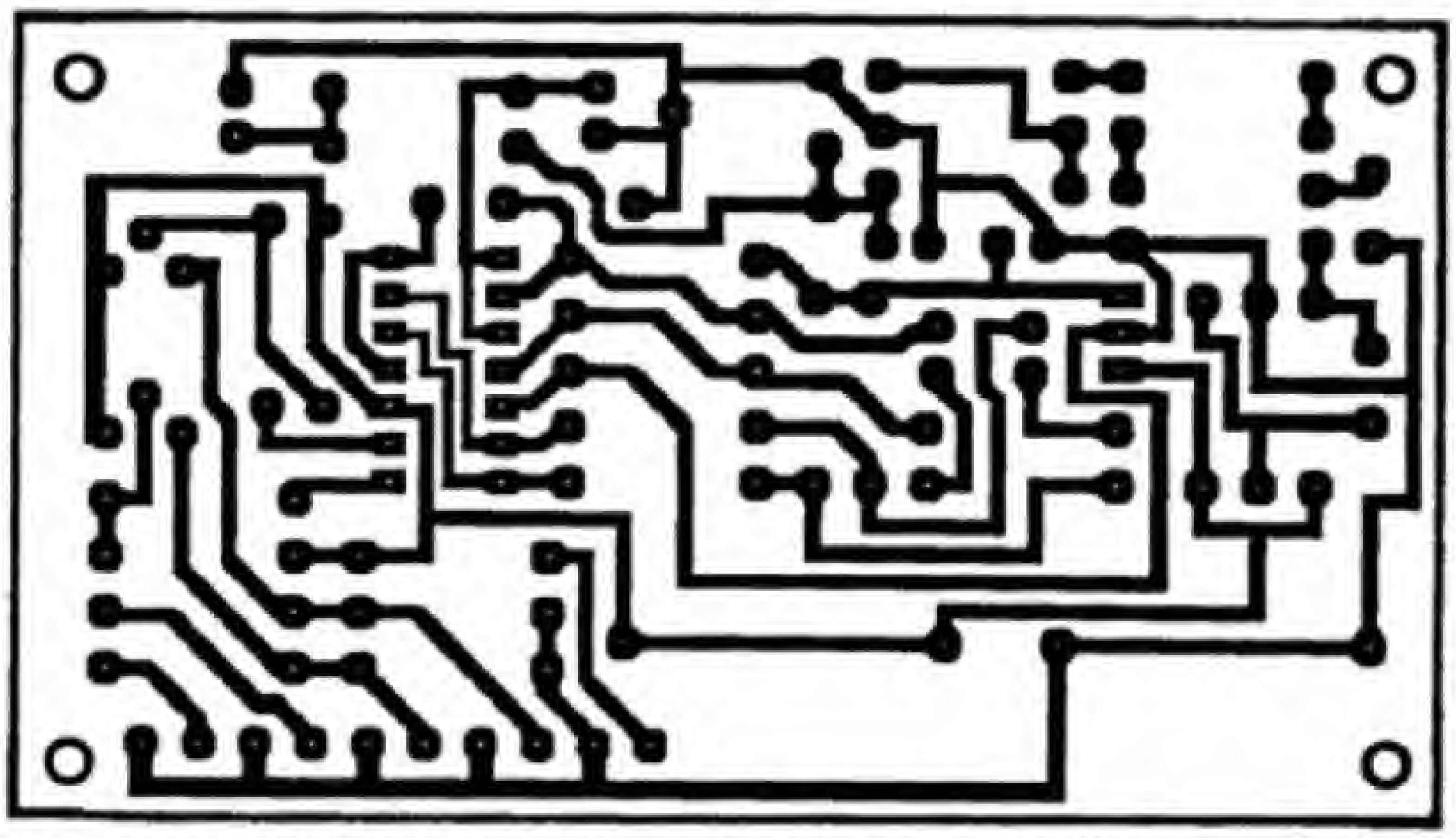


Fig. 3: Actual size PCB layout for heavy duty voltage stabiliser.

The step-up/down transformer forms the heart of any voltage stabiliser, accounting for over 50 per cent of the total cost of manufacture. If the ratings of this transformer are compromised, it leads to undue heating and power losses. Therefore, in building this project, the transformer should be made strictly to the specifications given.

The control circuitry is slightly unconventional since it senses the mains voltage directly rather than through a transformer. This results in a superior long-term accuracy of the trip points. Also, a separate auxiliary transformer can be omitted. The only minor disadvantage of this stabiliser is that the control circuit is no longer isolated from the mains. But even so, any point of the control circuitry, except the live line itself, could be safely touched without the risk of a shock.

The mains voltage is dropped by resistors R2 to R5 before being rectified and filtered. Four 1/4W resistors in series were found to be better than one 1W resistor in terms of stability and reliability. The rectification is carried out by diodes D6 and D7, while the filtering is done by R7, R8, C3, C4 and C5.

A third order filter is recommended because the 50Hz ripple at the output of the filter can be made low enough without making the filter too sluggish in following the input mains voltage. The output of this filter is fed to comparators 'a' and 'b' of IC2 which set the upper and lower trip points respectively. R12, C6 and R13, C7 form time dependent hysteresis networks. The outputs of these two comparators are fed to comparators 'c' and 'd' of IC2 which drive the bases of the relay switching transistors. If the mains voltage exceeds 240V, T1 conducts. Similarly, if the mains voltage becomes less than 200V, T2 conducts. Under normal input conditions, both transistors remain off. Diodes D9 and D11 indicate the input voltage status as 'high' or 'low' respectively.

The power supply for the control circuitry is derived from one of the windings of the main transformer itself. The reference voltage of 5V is derived from the unregulated 12V supply by means of IC1.

Fig. 2 shows the output versus input characteristics of this stabiliser in the no-load condition. The loaded output voltage may be about 2V to 3V lower than the no-load voltage in the high and low regions due to the effective series resistance of the transformer.

Construction

The PCB pattern for the control circuit is shown in Fig. 3 while the components layout is given in Fig. 4. No heatsinks are required for any of the components. Do not forget the jumper on the PCB. The wires connecting the relay contacts and the fuse carrier should be capable of handling at least 15 amps continuously. If the relays have two sets of contacts, connect them in parallel.

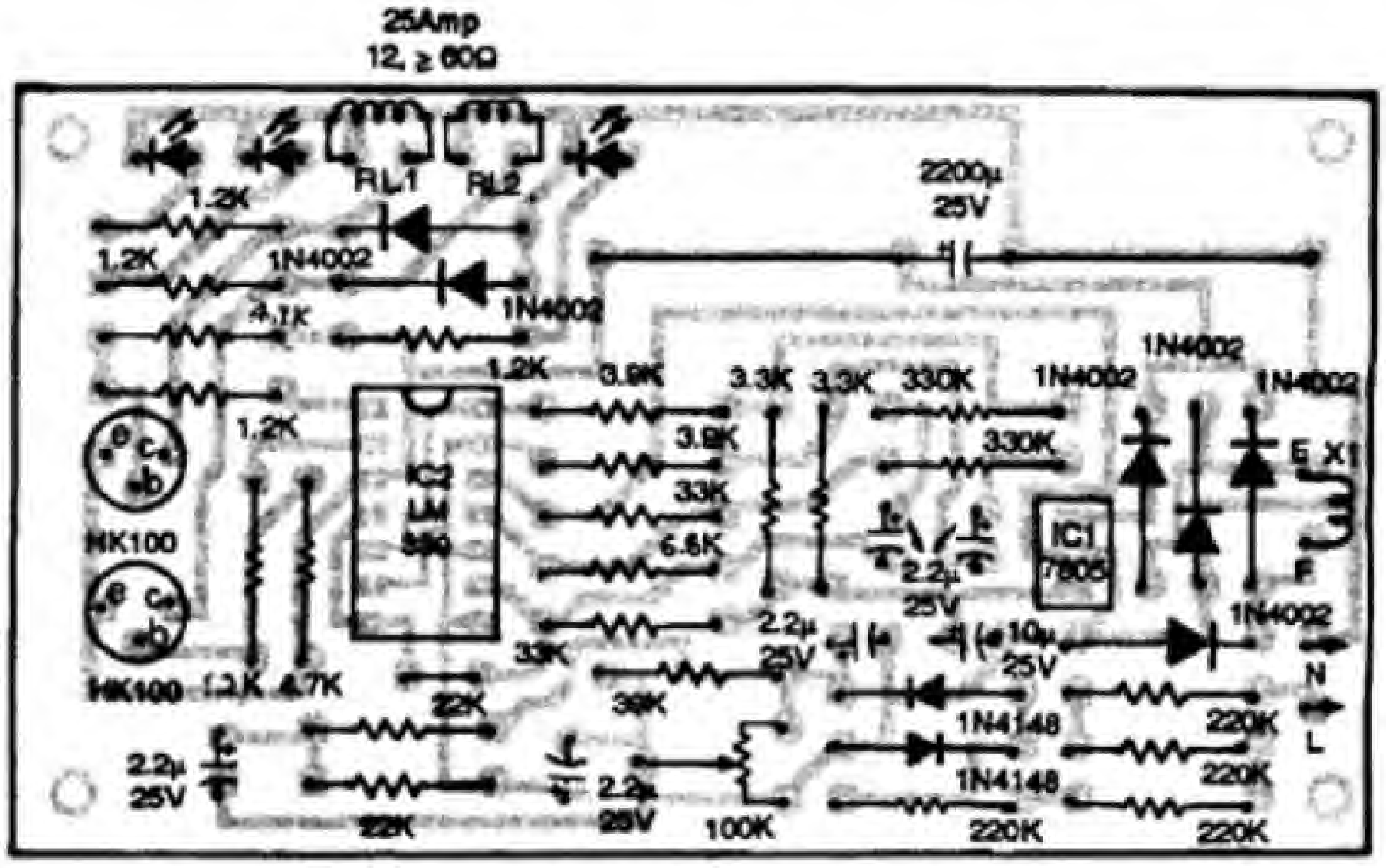


Fig. 4: Components layout for the PCB shown in Fig. 3.

The PCB should be located away from the transformer since the latter can get considerably warm during operation. No part of the circuit should touch the chassis. (Note that the negative supply line of the circuit is not earthed.) Only the earth terminal of the mains should be connected to the chassis. The moving iron meter as well as switches S1 and S2 are optional and may be omitted if not required.

Adjustment

The only component that needs to be adjusted is VR1. But a variac is necessary to adjust it. Initially, turn VR1 fully clockwise. Now connect the output of the variac to the input of the stabiliser. Adjust the output of the variac to exactly 200V with the help of a multimeter. At this stage, RL1 is closed and RL2 is open. Now very slowly adjust VR1 just until RL1 opens. This completes the calibration.

Next, slowly increase the output of the variac till RL2 closes. The output of the variac at this stage should be 240V. Finally, check the output of the stabiliser by sweeping the output of the variac from 170V to 270V. It should more or less comply with the graph of Fig. 2. If the relays operate properly but the output of the stabiliser is erratic, check the transformer and relay connections.

In some airconditioners high surge voltage is generated when the current is suddenly interrupted. When RL1 operates, high surge voltage appears across X1 and may damage the circuit. To prevent this, in place of winding E-F, a separate 12V, 300mA transformer can be used with its primary winding connected between the junction of F1 and RL1 and neutral. A 1/2W resistor of value equal to a fifth of the coil resistance may be connected in series with the coil of RL2 to prevent excessive heating at high mains voltage. □

Readers' comments:

I have some doubts in the circuit captioned 'Heavy Duty Voltage Stabiliser' by Mr R.Shankar

Could the author clarify how he has designed the main transformer? How can we get number of turns, core size, stack height, tongue width, ampere rating and size of the wire to be used?

RAKESH GUPTA
Ambala Cantt

❑ I have some queries regarding the Heavy Duty Voltage Stabiliser circuit. How to get the PCB and transformer? The output of the transformer is not clear. What is the function of RL1?

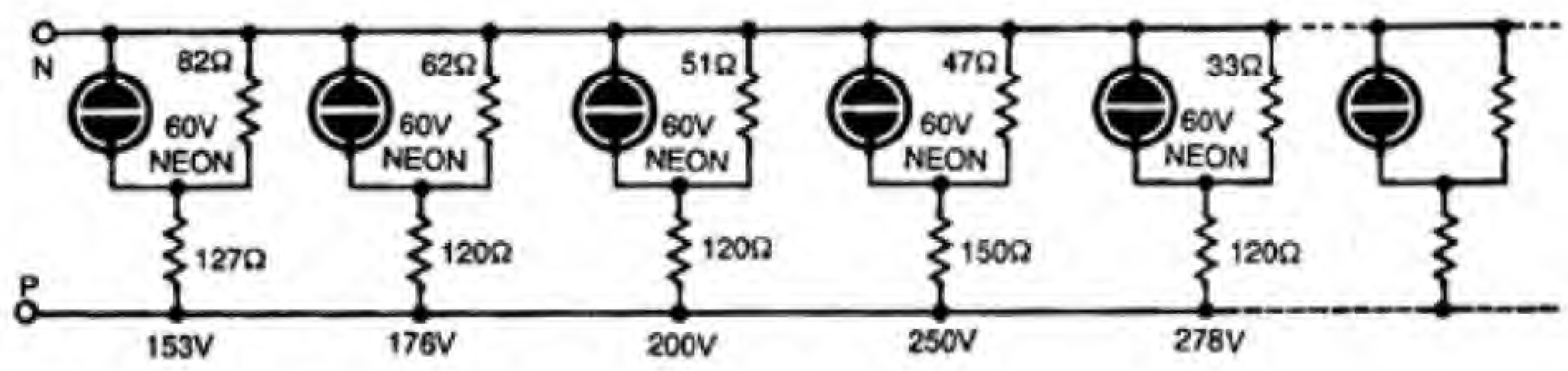
ARINJAY JAIN
Agra.

I have assembled the stabiliser published in EFY. Please convey my heartfelt thanks to Mr Shankar for his superb circuit.

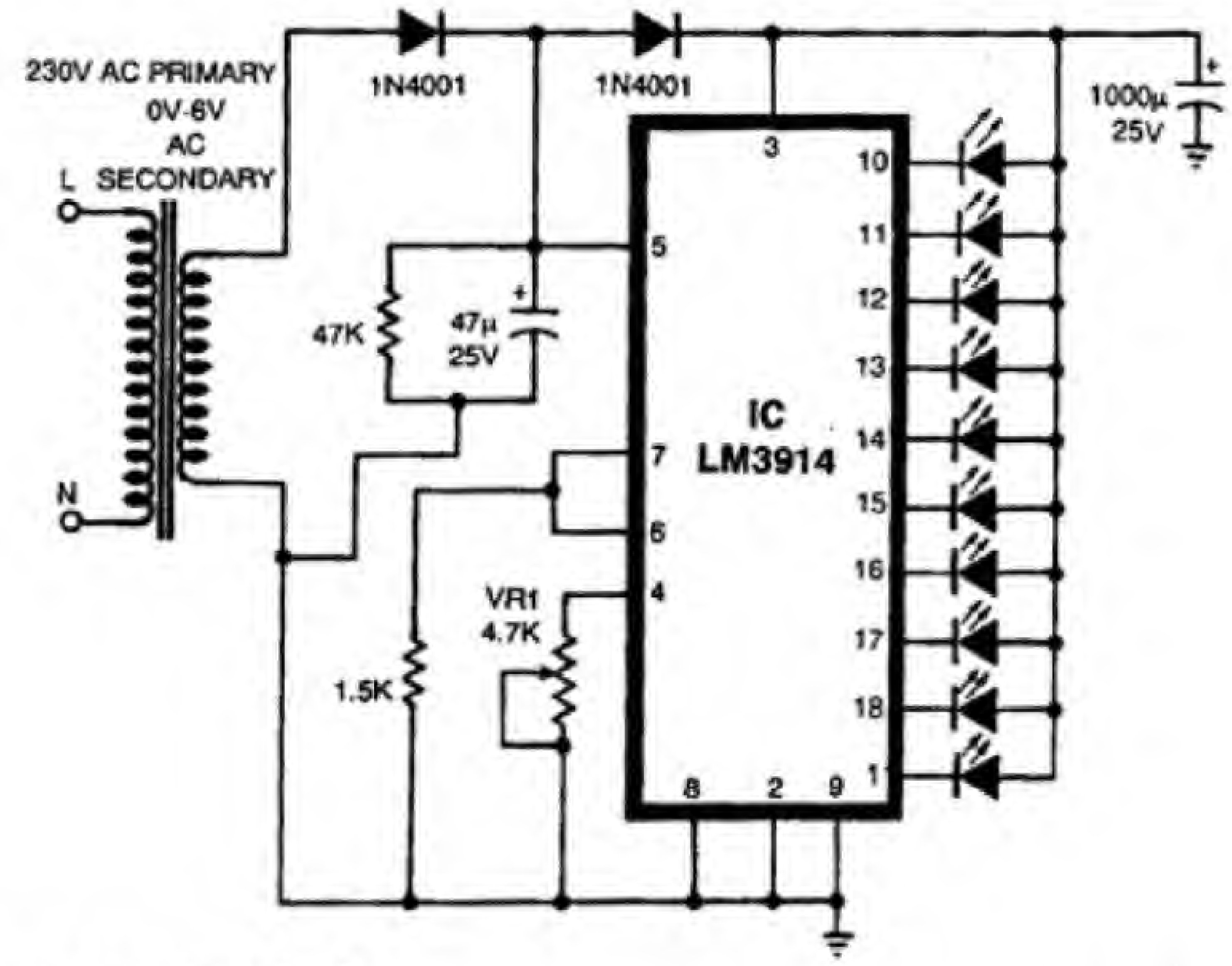
The circuit is, however, not working as automatic stabiliser at 130V AC. Please let me know about the number of turns of the transformer winding with the voltages (AB, BC, CD and EF etc) and the SWG of winding wire (for 15A, 300W) by which I can make an automatic stabiliser for input voltage between 130V AC and 270V AC.

The author, Mr R.Shankar, replies:

Regarding Mr Rakesh Gupta's letter, I am sorry I cannot offer the physical details of the main transformer. Those



Minhazuddin's modified circuit.



T.S. Shankar's modified circuit.

who are interested in winding their own transformer are advised to go through the 'Simplified Design of Transformers' series by Mr S.K. Biswas published in EFY a few years ago.

Mr Arinjay Jain is kindly requested to brush up his knowledge of auto transformers in order to help him understand the circuit.

I regret to inform Mr Banerjee that the operation down to 130V is not possible without making the circuit more complicated. It will increase the number of relays and transformer taps in the circuit. But I am unable to offer the circuit due to lack of space.

I thank both the readers for their interest in my article.

Switch Mode Power Supply For Personal Computer

P.C. Gupta

This article describes the design and construction of a switch mode Power Supply Unit (PSU) for IBM compatible Personal Computers.

The article has been divided into four sections. The first section describes the functional requirements/design objectives of the PSU, i.e. input/output currents and voltages, protection features and interface connections. The second section gives details of the design philosphy and description of the circuit diagram. Step-by-step hardware fabrication and testing is outlined in the third section, while the last section gives mechanical construction details and other precautions to be observed during fabrication and testing of the PSU.

TABLE I

Voltage (V DC)	Current (Amps)		Regulation
Nominal	Min.	Max.	Tolerance
+5.0	2.3	13.0	±5%
-5.0	0.0	0.35	±10%
+12.0	0.4	3.50	±5%
-12.0	0.0	0.35	±10%

Operating characteristics

The power supply unit described here is capable of providing continuous operation at over 110W. It is suitable for IBM compatible PC configuration supporting two floppy drives (360kB or 1.2MB) and one hard disc drive (20MB).

Various PC configurations demand different power supply requirements depending upon the add-on cards used in the expansion slots of the computer, types and number of disc drives used. The latest version of PCs utilising advanced low current devices/components consume much less power as compared to their predecessor. In general, PSU

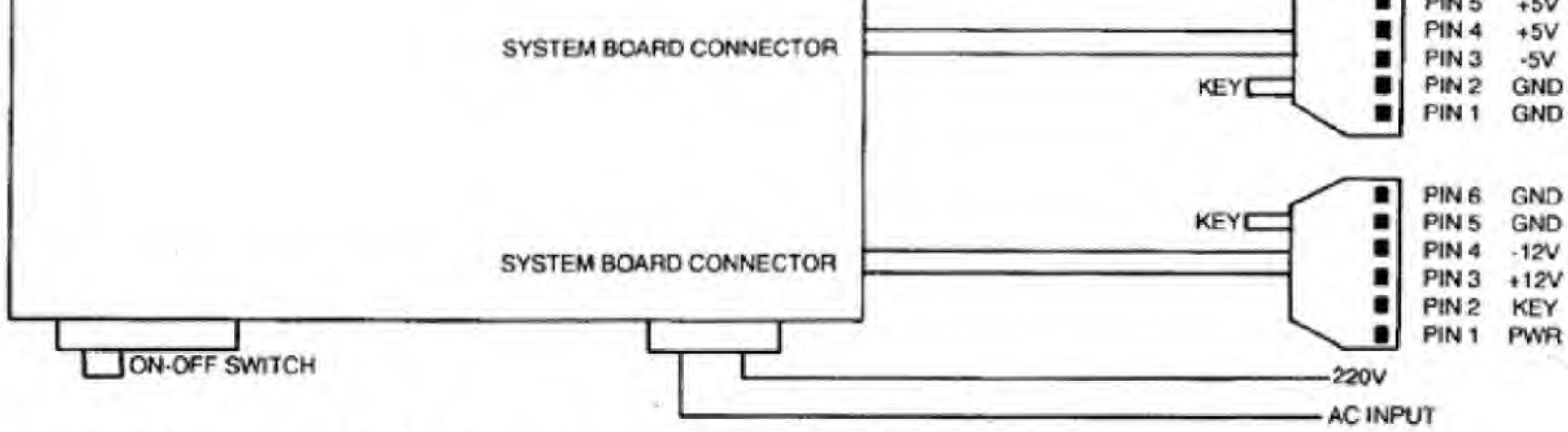


Fig. 1 : Power supply connectors and pin assignments.

The author is a deputy director in Defence Research and Development Organistation. A keen electronics hobbyist and amateur radio ham, VU2PPP, he has designed a number of electronic test and measuring instruments.

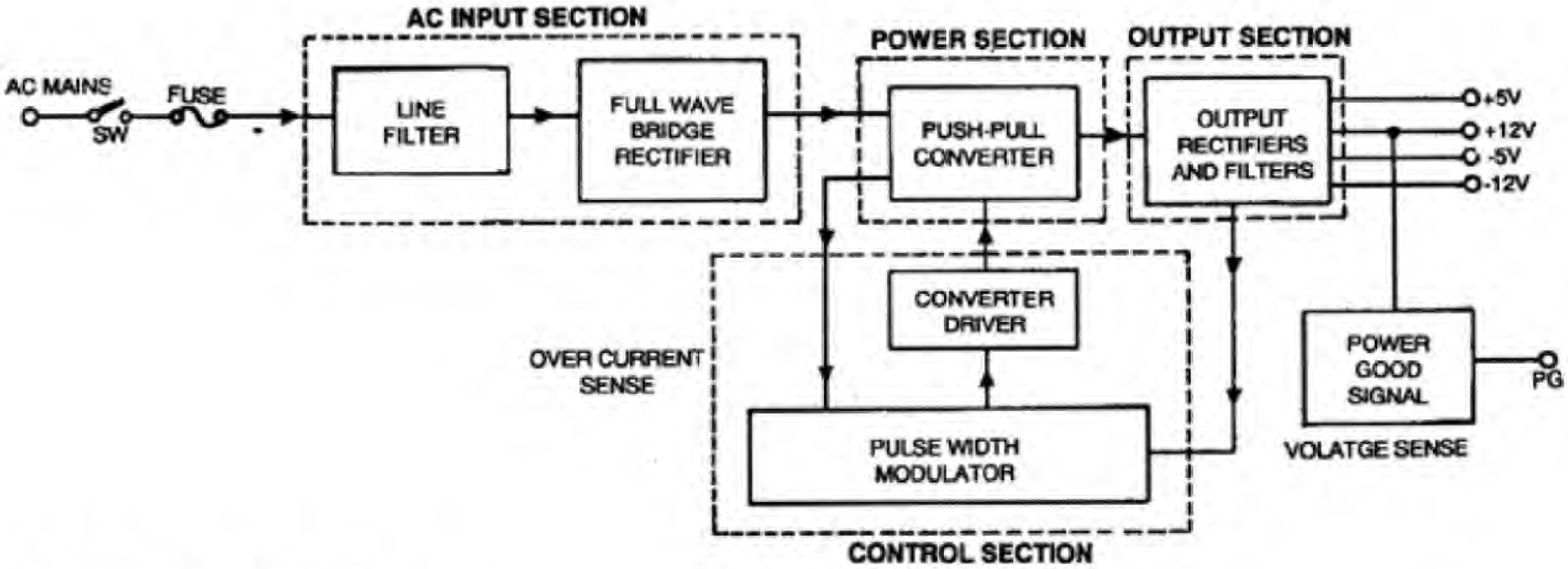


Fig. 2 : Block diagram of the PSU.

capable of providing continuous power of over 110W is adequate up to PC-XT configuration.

The PSU supplies various voltages and 'power good signal' necessary for the operation of PC's system board, keyboard and other installable optional cards. It can be operated over an input voltage range of 190V to 240V AC and provides four regulated DC output voltages of +5V, -5V, +12V and -12V.

Table I shows the current rating and regulation requirements of each of these supply voltages. These outputs are over voltage, over current and open circuit protected. The input portion of PSU is protected by a fuse of suitable rating.

The +5V DC powers the logic on the system board, the disc drives and adapters in the system expansion slots. The +12V is used for the system's dynamic memory and disc drive motors. It is assumed that only one drive is active at a time. The -5V DC level is designed for dynamic memory bias voltage and has a longer decay on power-off than +5V and +12V outputs. All four power levels are bussed across the system unit expansion slots.

Power good signal

When the power supply is turned on, it generates a power good signal which indicates that there is adequate power for processing. When the four output voltages are above the minimum sense levels as given in Table I, a TTL compatible high level (2.4V DC to 5V DC) is generated. This power good signal has a turn-on delay of about 100ms after the output voltages have reached their respective levels.

Interface connections

Fig. 1 shows the interface connections and pin assignments of the PSU. Two 6-pin connectors (or one 12-pin connector) are used for PSU connection to system board of the PC and two 4-pin connectors are provided for disc drives power connections.

Input supply is given through a mains connector or directly through a 3-core mains cable from the rear panel of the PC. An on-off switch is provided on the rear side panel of the chassis. PSU also houses a cooling fan to cool the entire system.

Circuit description

Fig. 2 shows the block diagram of the PSU. The input from mains is first filtered to suppress any spikes/surges entering the power supply circuit. This is an important part of the circuit and helps in preventing data loss or erroneous working during power line disturbances.

Filtered mains supply is then rectified by a full-wave bridge rectifier to produce +150V DC for the power converter section. The input supply is switched with the help of this power converter and the energy transferred to the output through a high frequency ferrite transformer.

The power converter consists of two externally driven transistors operating in push-pull configuration. These are driven by converter driver. The power converter transformer produces low voltage switched waveforms on the secondary side which are rectified and filterd to produce well regulated ±5V and ±12V DC output voltages.

The +5V DC output voltage is sensed by control section of the PSU which essentially consists of a pulse width modulator (PWM) controller IC. This PWM produces suitable drive pulses at about 22kHz for the converter driver. The width of these pulses is controlled by the modulator depending upon the output sense voltages and over current voltages, thus ensuring correct operating voltages at the output and providing necessary protection to the PSU.

Fig.3 shows the circuit diagram of the PSU. The input mains supply is applied to the circuit via an on-off switch to fuse F1. Resistor R1 limits the inrush of current. Power converters operating directly 'off-line' like this one draw heavy current when switched on. This inrush of current causes great stress on input components, switches, rectifiers and capacitors.

For low power applications, simple series resistor is used to limit the initial high voltage and high current. Special high current surge rated resistors are best suited for this application. However, adequately rated wirewound resistor also serves the purpose and is frequently used.

Capacitors C1, C2, C3 and C4 together with transformer X1 form a balanced input line filter. X1 has two separate inductors wound on a single core

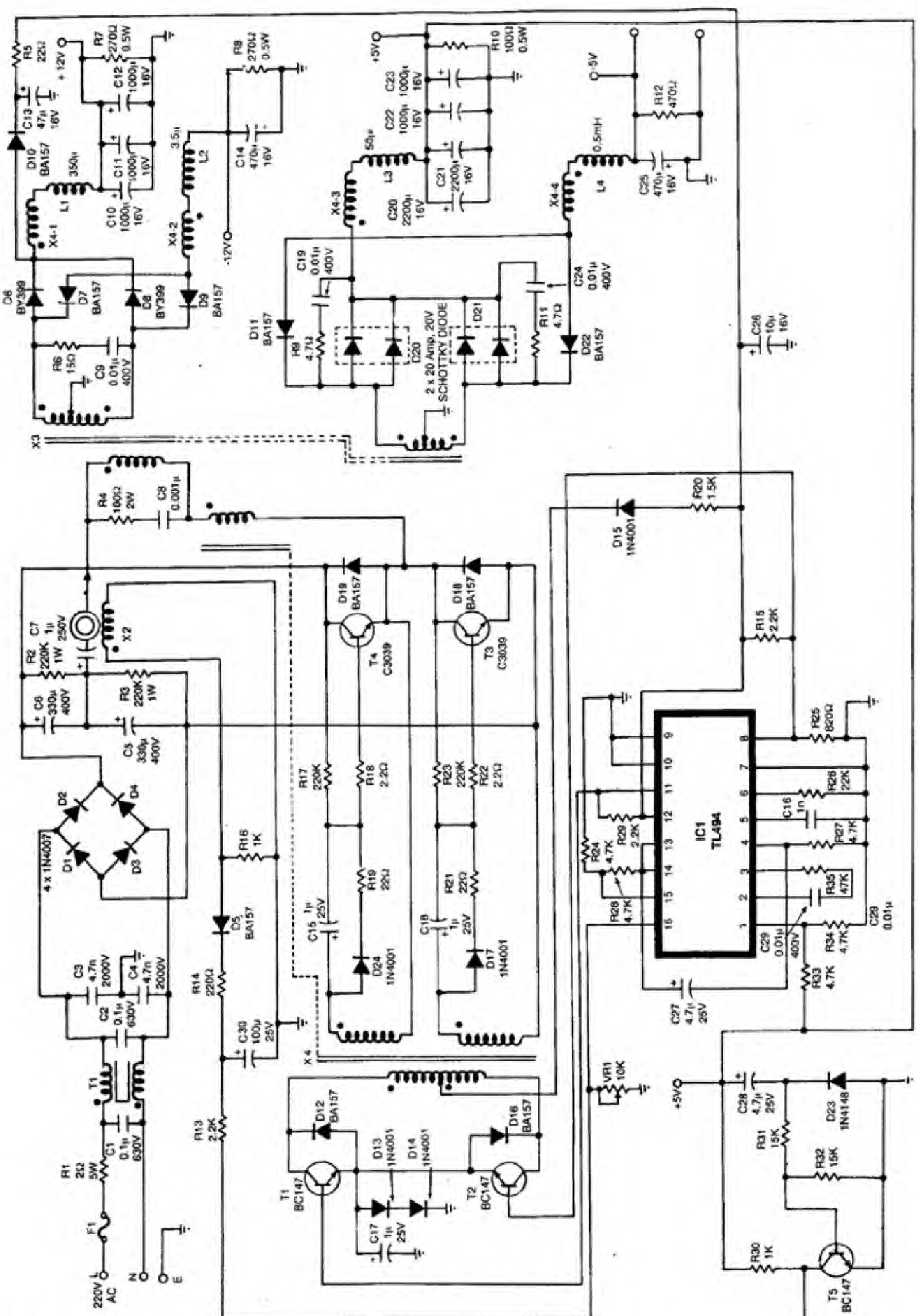


Fig.3: Circuit diagram for the switch mode PSU.

PARTS LIST

Semiconductors:

IC1	— TL494 pulse width modulator controller
D1-D4	— IN4007 silicon diodes
D6, D8	— BY399 silicon diodes
D5, D7, D9-D12, D16, D18, D19, D22	— BA157 silicon diodes
D13-D15, D17, D24	— 1N4001 silicon diodes
D20, D21	— 20 Amps 20V schottky diode
D23	— 1N4148 silicon diode
T1, T2, T5	— BC147 silicon transistor
T3, T4	— C3039 transistor

Resistors (all 1/4W, ±5% carbon unless stated otherwise):

R1	— 2-ohm, 5W
R2, R3	— 220-kilohm, 1W
R4	— 100-ohm, 2W
R5, R19, R21	— 22-ohm
R6	— 15-ohm
R7, R8	— 270-ohm, 0.5W
R9, R11	— 4.7-ohm
R10	— 100-ohm, 0.5W
R12	— 470-ohm
R13, R15, R29	— 2.2-kilohm
R14	— 220-ohm
R16, R30	— 1-kilohm
R17, R23	— 220-kilohm
R18, R22	— 2.2-ohm
R20	— 1.5-kilohm
R24, R27, R28, R33, R34	— 4.7-kilohm
R25	— 820-ohm
R26	— 22-kilohm
R31, R32	— 15-kilohm
R35	— 47-kilohm
VR1	— 10-kilohm preset

Capacitors:

C1, C2	— 0.1µF, 630V polyester
C3, C4	— 4.7nF, 2000V polyester, ceramic
C5, C6	— 330µF, 400V electrolytic
C7	— 1µF, 250V electrolytic
C8	— 1nF, ceramic disc
C9, C19, C24, C29	— 0.01µF, 400V ceramic disc
C10-C12, C22, C23	— 1000µF, 16V electrolytic
C13	— 47µF, 16V electrolytic
C14, C25	— 470µF, 16V electrolytic
C15, C17, C18	— 1µF, 25V electrolytic
C20, C21	— 2200µF, 16V electrolytic
C16	— 1nF, polyester, ceramic disc
C26	— 10µF, 16V electrolytic
C27, C28, C30	— 4.7µF, 25V electrolytic — 100µF, 25V electrolytic

Inductance:

L1	— 350µH
L2	— 3.5µH
L3	— 50µH
L4	— 0.5mH

Miscellaneous:

Transformers:

X1:	20 turns (bifillar) on iron powder toroidal core Mix-26, Ylw-wht, (permeability) µ=75, core size: T-80, inductance=0.8mH # thin hook-up wire, two colours
X2:	36 turns (single layer) on ferrite toroidal core Mix-72, µ (permeability) - 72, core size: FT-50, inductance=1mH #36SWG.
X3:	Primary turns=45, #23 SWG sec turns (5V winding)=6, centre tapped #21 SWG, sec turns (12V winding) = 14 (center tapped) # 22 SWG, ferrite core, type E42mmx21mmx15mm material HP3C
X4:	Primary turns=68# 36SWG sec turns (both windings)=9 each, #36SWG start winding's turns=2 #36SWG ferrite core, type E 20mmx 10mmx5mm material HP3C.

such that the two windings are in anti-phase.

When the two windings are connected in this way, the magnetic field that results from the normal supply currents is cancelled. Hence the low frequency line current will not saturate the core and a high permeability material may be used without the need for an air gap.

However, for noise which appears on both the lines at the same time with respect to ground, the two windings are in parallel and in phase. Also, a very high inductance is presented to common mode currents. This arrangement prevents any significant interference currents from being conducted back to the input supply lines.

Filtered AC mains lines are then connected to diodes D1 through D4 acting as a full-wave rectifier. C5 and C6 are the smoothing capacitors. This arrangement provides approximately ±150V DC to the power converter transformer with respect to the centre point, i.e. junction of C5 and C6.

The power converter has been configured in half-bridge, push-pull configuration. This is the preferred topology for direct off-line switch mode supplies because it causes reduced voltage stress on switching devices. Switching transistors T3 and T4 form only one side of the bridge circuit, the remaining half being formed by capacitors C5 and C6. The major difference between this and the full-bridge is that the primary of transformer X3 will take only half supply voltage into consideration, i.e. 150V DC approximately.

T3 and T4 are power switching transistors connected across the input supply, the centre point being connected to the second end of primary winding of X3. When transistor T4 turns on, half the input supply voltage is applied across the primary winding of X4 with the start going positive.

After a time duration defined by the control circuit of IC1, T4 is turned off. As a result of primary and leakage inductance, current will continue to flow into the primary winding. The junction of T3 and T4 will swing negative, and if the energy stored in the primary leakage inductance is sufficiently large, diode D18 will conduct to clamp any further negative excursion

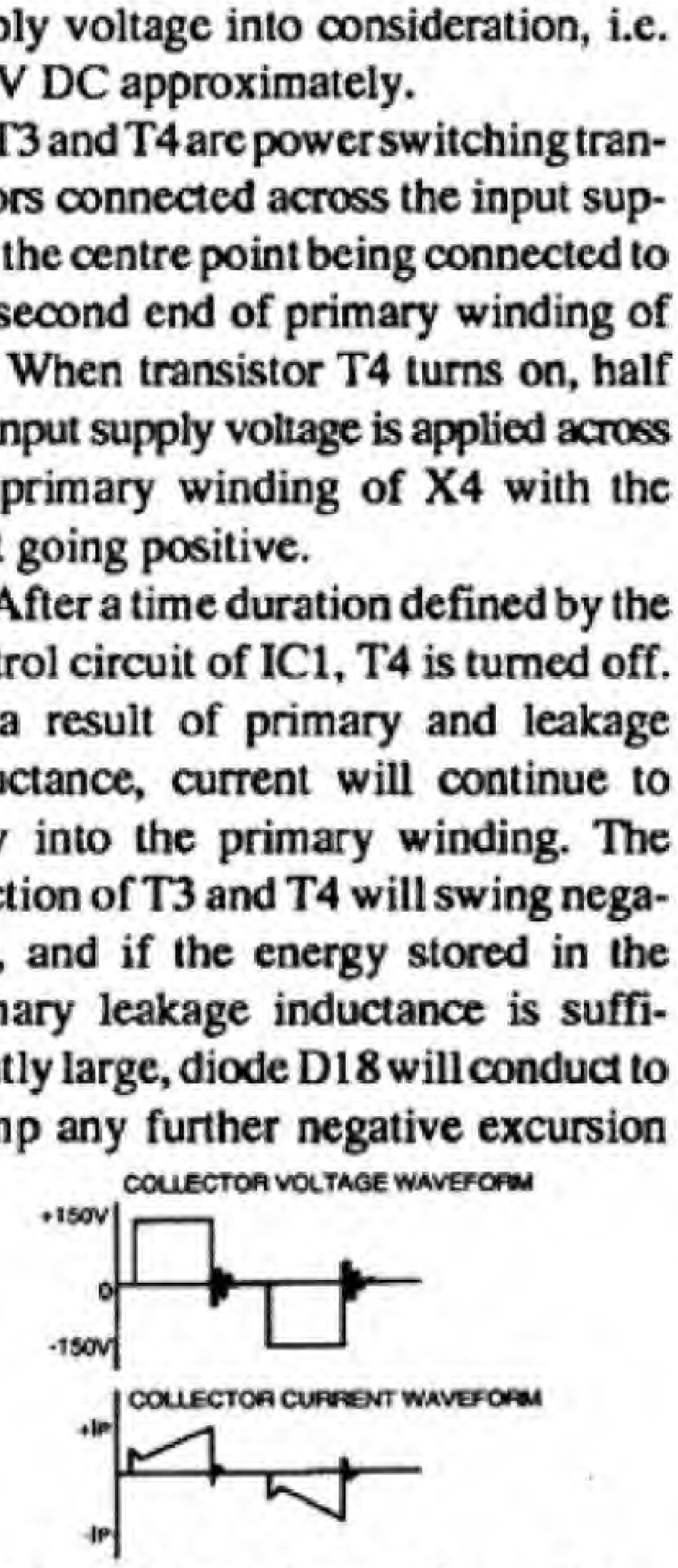


Fig. 4 : The waveforms for collector voltage and current at the junction of T3 and T4.

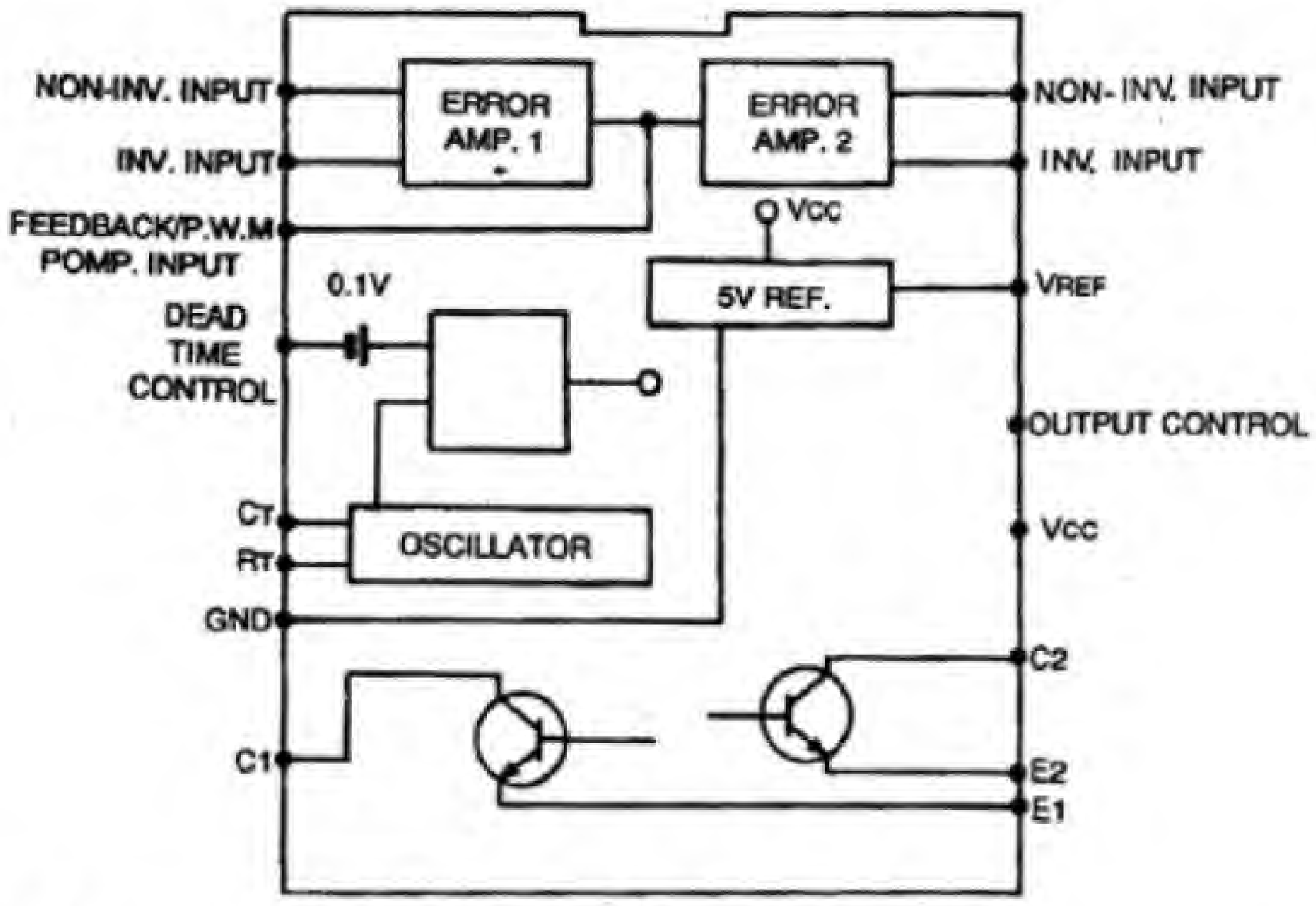


Fig. 5 : The internal diagram of IC TL494.

and return the remaining flyback energy to the supply. The voltage at the centre of T3 and T4 will eventually return to its orignal central value with a damped oscillatory action.

After a period defined by the control circuit, T3 will turn on, making the primary winding negative. The former process will repeat but with primary current in the opposite direction. The difference is that at the end of the on period, the junction of T3 and T4 will go positive, bringing D19 into conduction and returning the leakage inductance energy to the supply line. The junction of T3 and T4 will eventually return to the central voltage with a damped oscillatory motion. The cycle of operations is now complete and will continue. This waveform is shown in Fig.4.

As C5 and C6 are the main reservoir capacitors for the input filter, their value is very large. Consequently, the voltage at the junction point of the capacitors C5 and C6 will not change significantly during a cycle of operations.

Let us now consider the operation of secondary side of the switching transformer X3. When T4 turns on, the start of all the secondary windings (for 5V and 12V) will go positive. For 5V secondary, D20 will conduct. The current will flow from X4-3 and L3 into the capacitor bank C20 through C23 and external load.

When T4 turns off, the voltage on all transformer windings will fall, but the current will continue to flow in the secondary diodes as a result of forcing action of choke X4-3 and L3. When the secondary voltage has fallen to zero, diodes D20 and D21 share the inductor current almost equally, acting as flywheel diodes and clamping the secondary voltage at zero.

When the opposite transistor T3 turns on, similar operations result. Under steady state conditions, the current will increase in X4-3 and L3 during on period and decrease during off period with a mean value equal to the output current.

Ignoring losses, the output voltage is given by:

$$V_{out} = (V_{CC} \times D)/n$$

where Vcc is the primary voltage, n is turns ratio Np/Ns (with Np being primary turns and Ns being secondary turns), D is the duty ratio $[t_{on}/(t_{on}+t_{off})]$ with t_{on} the on-time and t_{off} being the off time.

Hence by using suitable control circuits to adjust the duty ratio, the output voltage is controlled and maintained at constant value for variations in supply or load. Operation is similar for the +12V, -12V and -5V output voltages.

As indicated, output voltage can be maintained at a contant by controlling the duty ratio, i.e on and off times. This is done in the circuit with the help of PWM IC TL494 which forms the heart of the controller section of PSU. TL494 is a fixed frequency, pulse width modulation controller. It incorporates an adjustable oscillator, a pulse width modulator and an error amplifier. Additional functions include over-current detection, dead time control, a precision 5V reference regulator and control logic which allows push-pull operation of the two switching transistors. Fig.5 shows the internal diagram of TL494.

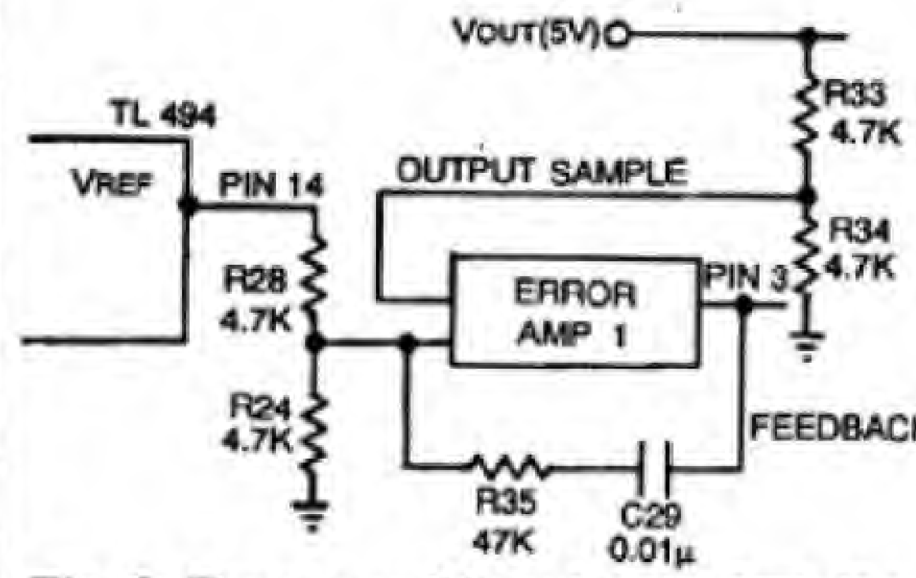


Fig. 6 : Error amplifier circuit of TL494.

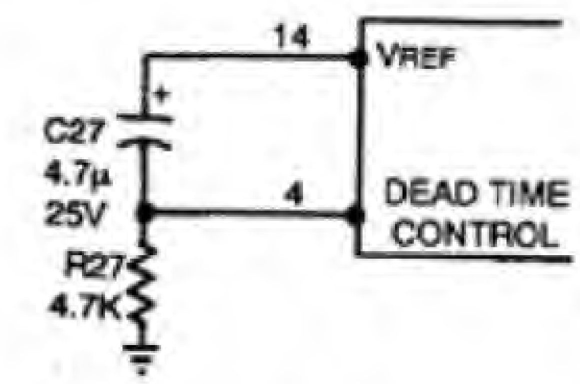


Fig. 7 : The soft-start circuit of TL494.

TL494 control circuit

Oscillator. The TL494 oscillator frequency is controlled by connecting an external timing circuit consisting of a capacitor and resistor to pins 5 and 6. The oscillator is set to operate at about 22 kHz using the component value calculated by the following equation :

$$f = 1/(2\,RC)$$

for push-pull operation where R is value of timing resistance R26 and C the value of timing capacitor C16.

Error amplifier. The error amplifier compares a sample of the 5V output to a reference and adjusts the pulse width modulator to mantain a constant output as shown in Fig. 6

The internal 5V reference of TL494 (pin 14) is reduced to 2.5V by R28 and R24 and the output voltage is also reduced to 2.5V by R33 and R34. To increase the stability of the error amplifier circuit, the output of error amplifier is fed back to the inverting input through R35, reducing the AC gain to 10.

Soft-start. To reduce stress on the

switching transistors at starting, the start-up surge which occurs as the output filter capacitor charges, must be reduced. The availibility of the dead time control makes implementation of a soft-start circuit relatively simple as shown in Fig. 7.

The soft-start circuit allows the pulse width at the output to increase slowly by applying a negative sloped waveform to the dead time control pin 4. Initially, capacitor C27 forces the dead time control input to follow the 5V reference which disables the outputs (100 percent dead time). As the capacitor charges through R27, the output pulse width slowly increases until the control loop takes command.

The soft-start time is generally in the range of a few hundred cycles. With the component values shown, the soft-start time can be calculated as follows:

Soft-start time = C27 x R27
= 22 msec

This helps to eliminate any false signals which might be created by the control circuit as power is applied.

Current limit circuit. The PSU has been designed to operate continuously at over 110W output load. The converter supply current is monitored by current transformer X2.

The induced pulses are rectified by diode D5 and filtered by R14 and C30 to produce a DC voltage proportional to the converter supply current. Potential divider formed by resistors R13 and VR1 produces a voltage of 2.5V at the maximum allowed load of 110W.

As the output load current increases, the converter supply current also increases, inducing more voltage in the current sense winding of transformer X2. This reduces the output pulse width, thus limiting the output load power up to a predetermined limit. By using a variable resistance the over-current limit of the circuit can be set accordingly.

Output driver stages. For push-pull operation (each output stage conducting alternately), output control pin 13 is connected to the internal reference voltage pin 14, enabling the pulse steering flip-flop. The flip-flop is toggled on the trailing edge of the pulse width modulated signal, gating it to each output alternately, thereby making the switching frequency of each output half the oscillator frequency.

The outputs of TL494 PWM, available at pins 11 and 8 for push-pull operation, are connected to driver transistors T1 and T2. Primary of centre tapped transformer X4 is switched alternately by these transistors, produc-

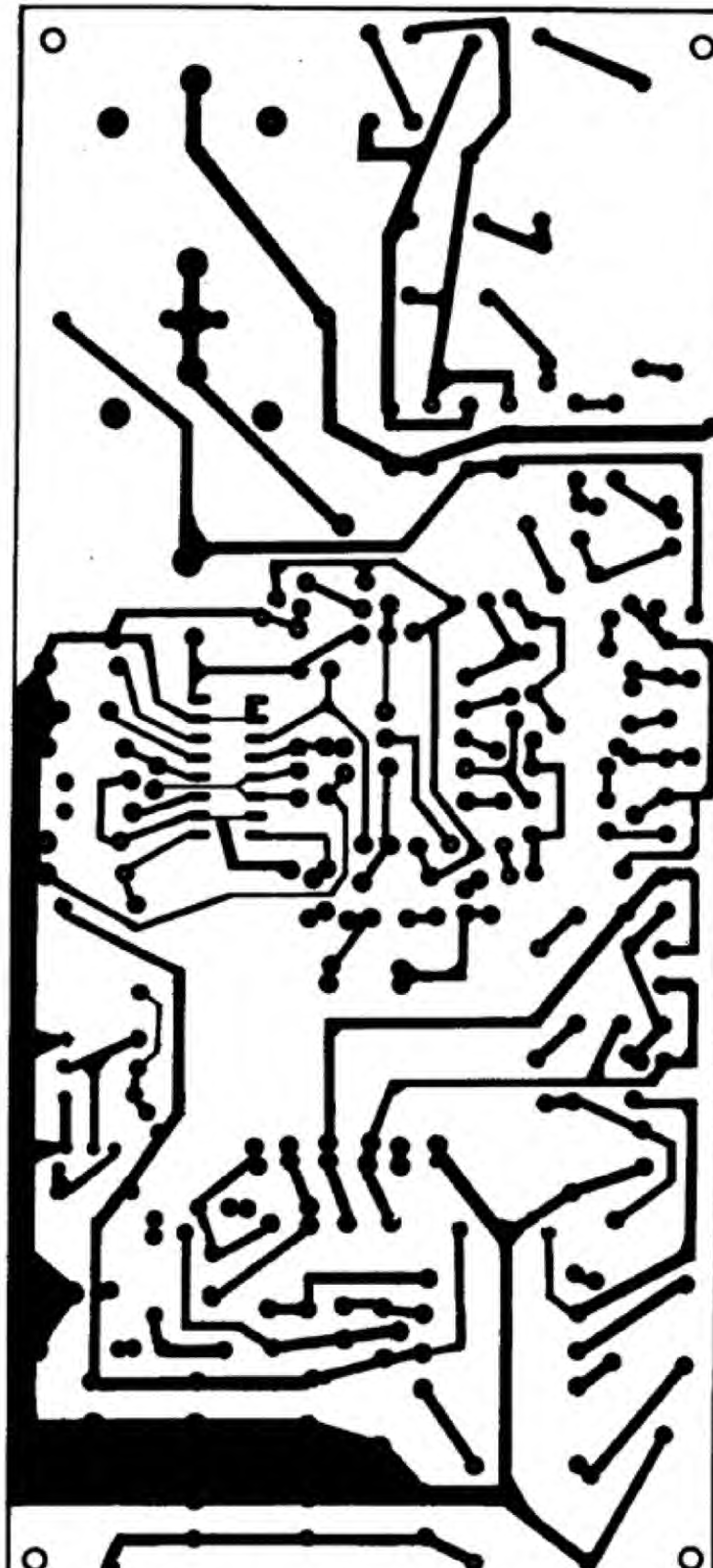


Fig. 8 : Actual-size PCB layout for the switched mode PSU.

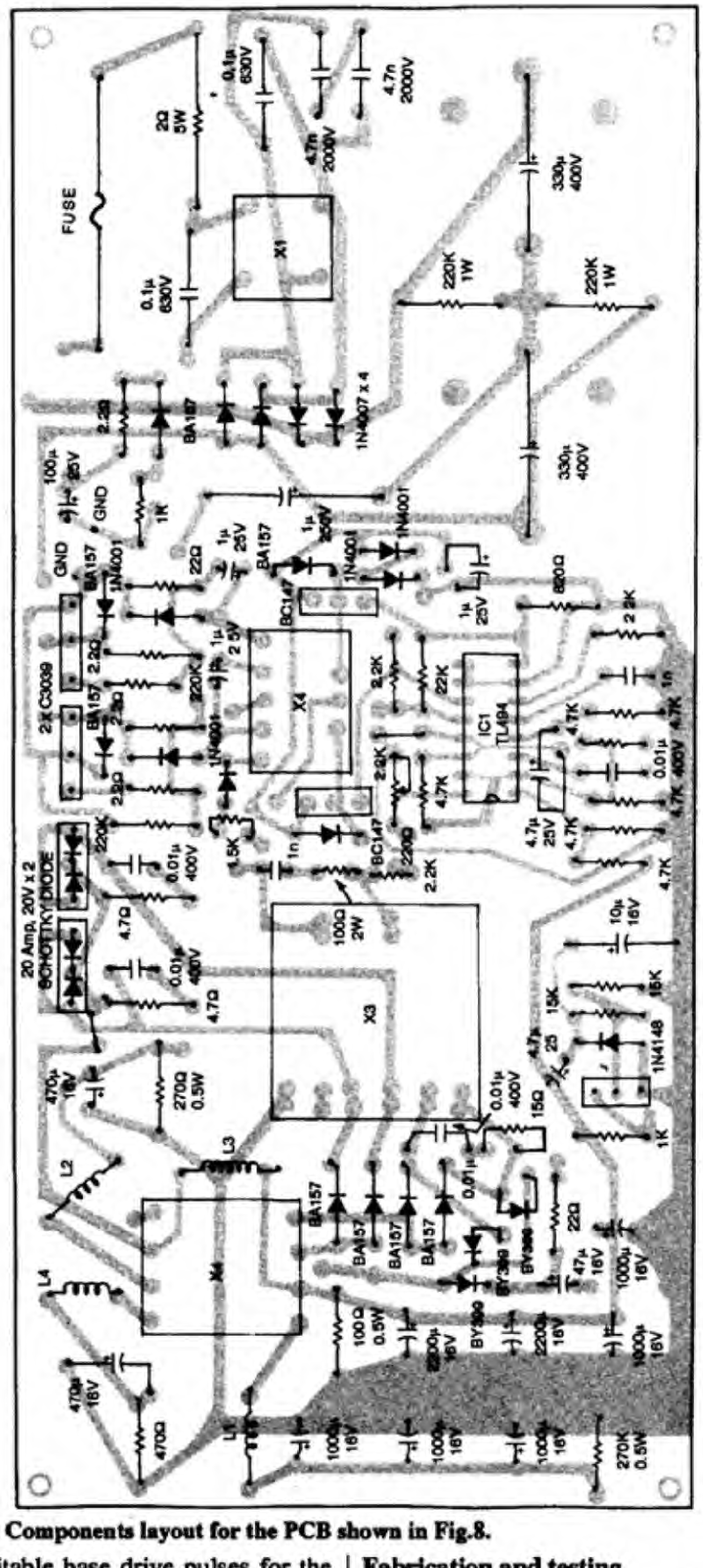


Fig. 9 : Components layout for the PCB shown in Fig.8.

ing suitable base drive pulses for the power transistors T3 and T4.

TL494 gets its supply voltage from the 12V output through D10, C13, R5 and C26.

Fabrication and testing

Fig. 8 shows the solder side PCB layout for the circuit diagram and Fig. 9 shows the components layout for it.

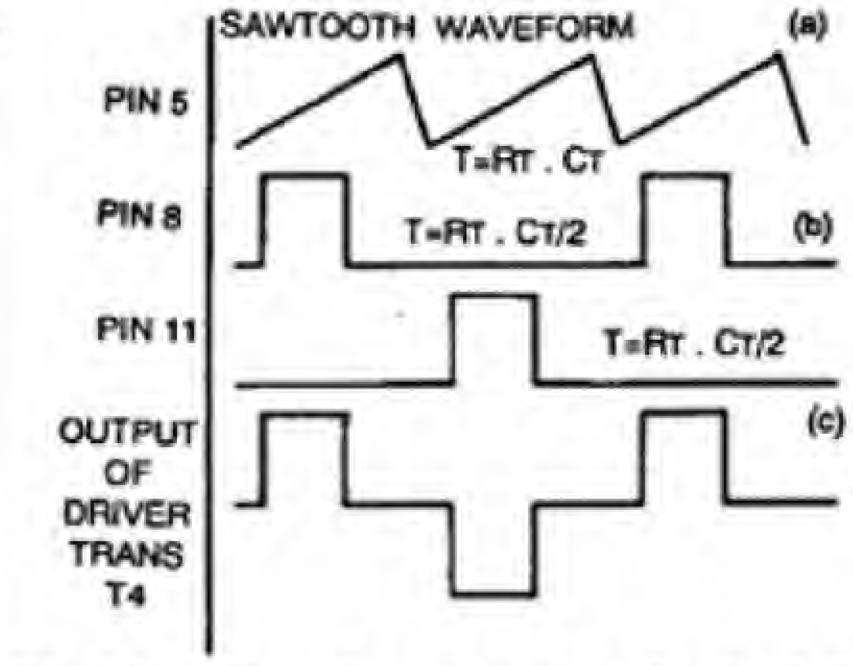


Fig.10 : Waveforms to be checked for testing operation.

The circuit can be constructed on a glass epoxy or paper phenolic PCB, though it is advisable to use glass epoxy sheet for better mechanical strength.

First, wire the AC input section. Measure the input mains voltage and connect it to input supply points L, N and E. Now measure the output DC voltage across R2 and R3 with the help of multimeter. It should read about 1.4 times the input AC supply voltage.

Next wire the pulse width modulator section together with power converter driver and 'power good' signal generator circuit. For testing this part of the circuit, an external 12V supply and an oscilloscope are required. Apply +12V between anode of D10 and ground to check for the following waveforms on the oscilloscope:

1. A saw-tooth waveform on pin 5 of IC1 (Fig. 10 (a)).

2. A rectangular pulse waveform having half the oscillator frequency on pins 11 and 8. These pulses will be non-overlapping (Fig.10 (b)).

3. Bipolar pulses at both the secondary windings of transformer X4 (Fig.10 (c)).

After completing and checking this portion, wire the remaining circuit. Transistors T3 and T4 along with diodes D20 and D21 should be properly mounted on the heatsink. Diodes D6 and D8, though in axial package, should be mounted such that their bodies touch the surface of the heatsink and the leads are not cut too short. This helps in better heat dissipation from the diodes.

Connect a 10k preset in place of VR1 and preadjust its value to about

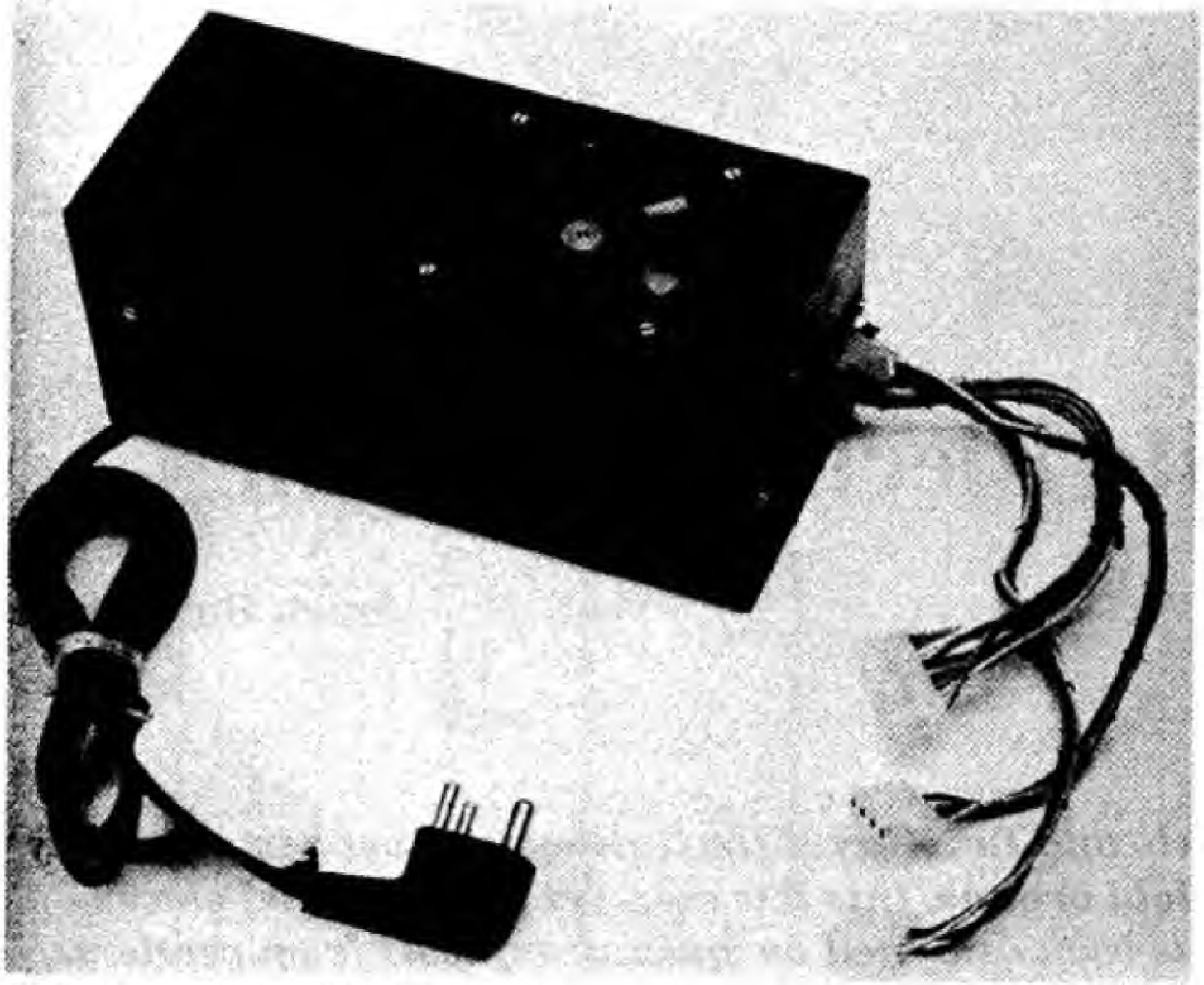


Photo I: External view of the PSU chassis.

2.2k. After completing the soldering connect 12V instrument cooling fan to the 12V output point and keep it near the board so as to provide sufficient cooling to all heatsink mounted components. Plug-in the fuse and switch on the supply.

Check all the output voltages and a high level PG signal. Next check the supply under light load condition and gradually increase the load up to its rated value. Observe the driver pulses at full load. They should be clean and free from any instability. Trim the value of preset for overload condition, measure its value and replace it with same value as VR1.

The supply should be tested for a minimum of four hours at about 70 per cent of its rated value and for about an hour at its full rated value.

After checking the operation of the PSU, connect the output leads and connectors as per details given in Fig. 1. Recheck the voltages on each pin of all the four connectors and PG signal. PSU is now ready for interface with the PC.

Mechanical details

Photos 1 and 2 show the internal and external views of the PSU chassis. The cooling fan is mounted on the top cover with its face oriented such that it sucks air into the chassis. The exit for the air is provided on the back cover behind the transistor and diode heatsinks.

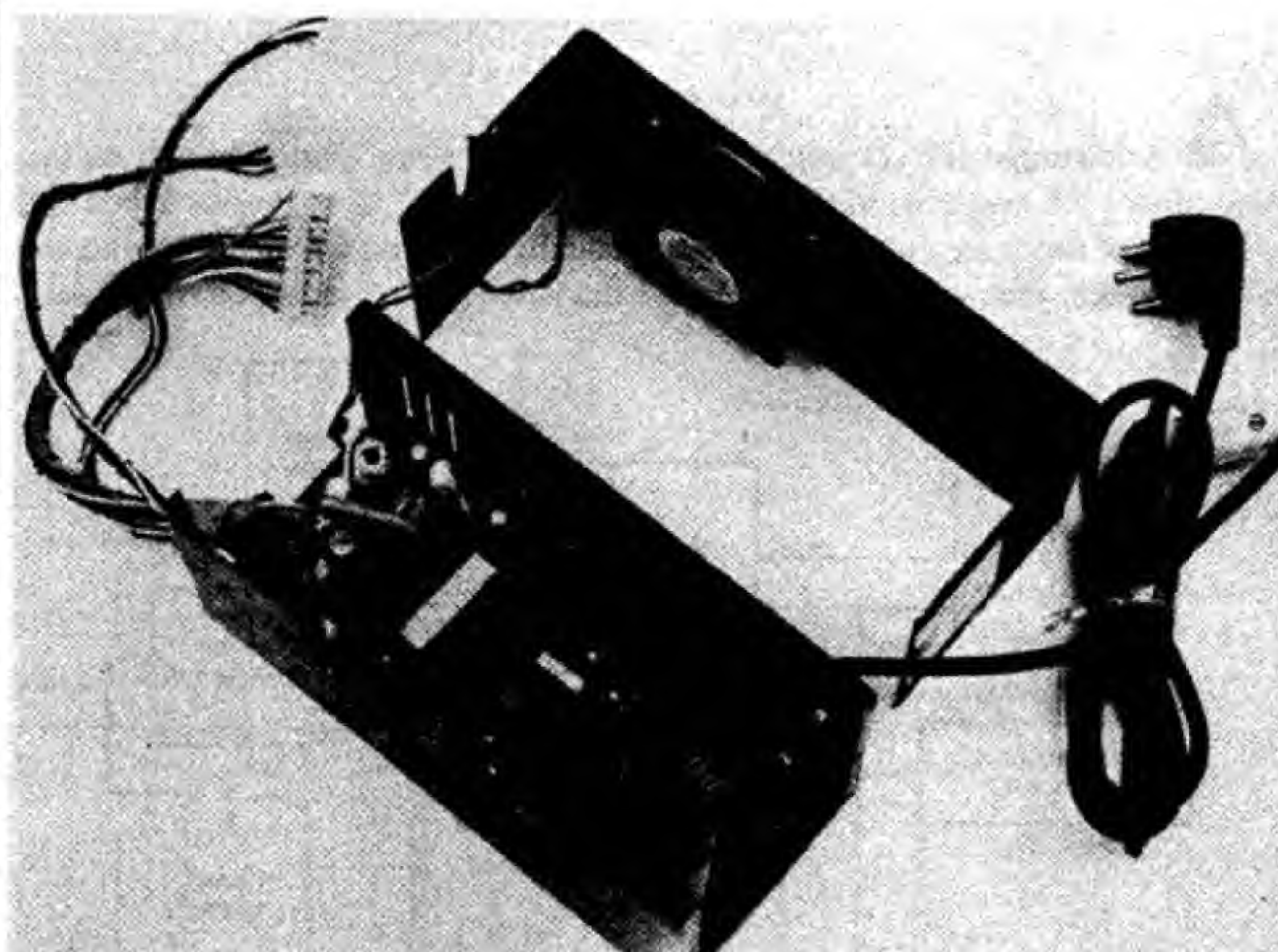


Photo II: Internal view of the PSU chassis.

Precautions

The following precautions should be observed during fabrication and testing of the PSU:

1. Transformer X1 should be wound using bifilar windings.

2. Output of current transformer X2 connected to diode D5 should be such that a positive pulse appears when the current flows into the core through the leg of capacitor C7.

3. Transformer X3 should be wound observing correct winding polarities (as shown by dots in Fig.3).

4. For choke X4 all the windings are wound in the same direction but the current is fed from opposite direction for negative output voltages as per PCB.

5. While checking the operation of the PSU, it is strongly recommended that an isolation transformer be used on the mains input side of the PSU or oscilloscope.

6. PCB contains unisolated mains supply voltages. Hence, due care should be taken while checking its operation.

7. You must be fully satisfied with the working of PSU before interfacing it with your PC.

Composite Electronic Organ

Amrit Bir Tiwana

Keeping in view the high costs and functional limitations of most commercially available electronic musical organs, this low cost, yet full featured eleven octave electronic organ has been designed on special requests from readers.

A wide range of electronic organs and pianos are available in the market but most of these are either too expensive or their characteristic operative frequencies are limited to just an octave or two. The former types are usually based on CMOS LSIs whereas the latter types consist of a simple usually transistorised AFO and a string of resistors (which results in rather non-standard notes).

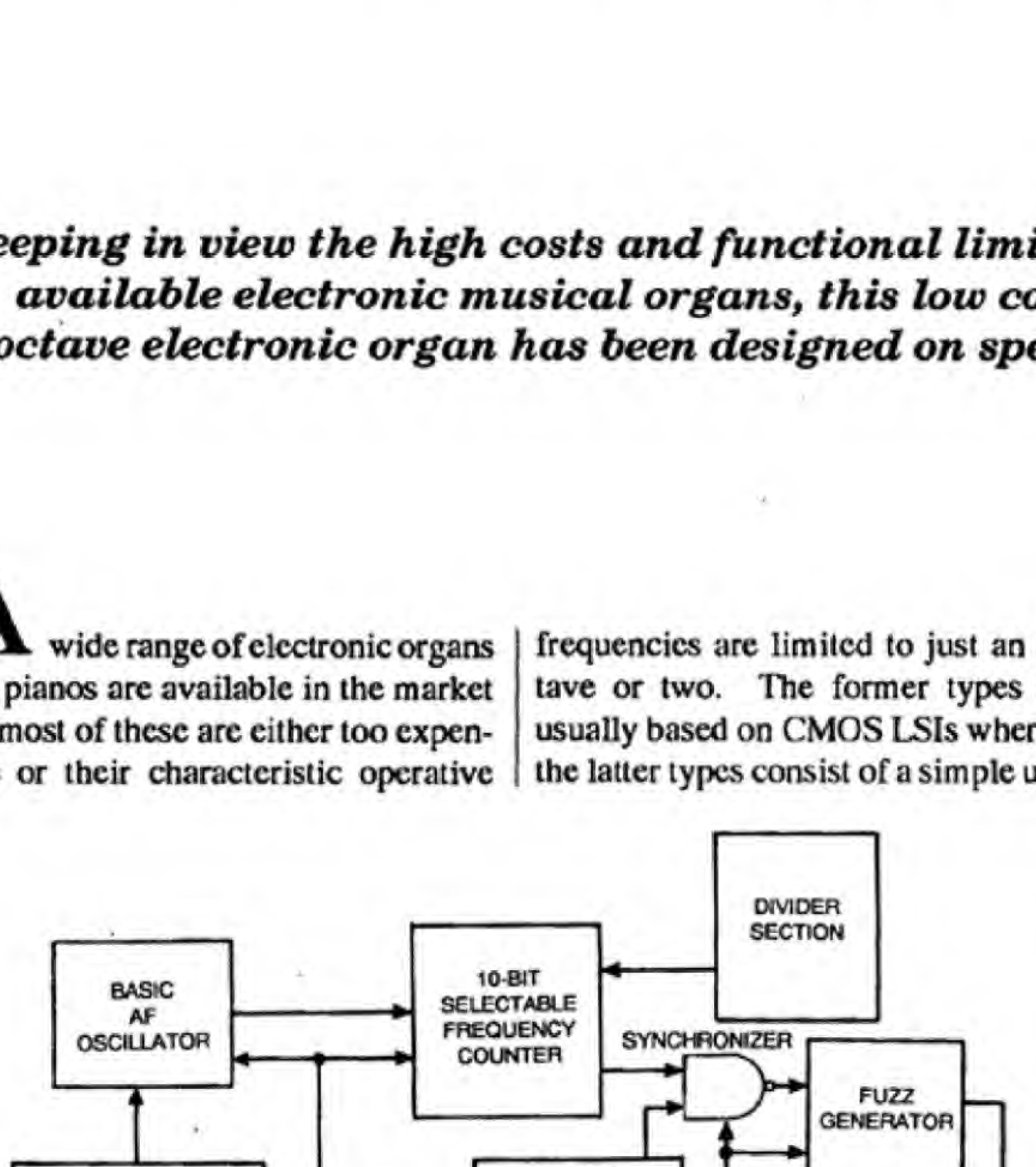


Fig. 1: Block diagram of composite electronic organ.

The functional and constructional details of a 'composite electronic organ', featuring a perfect balance between the operative characteristics and cost, are described here. The piano uses the chromatic scale and is capable of working in 0 to 10 octaves, with a tone-semitone of a 12-key keyboard. Special effects like vibrato and fuzz have also been incorporated. The piano has an internal amplifier, which delivers an output of several hundreds of milliwatt, and hence is capable of working independently. In order to keep battery drain low, the piano is usually built using easily available CMOS ICs. The complete organ circuit costs around Rs 80.

The fundamentals

The organ is based on the chromatic scale; the modified diatonic with semitones. The scale consists of twelve

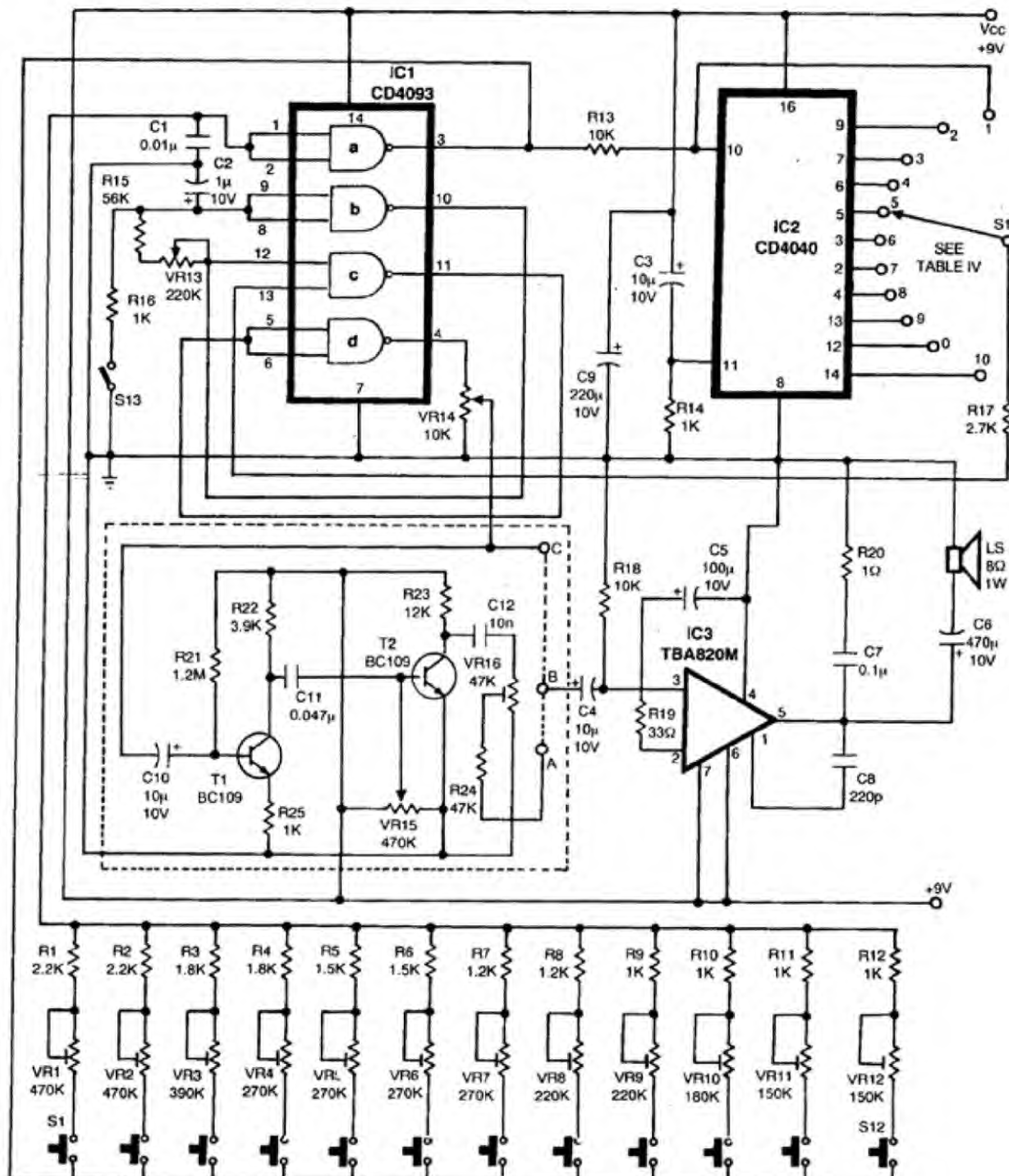


Fig.2: Main circuit diagram of composite electronic organ.

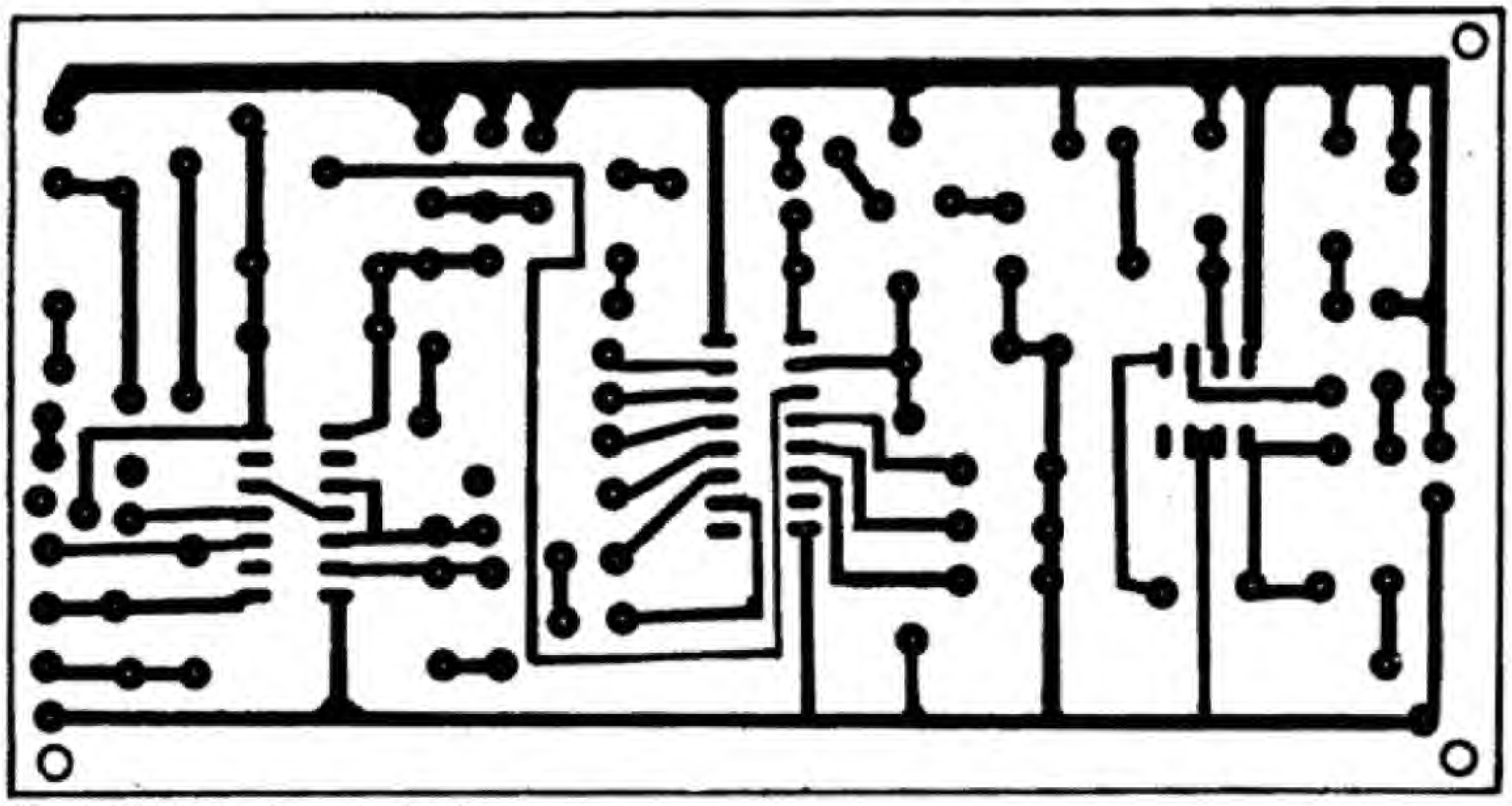


Fig. 3: PCB layout for main circuit.

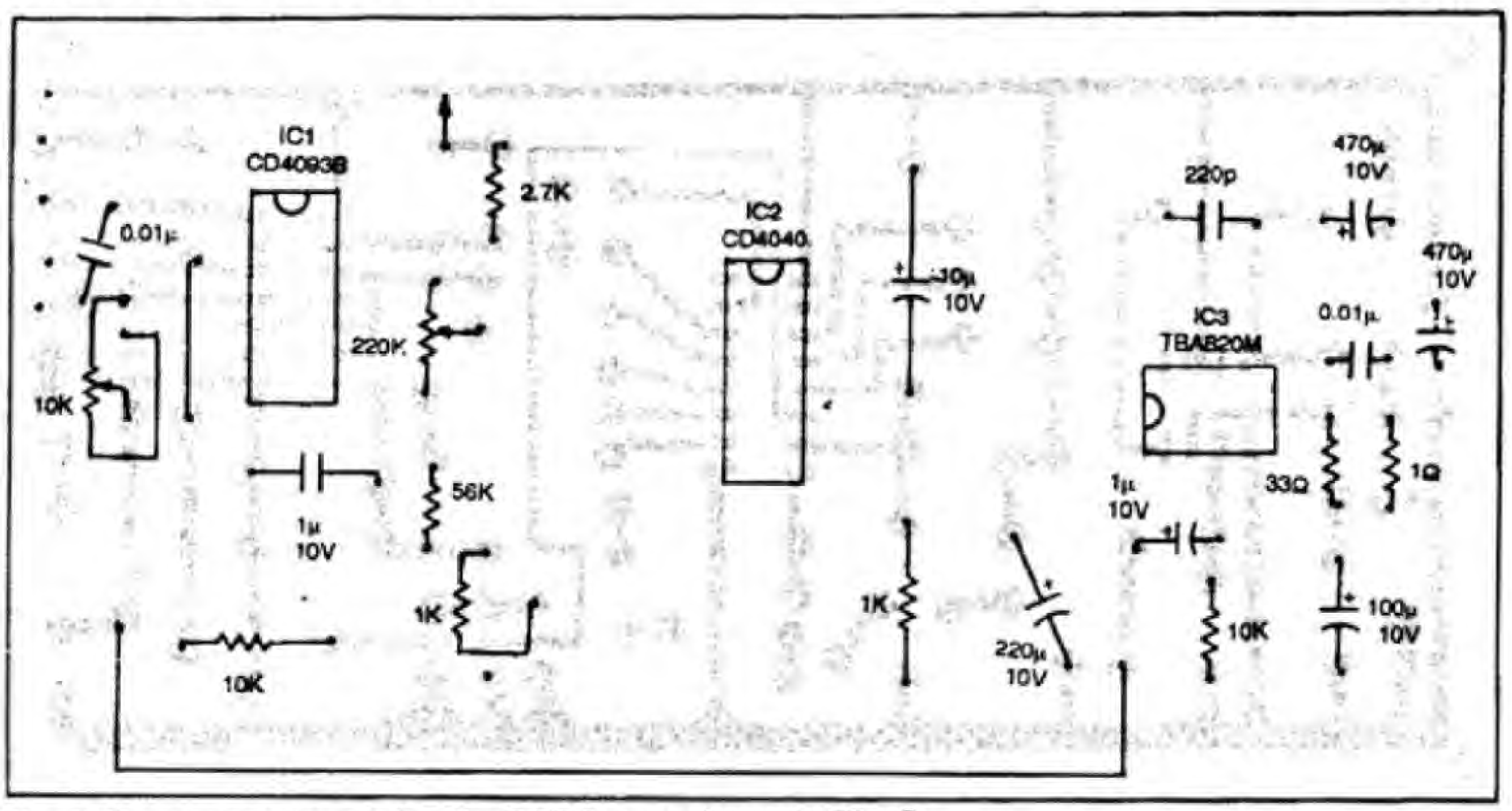
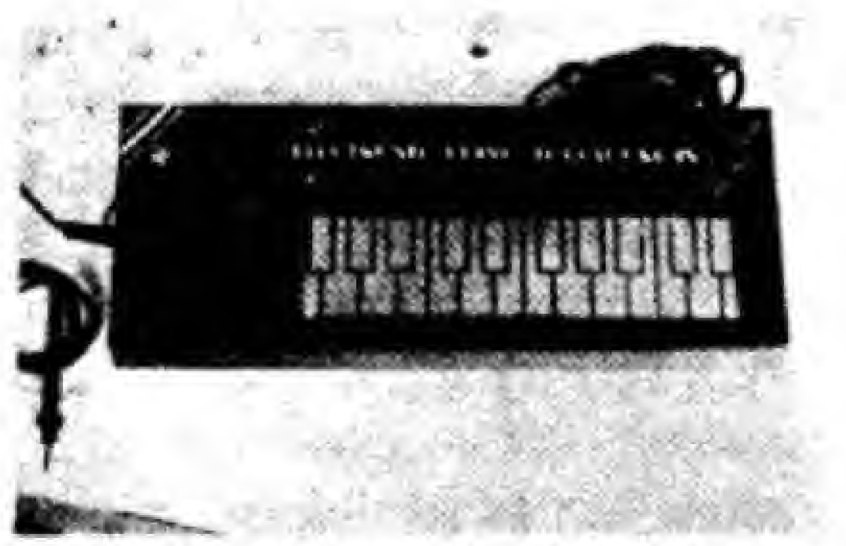


Fig. 4: Component layout for the PCB layout shown in Fig. 3.

Table I
Frequencies and Octaves of musical notes

Note	0	1	2	3	4	5	6	7	8	9	10
C	16.4	32.7	65.4	130.8	262.0	0.53K	1.05K	2.1K	4.2K	8.37K	16.744K
C#	17.3	34.7	69.3	138.6	277.2	0.56K	1.1K	2.22K	4.44K	8.87K	17.74K
D	18.4	36.7	73.4	146.8	293.7	0.59K	1.12K	2.35K	4.7K	9.4K	18.8K
D#	19.5	38.9	77.8	155.6	311.0	0.62K	1.25K	2.49K	4.98K	9.96K	19.9K
E	20.6	41.2	82.4	164.8	329.7	0.66K	1.32K	2.64K	5.28K	10.55K	21.1K
F	21.8	43.7	87.3	174.6	349.3	0.698K	1.4K	2.8K	5.59K	11.18K	22.4K
F#	23.1	46.3	92.5	185.0	370.0	0.74K	1.48K	3.0K	6.0K	11.84k	23.7K
G	24.5	49.0	98.0	196.0	392.0	0.78K	1.6K	3.14K	6.28K	12.55K	25.08K
G#	26.0	51.9	104.0	207.7	415.3	0.83K	1.67K	3.32K	6.64K	13.29K	26.56K
A	27.5	55.0	110.0	220.0	440.0	0.88K	1.76K	3.52K	7.04K	14.08K	28.2K
A#	29.2	58.3	116.6	233.0	466.2	0.933K	1.87K	3.73K	7.46K	14.92K	29.8K
B	30.9	61.7	123.5	247.0	493.9	0.988K	1.98K	3.95K	7.9K	15.8K	31.6K



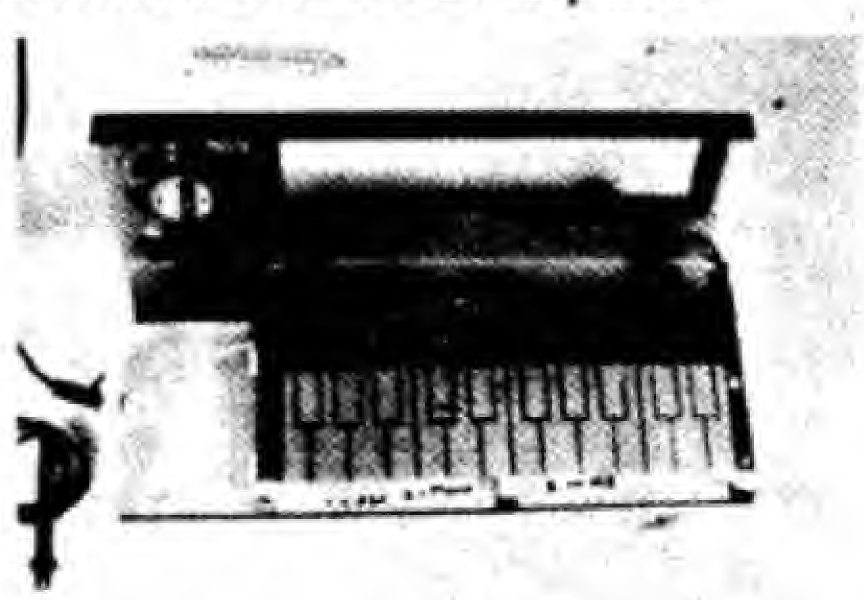
External view of composite electronic organ.

notes in each octave, seven of which are 'flat' and five 'sharp'. The ideal, standard and practical (rounded off) notes and their frequencies in eleven octaves are given in Table I. These frequencies are based on 440Hz as treble 'A'. The frequency increment in each note of an octave is 0.595 times, i.e. the note is 1.0595=1.06 times that of the previous one.

In actual practice, as clear from Table I, this would mean the use of 132 push-buttons and several hundreds of timing resistors to obtain all the notes. But as shown in Table I, the actual frequency of each note in each successive octave is precisely double. Utilising this fact, the same note may be produced in the octaves 10 to 0 by dividing the frequency of the note in the 10th octave by 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, and 1024 respectively. This may be easily done using a selectable multibit binary counter. Special effects like tremolo etc may be effectively gated and synchronised with the final output frequency.

The circuit

The block diagram of the complete organ is given in Fig.1. The organ consists of a basic tone generator (AFO), a vibrato oscillator, a multistage frequency divider, a signal combiner, a frequency selector and an audio amplifier.



Internal view of composite electronic organ.

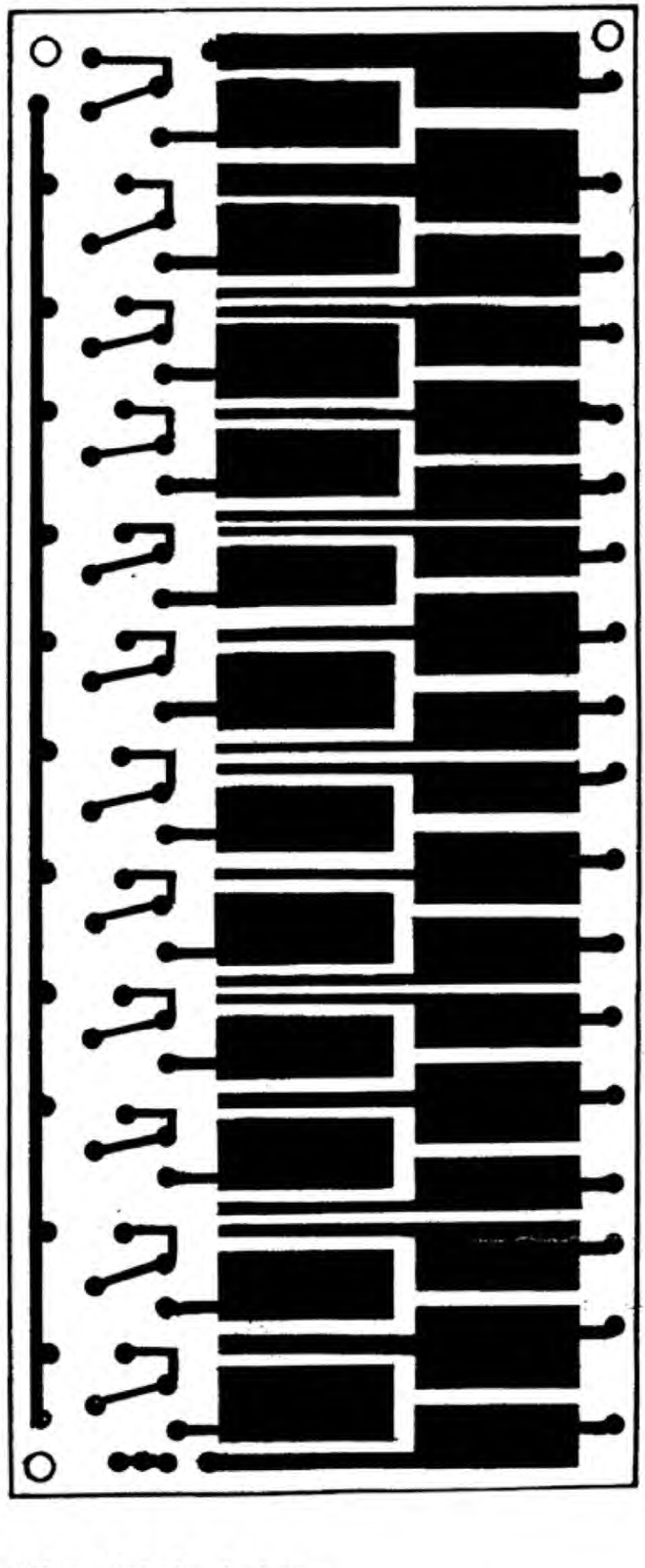


Fig. 5: PCB layout for keyboard switches.

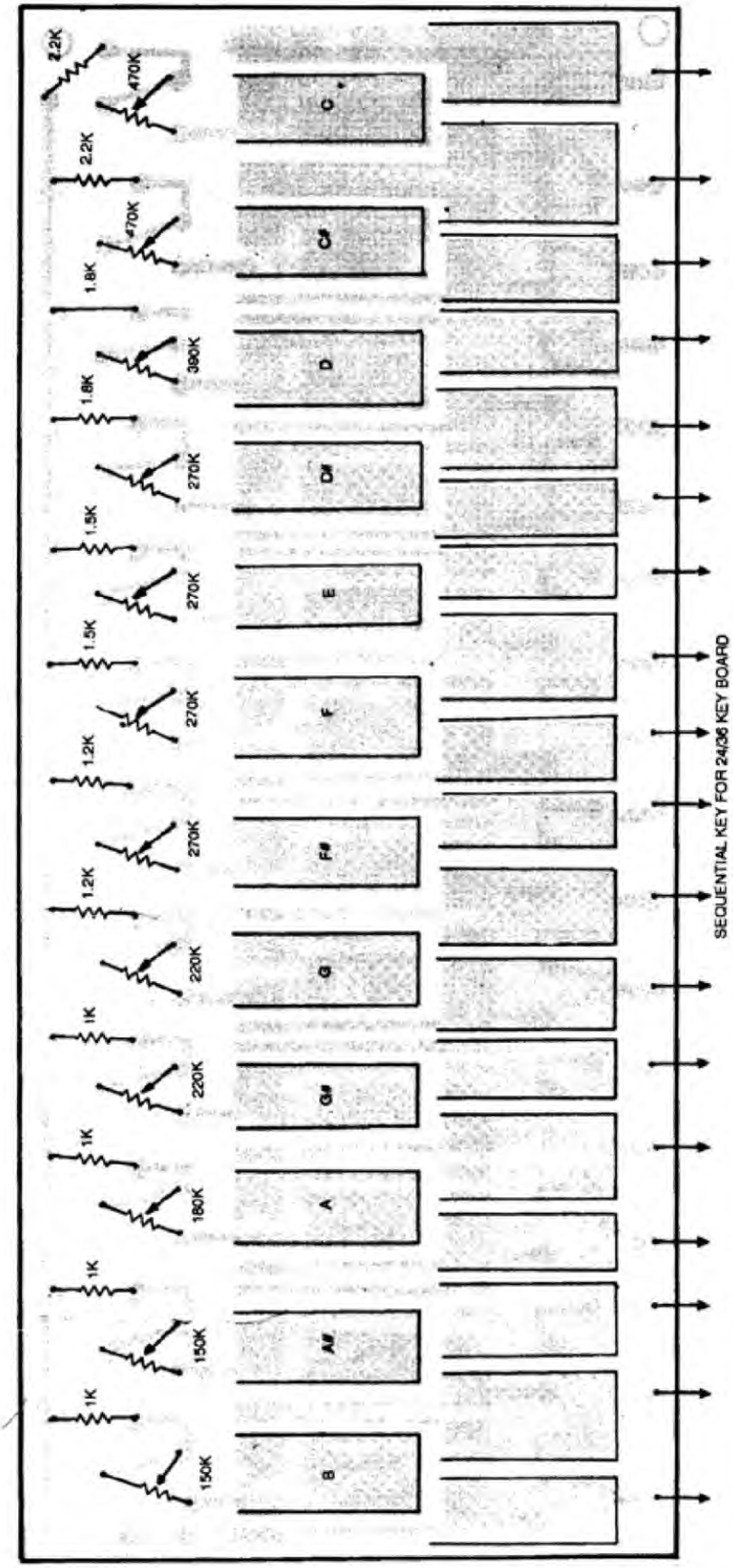


Fig. 6: Component layout for the PCB layout shown in Fig. 5.

IC1, a CD 4093, contains four independent 2-input schmitt NAND gates. NAND gate 'a', accompanied with the keyboard resistors and C1, forms the AFO. The frequency of the oscillator, which may be between 16Hz and 32kHz, is determined by the values of C1 and Rk, where Rk is the resistor selected by the keyboard switches S1 to S12. The output of this section is fed to the divider IC2, CD4040, the divisions of which are selected by the 11-position switch S14. The 12-stage binary counter has 12 dividing outputs as shown in Table II. Only the first 10 stages are used here. S14 is used to select the functional octaves.

The output of this IC is fed to gates 'c' and 'd' which are used to 'gate in' the vibrato input. The vibrato LF oscillator is built around gate 'b' and the oscillative components C2, R15 and VR13. VR13 is used to control the vibrato frequency which should preferably lie in the infrasonic range. S13 is used to enable/disable the vibrato effect.

The final output is taken through and fed to the AF amplifier section through VR14 which serves as the volume control. The fuzz generator is built around two low power and low noise transistors. The circuit, as shown in Fig. 2 in the dotted lines, is purely optional. In case it is not needed, it may be bypassed by connecting points B and C. C4 serves as the input coupling capacitor. The AF section is built around IC3, a low voltage TBA820 amplifier. C6 serves as the output coupling capacitor. R20 and C7 form a zoebel network which aids in the stability of the amplifier. This IC in turn drives the speaker. In order to drive an external amplifier, the output should be taken from the wiper of the volume control pot. If no volume control is needed, then VR14 may be omitted.

In practice, the notes are played on the keyboard switches, S1-S12 and S14 is used to shift from one octave to the next. Such slide switches usually have more than one pole and in such cases the octave indicator shown in Fig. 7 may be added. (If such slide switch is not easily available then a rotary type

PARTS LIST

Semiconductors:		VR8, VR9	— 220-kilohm preset
IC1	— CD4093B, quad 2-input schmitt NAND gates	VR10	— 180-kilohm preset
		VR11, VR12	— 150-kilohm preset
		VR13	— 220-kilohm pot.
IC2	— CD4040, 12-bit binary ripple counter	VR14	— 10-kilohm linear pot.
		VR15	— 470-kilohm preset
IC3	— TBA820M, low voltage amplifier	VR16	— 47-kilohm preset
		VR17, VR18	— 100-kilohm preset
IC4	— 7809, 9V voltage regulator		
		Capacitors:	
IC5	— LM387, Op-amp	C1, C12	— 0.01µF, ceramic disc
T1, T2	— BC109, transistor	C2	— 1µF, 10V electrolytic
D1-D4	— 1N4001, diode	C3, C4, C10	— 10µF, 10V electrolytic
D5	— 1N4007, diode	C5	— 100µF, 10V electrolytic
Resistors (all 1/4W, ±5% carbon unless stated otherwise):		C6	— 470µF, 10V electrolytic
R1, R2	— 2.2-kilohm	C7	— 0.1µF, ceramic disc
R3, R4	— 1.8-kilohm	C8	— 220pF, ceramic disc
R5, R6	— 1.5-kilohm	C9	— 220µF, 10V electrolytic
R7, R8,	— 1.2-kilohm		
R9-R12, R14,		C11	— .047µF, ceramic disc
R16, R25	— 1-kilohm	C13	— 1000µF, 16V electrolytic
R13, R18,			
R37-R39	— 10-kilohm	C14	— 100µF, 16V electrolytic
R15	— 56-kilohm		
R17	— 2.7-kilohm	C15, C22	— 4.7µF, 16V electrolytic
R19	— 33-ohm		
R20	— 1-ohm	C16, C17	— 0.033µF, ceramic disc
R21	— 1.2-megohm	C18, C19	— 3.3nF, ceramic disc
R22	— 3.9-kilohm	C20	— 1µF, 16V electrolytic
R23, R40,		C21	— 10µF, 16V electrolytic
R41	— 12-kilohm		
R24	— 47-kilohm	*Miscellaneous:*	
R26-R35	— 680-ohm	X1	— 220V AC Pri. 0-12V AC, 350 mA Sec. transformer
R42	— 180-kilohm		
R43	— 1-megohm		
R44	— 180-ohm	LS	— 8-ohm, 1W speaker
VR1, VR2	— 470-kilohm preset	S1-S13, S16	— Push-to-on switch
VR3	— 390-kilohm preset	S36	
VR4-VR7	— 270-kilohm preset	S14, S15	— 1-pole, 12-way switch

Fig. 7: Optional octave indicator.

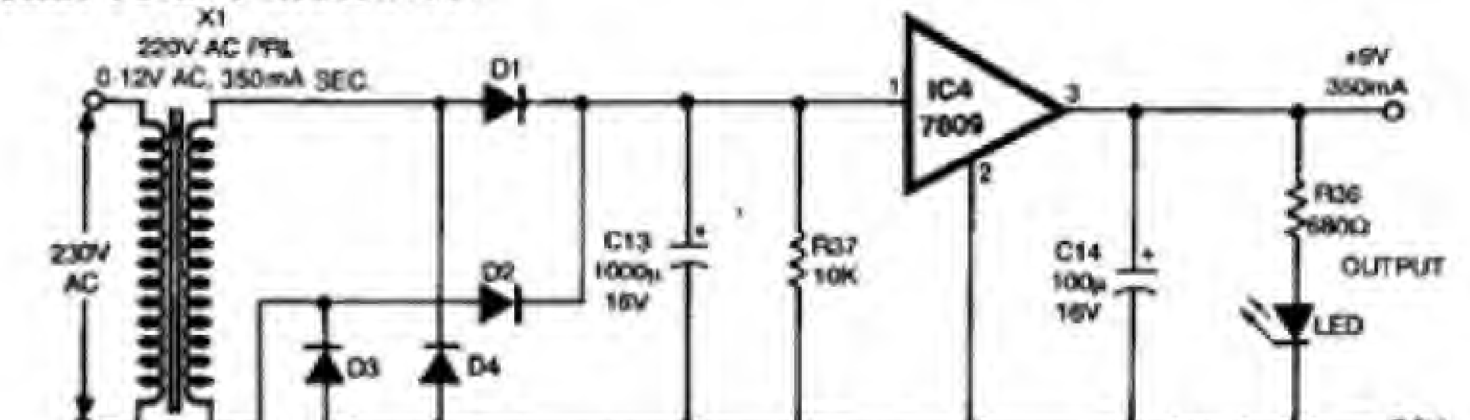


Fig. 8: Power supply arrangement for the composite electronic organ.

may be used instead.)

If desired, the active tone control, built around an LM387 (Fig. 9), may be introduced between points B and A/C. VR17 and VR18 are used for bass and treble control respectively.

Power supply

Although designed for 9 volt operation, the organ can operate from voltages ranging from 6 to 15 volts, after slight modification. Battery operation is preferred for most applications. For mains operation, the circuit given in Fig. 8 may be used.

The circuit consists of a full-wave rectifier and filter followed by a 3-terminal fixed 7809 regulator chip. LED monitors the working of the circuit and R37 helps in speedy discharge of the filter capacitor, which may otherwise result in the damage of IC7809, when the power supply is turned off. The circuit delivers a precise 9-volt output, ±1%, @350mA. A small aluminium heatsink may be attached to IC4 if necessary.

Construction

The complete organ is constructed on two PCBs. One PCB accommodates the main circuitry while the second contains the keyboard and the tuning resistors. A PCB keyboard has been used as the use of pushbuttons (computer types) will increase the cost tremendously and the same are not available easily. Utmost care should be taken while soldering the components, especially the semiconductors. (Beginners may please refer to the Feb '90 issue of EFY.) The use of sockets is mandatory in case of ICs. The PCBs and their corresponding layouts are given in Fig 3, 4, 5 and 6.

The sequence of soldering the components should be resistors, presets, capacitors and semiconductors. All soldering should be done using the 60/40 type of core and a 10-watt soldering rod. The keyboard PCB should be nickel or tin plated.

All inter wiring should be done using 8-way ribbon cable. The colour code may be followed to facilitate easy

Table II
Frequency divisors in the CD4040 counter (First 10 stages)

Output	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Pin No.	9	7	6	5	3	2	4	13	12	14
Divisor	2^1	2^2	2^3	2^4	2^5	2^6	2^7	2^8	2^9	2^{10}
Divisions	2	4	8	16	32	64	128	256	512	1024

Table III
Preset frequency adjustment table

Preset to be set	VR1	VR2	VR3	VR4	VR5	VR6	VR7	VR8	VR9	VR10	VR11	VR12
Operative octave	10	10	10	10	10	10	10	10	10	10	10	10
Frequency	16.75K	17.74K	18.8K	19.9K	21.1K	21.4K	23.7K	25.1K	26.5K	28.2K	29.8K	31.6K

Table IV
Positions of octave selector and corresponding octaves

Position	I	II	III	IV	V	VI	VII	VIII	IX	X	0
Octave	9	8	7	6	5	4	3	2	1	0	10

Note: K = Kilohertz/Kilohm (in lists)
All other frequencies are in hertz in the tables.

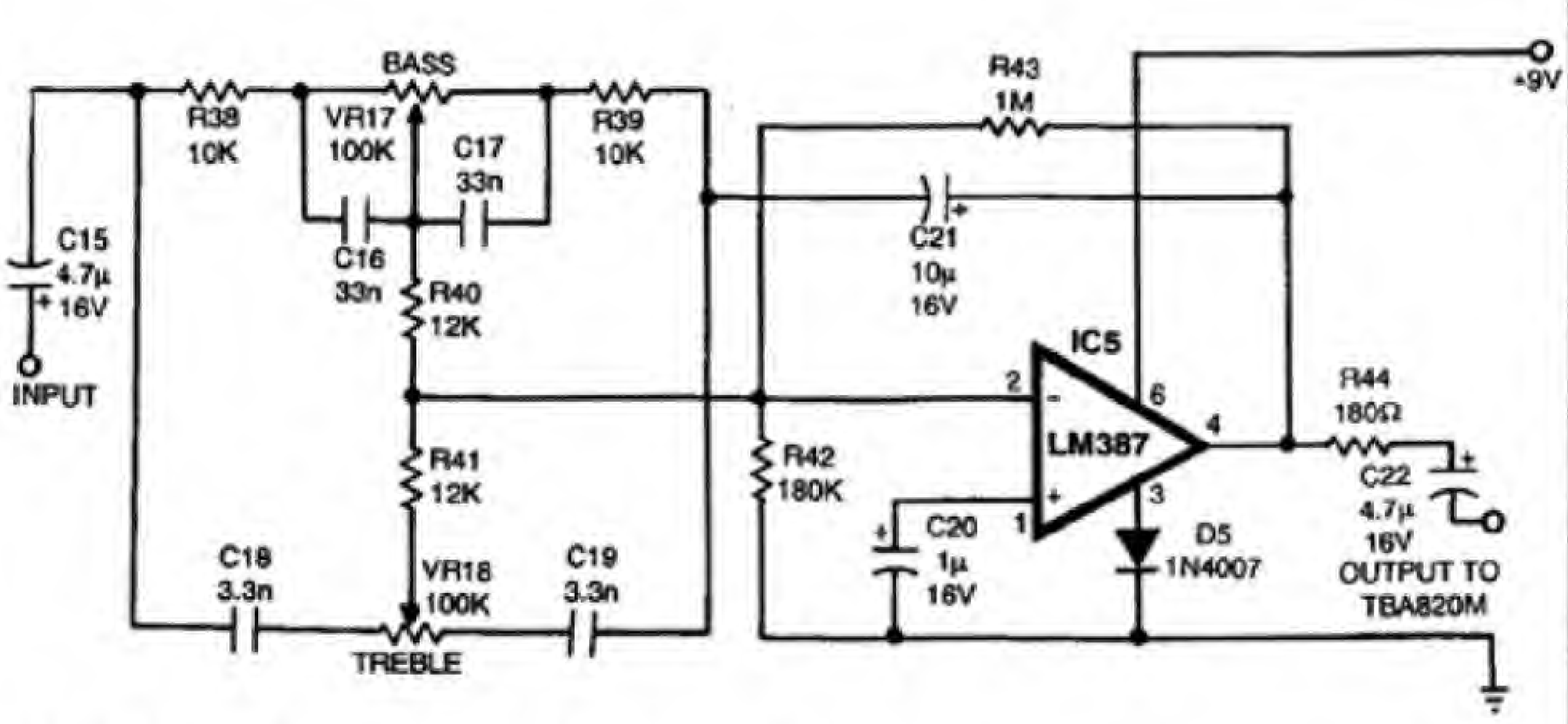


Fig. 9: Active tone controller for the organ.

checking and fault finding in future. (Let's hope the other way!).

A fine multimeter lead and old telephone coiled cable with a ball point tip pen or audiojack... Just any thing can serve as the probe.

The complete circuit should be checked after which it may be housed in a suitable cabinet. Various cabinets are available in the market for this purpose. (The author used a metallic cabinet which was obtained from Gala Electronics, 20 Kalpana Bldg, 357 Lamington Road, Bombay 400 007, at the cost of Rs 85). In case of difficulties in etching the PCBs, the readers may obtain them directly from EFY associates, Kits 'n' Spares (46 Nehru Place, 303 Dohil Chambers, New Delhi 100 019) or may use other similar PCBs after slight modifications. As shown in the photographs, the PCB is fixed on the front panel, and the speaker on the front frame, alongwith the fuzz and vibrato controls. The other switches may be fixed on the back panel, along with the volume controls. The volume control may be eliminated if not required. The PCBs should be mounted away from the transformer (if used).

Testing

After the unit is constructed, it must be tested for proper operation. For this keep the vibrato enable-disable switch in disable position and feed in a square-wave of 100 kHz frequency at the input of IC2, from a CMOS compatible source. The output frequencies at the first 10 outputs and the output of N1 must be tallied with Table II. The output frequencies with respect to ground, starting from N1, Q1 to Q10 must equal 100kHz, 50kHz, 25kHz, 12.5kHz, 6.25kHz, 3170Hz, 1587.5Hz, 793.75Hz, 396Hz, 198Hz, 99Hz. If all is well, the unit is ready to set.

Adjustments

After proper assembly and testing, the organ needs to be set to produce notes of the standard frequencies. Initially VR1 to VR12 should be kept in the maximum resistance position. Now

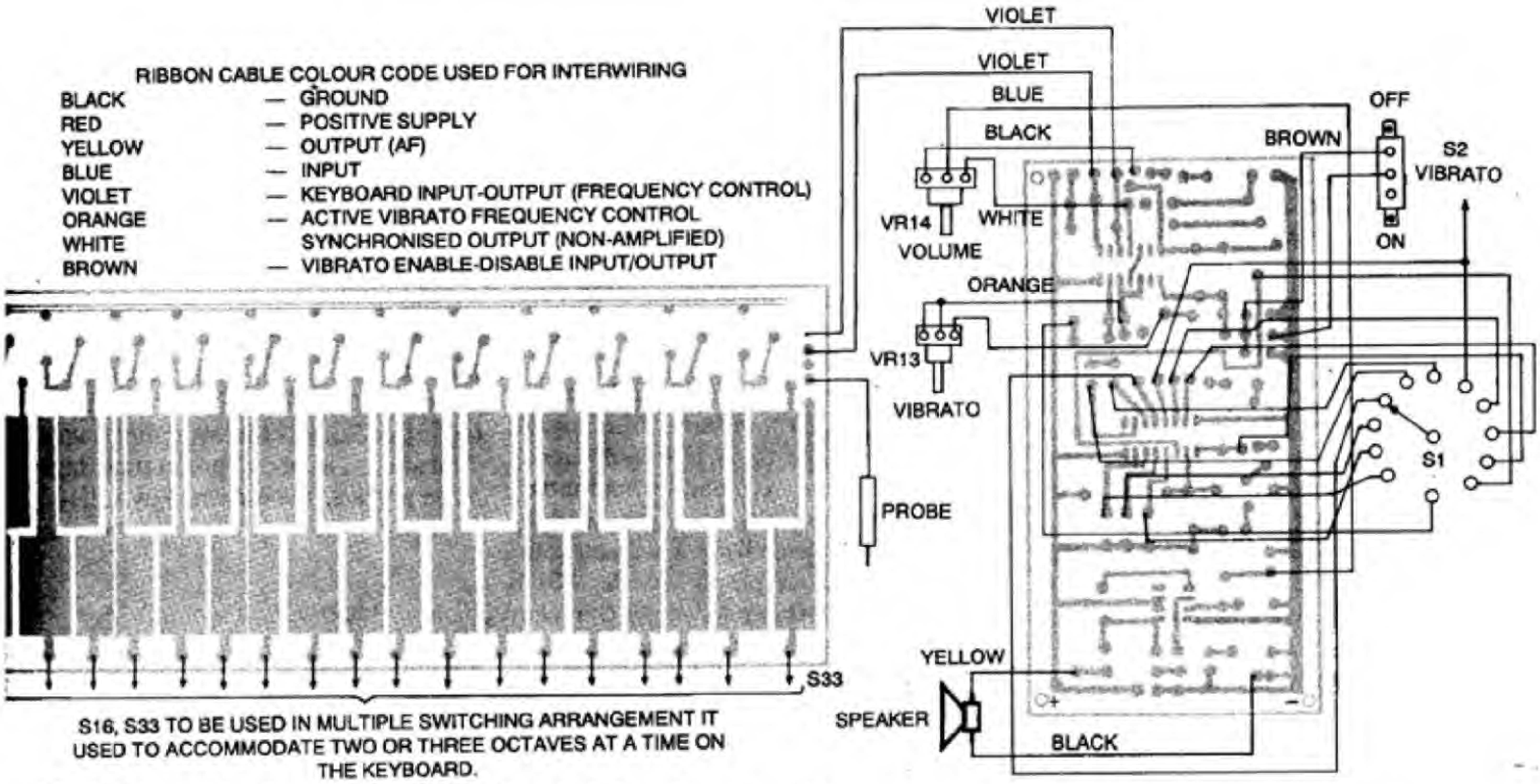


Fig. 10: Interwiring between the two PCBs and off-board components.

a frequency meter should be connected between the output and Ground. VR1 should then be adjusted to produce a note of 16.75 Hz frequency. Similarly, the remaining presets should be adjusted to produce the frequencies listed in Table III. Now each key will produce a note of approximately 1.06 times that of the previous.

Your composite electronic organ is now ready. So go ahead and discover the Bon Jovi in you! □

Readers' comments:

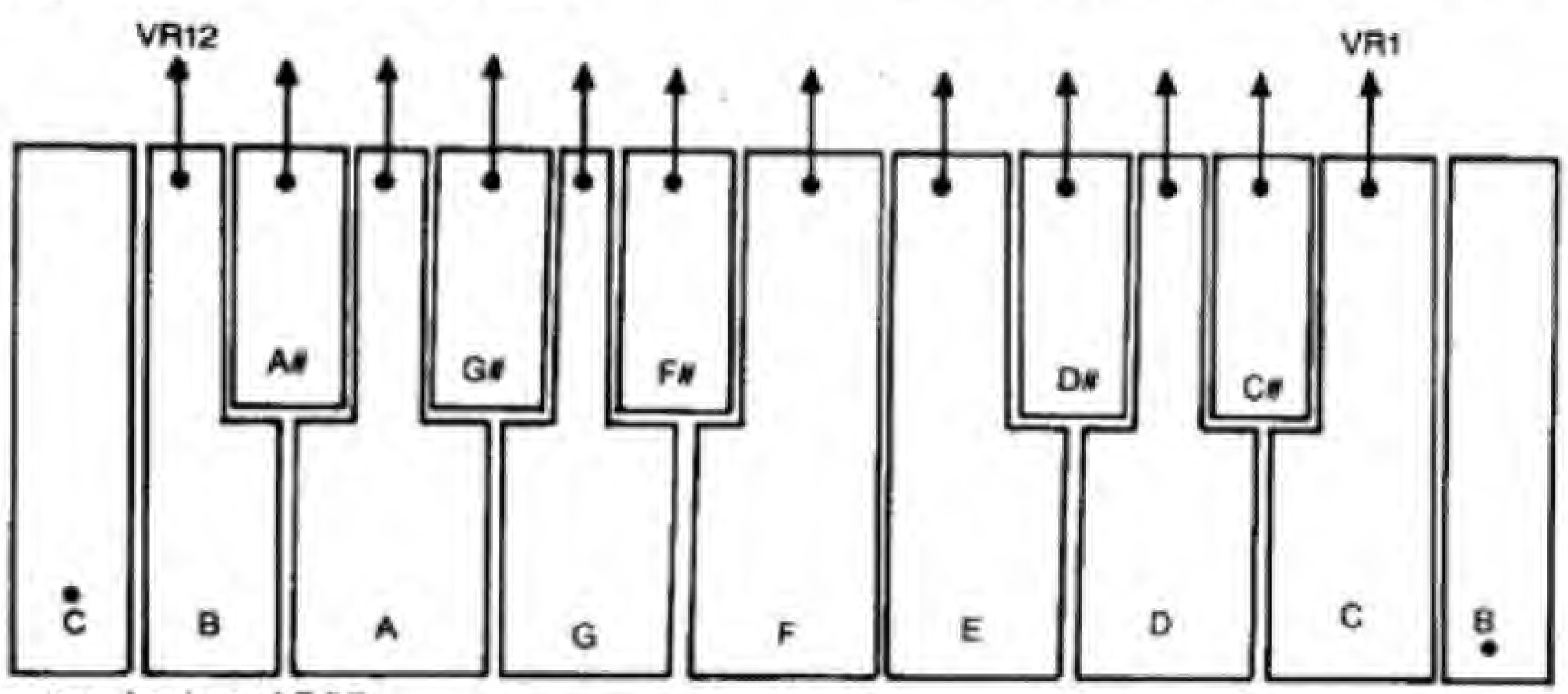
The Project was very good

Can the presets for adjusting the frequency be replaced by suitable resistors? If so, please give their values. Resistors would be more convenient as a frequency meter is not easily accessible to most experimenters.

SUNISH ISSAC
Kozhikode

❑ The article does not specify the 'sounds' produced by the organ. In the text it is mentioned as a piano; does it really produce the sound of a piano? If so, the necessary 'attack-sustain-decay' circuits for producing string sounds are not seen in the diagram.

Generally, musical instruments are made abiding the international standards. But it is painful to see that the published 'PCB' keyboard pattern is far from the well-accepted traditional standards. All the 12 keys from C to B (one octave) are placed in a line, without providing white-key positions. Playing music on this keyboard is like typing with a typewriter having an unusual keyboard.



One-octave keyboard PCB.

On the contrary, the keyboard shown in the photograph of the prototype is quite alright. It is a standard '2-octave' keyboard with 14 full tones and 10 semi-tones. A corrected 'one-octave' keyboard PCB pattern is therefore being given here.

Playing music by touching the keyboard with a probe is definitely handicaping the genuine talent. And as the described circuit provides a wide range of octave selection, addition of bass and treble controls is unnecessary.

The author has advised tin plating of the PCB but hasn't explained how an average hobbyist can actually do so.

SAKTHIDHARAN K.A.
P.O.Korattikkara (Kerala)

The author, Mr Amrit Bir Tiwana, replies:

The presets can be replaced with resistors but in that case fine adjustments can't be made. Use of frequency meter can be avoided by comparing the sounds with those provided by some commercially available organs. It can produce piano sounds. ASDR circuit is neither needed nor that easy to implement. Yet the sound produced by this organ is as rich as that of most synthesisers.

There is no dearth of readymade organs complying with the 'standards' but none of these cost less than Rs 1500. One can either build a synthesiser complying 100% to the 'standrads' at a 'standard' cost or deviate 10% and pay just one-tenth the amount.

Bass-treble controls were incorporated just to facilitate ease of use, and not having to change octaves too frequently. As for the keyboard, I still recommend the published type. However, PCBs for keyboards of the type shown in my prototype's photograph can be obtained from some kits suppliers. These can be modified to requirement. Though there is no limit to the types of keyboards, I thank Mr Sakthidharan for his keyboard design which some readers may find useful.

As for tin plating, I've clearly explained this in my article on PCB designing published in March'90 issue of EFY.

The defrost condition is indicated by LED2. Each clock output of IC 4060 is indicated by LED1 through transistor T3. Base of T3 (point D) can be conected to pin 6 or 5 of IC2 for lower time output indication. The end of preset time (high pulse at pin 11) is indicated by LED4.

Digital Clock With on-off Timer

Yusuf I. Motiwala

To operate any instrument in a particular time duration it is necessary for you to be present during that time. But using this timer you can control the instrument in your absence. In your radio cassette recorder, suppose you want to record some programme in your absence between the time period 8.00 to 8.30, all you have to do is to set the time in the timer. At 8.00 sharp the timer will turn on and recording will start automatically. Similarly, at 8.30 the timer will turn off and recording will stop.

Construction

For simplification, we can divide the construction of an on-off timer into three different units, namely:

1. The power supply unit
2. The digital clock unit
3. The timer unit

Power supply unit

It consists of 7805 voltage regulator IC. It gives +5V regulated output.

Digital clock unit

This unit is the heart of the timer. IC 555 is the timer IC which is in astable mode. It gives square wave output of 100 Hz. Frequency of this square wave is divided by ICs 3, 4, 5, and 6. ICs 3, 4 and 5 are 7490 decade counters in divide-by-ten mode, whereas IC6 is 7492 divide-by-twelve counter and is in divide-by-six mode. Outputs of ICs 3, 4, 5 and 6 are square wave pulses of frequencies 10Hz, 1Hz, 1/10 Hz, and 1/60 Hz respectively. The final output from IC6 is 1/60 Hz, meaning 1 pulse/minute.

Output of IC6 is given to decade counter 7490 (IC7) which gives BCD output for each clock pulse. At 10th pulse 7490 resets and output changes from 1001 to 0000. When output D1 of 7490 changes from 0 to 1, negative

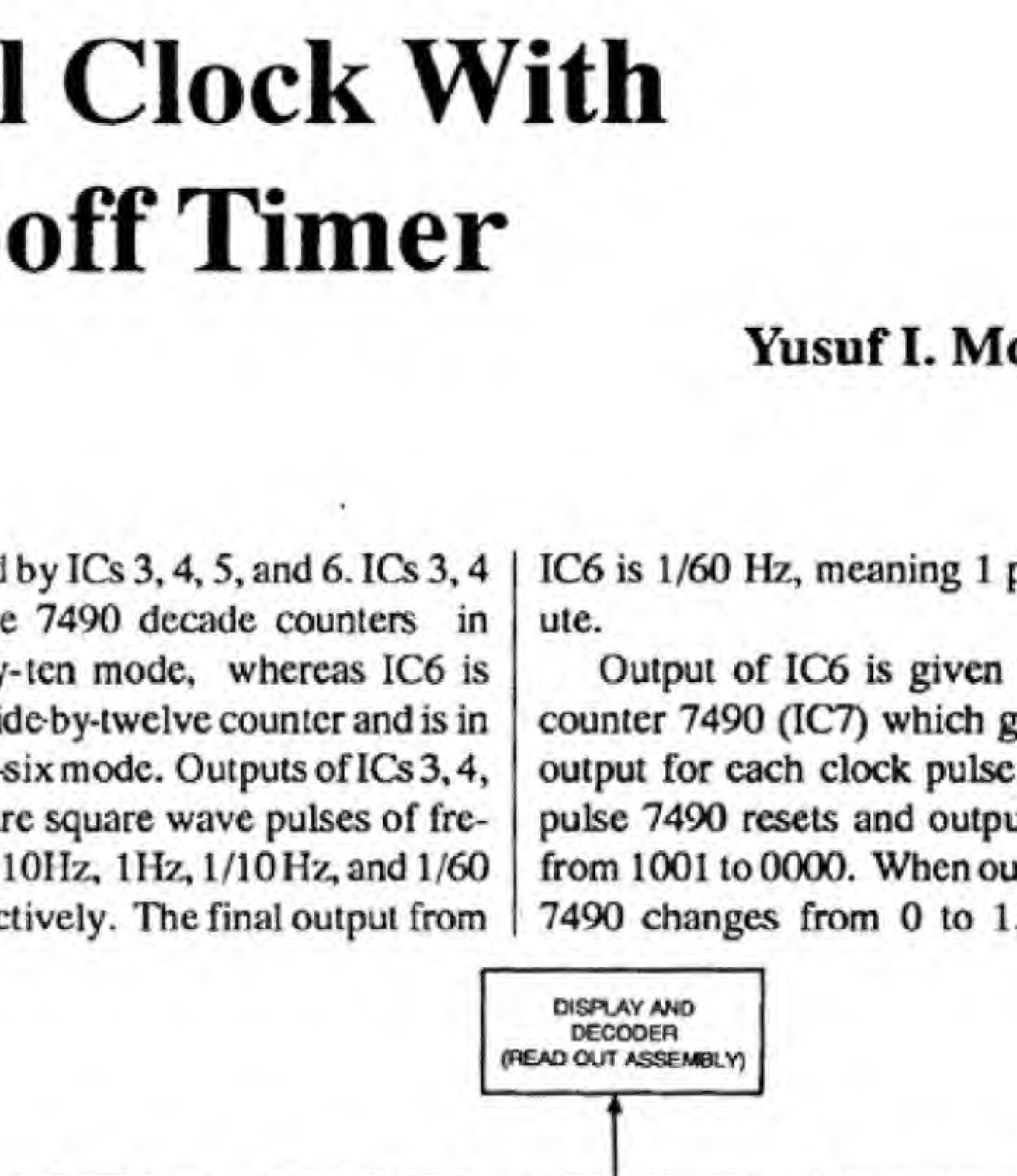


Fig. 1: Block diagram for digital clock with on-off timer.

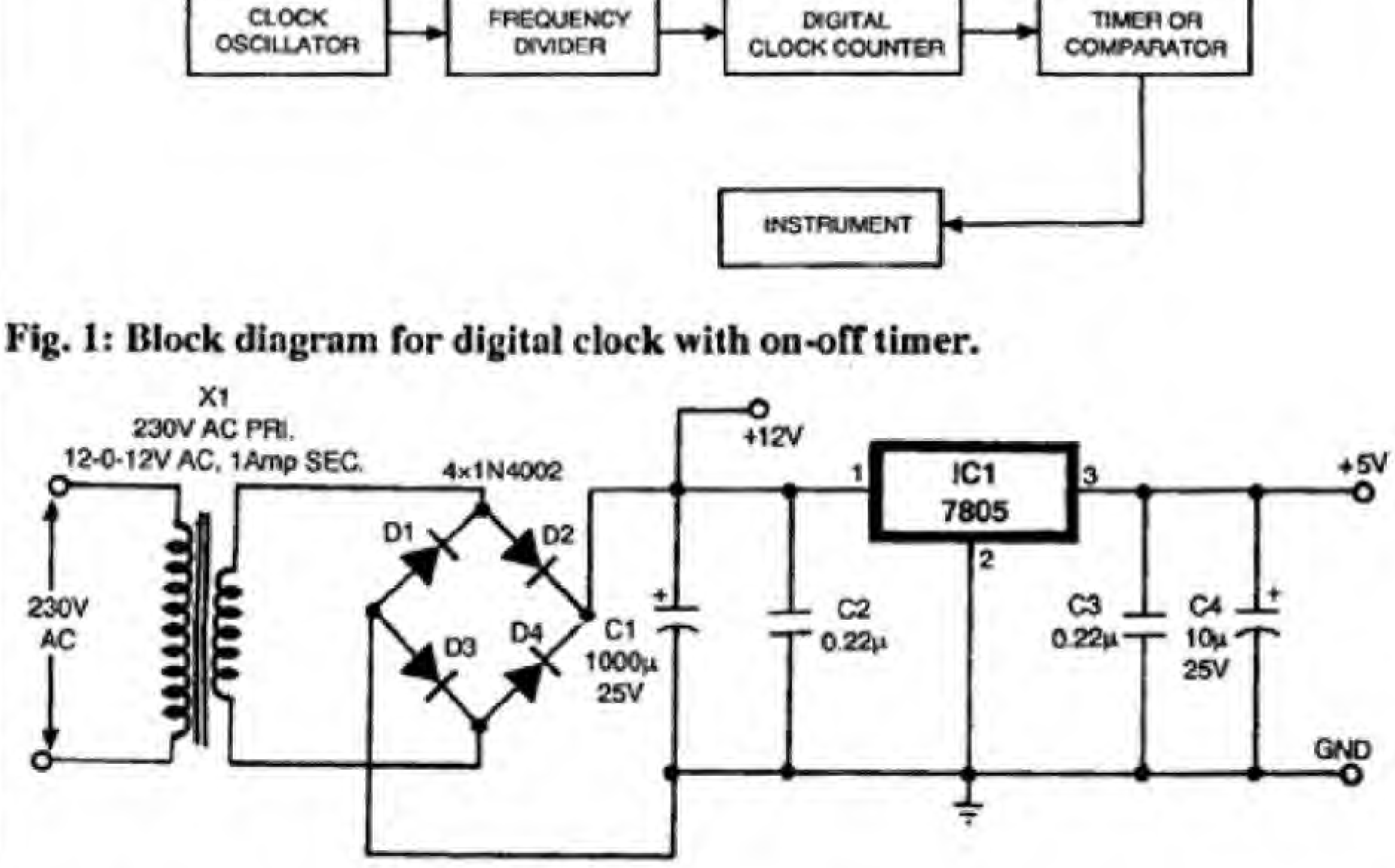


Fig. 2: Regulated power supply for digital clock.

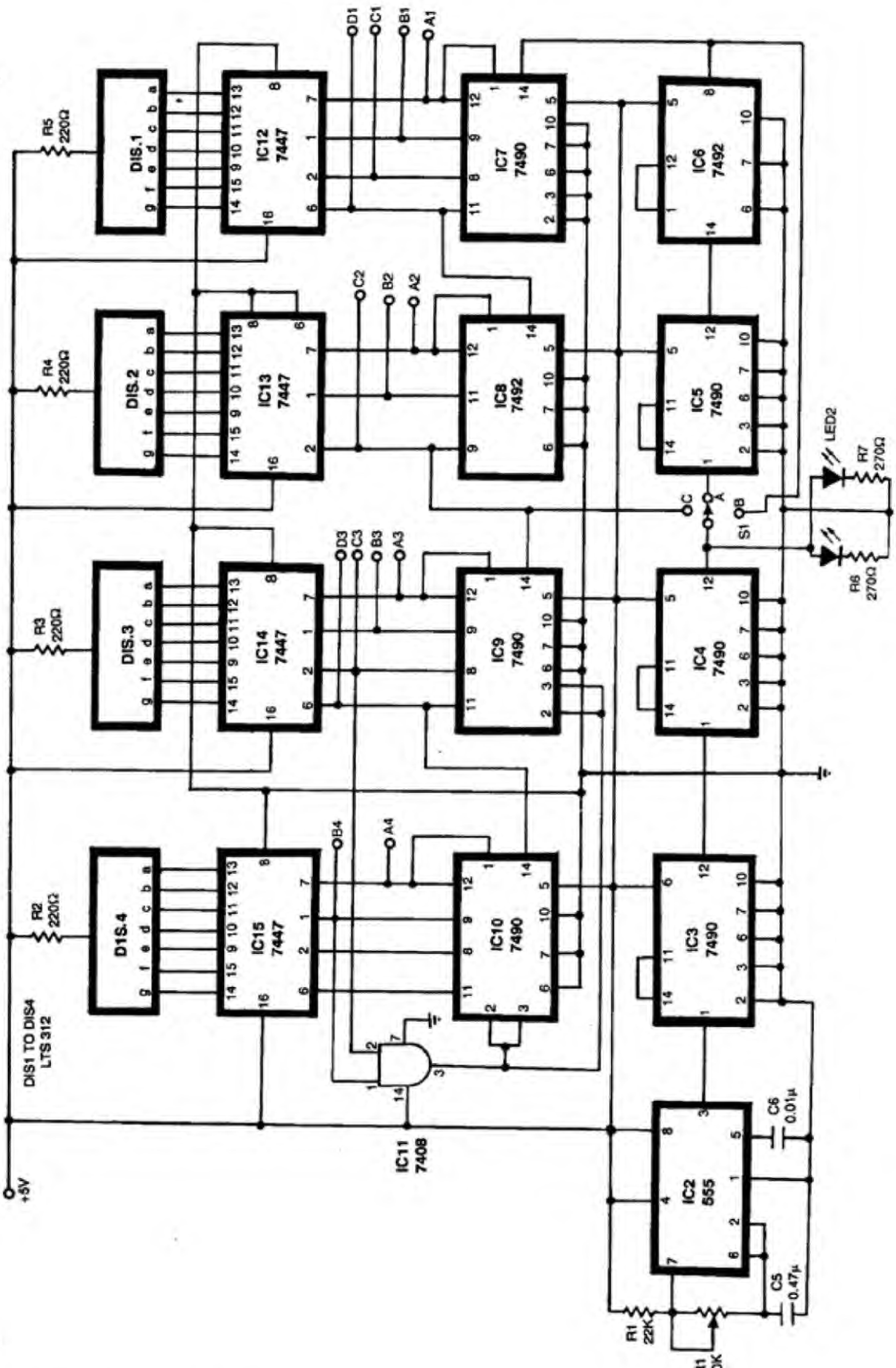


Fig.3. Circuit diagram for digital clock unit.

PARTS LIST

Semiconductors:

IC1	— 7805, +5V voltage regulator
IC2	— 555 timer
IC3-IC5, IC7, IC9, IC10, IC23	— 7490 decade counter
IC6, IC8	— 7492 divide-by-twelve counter
IC11	— 7408 quad two input AND gate
IC12-IC15	— 7447 BCD to 7 segment decoder
IC16-IC19	— 7486 quad XOR gate
IC20, IC21	— 7427 three-input NOR gate
IC22	— 7430 8-input NAND gate
T1	— BC148 transistor
T2	— SL100 transistor
D1-D4	— 1N4002 diodes

Resistors (all 1/4W, ±5% carbon unless stated otherwise):

R1	— 22-kilohm
R2-R5	— 220-ohm
R6-R9	— 270-ohm
R10	— 10-kilohm
R11	— 1-kilohm
R12, R13	— 4.7-kilohm
VR1	— 100-kilohm preset

Capacitors:

C1	— 1000µF, 25V electrolytic
C2, C3	— 0.22µF ceramic
C4	— 10µF, 25V electrolytic
C5	— 0.47µF, 16V ceramic
C6	— 0.01µF, 16V ceramic

Miscellaneous:

X1	— 230V AC Pri 12-0-12V, 1A Sec. transformer
S1	— One pole three way switch
S2	— Push-to-on switch
RL1, RL2	— 12V, 200-ohm relay
	— LEDs
	— 8 thumbwheel switches
DIS1-DIS4	— LTS 312, common anode type display

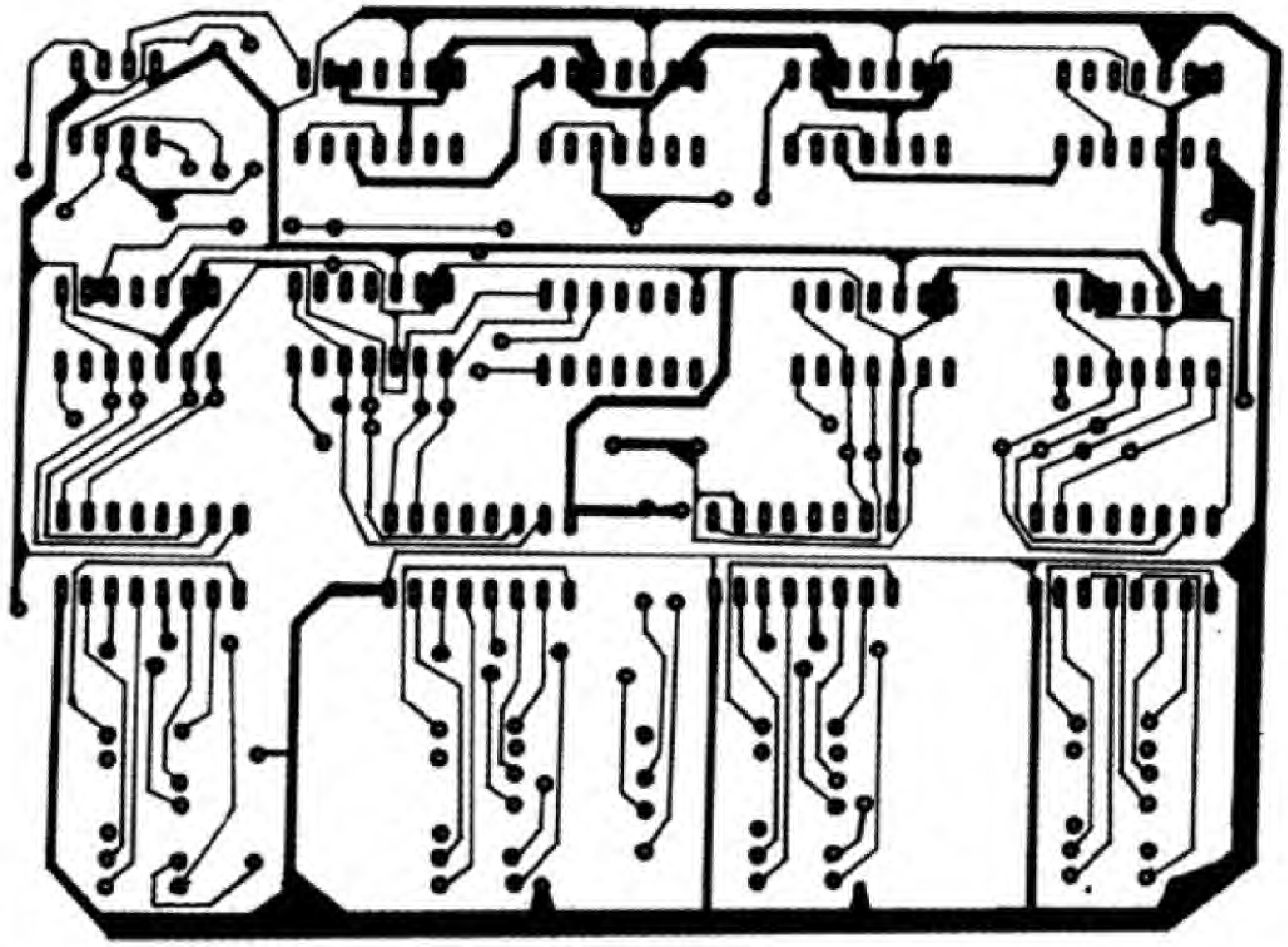


Fig. 4: PCB layout for digital clock unit.

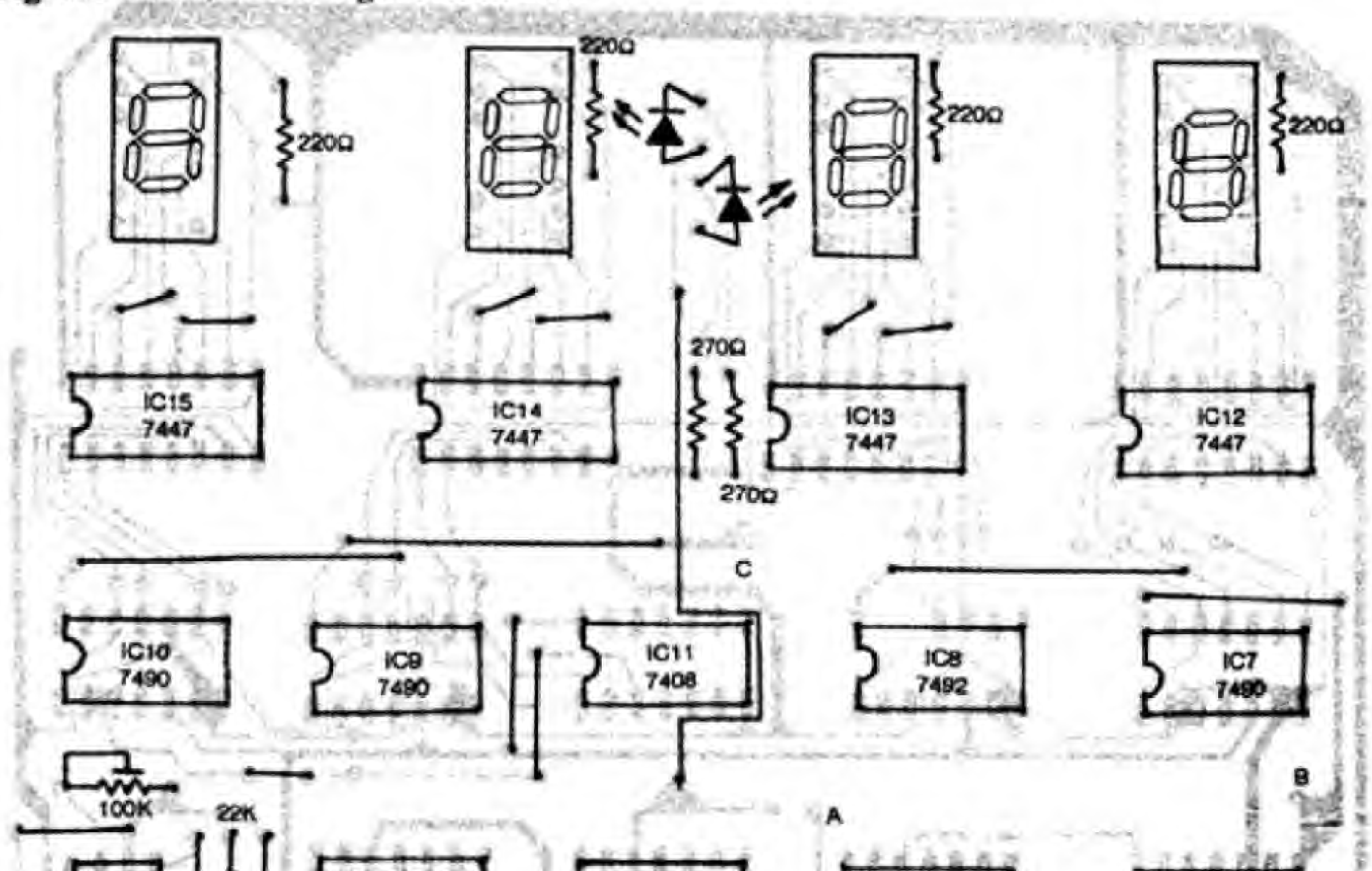


Fig. 5: Components layout for the PCB shown in Fig. 4.

transition occurs and pulse of 1/10 minute frequency is produced which is input pulse for next counter 7492 (IC8) that is in divide-by-six mode. In this counter, output is obtained till five pulses and at sixth pulse counter resets and gives 0000 output. Here also, negative transition occurs and pulse of frequency 1/60 minute is obtained which is input pulse for next counter. IC7 gives units of minute output and IC8 gives tens of minute output and total minute output is 00 to 59 and then resetting to 00.

When IC8 resets, it gives small spikes and trailing edge of this is used to initiate the IC9 which is the hour counter. IC9 is the decade counter which counts up to 9 pulses (9 hours) and at 10th pulse it resets and initiates IC10 which is 7490 in divide-by-ten mode. Here it is necessary that the hour output is up to 23 only and then it should reset. At 24th pulse, output of IC9 and IC10 becomes 0010. To reset IC9 and IC10, C output of IC9 and B output of IC10 is given to IC11 (7408) which is 2-input

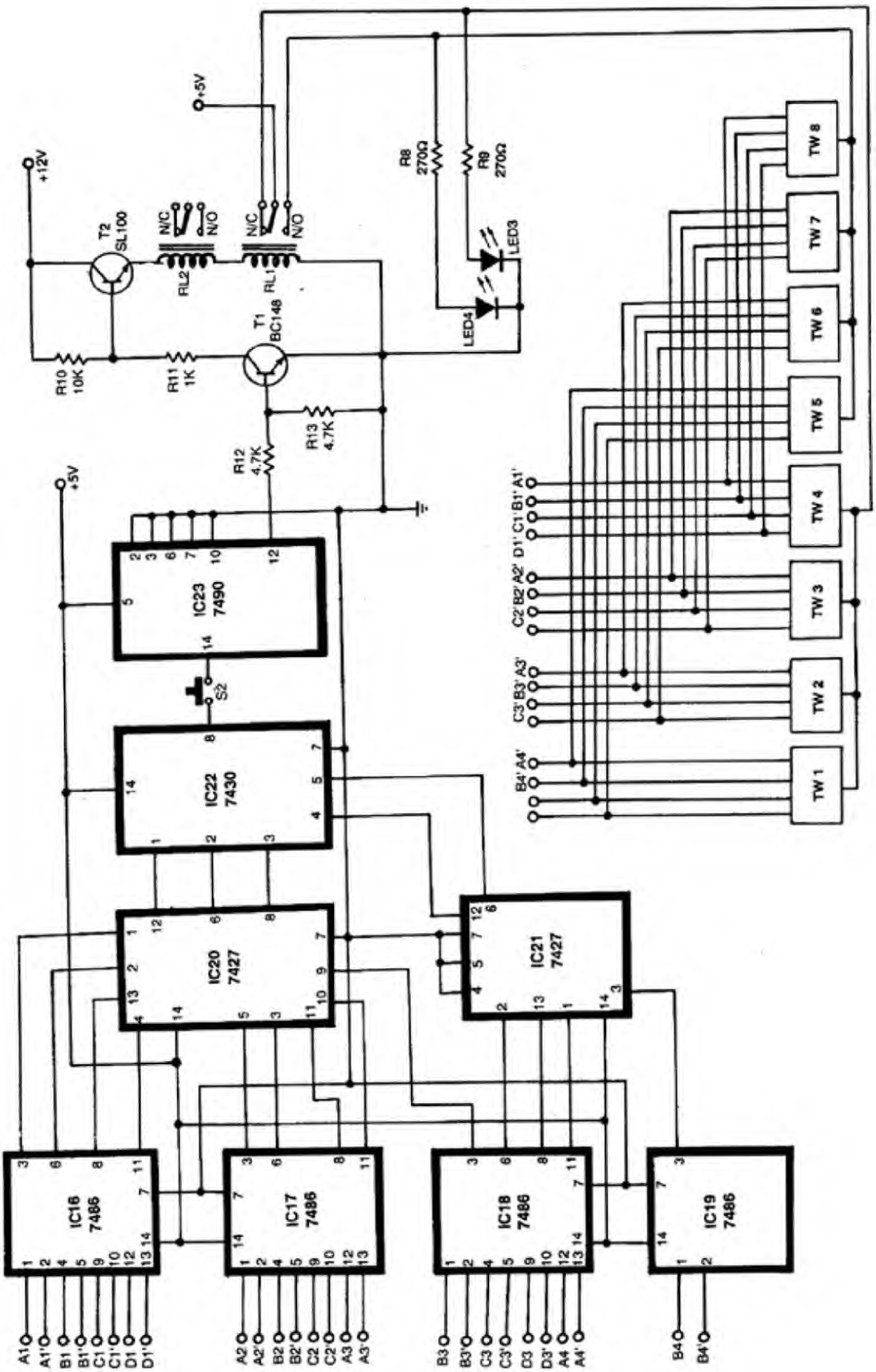


Fig. 6: Circuit diagram for the timer unit.

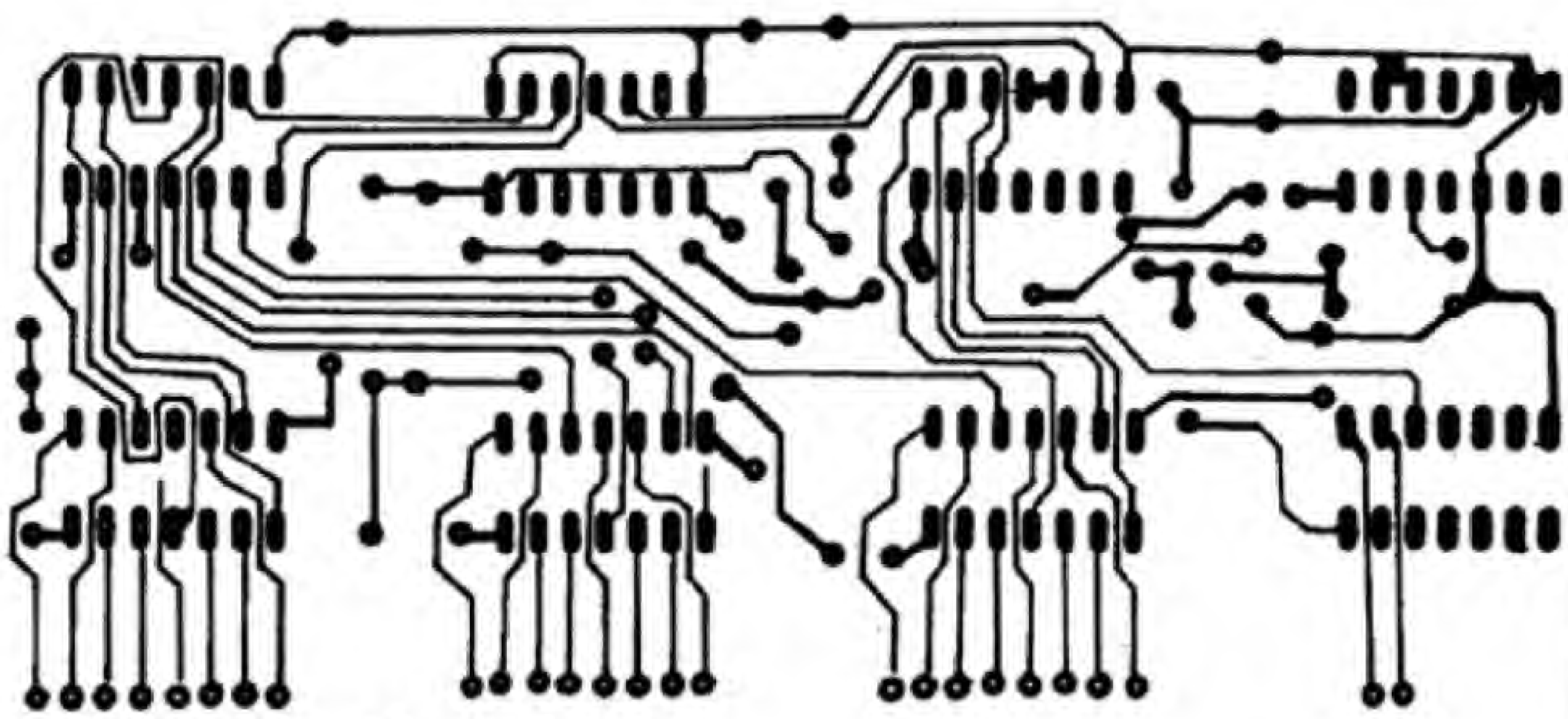


Fig. 7: PCB layout for the timer unit.

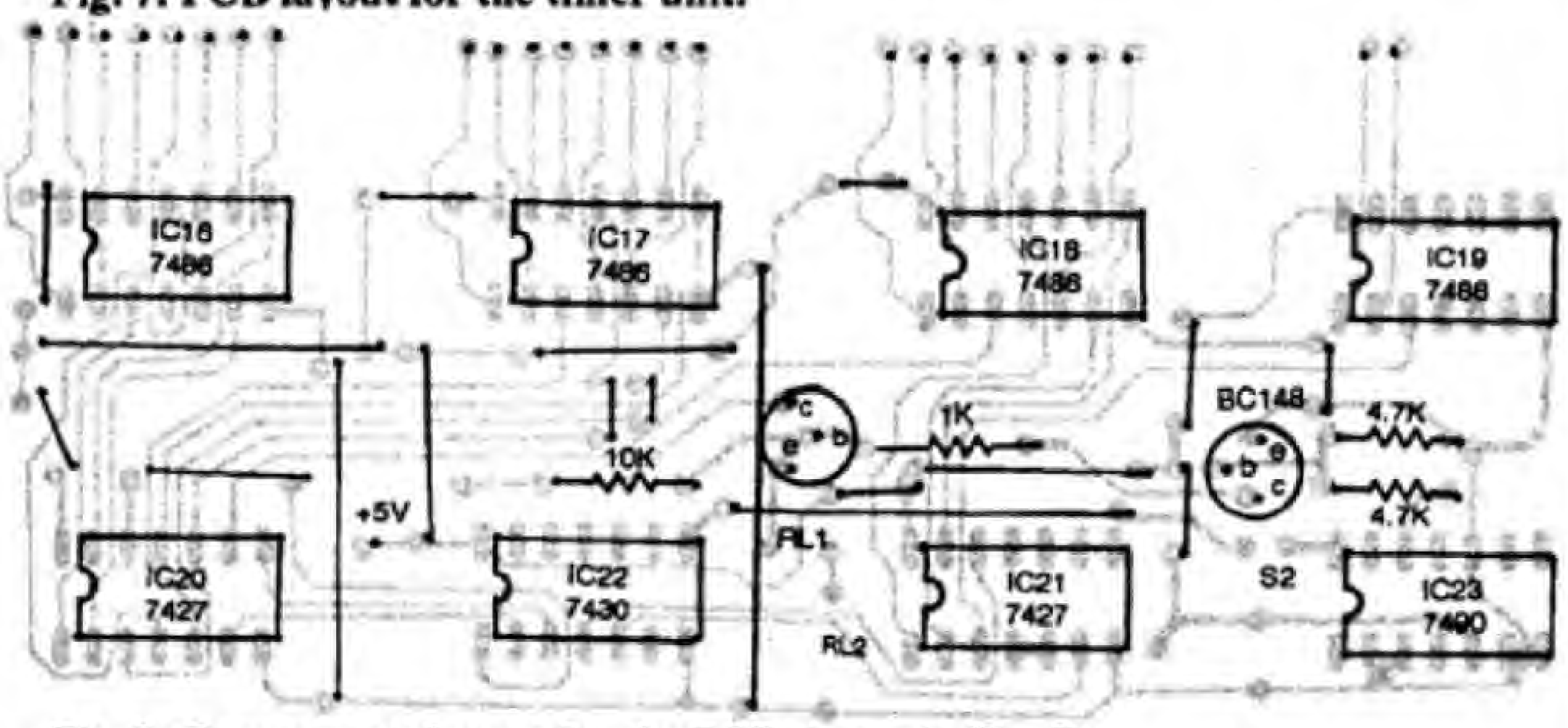


Fig. 8: Components layout for the PCB shown in Fig. 7.

AND gate. When both the inputs of AND gate are high, it gives high output which is given to the reset terminals of IC9 and 10 (pins 2 and 3) which reset ICs 9 and 10 to 0000 0000.

BCD output of all counters (ICs 7, 8, 9 and 10) are given to ICs 12, 13, 14 and 15 respectively. These ICs are 7447, BCD to seven segment decoder driver. Output of each 7447 is given to 7-segment display through current limiting resistor.

All the displays are LTS 312 common anode display. All the four displays indicate the time between 00:00 to 23:59 hrs.

Switch S1 is used for setting the desired time. When switch is in position A the clock is in normal mode. When switch is in position C, it gives 1Hz pulse to hour counter IC9. When it is in B position 1Hz pulse is given to minute counter IC7.

Two LEDs are placed between hour and minute displays. They are driven by output of IC4. BCD output from each counter is taken out for timer circuit.

Timer unit

The timer unit compares the time of a digital clock with preset on and off time.

In the timer unit, there are two sets of thumbwheel switches. Each set has four thumbwheel switches—one set for on timing and the other for off timing.

Thumbwheel switches TW 1, 2, 3 and 4 are for on timing and TW 5, 6, 7 and 8 for off timing.

As shown in the timer unit circuit (Fig. 6), each thumbwheel output is given to EX-OR gate with digital clock output, e.g. unit minute output of thumbwheel switch is given to EX-OR gate with unit minute output of digital clock. ICs 16, 17, 18 and 19 are 7486, quad EX-OR IC. Outputs of three EX-OR gates are given to 3-input NOR gate (IC 7427). Outputs of all the NOR gates are given to 8-input NAND gate (IC 7430). Here only five terminals of 8-input NAND gate are used. Therefore the remaining three terminals are kept at high logic level. Output of NAND gate is given to IC23 which is 7490 in divide by two mode that acts as a master slave JK flip-flop in toggle mode.

When the inputs of EX-OR gates are not equal, some of the gates will have high output . Therefore, one of the NOR gates output becomes zero. So the output of NAND gate will be high.

When the on time is equal to digital clock time, inputs of all the EX-OR gates are same and all the EX-OR gates give low output. Therefore, all the NOR gates give high output and hence output of NAND gate becomes low. As the NAND gate output becomes low from high state, flip-flop changes the state and gives a high output. Relays RL1 and 2 operate through current amplifiers. As RL1 operates, it disconnects the power supply to TW 1, 2, 3, and 4 and connects it to TW 5, 6, 7 and 8. Now inputs of all the EX-OR gates are not equal. Therefore, output of NAND gate goes high from low state. As here positive transition occurs, flip-flop does not change its state.

Now, for off time, same operation is performed by TW 5, 6, 7 and 8.

RL2 is for external connection where we can connect the instrument.

Sometimes relays are pre operated. So for putting off the relay, press switch S2, which is push-to-off switch.

LED 3 indicates that the timer is in off position and LED 4 indicates that the timer is in on position. □

Day Date Computer

A. Rajan CBE

With the circuit described here one can easily find out the day for any date within 1901 to 2000 AD.

This circuit is basically an adder, built around IC7483 (adder), IC74195 (shift register) and IC74147 (priority encoder). IC7445 is used for input and output.

Circuit description

IC74147 converts currents input from switches (S0-S7) into their binary equivalents. Output from IC74147 is given to the IC7483.

Table I

Year				Code
1901	1929	1957	1985	G
1902	1930	1958	1986	F
1903	1931	1959	1987	E
1904	1932	1960	1988	C*
1905	1933	1961	1989	B
1906	1934	1962	1990	A
1907	1935	1963	1991	G
1908	1936	1964	1992	E*
1909	1937	1965	1993	D
1910	1938	1966	1994	C
1911	1939	1967	1995	B
1912	1940	1968	1996	G*
1913	1941	1969	1997	F
1914	1942	1970	1998	E
1915	1943	1971	1999	D
1916	1944	1972	2000	B*
1917	1945	1973	2001	A
1918	1946	1974	2002	G
1919	1947	1975	2003	F
1920	1948	1976	2004	D*
1921	1949	1977	2005	C
1922	1950	1978	2006	B
1923	1951	1979	2007	A
1924	1952	1980	2008	F*
1925	1953	1981	2009	E
1926	1954	1982	2010	D
1927	1955	1983	2011	C
1928	1956	1984	2012	A*

Note: * stands for leap year

IC7483 adds the given binary input from encoder with the contents of shift register 74195 (parallel in parallel out shift register). When enter key is pressed, the sum output from IC7483 is transferred to the shift register. Hence, next input is added with the previous sum. In this way circuit performs serial addition. IC7445 decodes the output of shift register. LEDs 1 to 7 indicate the days from Sunday to Saturday respectively. Before entering the next set of data, the contents of shift register should be made zero, i.e. the LEDs must be in off state. Contents of shift register can be cleared by pressing reset switch (S9).

Table II

Switch	Year	Months	Date
S0		Jan*, Apr, Jul	1, 8, 15, 22, 29
S1	A	Jan, Oct	2, 9, 16, 23, 30
S2	G	May	3, 10, 17, 24, 31
S3	F	Aug, Feb*	4, 11, 18, 25
S4	E	Feb, Mar, Nov	5, 12, 19, 26
S5	D	Jun	6, 13, 20, 27
S6	C	Sep, Dec	7, 14, 21, 28
S7	B		

Note: * stands for leap year

The switches (S0-S7) corresponding to codes for date, month, year are listed in Table II. Their codes are converted into their binary equivalents by encoder.

Adder adds the binary input from encoder with the contents of shift register (initially 0). If the sum exceeds 7, then 7 should be subtracted from the sum. This can be done easily by connecting MSB of sum (pin 15 of IC2) to carry-in input (pin 13 of IC2). MSB is 1 for sum>7 and hence 1 is added to the output of sum.

Only 3 bits of output are taken from the adder. Therefore, output is always less than or equal to seven.

Table IV

LED	Day
1	Sunday
2	Monday
3	Tuesday
4	Wednesday
5	Thursday
6	Friday
7	Saturday

The sum output from adder is transferred to parallel in parallel out shift register. The output of shift register is connected to input of the adder and the decoder IC7445. Shift register copies the sum output when clock input goes from high to low state. This clock input is given using switch S8. The next input data is added with previous data input.

Decoder converts the binary to re-

Table III

Year	Numerical Value	Month	Code	Days	Code
A	1	Jan	1	1, 8, 15, 22, 29	0
B	7	Feb	4	2, 9, 16, 23, 30	1
C	6	Mar	4	3, 10, 17, 24, 31	2
D	5	Apr	0	4, 11, 18, 25	3
E	4	May	2	5, 12, 19, 25	4
F	3	Jun	5	6, 13, 20, 27	5
G	2	Jul	0	7, 14, 21, 28	6
		Aug	3		
		Sep	6		
		Oct	1		
		Nov	4		
		Dec	6		
		Jan*	0		
		Feb*	3		

Note: * stands for leap year

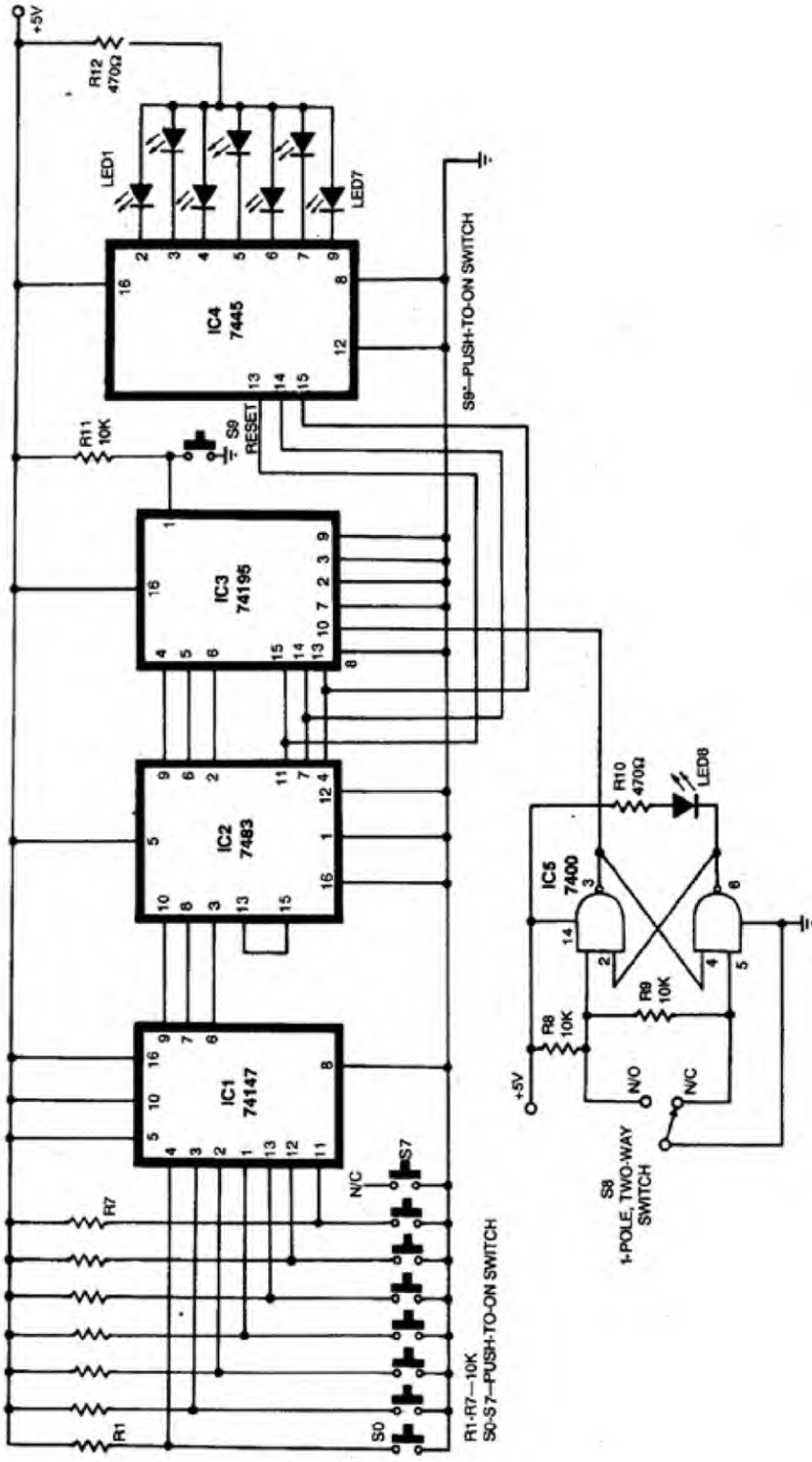


Fig. 1: Circuit diagram for day-date computer.

spective decimal equivalent and corresponding LED glows indicating the day.

Priority encoder produces 4-bit BCD for corresponding decimal input but actually one's complement of input is generated. In this particular circuit only 3-bit output is needed hence input switches can be selected so as to get the necessary output.

Owing to switch debounce problem, in clock input, a switch debouncer using NAND gate is used between switch S8 and clock input of shift register.

Principle

Basically the circuit performs only addition and it is possible to find out day by adding codes for year, month

Parts List

Semiconductors:	
IC1	— 74147 priority encoder
IC2	— 7483 4-bit binary full adder
IC3	— 74195 4-bit shift register
IC4	— 7445 1-of-10 decoder
IC5	— 7400 quad 2-input NAND gate
Resistors:	
R1-R9, R11	— 10K
R10, R12	— 470 ohms
Miscellaneous:	
S1-S9	— Push-to-on switches
S10	— One pole, 2-way switch
	— LEDs

and date. Code for year is given in Table I. Codes for month and date are given in Table III. For example, consider a date 27/1/1971. To find the day on this date, find out the code for year 1971 from Table I. Code for year is D, which is equal to 5 (from Table II). Code for the month January is 1 and for date 27, it is 5 (Table II). Sum of all these codes is equal to 11. Since 11 is greater than 7 (total no. of week days), subtract 7 from 11. We get 4, which indicates that LED4 is glowing which stands for Wednesday (Table IV).

Working

To find out the day for any date, codes for year, month and date are entered one by one.

The circuit is reset by pressing the reset switch momentarily. Then find out the code (A-G) for particular year from the Table I. Switch in corresponding to the code is pressed, then enter key (S8) is pressed. All the switches are then restored to normal position. Now the circuit is ready to accept next data (i.e. month). Code for the month is given in Table III. Switch to be pressed for a particular month is given in Table II. Switch corresponding to the month is pressed followed by enter key (S8). In the same way, date is entered. The glowing LED indicates the day after the date has been entered. To enter the date 27-01-1971 following sequence of switches will be pressed.

For year 1971, code is D (from Table I). To enter D, press switch S5. Then press enter key S8. Restore switches S5 and S8 to normal position. For month, refer Table II. For January, switch S1 is pressed and then enter key, S8 is pressed. Switches S1 and S8 are restored to normal position.

To enter the date 27 refer Table II. For 27, press switch S5 and then S8. Now restore switches S5 and S8 to normal position.

The LED corresponding to Wednesday starts glowing. The circuit must be reset before entering next date. Therefore, for the date 27/01/1971, sequence of keys are S5, S8, S1, S8, S5 and S8.

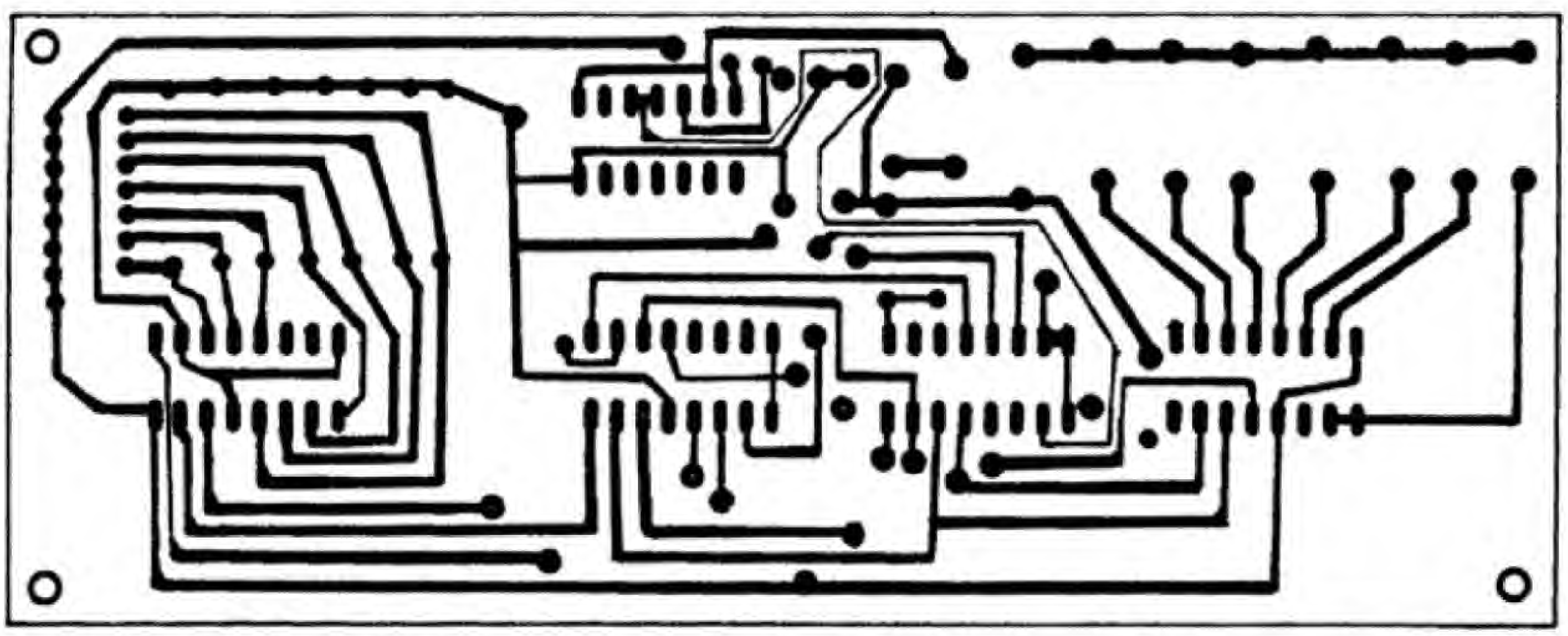


Fig. 2: PCB layout for the day date computer.

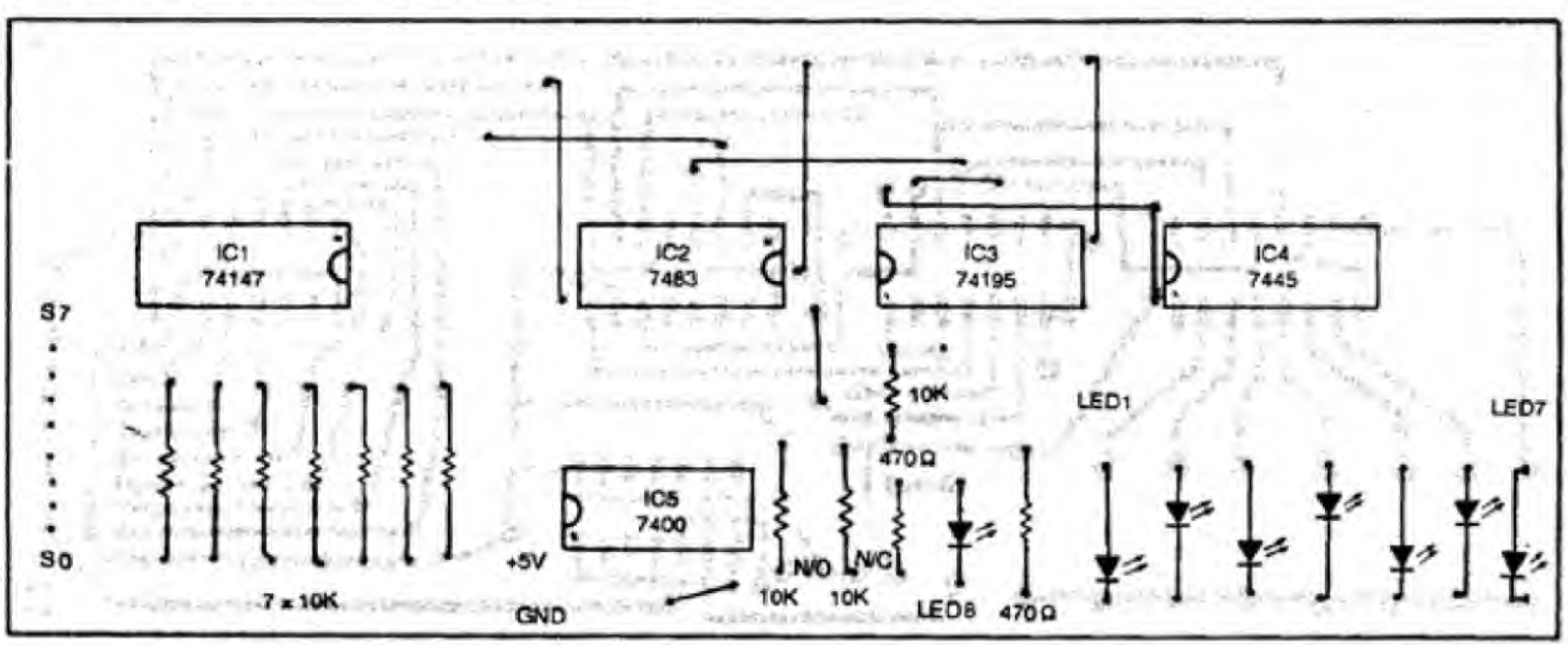


Fig. 3: Components layout for the PCB shown in Fig. 2.

Note: This circuit can be greatly simplified by using keyboard encoder IC74HC922. Non-availability of this IC is the reason for using IC74147 with switch debouncer. □

Authors' comment:

The circuit can be modified to accept date, month and year codes simultaneously rather than serially. But such a circuit needs 21 (7 x 3) switches, three priority encoders (74147) and two adders (7483) which increases the cost. Such a circuit does not require switch debouncer or PIPO shift register. Block diagram for such a scheme is shown here.

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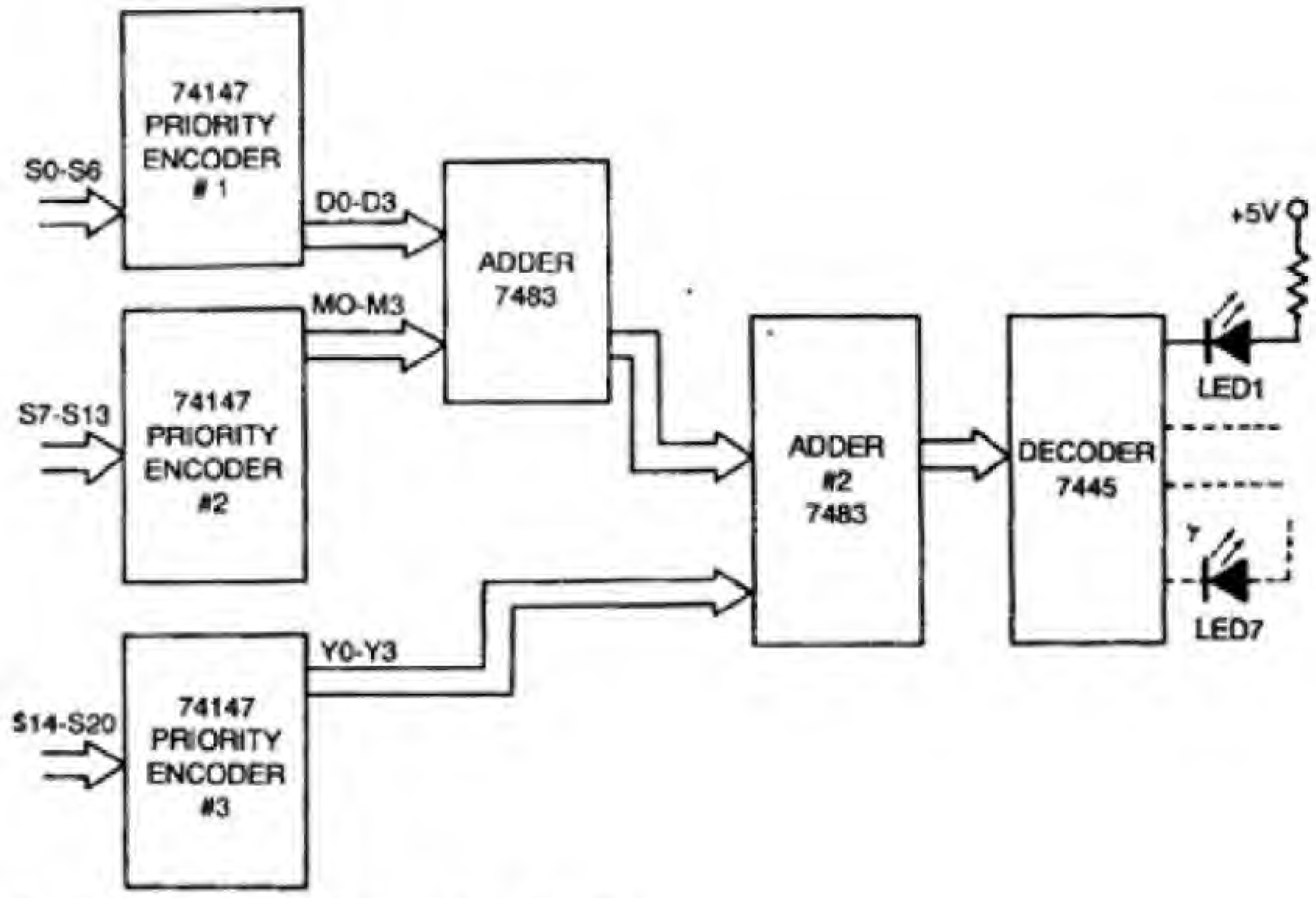
Coimbatore



Block diagram for modified computer circuit.

Electronic Ignition System for Automobiles

C. Sanjay

The ignition system in a car is very simple and is known to everybody. The primary of the ignition coil is connected to the battery and when the contact breaker trips the connection, a voltage of about 400V is produced across the primary. This 400V is stepped up to about 40kV and used to produce a spark in the spark plug. All this is fairly simple when you have a 12V battery which can supply the current taken by the ignition coil, normally about 2.5A.

But when you are stranded in the middle of the road with your car's battery down perhaps you won't know what to do. However, if you use the 'electronic ignition system' described here you may never get any ignition trouble.

Some of the advantages of this ignition system are:

1. Improves engine efficiency due to multiple sparks.

2. Decreases load on battery.

3. Starts even when the battery voltage is 8V.

4. Fuel efficiency of the engine is increased.

The electronic ignition system consists of a high voltage generator (about 600V at supply voltage = 11.5V) which is triggered by the contact breaker. In this system the current passing through the contact breaker is only 12mA, which increases the life of the contact breaker. This is another advantage!

When the contact breaker points are open, a pulse of about 2ms is produced at the collector of T2 which triggers the

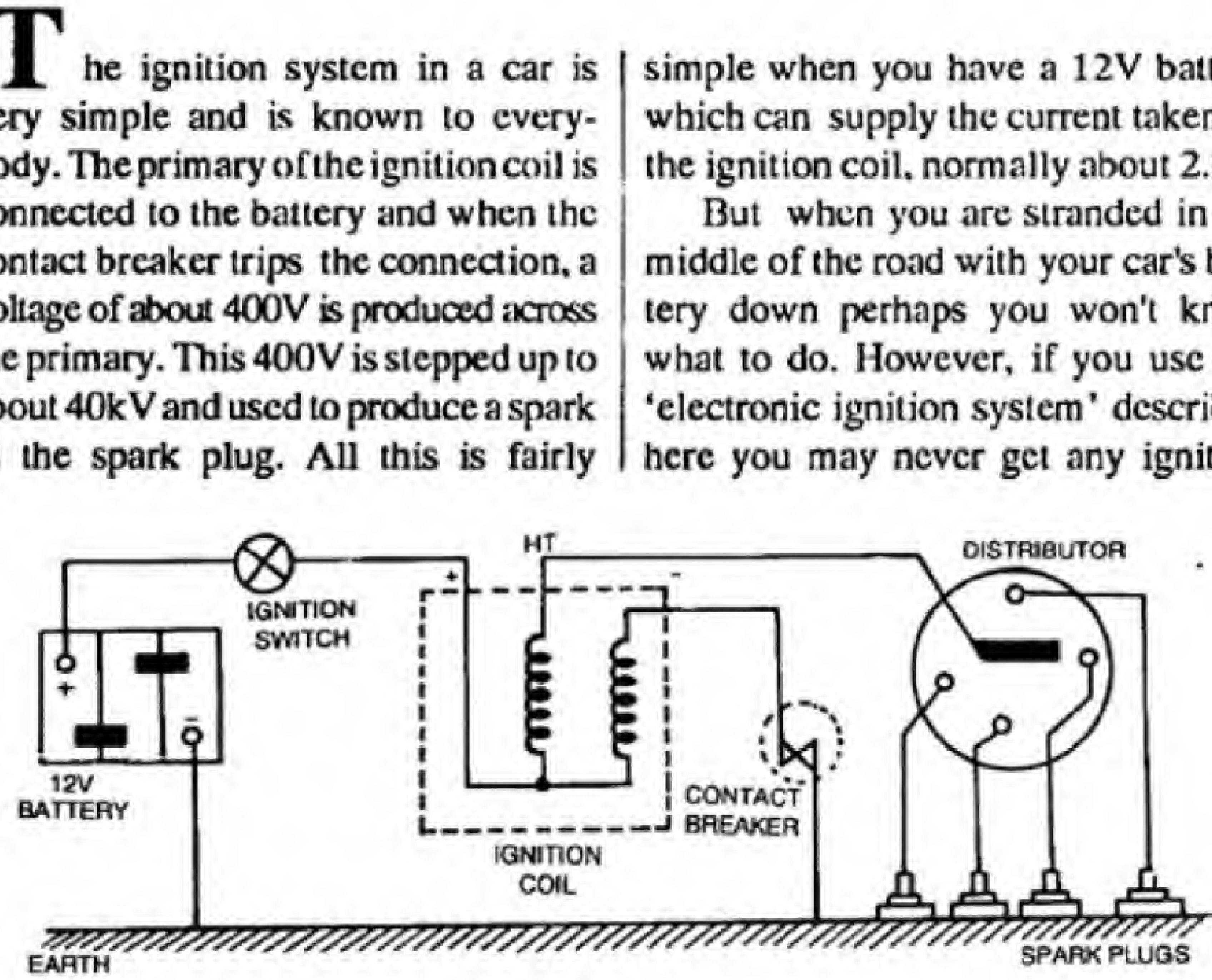


Fig. 1: Typical ignition system existing in cars.

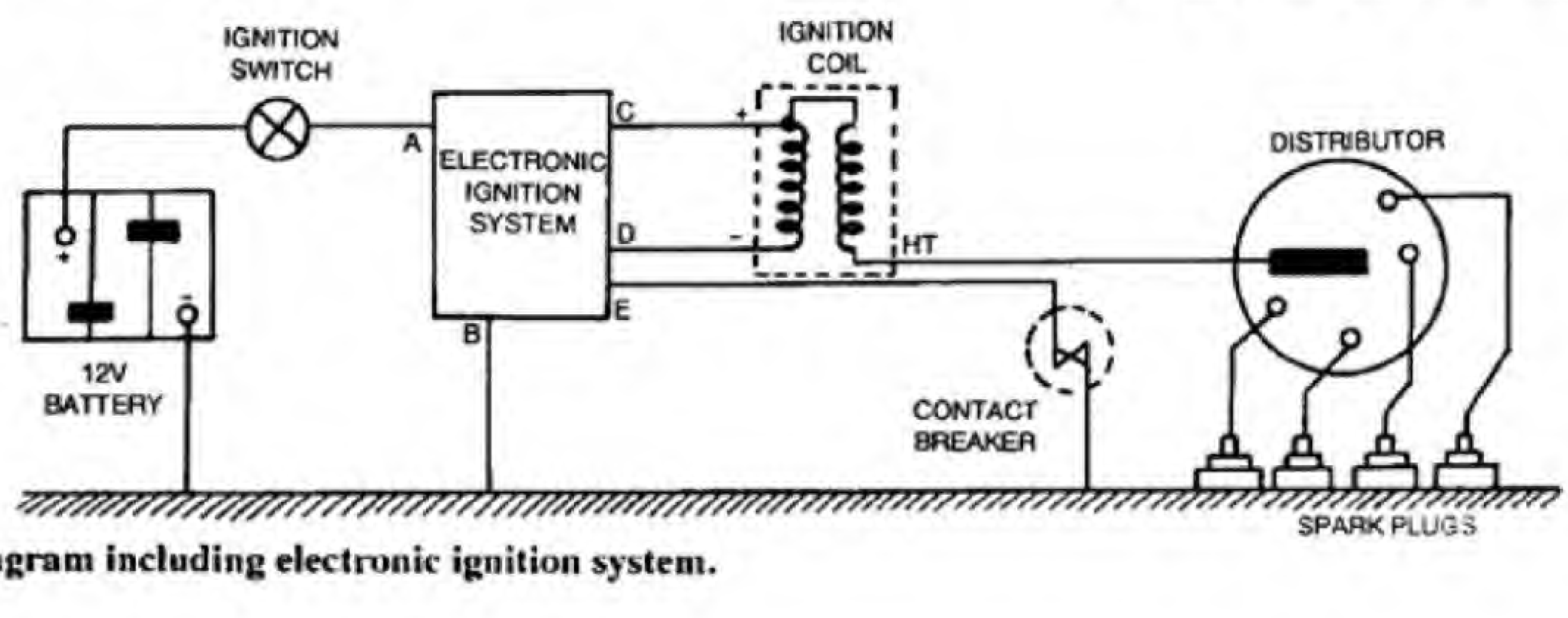


Fig. 2: Wiring diagram including electronic ignition system.

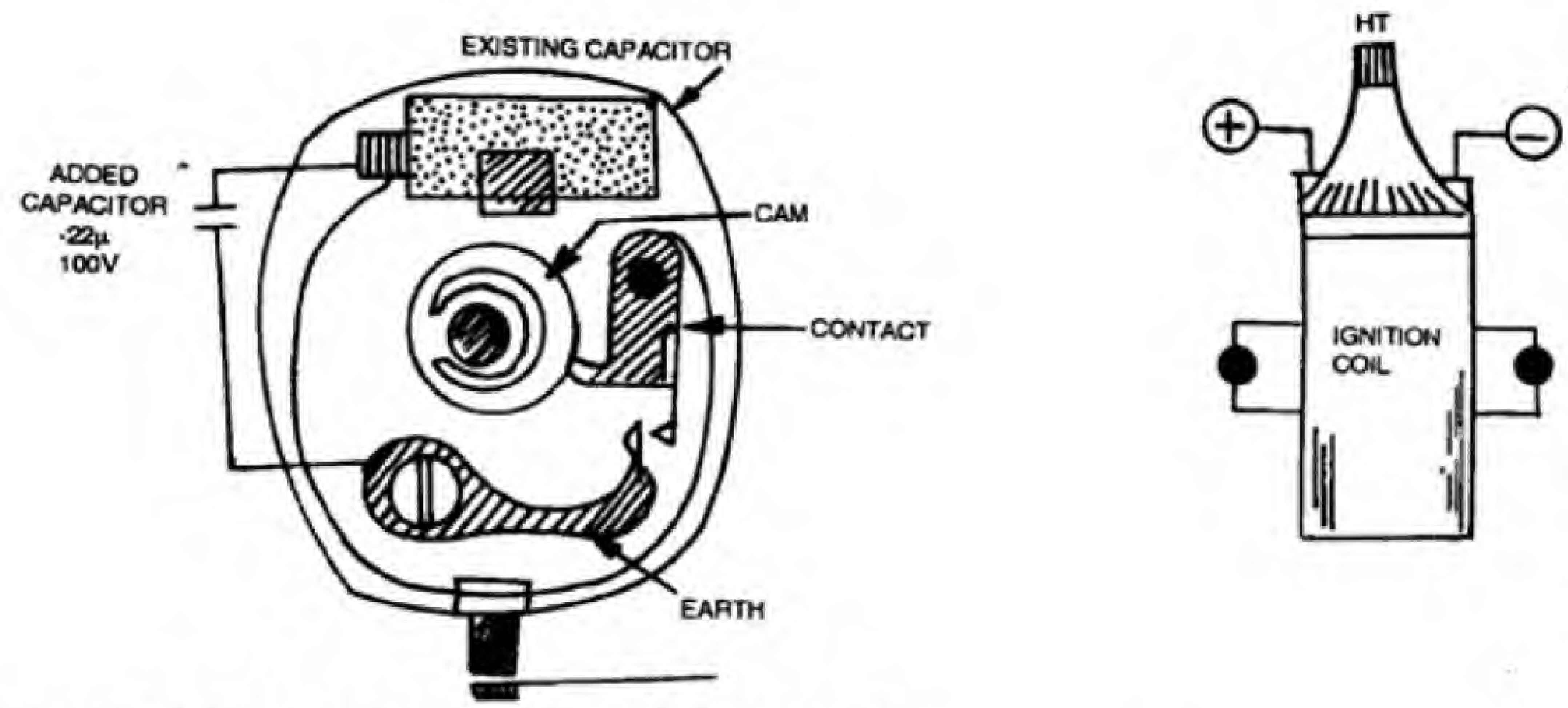


Fig. 3: (a) Adding capacitor for extra noise suppression; (b) ignition coil.

multivibrator consisting of T3 and T5. The multivibrator produces pulses of 2kHz. As the frequency is high, an ordinary (3V-0-3V) transformer will withstand up to 9V. This multivibrator switches on transistors T7 and T8 alternately, thereby switching on transistors T4 and T6. As T4 and T6 are connected to the 3V windings of transformer X1, a secondary voltage of about 600V is produced. (The transformer is 220V to 3V and gives 600V when the 3V is connected to 9V AC.) The 600V is fed to the primary of the ignition coil and the output voltage obtained from it is about 60kV. That is why 35kV (minimum value) is provided even when the battery voltage is about 8V.

The original wiring system in a car is shown in Fig. 1 while the change in the wiring system is shown in Fig. 2. Fig. 3 shows how the 0.22μF, 100V capacitor can be connected. This capacitor will help to suppress interference signals caused due to contact break switching. The wire connecting the terminals A and B should be able to withstand 5A min.

Construction

The circuit can be wired on the PCB shown. Only two power transistors T5 and T6 are placed outside the PCB with heatsinks of 10cm × 10cm × 0.3cm each. The transistors T7 and T8 also need heatsinks of about 2cm × 2cm × 0.3cm. A 10,000μF, 16V capacitor may also be connected across the supply which will help during ignition. If

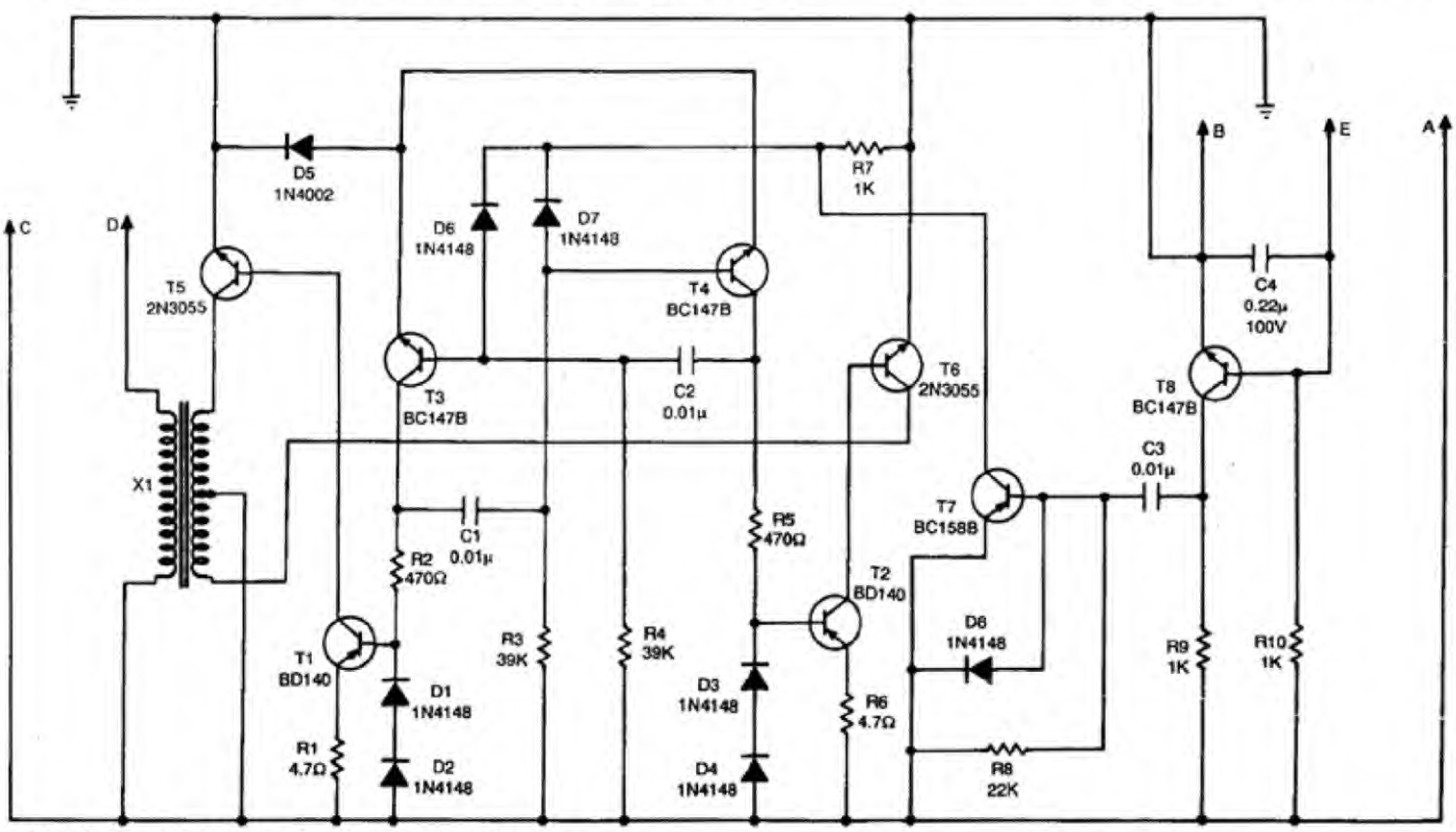


Fig. 4: Circuit diagram for the electronic ignition system.

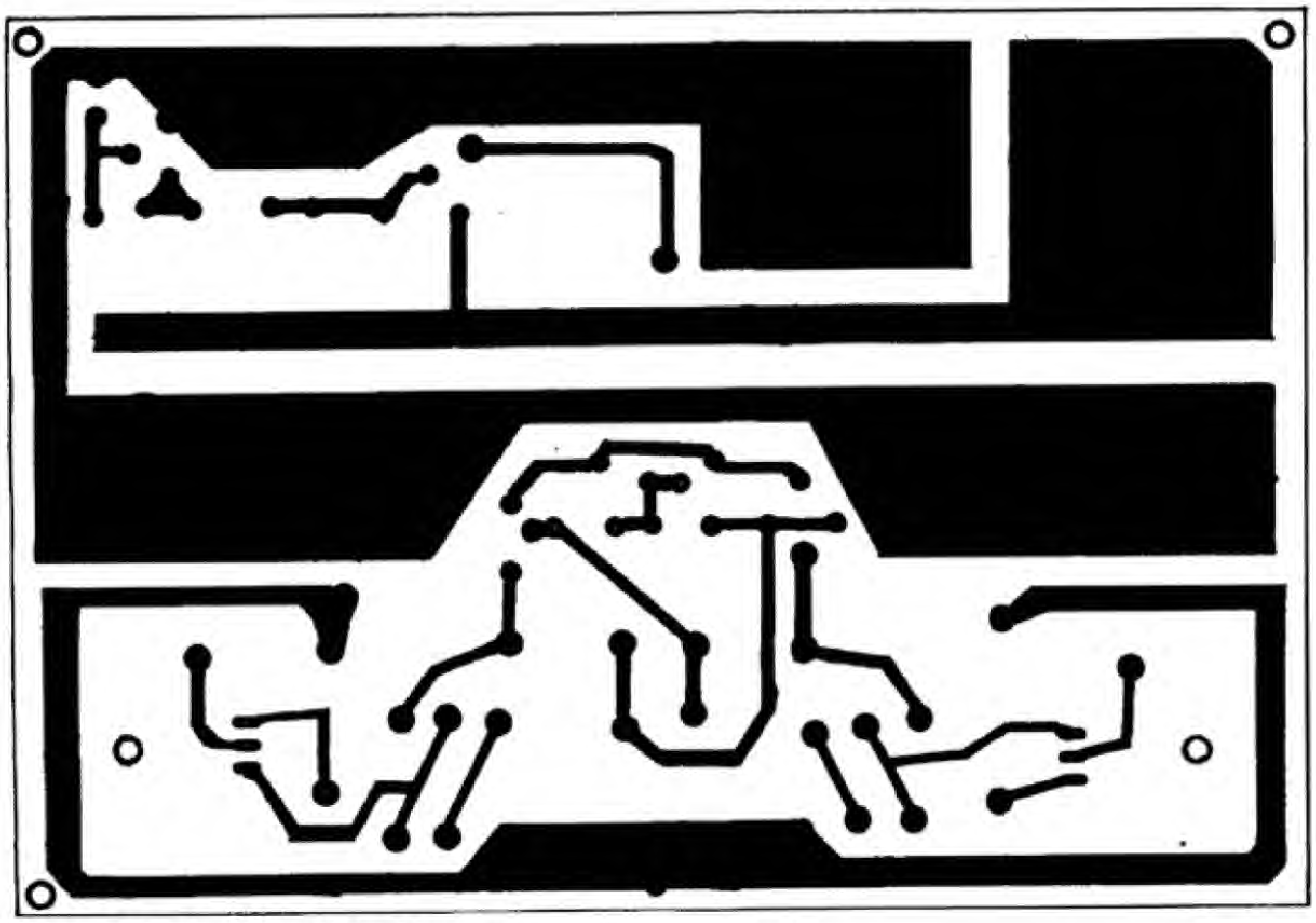


Fig. 5: PCB layout for the electronic ignition system.

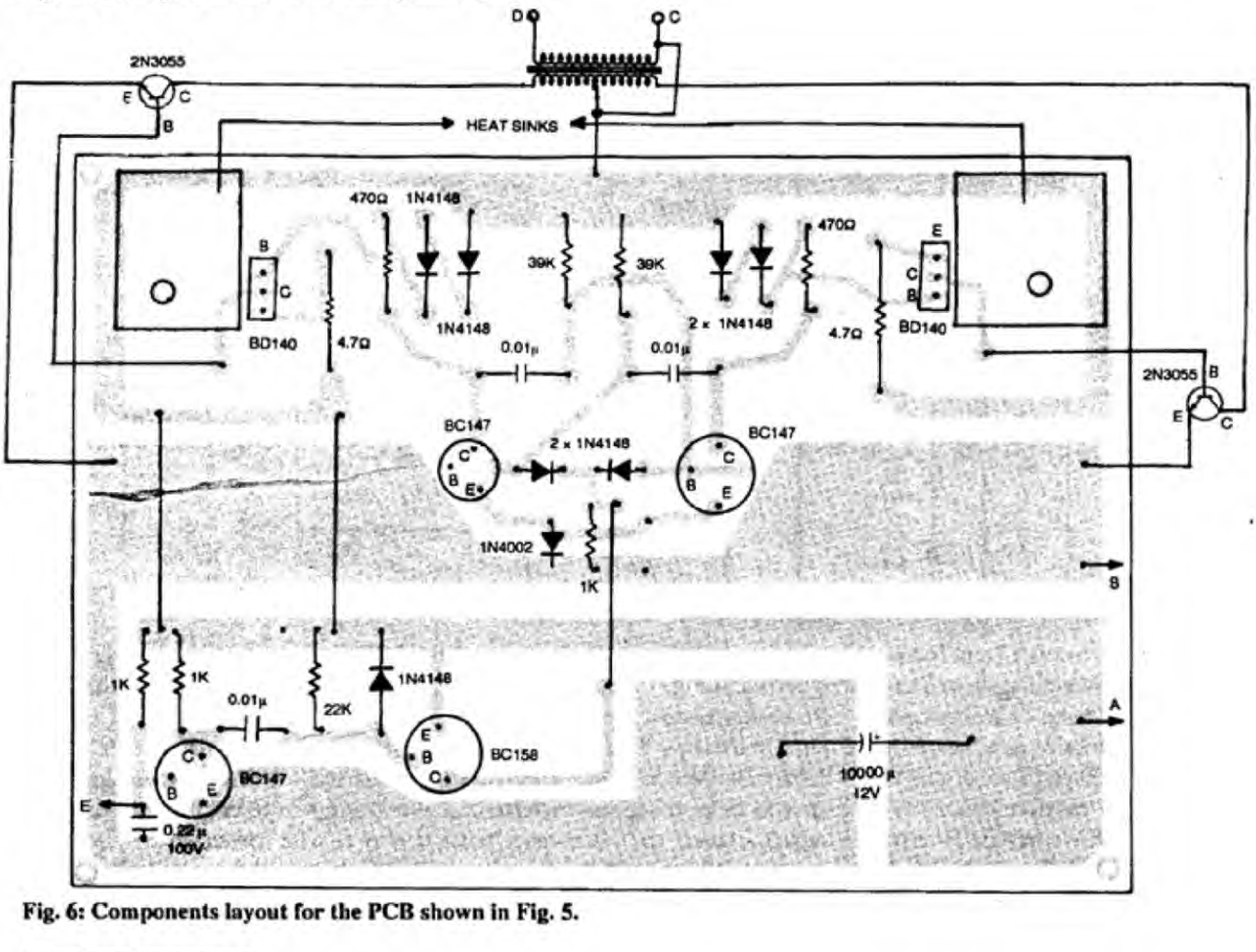


Fig. 6: Components layout for the PCB shown in Fig. 5.

PARTS LIST

Semiconductors:

T1, T2	— BD140 transistor
T3, T4, T8	— BC147B transistor
T5, T6	— 2N3055 transistor
T7	— BC158B transistor
D1-D4, D6-D8	— 1N4148 silicon switching diodes
D5	— 1N4002 silicon rectifier diode

Resistors (all 1/4W, ±5% carbon unless stated otherwise):

R1, R6	— 4.7-ohm
R2, R5	— 470-ohm
R3, R4	— 39-kilohm
R7, R9, R10	— 1-kilohm
R8	— 22-kilohm

Capacitors:

C1-C3	— 0.01µF ceramic disc
C4	— 0.22µF, 100V ceramic disc

Miscellaneous:

X1	— 230V AC primary 3V-0-3V, 3A secondary

the capacitor of 0.22µF, 100V is connected, the existing bulky condensor can be removed (Fig. 3). The wires to T4 and T6 should be able to withstand minimum 3A. The wires from transformer X1 should be well insulated. Use of heatsink is recommended.

Transformer

Some transformers do not work at high frequencies. In such cases, replace the core by that used in audio output stage transformers. High voltage side should have good insulation.

Testing

Connect the terminals A, B, C and D to their respective places and earth E with a short-wire. Now there should not be any secondary voltage on the primary of X1 (220V side).

When the earth connection to E is disconnected, a pulse appears at the collector of T2. This pulse can be seen on an oscilloscope. If oscilloscpe is not available, connect a multimeter at the base of T4 or T6. A fluctuating DC will be seen in the multimeter. If there is a fluctuating voltage, there will also be a high voltage at the 220V side of X1. This voltage when connected to the ignition coil will be stepped up to 60kV. Insulate the HT wire going to the distributor carefully, by covering it with polythene sleeves.

Power requirements

As the circuit consumes power only for a short period (about 2 ms), each time the contact breaker's contact is 'open', the rms value of current will be about 2A. The total cost of the circuit is about Rs 100 excluding the cabinet and heatsinks. □

6-Band Low-Cost Graphic Equaliser

Amrit Bir Tiwana

Most EFY readers are familiar with graphic equalisers. A 10-band professional equaliser system was featured in this magazine a few years ago.

This low-cost 6-band graphic equaliser is meant for casual audio enthusiasts. With two ICs, the circuit seems quite simple but its operative quality levels are no less if not better than a professional one's. The complete system costs around Rs 100, nearly one-eighth the cost of a readymade graphic equaliser. The high operative quality of the equaliser is evident from the figures in its specifications table.

Earlier graphic equalisers used LC tuned coil/inductor circuits which were rather bulky. Such circuits were prone to noise pick-up. These circuits were originally based on transistors. Gradually transistors were replaced by ICs which worked with inductors. Then came op-amp simulated inductors which eliminated the need of any coil. It helped in constructing a more compact circuit (as in most commercial designs) around a dozen op-amps. Further improvements have facilitated the present design around just two ICs!

Using gyrators for LC simulation highly reduces cost and size of the device. As shown in the block schematic (Fig. 1), a gyrator consists of an op-amp with a rather unconventional feedback network. At resonance its impedance drops. With the control in mid position the gain is unity. When the gyrator control wiper is shifted towards the input, the output potential rises to maintain the input voltage balance and so the output is boosted. When it is moved towards the input, the output potential decreases and the output signal is attenuated.

Working

The circuit (Fig. 2) uses two quad op-amp LM324 ICs, which by far are the most common and least expensive op-amps of their type (and sell at Rs 10 a piece). Each IC has four independent op-amps, all of which are used in case of IC1. Only three op-amps are used from IC2. Each op-amp and the accompanying pair of two resistors and capacitors set the frequencies and simulate an inductor. The circuit can provide a boost of +15dB and attenuation of -15dB.

Capacitors C2 and C16 provide input and output coupling. Controls VR1 through VR6 work at 50Hz, 150Hz, 500Hz, 1500Hz, 5kHz and 15kHz. These frequencies can easily be altered by changing the accompanying capacitors. C15 provides supply decoupling. VR7 is used to adjust the final gain.

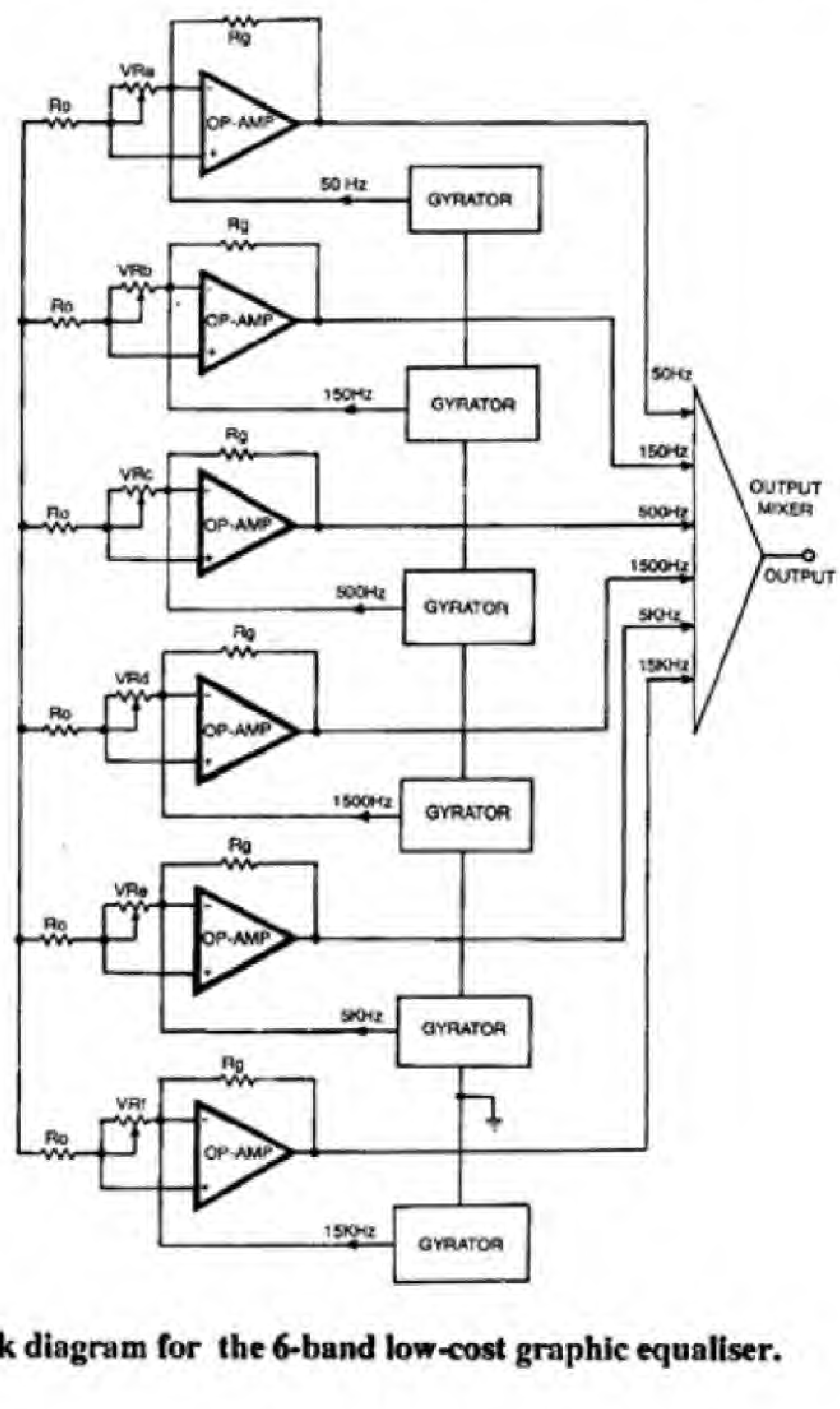


Fig. 1: Block diagram for the 6-band low-cost graphic equaliser.

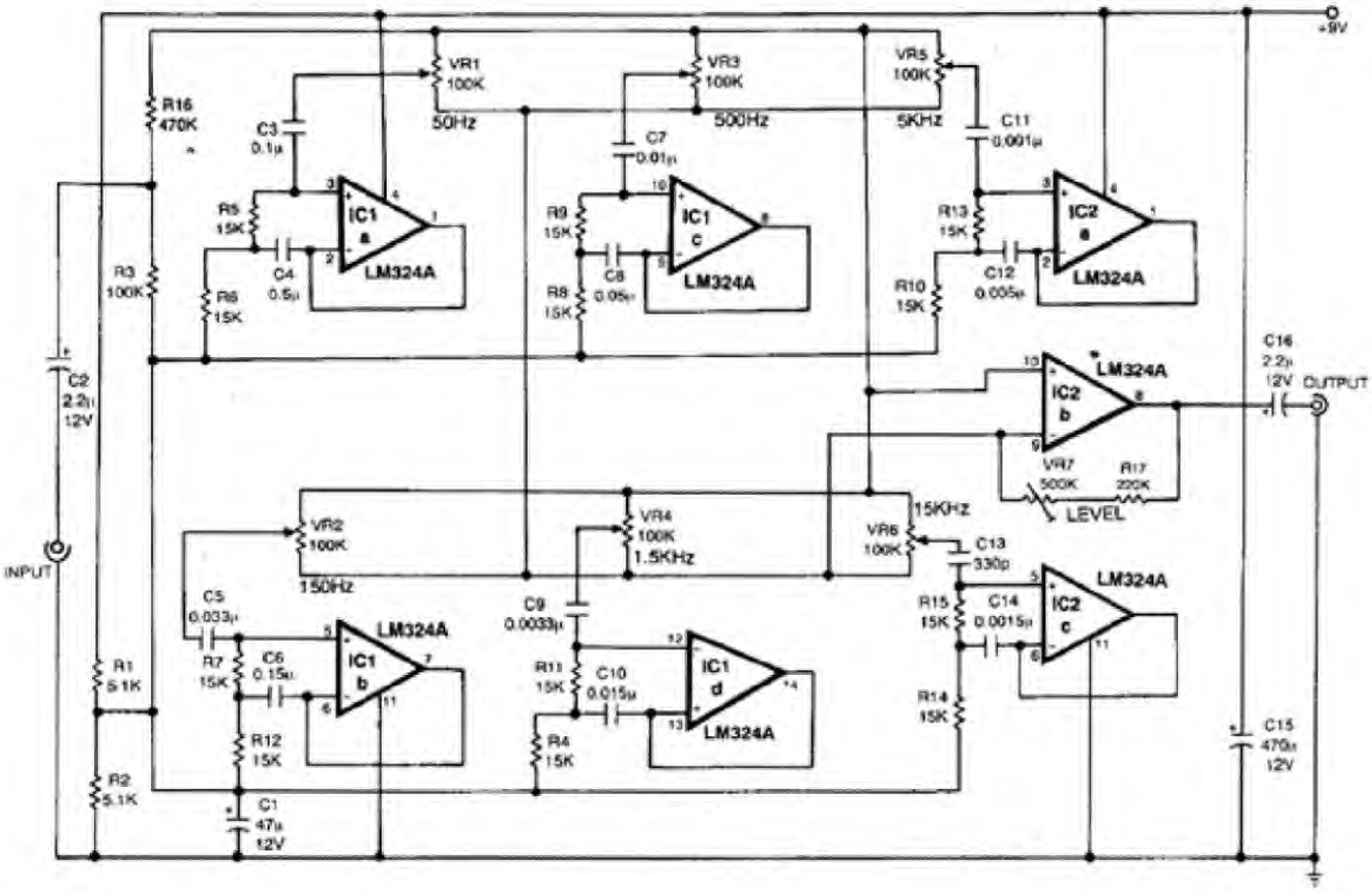


Fig. 2: Circuit diagram for the 6-band low-cost graphic equaliser.

PARTS LIST

Semiconductors:

IC1, IC2	— LM324A, quad op-amp

Resistors (all 1/4W, ±5% carbon, unless stated otherwise):

R1, R2	— 5.1-kilohm
R3	— 100-kilohm
R4-R15	— 15-kilohm
R16	— 470-kilohm
R17	— 220-kilohm
VR1-VR6	— 100-kilohm linear pot.
VR7	— 500-kilohm preset

Capacitors:

C1	— 47μF, 12V electrolytic
C2, C16	— 2.2μF, 12V electrolytic
C3	— 0.1μF ceramic
C4	— 0.5μF ceramic
C5	— 0.033μF ceramic
C6	— 0.15μF ceramic
C7	— 0.01μF ceramic
C8	— 0.05μF ceramic
C9	— 0.0033μF ceramic
C10	— 0.015μF ceramic
C11	— 0.001μF ceramic
C12	— 0.005μF ceramic
C13	— 330pF ceramic
C14	— 0.0015μF ceramic
C15	— 470μF, 12V electrolytic

In the prototype, VR7 was adjusted at mid position, where it gave excellent results. All the measurements were made at this position. A suitable power supply (substitute for batteries) for the circuit can also be used, which can be accommodated on the main PCB itself.

Construction

The complete circuit can be assembled on the PCB shown in Fig. 3. Begin by soldering the resistors followed by capacitors. IC sockets are not required, provided adequate care is taken while soldering to prevent the temperature from exceeding 300°C. Once the ICs are soldered, the potentiometers and other input and output sockets may be soldered. While ribbon cable is used for the former, shielded wire is a must for the latter.

Clean the PCB with protective spray or petrol. Varnish its copper side. To give a neat finish, use solder pins on the PCB. Keep all wires as short as possible. Note that the PCB is designed so as to keep all wiring on one side in proper order.

If the potentiometers are of sliding or plastic type then no chassis is needed. A wide variety of commercially available cabinets can be adapted for this purpose. The choice of sliding or rotary controls is left to the reader. The input and output sockets are mounted on the back panel. The PCB may be mounted using 6mm spacers. A suitable cabinet for the stereo version of the circuit is available @ Rs 75 a piece from Gala

Specifications Table For 6-Band Low-Cost Graphic Equaliser

Operative voltage	: 9 volts DC or 230V AC @50 Hz	
Nominal input	: 200 mV	
Output (Peak to Peak) = 4 volts		
Control ranges	: 50 Hz, 150Hz, 500 Hz, 1500 Hz, 5 KHz, 15 KHz	
Frequency response (typical)		
At	30 Hz	: +2 dB
	40 Hz	: + 4 dB
	100 Hz	: + 11 dB
	150 Hz	: + 16 dB
	300 Hz	: + 6 dB
	1 kHz	: + 2 dB
	2 kHz	: 0 dB
	4 kHz	: -12 dB
	5 kHz	: -15 dB
	10 kHz	: -5 dB
	15 kHz	: -4 dB

Note: These readings were taken in author's prototype using a Meco DMM with 1-megohm impedance and on a Hewlett Packard digital storage oscilloscope.

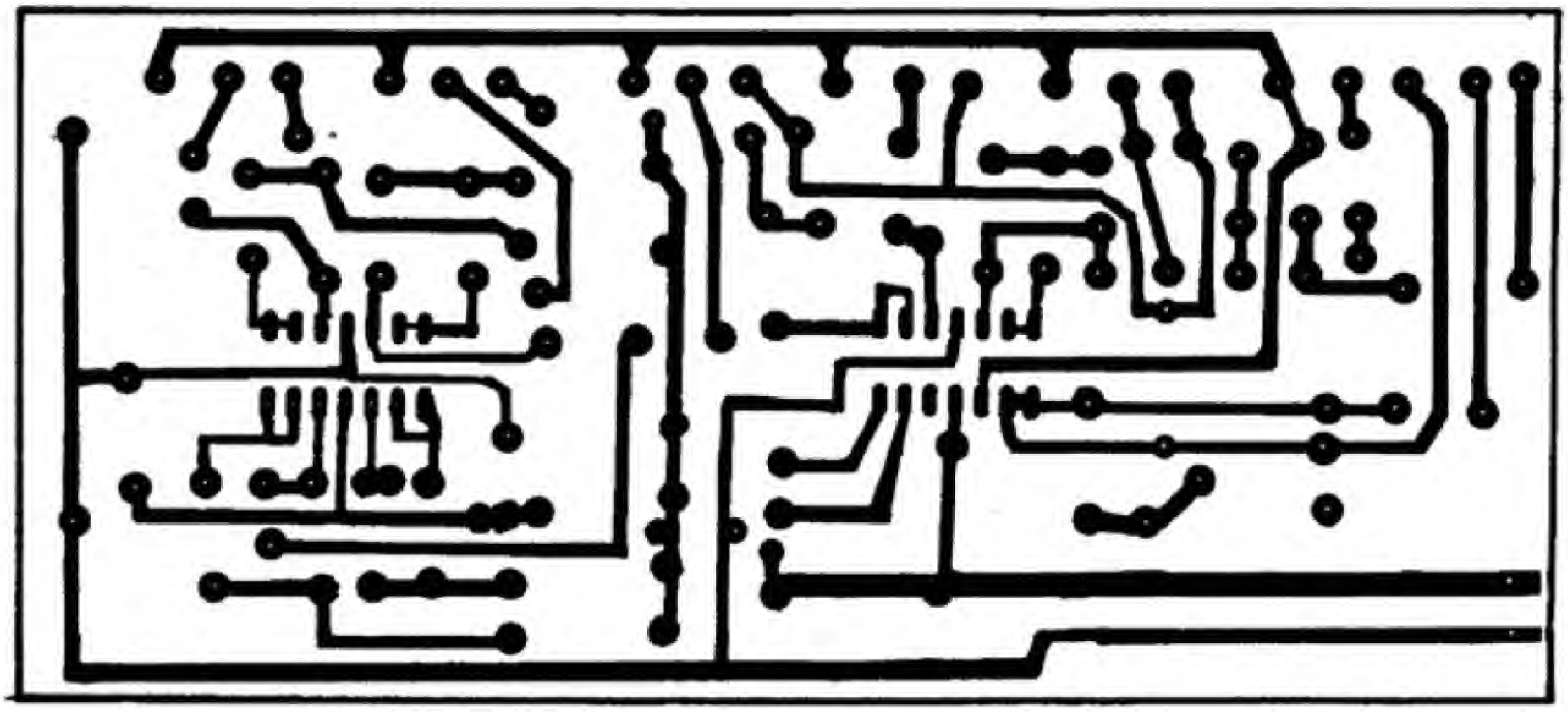


Fig. 3: PCB layout for the 6-band low-cost graphic equaliser.

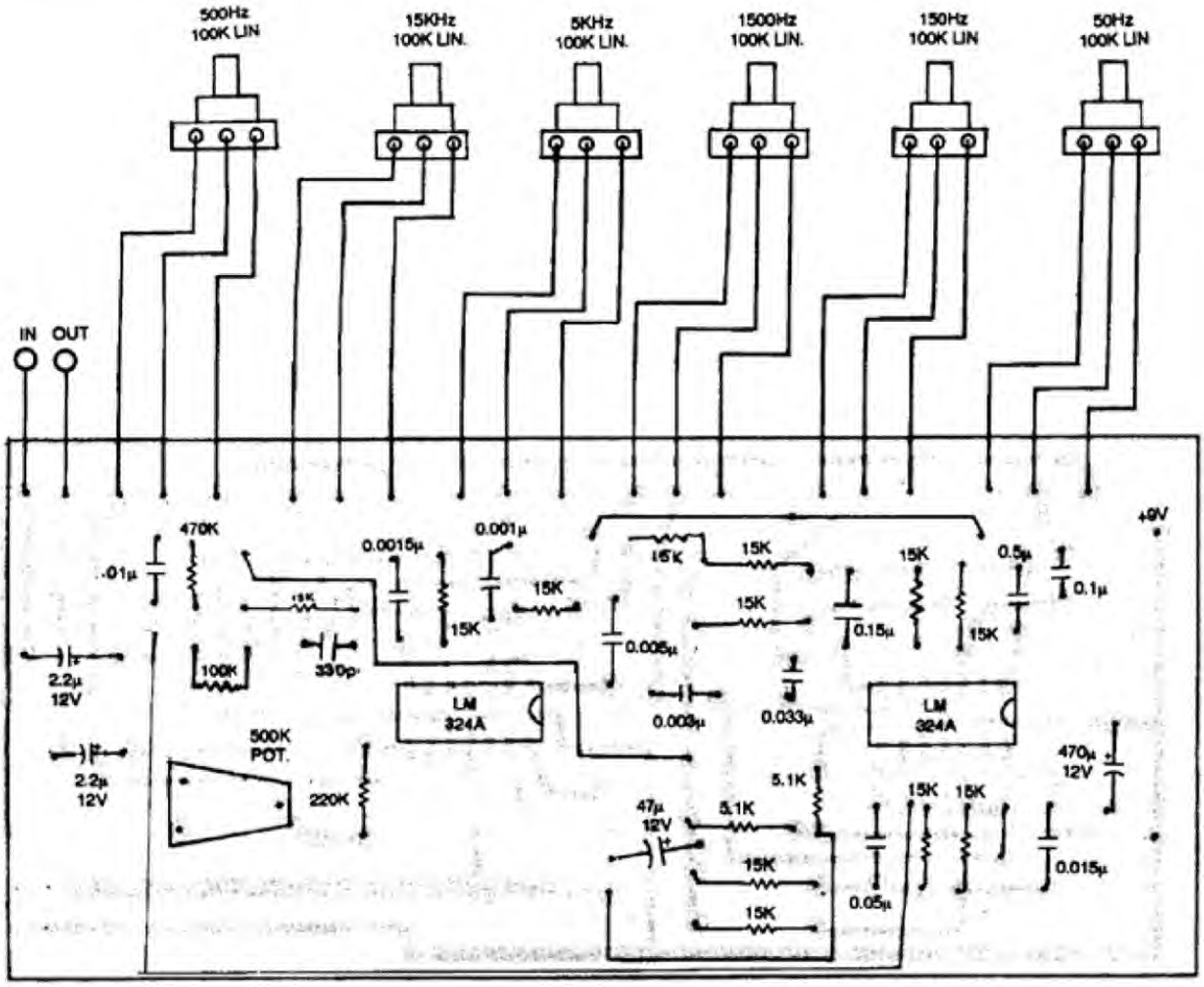


Fig. 4: Component layout for the PCB shown in Fig. 3.

Electronics, Bombay.

The equaliser has to be connected between a preamplifier having an output between 220mV and 3.8 volts and an amplifier. The system has a remarkably excellent signal-to-noise ratio. □

Make Your Own VHF ANTENNA BOOSTER

R. Shankar

Many areas in our country are at considerable distance from the nearest TV transmitter. In these areas satisfactory TV reception is not possible without a high gain antenna and/or booster. This article gives the construction details of a high quality booster for VHF bands.

But first an important fact about booster. Many people tend to believe that boosters improve the quality of the signal available from the antenna. Nothing is further from the truth. A booster could at the most prevent the quality of the signal from deteriorating, let alone improve it. A booster is therefore no panacea for an inefficient antenna system. Before attempting to construct this booster, the reader is advised to go through the article on Yagi antenna design in the December '90 issue of EFY.

Boosters are of two types: wideband and narrowband. Wideband types cover the entire VHF range of 47-230 MHz including the FM band. On the other hand, narrowband types cover only one channel.

Though narrowband boosters are superior to wideband types as far as performance is concerned, the fact that they cannot be used for more than one channel restricts their popularity. For this reason, invariably all boosters available in our country are of the wideband type.

The booster given in this article falls midway between the two types. Actually, two versions are given, one for band I and the other for band III. Unlike the wideband type, this booster doesn't cover both the bands. But unlike the narrowband type, this booster covers all the channels in either of the two bands instead of just a single channel.

The fact that this booster doesn't cover both the bands simultaneously should not be a disadvantage because most antenna systems do not have that wide a bandwidth anyway. In fact the sacrifice of the bandwidth means that interfering signals from the unwanted band are kept to a minimum.

The quality of a booster is governed by three parameters, namely noise figure, gain and signal handling capability. The noise figure is the most important parameter of all since no amount of gain could compensate for the damage done to the signal by the noise generated in the booster. A good booster should have a noise of less than 3 dB. This booster has a noise of only 1.5 dB for band I version and 2 dB for the band III version.

Contrary to popular belief, the gain is not a very important parameter. A figure of 20 to 30 dB is perfectly adequate. In fact gain greater than 40dB could lead to undesirable effects such as cross modulation and intermodulation. They manifest themselves in several ways: (a) A dark band across the picture, (b) excessive contrast, (c) buzzing sound in the speaker, (d) complete blackout; and (e) swamping of a weak signal by the local signal of a different channel. The gain of this booster is about 30 dB.

Closely related to the gain is the maximum signal handling capacity of the booster. If the gain is high, the booster should be able to handle the correspondingly higher output level. Otherwise cross modulation and intermodulation would result. The output handling capacity of this booster is at least 100 dBμV (0.1V), which is much higher than what most TV receivers can handle.

Last but not the least, this booster is designed for 300 ohms twinlead cable which is much cheaper than a good quality coaxial cable.

The circuit

The high performance of this booster is due to the new generation semiconductors, namely the BF981 MOSFET and the 2SC2570 bipolar transistor. The former is a gem of a device having a typical noise figure of only 1dB at 200MHz! (In comparison, the lowly BF200 has a noise figure of 2.7dB while even the relatively expensive BFR91 has a noise figure of 1.9dB.) The other transistor used, the fairly well known 2SC2570, has a very large bandwidth (5GHz) despite being very cheap. It is noisier than the BF981, but since it is used only in the second stage, this fact is of hardly any consequence.

Fig. 1 shows the circuit diagram of the booster. The power supply unit (PSU) for the booster is given in Fig. 5.

The balanced 300-ohm signal from the antenna is stepped up by X1 and fed to gate 1 of T1. Similarly, the amplified signal at the drain of T1 is stepped

Table I

	Band I	Band III
C1, C2, C5, C10, C14, C15	1nF	100pF
L3	—	8t, 20SWG
L4	—	11t, 20SWG
L1	6t, 30SWG	5t, 30SWG
L2	11t, 30SWG	7t, 30SWG
L5	12t, 30SWG	8t, 30SWG
L6	3t, 30SWG	2t, 30SWG
L7-L9	5t, 30SWG	3t, 30SWG
L10, L11	8t, 30SWG	8t, 30SWG

down by X2 and fed to T3. The unbalanced signal at the collector of T3 is converted into a balanced one by X3 and fed to the twin lead which connects the booster and the PSU. Gate '2' of T1 is fed with a DC bias of 4.5V. The circuitry around T2 automatically adjusts the bias on gate '1' of T1 so that the latter's drain current is held at around 7 mA. Similarly, T4 maintains the collector current of T3 at around 9 mA. This active biasing does away with the need for source and emitter degeneration resistors which decrease RF stability.

PARTS LIST

Semiconductors

T1	— BF981 dual gate MOSFET
T2, T4	— BC558B pnp transistor
T3	— 2SC2570 HF transistor
D1, D4, D5	— 1N4148 silicon diode
D2	— 18V, 400mW zener diode
D3	— 4.7V, 400mW zener diode
D6, D7	— 1N4002 silicon diode

Resistors (all 1/4W 5%, carbon, unless stated otherwise):

R1, R2, R5, R7	— 100-kilohm
R3	— 220-kilohm
R4	— 68-kilohm
R6, R11	— 1.2-kilohm
R12	— 100-ohm
R9	— 2.2-kilohm
R8, R10	— 82-ohm

Capacitors:

C1, C2, C5, C10, C14, C15	— Ceramic disc (see Table I)
C3	— 100µF, 25V electrolytic
C4, C11	— 22nF ceramic disc
C6	— 1000µF, 25V electrolytic
C7, C8, C9, C12, C13, C16	— 1nF ceramic disc

Miscellaneous

	— 5 Balun core of small size
X4	— 230V AC primary to 0V-9V AC, 150mA secondary transformer

The 9V AC power supply which also flows through the twin lead cable is rectified by D6 and D7 to get +11V and -11V respectively. The negative power supply is necessary because gate 1 of T1 may have to be biased at a negative voltage depending on the specimen. D2 protects the booster against excessive power supply transients.

You might have noticed that the values of some of the components in Fig. 1 and Fig. 5 have been left unmarked. This is because these values depend on the version of the booster. Table I gives the values of components for the two versions.

L3 and L4 are present only for the band III version. Together with the capacitances present at the gate 1 and drain terminals of T1, these inductors

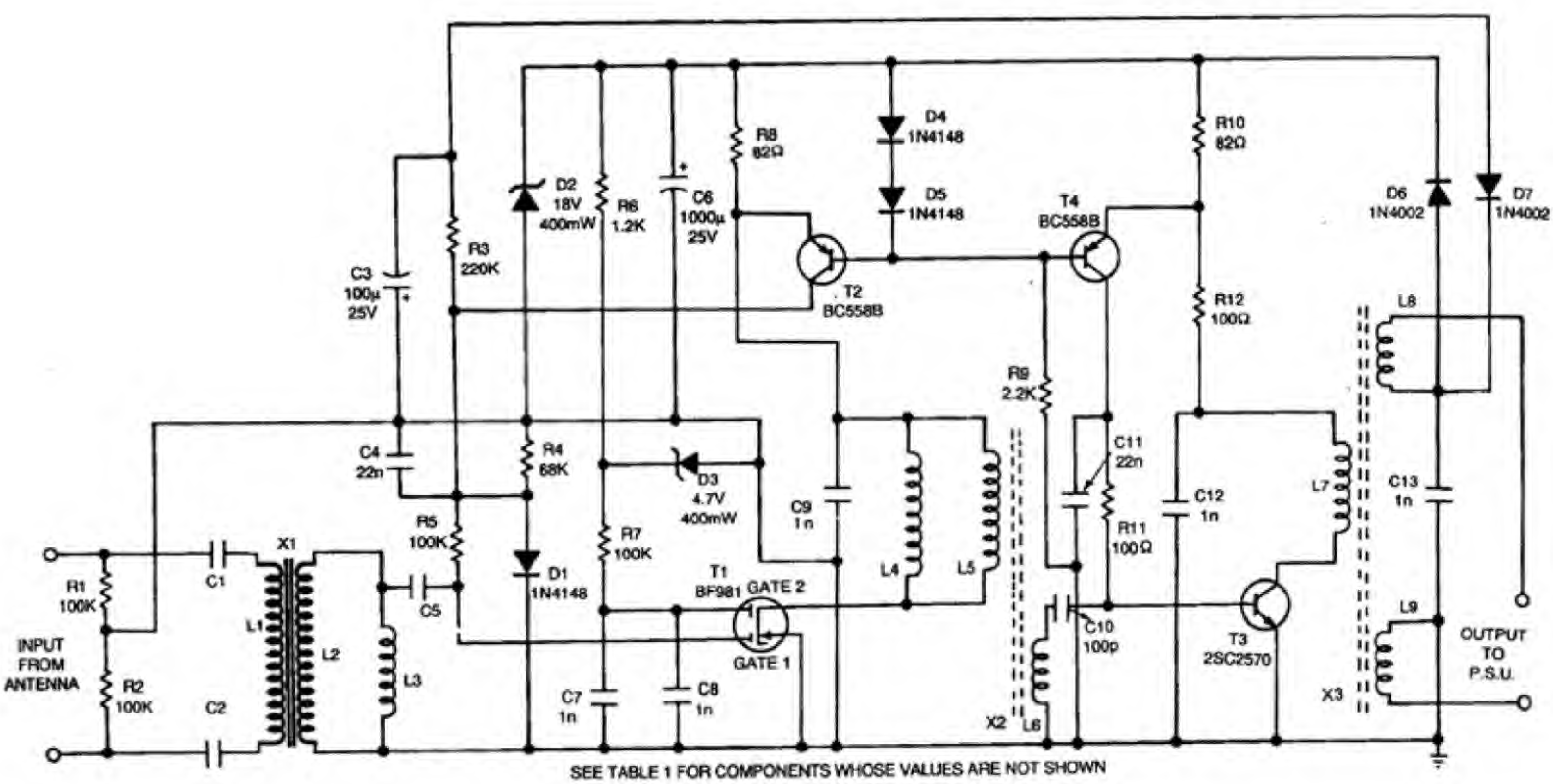


Fig. 1: Circuit diagram for VHF Antenna booster.

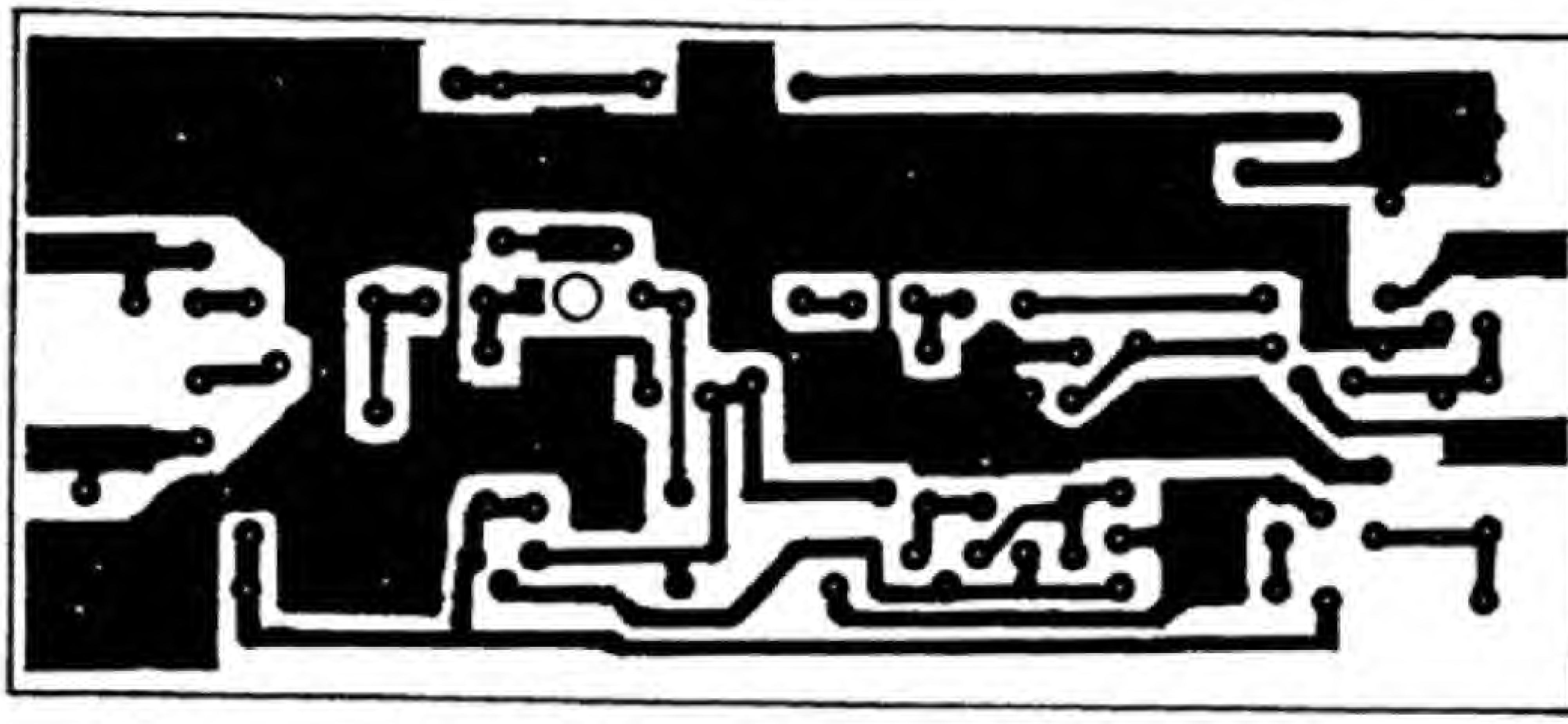


Fig. 2: Actual size PCB layout for VHF antenna booster.

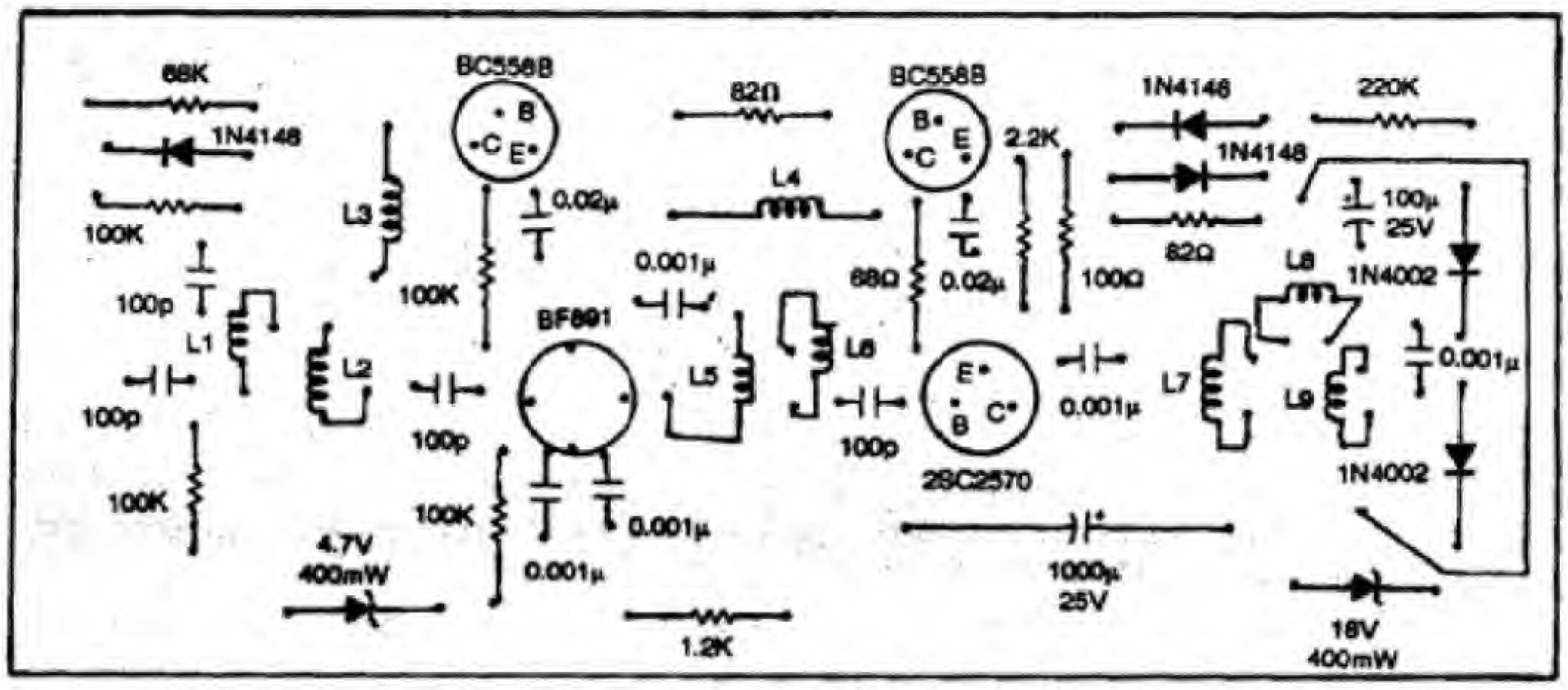


Fig. 3: Component layout for the PCB shown in Fig. 3.

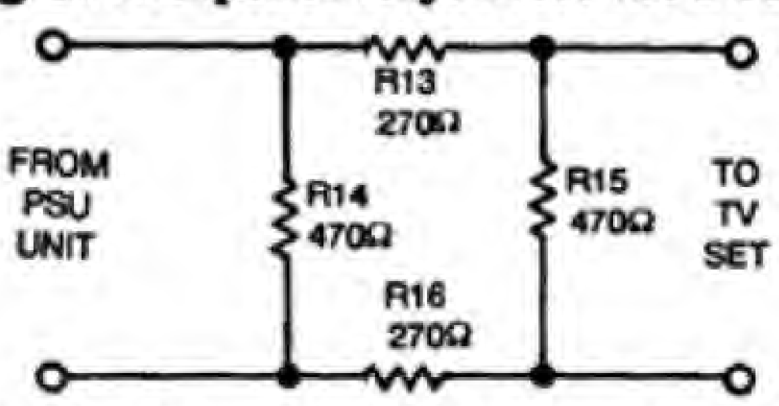


Fig. 4: Attenuator to decrease signal by about 12 dB.

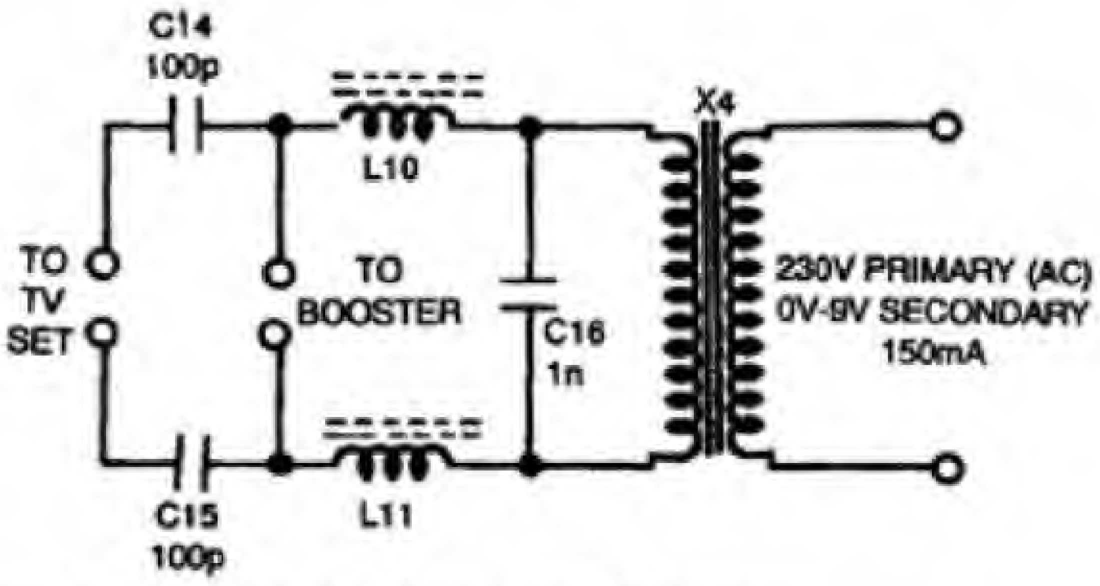


Fig. 5: Power supply unit for VHF antenna booster.

form bandpass filters for band III. In their absence, the inductances of X1 and X2 cause the resonant frequency to fall in band I. Also note that there are differences in the number of turns of the transformer windings for the two versions.

The power supply is relatively straightforward. The RF signal is fed to the TV via C14 and C15 which block the 9V AC. Similarly, L3 ad L4 block the RF signal from reaching the mains transformer.

Construction

Fig. 2 shows the PCB pattern and Fig. 3 the components layout. The PCB should be silver- or tin-plated glass epoxy type. The rectangular pattern on the right hand side of the PCB should be cut from the rest of the board. This section is to be used as an RF shield between the gate 1 and drain terminals of T1. Also a 5mm hole should be drilled at the point marked by a '+' sign on the main PCB.

First solder all the resistors, capacitors, diodes and transistors T2, T3 and T4. Insert T3 and the ceramic capacitors into the PCB as much as they would go without unduly straining their leads.

Now take two bits of excess resistor leads which have been cut off after soldering. Solder them on to the shield section immediately below the marker holes so that the shield section becomes a two-lead 'component'. Now solder this 'component' after inserting it fully into the holes provided on the main PCB so that the copper side faces the input of the booster. The shield should be perpendicular to the PCB. Fix this shield firmly on to the PCB by smearing quickfix along the bottom edge.

Transformers X1, X2 and X3 are made by winding enamelled 30SWG copper wire on balun cores (small size type). The balun core is held in such a way that the holes are vertical. Only one hole is used. The windings are tightly wound in a single layer. Leave some gap between different windings.

Make sure that the windings L8 and L9 are wound 'in phase'. This is very important.

After soldering the transformer leads, coat the windings with insulating varnish. This protects them against corrosion as well as accidental short circuits between adjacent turns. L10 and L11 are also wound on balun cores the same way as X1, X2 and X3.

A word about balun cores: Some manufacturers use high permeability material which is quite lossy at VHF. Therefore,buy samples of different brands and see the strength with which they get attracted by a magnet. Use the type which is attracted the least.

L3 and L4 are made by winding closely 8 and 11 turns respectively of 20SWG enamelled copper wire on a standard pencil. Then they are uniformly stretched so that the ends go into the PCB fully. As previously mentioned, L3 and L4 are necessary only for the band III version.

Now coming to the most delicate component of all, the BF981. It should be the last component to be mounted on the board. While buying it, ask the shopkeeper not to put it in a polythene cover since the static electricity could 'kill' it. A paper cover is perfectly alright.

To solder the MOSFET follow this procedure carefully: First completely tin the pads meant for the leads of the MOSFET on the PCB. Insert the body of the MOSFET into its hole from the copper side of the PCB so that the type number is visible from the copper side and the longest lead rests on the pad meant for the drain. Cut the leads of the MOSFET to the size of the pads.

If you have a low leakage soldering iron, solder the leads by applying the iron for not more than half a second at a time. Also allow a cooling time of 10 seconds between solderings. If you do not have a low leakage iron, remove the plug of the iron (merely switching it off is not enough) immediately before soldering and re-plug it soon afterwards. This step is repeated for each of the leads.

After soldering thet MOSFET, the board could be soldered to the input/output terminal strips provided in the booster box.

Testing

Before mounting the booster near the antenna, it is better to do a 'floor test' to check the DC bias conditions. For this, connect the power supply and the booster by short wires, without connecting the antenna and TV leads.

After switching on the power supply, test the voltages across C3 and C6. They should be about 10 to 11 volts. Next, check the voltage between the anode of D1 and ground. It should lie between -2V and +0.3V.

The voltages across R12 and D3 should be about 0.9V and 4.5V respectively. If they are not, check all connections once again. Also examine for any possible shorts/open circuits of the balun transformers.

The booster is now ready for operation. Use a good quality twin lead to connect the antenna to the booster. The booster should not be mounted too close to the antenna as instability might result. The optimum distance is between one and two metres.

If the gain of the booster is too high, Fig. 4 shows an attenuator which can be used at the TV input to attenuate the signal by about 12 dB. If still there is no effect, R11 can be reduced to 68 ohms or 47 ohms. □

Resetting Protector For Computers

Amrit Bir Tiwana

This low cost resetting protector, which is compatible with almost all types of home computers and PCs, ensures complete protection against faulty or inadvertant resetting of computers.

Most sophisticated computer programs include software which ensures protection against immediate execution of hasty commands. However, even the most advanced computer programs do not offer protection against accidental operation of the panel mounted reset switch. This often leads to incompletely entered software, improperly closed files, and results in useless memory accumulation in the hard disc. The need and utility of a device which can prevent instant (accidental or normal) resetting of the computer is thus quite obvious.

The resetting protector described here is a low-cost solution to accidental resetting. When the reset key is pressed for the first time (may be intentionally) the unit sounds an alarm. The user can disengage the alarm by pressing the same switch again. Thereafter, a panel-mounted LED will start glowing to warn the user that the computer will be reset on the next press.

The unit is built around just two easily available CMOS ICs and is compatible with IBM compatible AT/XT personal computers and a variety of home computers. A compact PCB, which can easily be accommodated in the computer cabinet, has also been included to simplify the construction.

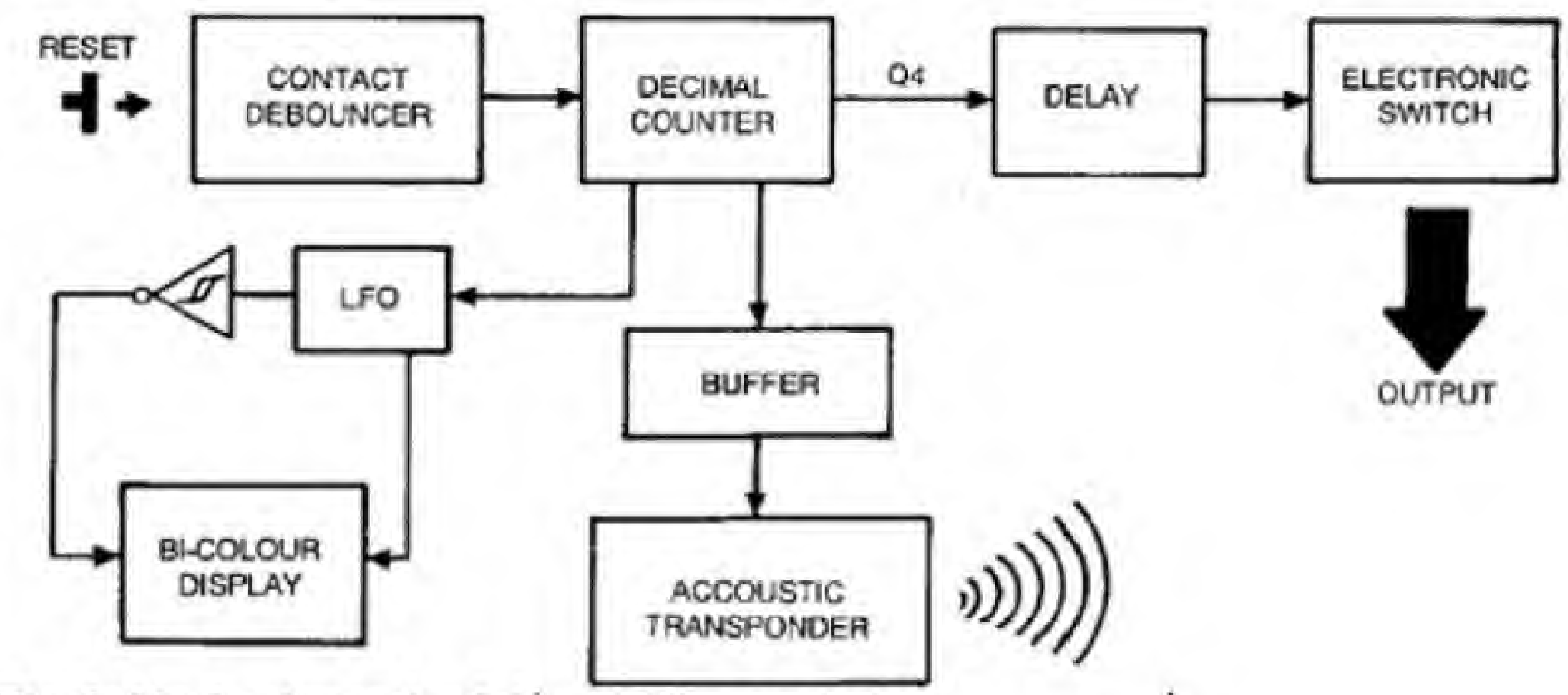


Fig. 1: block schematic of the resetting protector.

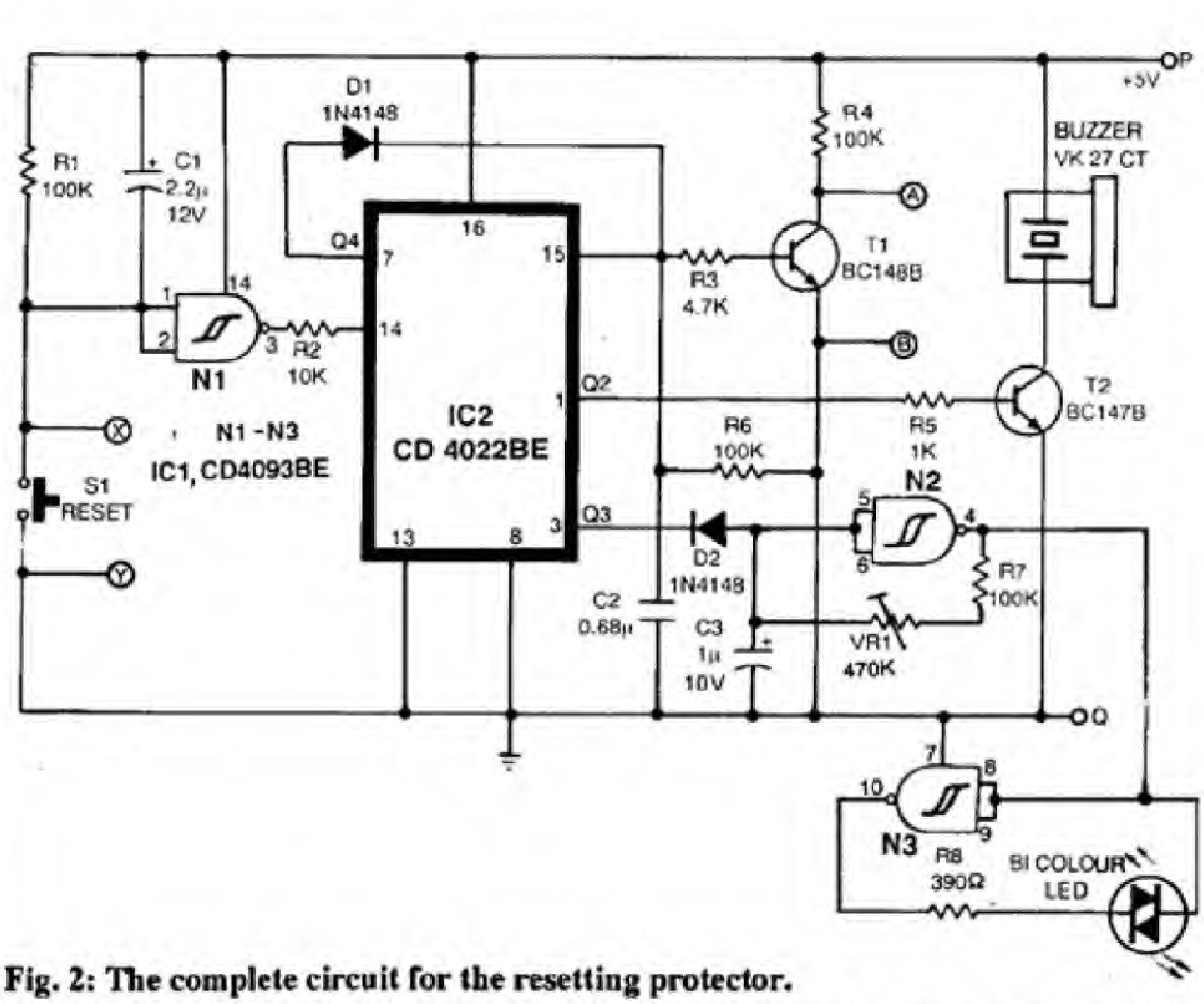


Fig. 2: The complete circuit for the resetting protector.

Working

The block schematic of the protector is given in Fig. 1 and the complete circuit is given in Fig. 2. The circuit is based on a CD4022 octal decimal counter and a CD4093BE quad 2-input schmitt NAND gate IC. The circuit is introduced between the reset switch and the PC's mother board containing the CPU (refer Fig. 7). N1 is used as a contact debouncer which prevents multiple counting when reset switch S1 is pressed.

When the reset switch is pressed for the first time, the output of N1 goes high momentarily, and the output of IC2 (counter) is incremented by 1. Output pin 1 (Q2) of IC2 goes high and the buzzer is activated through the buffer transistor. When S1 is pressed again, the output Q2 goes low and Q3 (pin 3) goes high, which in turn activates the bicolour LED flasher built around N2 and N3. VR1 is used to adjust the flashing rate. When S1 is pressed again, Q4 (pin 7) of the counter goes high momentarily and applies a high pulse to the reset input of IC2 and resets.

Simultaneously, T1 also starts conducting and the points A and B are shorted momentarily and the computer is reset.

Construction

The complete circuit can be assembled on a PCB as shown in Fig. 4. The PCB should preferably be etched on a glass epoxy board. Extreme care should be taken while soldering semiconductors. The lead temperature of ICs should not exceed 250°C. Sixty to forty per cent type core may be used along with a 10-watt rod for this purpose. After soldering is done, recheck the entire circuit and clean the PCB with some petrol and give a coat of varnish to prevent oxidation of tracks. Ribbon cable may be used for connections. The module is now ready for installation.

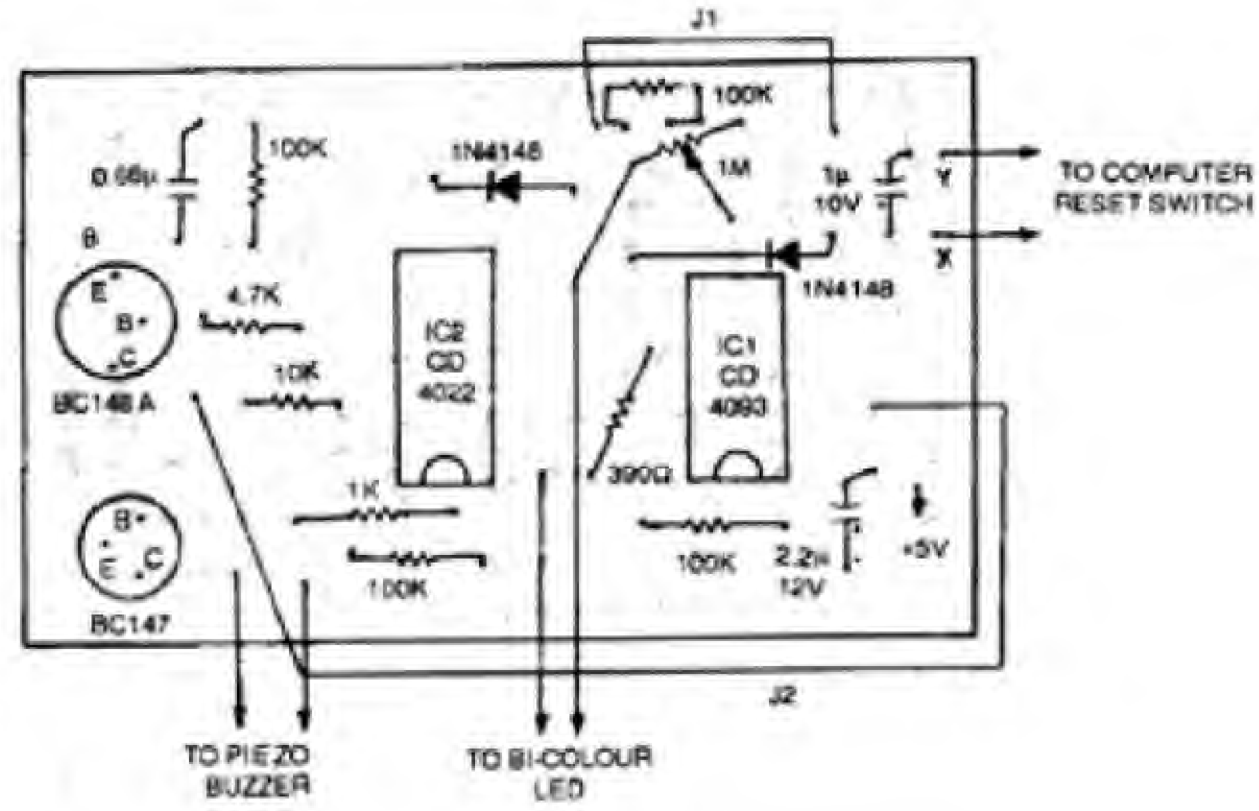


Fig. 5: Components layout for the PCB shown in Fig. 4.

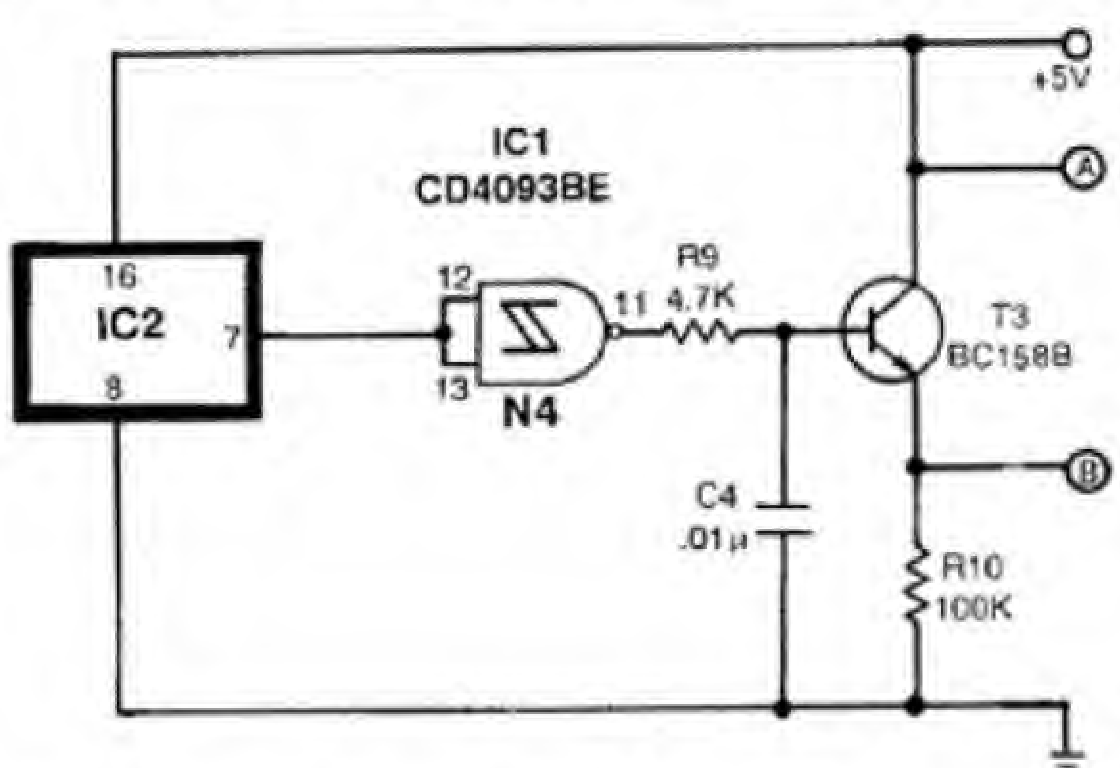


Fig. 3: Modifications for positive resetting of computer.

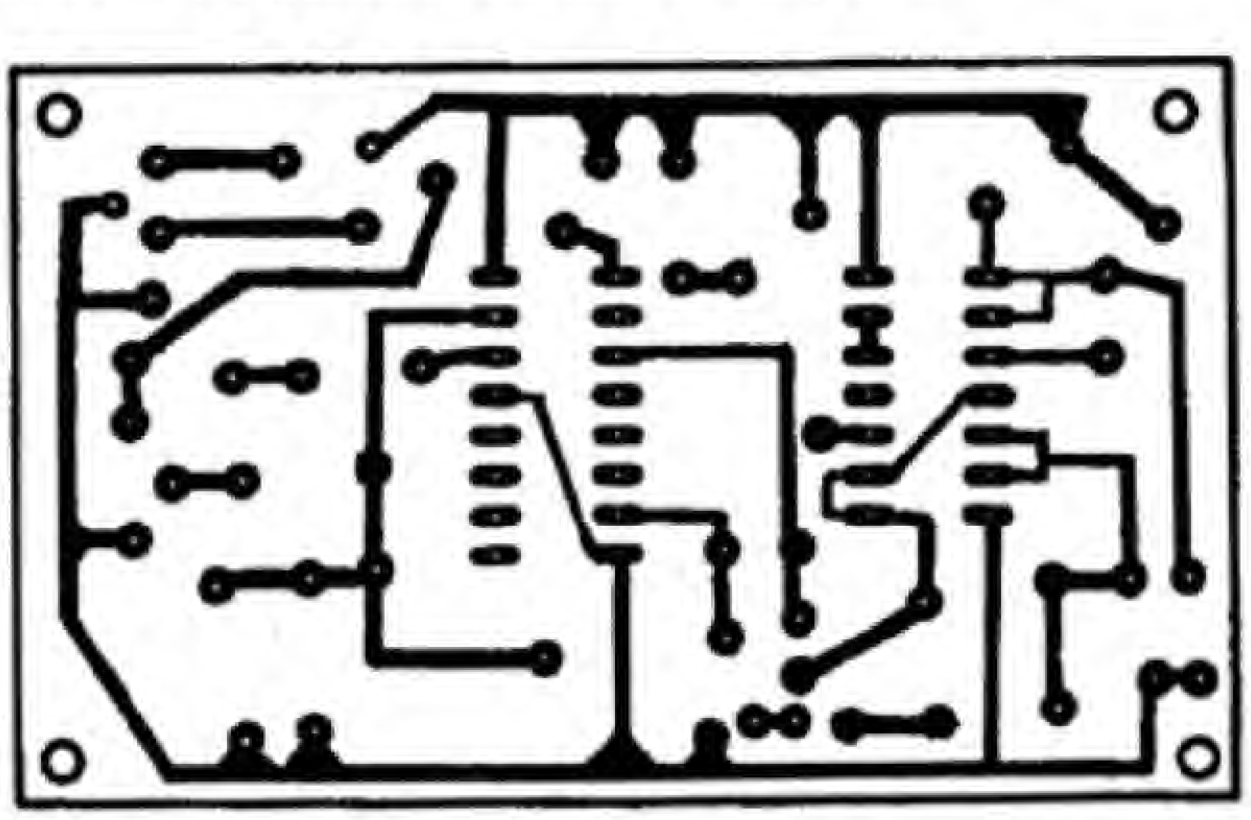


Fig. 4 PCB layout for the resetting protector.

PARTS LIST

Semiconductors:	
IC1	—CD4093, quad 2-input schmitt NAND gate
IC2	—CD4022, octal decimal counter
IC3	—7805, +5V regulator
T1	—BC148B, silicon transistor
T2	—BC147B, silicon transistor
D1, D2	—1N4148, silicon diode
D3-D5	—1N4001, silicon diode
Resistors (all 1/4W, ±5% carbon unless stated otherwise)	
R1, R4, R6	
R7, R10	—100-kilohm
R2	—10-kilohm
R3, R9	—4.7-kilohm
R5, R11	—1-kilohm
R8	—390-ohm
VR1	—470-kilohm potentiometer
Capacitors:	
C1	—2.2µF, 12V electrolytic
C2	—0.68µF ceramic disc
C3	—1µF, 10V electrolytic
C4	—0.01µF ceramic disc
C5	—470µF, 16V electrolytic
C6	—0.22µF ceramic disc
Miscellaneous:	
X1	—230V AC primary to 9V-0-9V AC, 300mA secondary transformer
S1	—Push-to-on switch
	—LEDs
	—Bi-colour LED
	—Buzzer

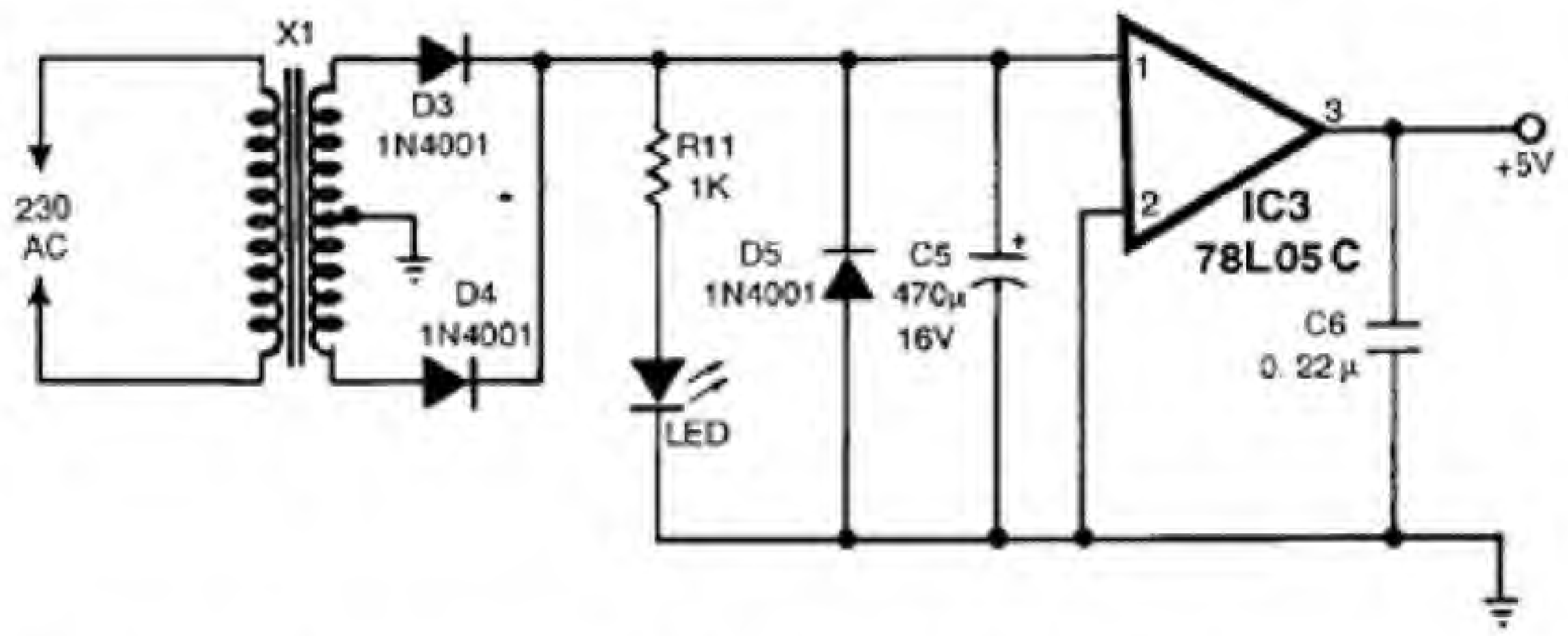


Fig. 6: Power supply arrangement for the resetting protector.

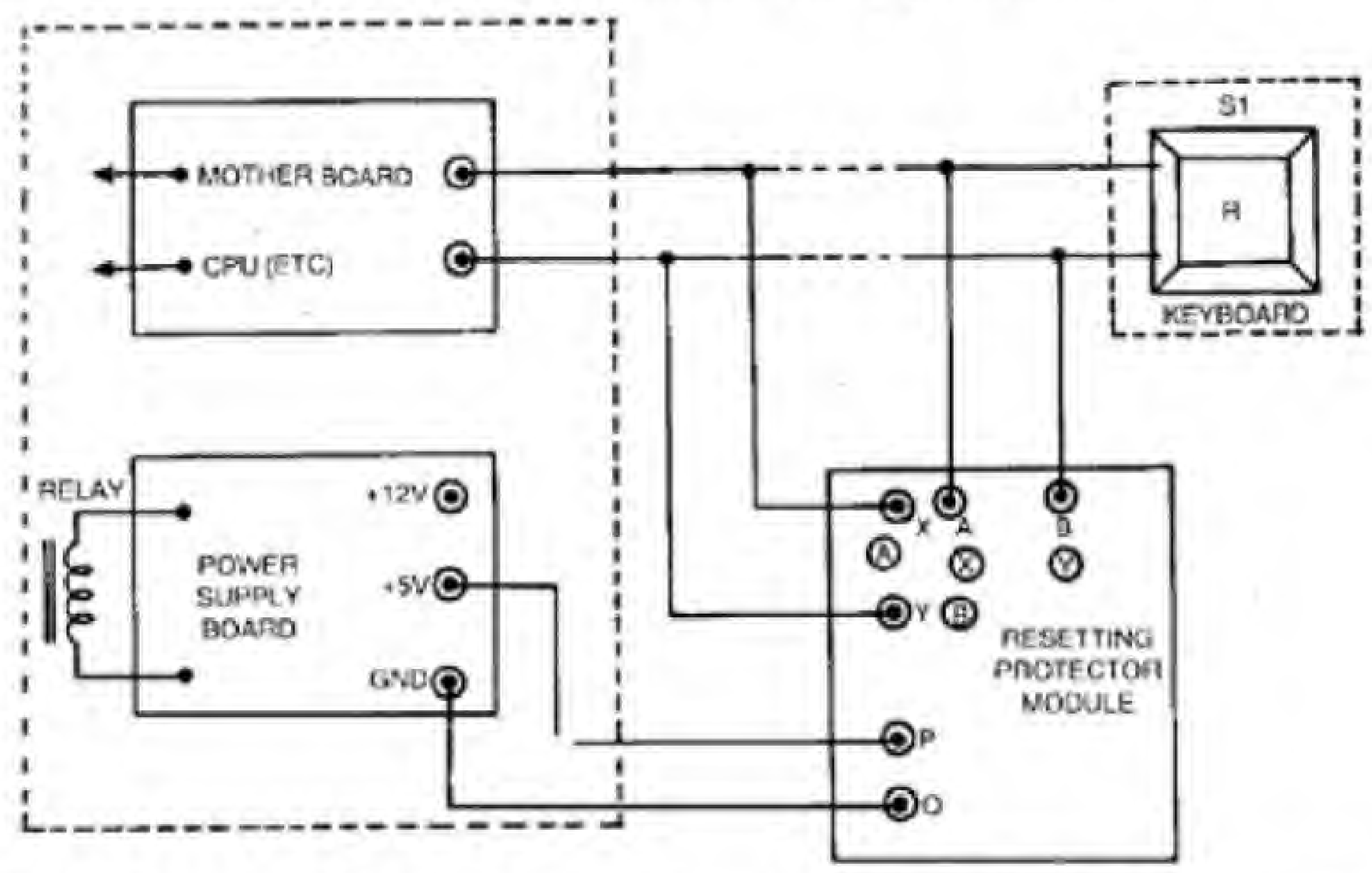


Fig. 7: Wiring diagram showing how the module is installed in the computer.

Installation

The procedure given here must be followed while installing the circuit.

Remove the top cover of the computer. The reset switch is mounted on the front panel with one lead connected to the reset circuitry and the other usually to the ground. Cut the wires shown by dotted lines in Fig. 7 and solder them to points X and Y of the module. Solder the wires coming from the reset switch to points A and B. Connect the ground and +5V terminals of the PSU to points P and Q. Now fix the PCB in a suitable position. In the prototype, it was fixed on the power supply board using 12mm spacer. Now replace the cover and switch on the computer. Test the unit by pressing the reset switch.

Useful hints

If one terminal of the reset switch is connected to the positive terminal supply then the circuit may be modified as shown in Fig. 3. If a separate power supply is required for the circuit, then the circuit given in Fig. 6 may be used.

The complete circuit would cost around Rs 40.

Add-On Telephone Devices

K. Sundararajan

Earlier the telephone was considered a luxury item. Now, times have changed. People have realised the importance and necessity of the telephone. It can be used to perform various functions other than making and receiving calls.

This article enables the reader to increase the performance and usefulness of his telephone by incorporating a variety of circuits. Five such circuits are presented here. The projects described here can be built and used independently.

When the telephone is in idle condition (on hook), the full battery voltage of -48 volts from the telephone exchange appears across the telephone line. To indicate an incoming call, a ringing signal of 75V, 17Hz is sent on the line. The ringing tone duration is 0.4 sec on, 0.2 sec off. This ringing signal is needed to operate the bell or other devices used in the subscriber's telephone instrument.

Projects included in this article are based on the telephone ring detector circuit with or without the ring counter circuit. The ring detector circuit detects the incoming ring signal and then converts it into an electrical pulse.

Ring detector and counter

The ring counter circuit, as the name implies, is used to count the number of rings. Fig. 1 gives the complete circuitry for the ring detector and counter.

Condensers C1 and C2 connected across the telephone line block the normally available DC voltage (-48V). The resistors R1 and R2 form a voltage divider for transistor T1. When the telephone rings, AC voltage of about 75V rms is superimposed on the DC voltage across the telephone line. During positive half cycles of the ring signal, diode D1 is reverse biased and the current is applied to the base of transistor T1. Diode D1 also prevents T1 from being reverse biased by grounding its base during negative half cycles. Transistor T1 conducts during each ring and provides a negative going signal to the ring counter circuit. To convert this pulse into a positive going signal, gate N1 is used. This gate not only inverts the signal but also cleans up the signal for IC2, a 4017 decade counter.

With each clock pulse input, IC2 places a positive voltage on its corresponding output pin while remaining nine outputs are at 0V. Pins 13 (ENABLE) and 15 (RESET) are kept low and IC2 counts the number of clock pulses. If a positive voltage is applied at the ENABLE input, the counter will automatically stop counting. If a positive voltage is applied at the RESET input, counting will immediately stop and the counter will be cleared. By connecting output pins of IC2 to the rotary switch S1, the positive pulse from any output can be applied to pin 13, to disable the IC2 once the predetermined count is reached. To control the RESET pin of IC2, an IC 555 timer (IC3) is employed.

The output of ring detector circuit is fed to pin 2 of IC3. Normally, this trigger input at pin 2 of IC3 is high, and hence the output at pin 3 is low. Gate N2 converts this low signal into high and thus resets the decade counter IC2. The LED connected to the Q0 output glows to indicate that IC2 is reset. However, when T1 conducts due to the presence of the ring signal, pin 2 of IC3 goes low. This triggers the timer into operation and the output at pin 3 becomes high, making pin 15 of IC2 low.

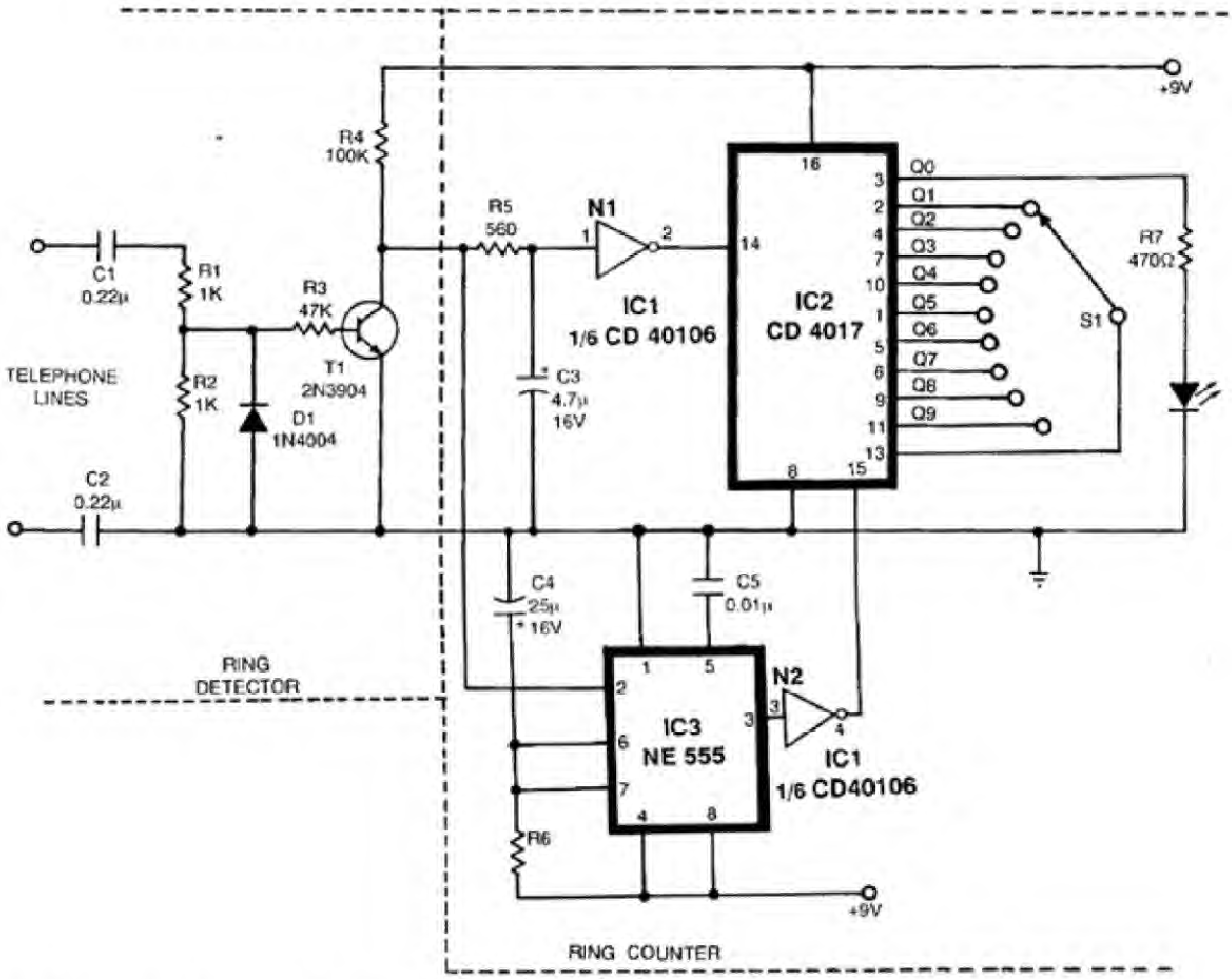


Fig. 1: Ring detector and counter circuit.

Gate N1 inverts the output of the ring detector circuit and gives a clock signal to IC2. Every subsequent ring pulse increments the counter by one until ringing stops.

In this circuit, IC3 is wired as a monostable multivibrator. When trigger (pin 2) is grounded, output (pin 3) goes high for a period determined by the values of R6 and C4. The value of the time constant is 0.693 R6 x C4 sec. But the actual values obtained from the circuit will not be equal to the ideal value derived from the formula because of the tolerance of resistors and capacitors. Similarly, a 1 meg preset/potentiometer can be used for correct value of the resistor. IC3 responds to the first trigger pulse and ignores subsequent trigger pulses during its timing cycle. After the timing cycle, the output at pin 3 goes low and resets IC2. Output of IC2 is cleared back to zero and the LED turns on.

The five add-on circuits are explained below.

Soft ringer

The normal telephone bell is too loud and annoying. One can easily convert this dull sounding telephone ringer into an electronic device which generates a soft, pleasing tone.

It can also be used as an extra bell in addition to the existing telephone bell. For each ring of the telephone, this circuit produces a soft tone.

The soft ringer circuit, based on the telephone ring detector circuit of Fig. 1, is shown in Fig. 2. Piezo buzzer is connected at the collector of T2. Transistor T2 is in cut-off mode when the telephone is idle. When the ringing signal appears across the telephone line, T2 responds and collector current flows through the piezo buzzer. The piezo buzzer sounds in tune with the ringing signal.

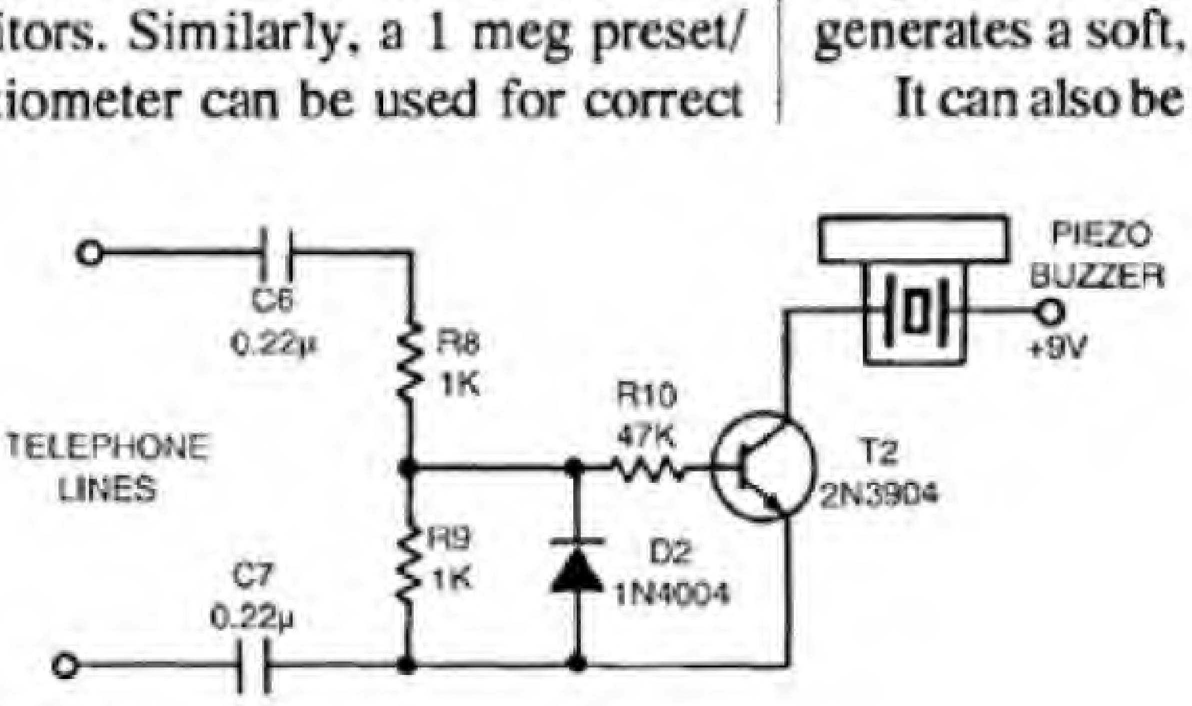


Fig. 2: Soft ringer circuit.

Delayed musical ringer

At times, when the telephone user is fast asleep, the shrill ring of the telephone not only wakes him up but also forces him sometimes to answer a wrong number. This circuit (Fig.3) can be set to intercept the ring signal for a preset number of pulses before the telephone actually starts ringing. Thus, unwanted calls are avoided. Only genuine callers, who allow the ring to continue beyond the preset time, can get the call

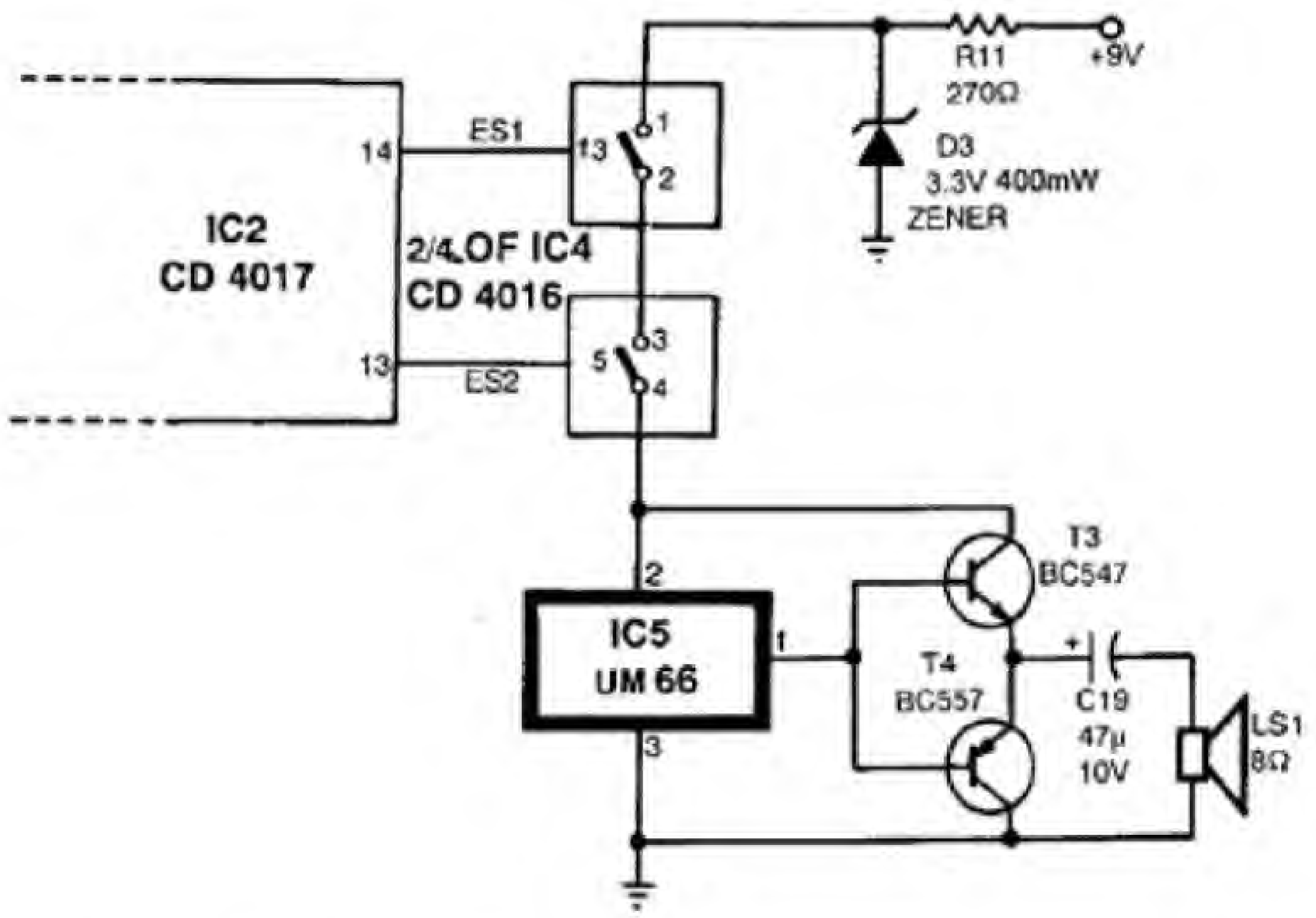


Fig. 3: Delayed musical ringing circuit.

through. At the end of the time constant, the circuit automatically returns to monitoring the telephone for the next call after the preset time.

Operation of the circuit will not affect the normal working of the telephone. The on/off sequence of the musical ringer is determined by bilateral switch IC4 (CD4016). Two out of four switches of IC4 are connected in series with each other. Positive voltage at control pins 13 and 5 close the switches ES1 and ES2 and DC voltage appears at pin 4 of IC4. The clock pulse fed to IC2 is also given to pin 13 of IC4 and the enable pin of IC2 is connected to pin 5 of IC4. Thus, whenever the telephone rings, pin 13 becomes high. When the predetermined count is reached, pin 5 becomes high and 3.3V supply is connected to IC5(UM66 music generator) which generates a pleasant ring.

When the telephone is answered, ES1 opens and the musical ring from UM66 stops. After the set time, pin 13 of IC2 goes low and opens ES2. Now the circuit is ready for intercepting the ring signal of the next call.

Thus, this circuit not only allows the telephone to ring only a few, predetermined times but also plays music.

The important feature of the two circuits mentioned above is that the ringing tone is not continuous. To avoid continuous ringing, the tones are interrupted in tune with the normal telephone ringing signal.

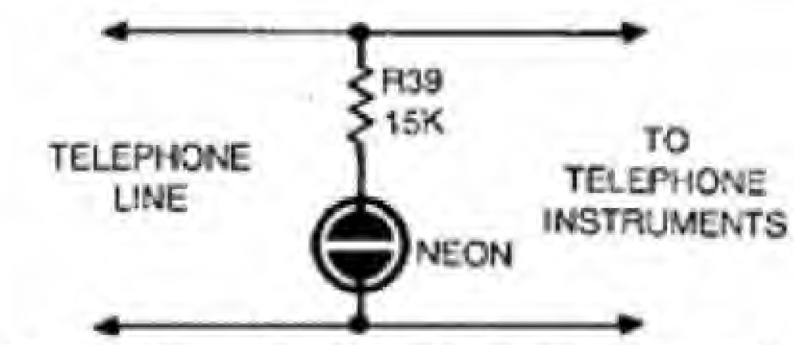


Fig. 4: Simple visual ringing circuit.

Visual indicator

Sometimes the sound of the telephone bell is too low to be heard, particularly when the telephone subscriber is at a distance from the instrument. In such cases, there are chances of missing an important call. This visual indicator circuit (Fig.4) lights up a lamp to indicate an incoming call. This circuit will also help those who are awaiting a call at night but do not want to disturb others. Besides, it can help to attract the attention of deaf people.

The circuit shown in Fig. 4 consists of a neon lamp and a resistor only. The circuit is thus very cheap and easy to fix across the telephone line.

Under idle condition, the -48 volts DC available on the telephone line is not sufficient to ionise the neon gas. When the ring signal of 75V AC at 17 Hz is superimposed on the line, neon gas ionises. The lamp then flashes on and off at the ringing rate. But the main drawback of this circuit is that it is not visible from a long distance.

Visual indicator circuit using a relay is shown in Fig. 5. This circuit is based on the ring detector circuit of Fig. 1. Under normal condition, with low output at the base of T11, T10 is held at cut-off by R38. When the tele-

PARTS LIST

Semiconductors:	
IC1	—CD40106 hex schematic inverter
IC2	—CD4017 decade counter
IC3, IC6	—NE555 timer
IC4	—CD4016 quad SP/ST bilateral switch
IC5	—UM66 musical IC
IC7	—CD4013 dual flip flop
Transistors:	
T1, T2, T5, T6, T8, T9, T11	—2N3904
T3	—BC547
T4	—BC557
T7, T10	—2N3906
D1, D2, D4-D12	—1N4004 diodes
D3	—3.3V, 400mW zener
Resistors (all 1/4W, +5% carbon unless stated otherwise):	
R1, R2, R8, R9, R14, R15, R17, R18, R34, R35	—1-kilohm
R3, R10, R13, R33, R36	—47-kilohm
R4, R12, R19, R32	—100-kilohm
R5, R16, R20	—560-ohm
R6, R22	—See text
R7	—470-ohm
R11	—270-ohm
R21	—390-ohm
R23, R38	—1.5-kilohm
R24, R37	—3.3-kilohm
R25	—22-kilohm
R26, R27, R29	—2.2-kilohm
R28	—10-kilohm
R30, R31	—6.8-kilohm
R39	—15-kilohm
VR1	—360-kilohm (preset)
Capacitors:	
C1, C2, C6-C9 C12, C13, C16, C17	—0.22µF ceramic disc
C3, C14, C18	—4.7µF, 16V electrolytic
C4	—25µF, 16V electrolytic
C5, C11	—0.01µF ceramic disc
C10	—10µF, 16V electrolytic
C15	—0.1µF disc ceramic
Miscellaneous:	
S1	—Single pole, 7/11 way rotary switch
S2	—On/off switch
S3	—Push-to-off switches
S4, S5	—Push-to-on switches
RL1-RL5	—9V relay (more than 50Ω resistance)
Piezo buzzer	—1 no.
Triac	—SC146 or equivalent
SCR	—Any
230V, 60W AC bulb	—2 nos.
LS1	—8-ohm loudspeaker

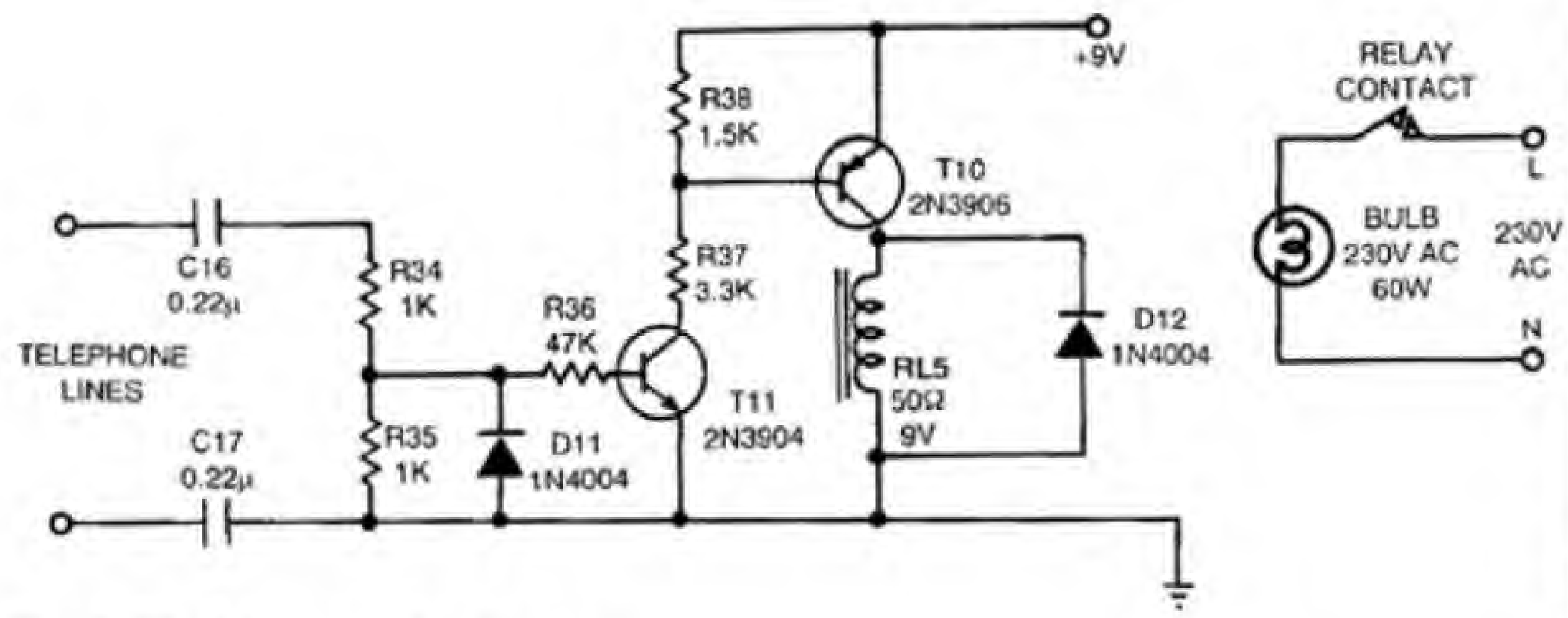


Fig. 5: Flashing visual indicator.

phone rings, a high signal appears at the base of T11. Hence both T11 and T10 are driven to saturation and the relay operates. The relay contact in turn operates the lamp. During the off period of ring signal, the relay is released and the lamp goes off.

Thus, whenever the telephone bell rings, the relay goes on/off and the bulb connected to the relay contact flashes. The lamp glows for approximately one second.

Shown in Fig. 6 is another visual indicator for those who are dissatisfied with the performance of the above circuit. In this circuit duration of the lamp glow can be adjusted using IC 555.

IC6 (IC 555) is connected to operate as a monostable multivibrator and it produces pulse of about 2.5 seconds duration. The pulse width can be adjusted with the help of preset VR1. Pulse width should be greater than one ring, but should end before the start of the next ring. As our ring is of 0.4 sec on, 0.2 sec off, the output of IC6 should be more than 1 sec but less than 3 sec. When the output of IC6 goes high, relay RL1 energises and the bulb starts glowing. Thus, the lamp will flicker in response to the ringing signal.

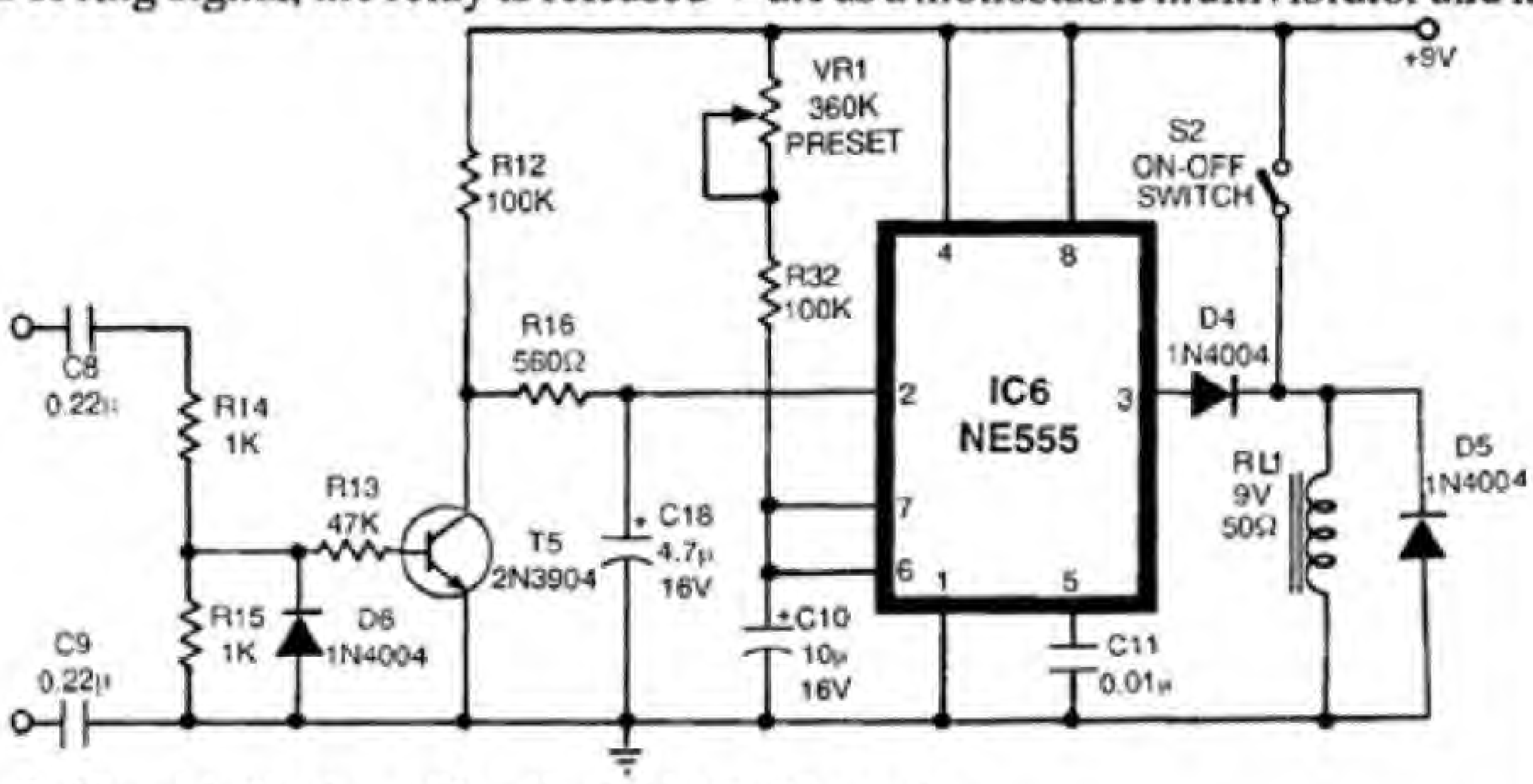


Fig. 6: Visual indicator with adjustable flashing rate.

Switch S2 turns the lamp on when the telephone is not ringing. It applies positive potential to the relay directly. Diode D4 provides protection for IC6 when switch S2 is closed.

To keep the lamp glowing till the conversation is over, value of time constant 0.693 R32 x C10 can be changed.

Shown in Fig. 7 is the schematic diagram of another visual indicator using triac instead of a relay. This circuit also lights the lamp continuously until the telephone is picked by the subscriber. Normally, when the telephone is not ringing, the gate of the triac is grounded. When the ring signal is available on the telephone line, transistor T6 conducts and gate N3 converts this low going pulse into high going pulse. As the triac gets the supply in its gate, it conducts and the lamp glows.

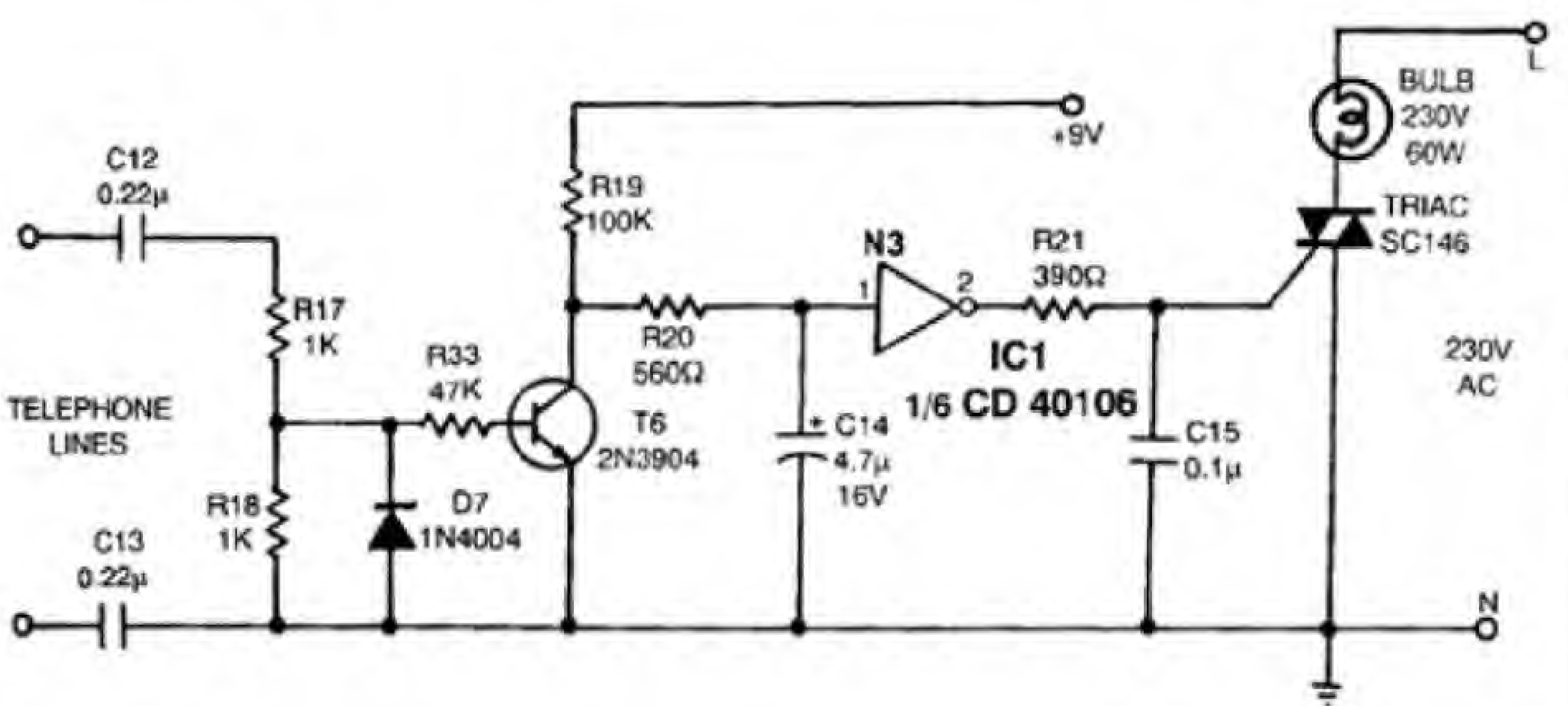


Fig. 7: Continuous lighting circuit.

Automatic audio attenuator

It is very difficult to converse on telephone when the radio or TV are at high volume. The circuit shown in Fig. 8 reduces the volume when the telephone rings and after a predetermined time it restores the original volume level automatically. Circuits shown in Figs 1 and 8 form the complete automatic audio attenuator.

Under normal conditions, output at pin 13 of IC2 is low. Gate N4 inverts it and high pulse is given to pin 6 of electronic switch ES3 of IC4. Thus the audio signal is brought to its original volume. When the telephone rings, the counter (IC2) counts the number of rings to reach predetermined count and opens the electronic switch through gate N4. The audio signal now passes through resistor R22 which results in reduced volume.

The resistor R22 must be introduced between the volume control and the power amplifier. The value of the resistor may be selected as per one's wish and need. The time constant of IC3 should be adjusted such that pin 3 goes

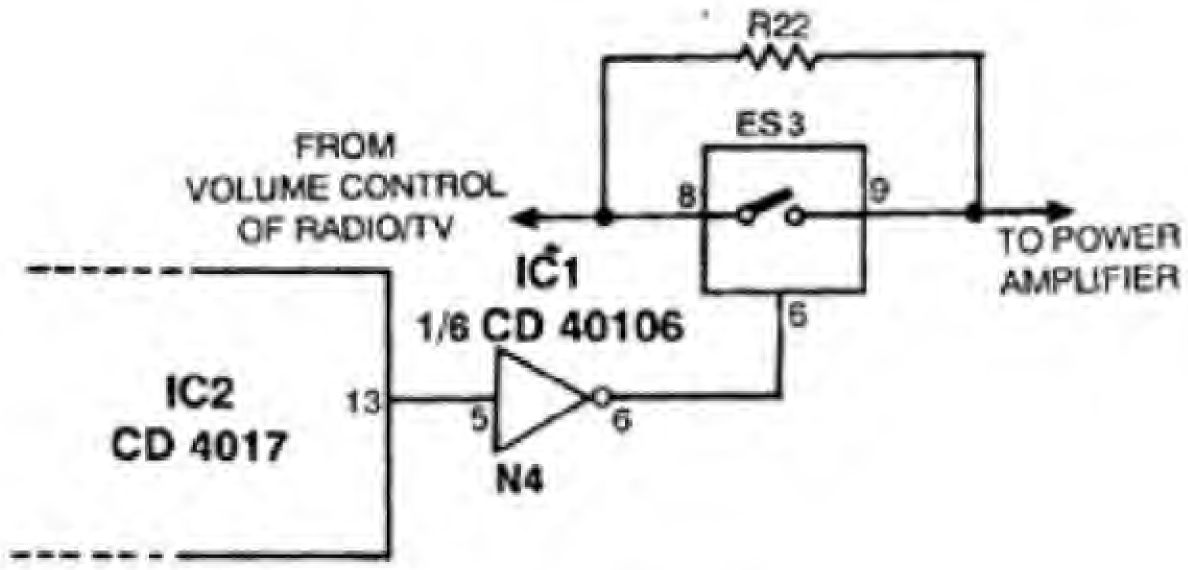


Fig. 8: Automatic audio attenuator circuit.

low after the completion of the call.

Remote control of electrical devices

The remote control circuit described here responds to the sound of the telephone bell to energise any electrical device.

The circuits given in Figs 6 and 7, can also be used for this purpose. Instead of a bulb, other electrical devices can be connected.

Fig. 9 along with Fig. 1 forms the complete circuit for remote control of electrical devices. Under normal conditions, with low output at pin 13 of IC2, T8 is held at cut off and relay does not operate. When the telephone rings, pin 13 of IC2 becomes high after the predetermined number of rings. As this high is given to the base of T8, both T7 and T8 are driven to saturation, and the relay operates. The relay contact completes the electrical circuit of the device. After the set time (by IC3), the relay disconnects the electrical device.

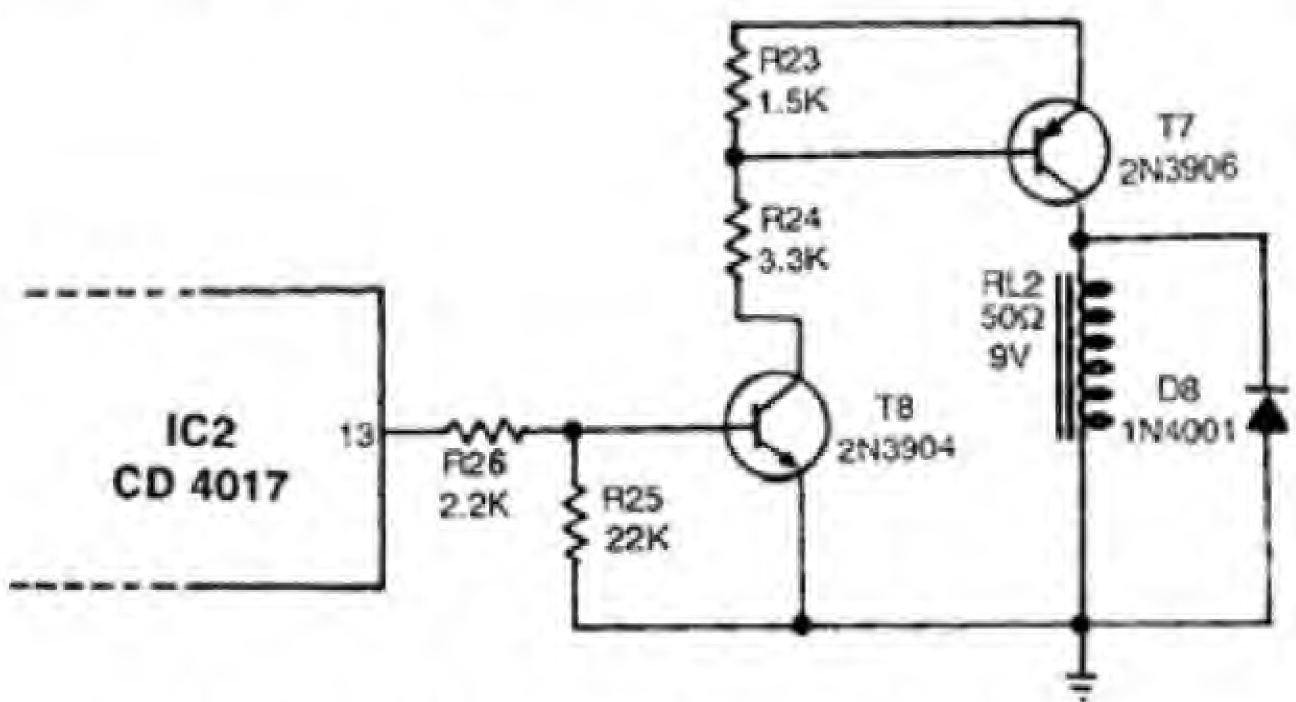


Fig. 9: Remote control of electrical devices by relay coil.

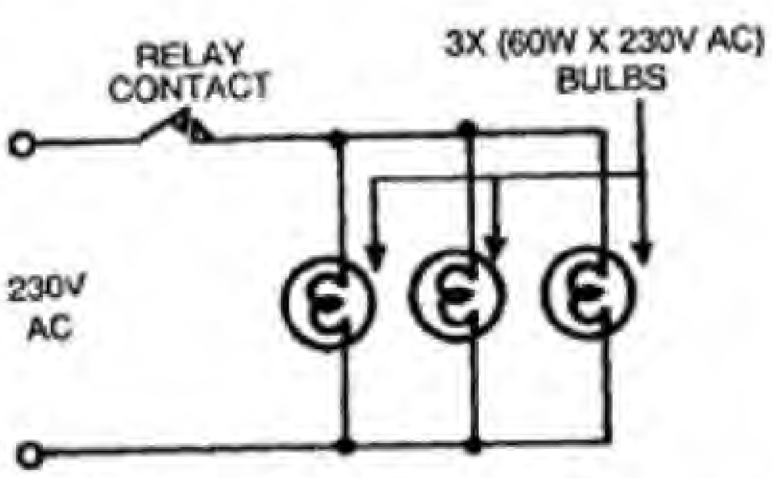


Fig. 10: Suggested use of relay contacts.

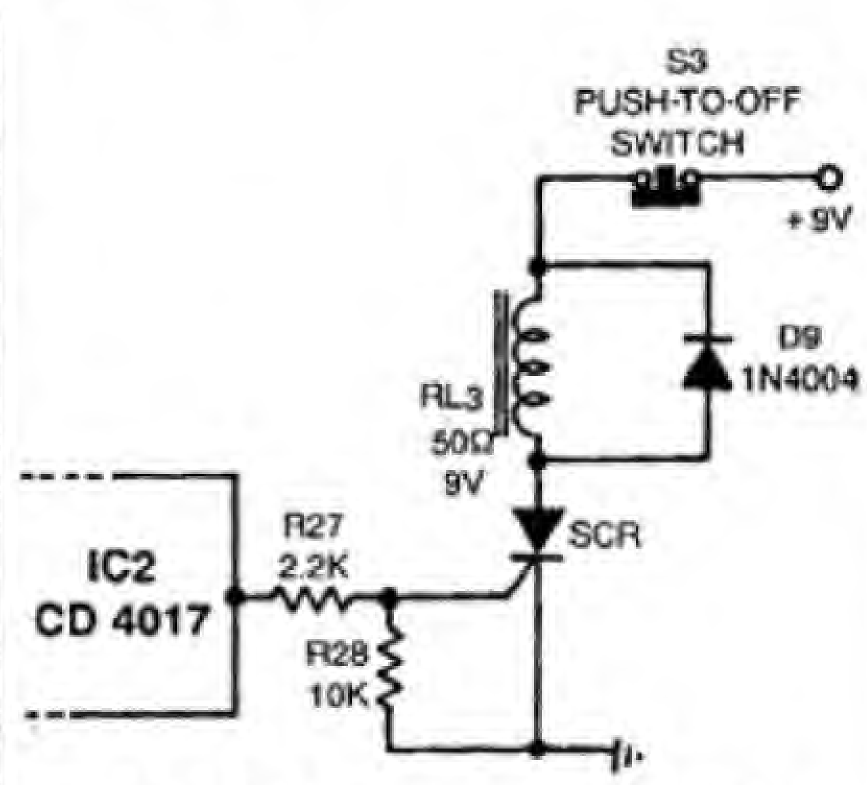


Fig. 11: SCR based remote control circuit.

The circuit shown in Fig. 11 along with Fig. 1 forms the complete circuit for latching the device. Here the relay coil is energised in response to the output at pin 13 of IC2. The positive going output pulse at pin 13 triggers the SCR and the SCR operates the relay. Once triggered, SCR remains on after the trigger pulse is removed. The device can be turned off by opening switch S3 momentarily and interrupting the current in SCR.

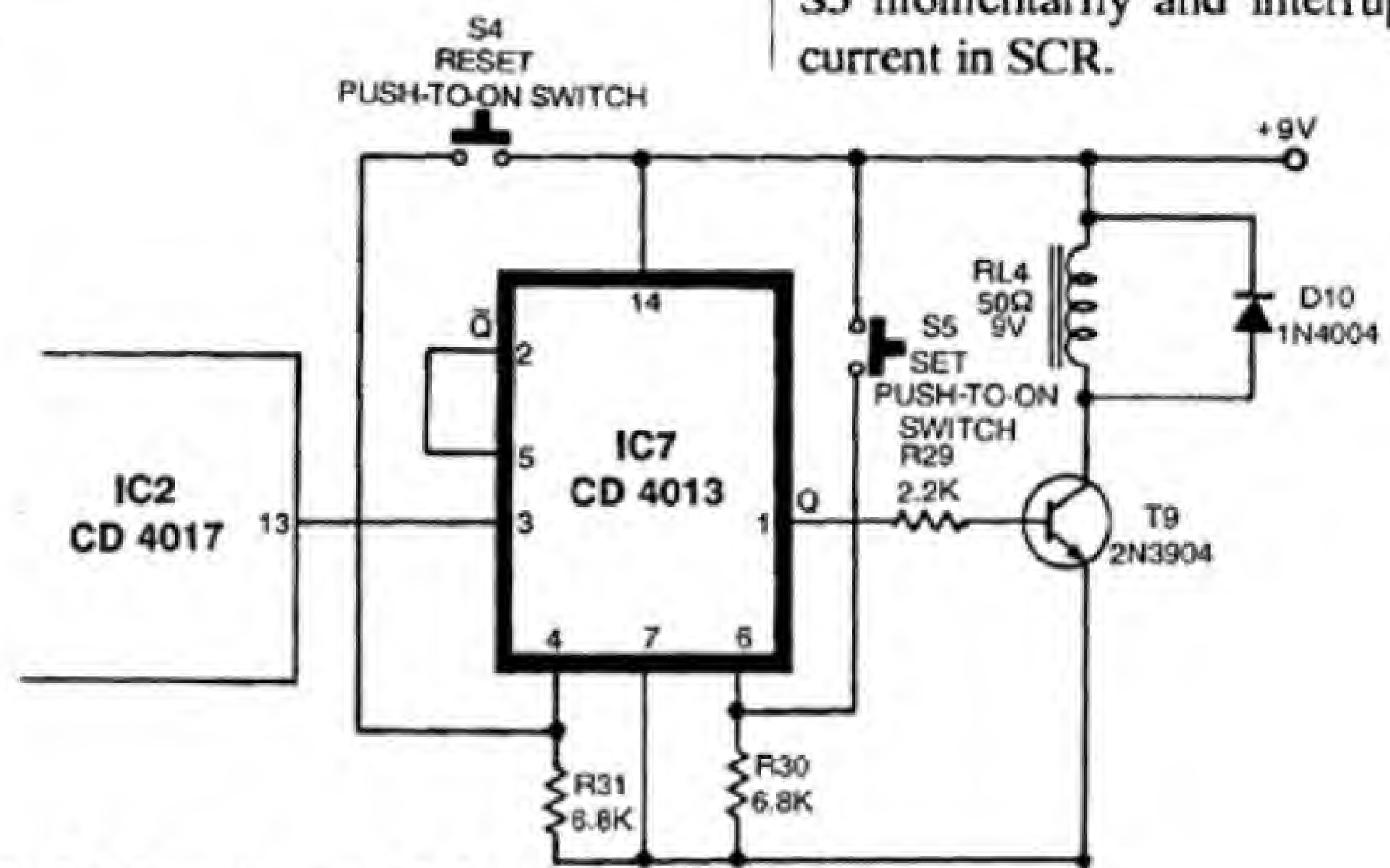


Fig. 12: Remote controlled toggle action.

The circuit shown in Fig. 12 allows a device to be turned on or off with the first telephone call and then be turned off or on with second call. This cycle is repeated with each succeeding call and the load can be switched on and off any number of times.

The heart of the circuit is the D flip-flop (IC CD4013). The clock signal that drives IC CD4013 is taken from pin 13 of IC2. Data available at pin 5 of the flip-flop is transferred to pin 1, when the circuit is triggered by the positive going clock pulse. Outputs at pin 2 ($\overline{Q}$) and pin 1 (Q) are always opposite. Since the data input of the IC is connected to the inverted output ($\overline{Q}$), the flip-flop toggles for each clock pulse, which in turn switches transistor T9 into conduction or cut-off.

Since the flip flop can assume any logic state initially, the set and reset switches are introduced. Set switch S5 forces the circuit to energise the relay coil while the reset switch S4 turns the relay off.

MASTER-SLAVE CLOCK

Suresh Batra

If you happen to reach Bombay VT station by a local train, perhaps you may not miss a pair of giant clocks (about 1.5 m dia) mounted symmetrically across the local platform. These English-made clocks are about a century old and are driven by half-a-minute pulse from their master control. Hence, the concept of a master-slave clock is not a new one. Whenever synchronism among various clocks is required, the idea of master slave is used. The stability and accuracy achieved is that of the master clock. The above-mentioned master clock generally used a metre long pendulum to generate a half-minute pulse.

A more or less similar concept is applied for designing a digital master-slave clock. In place of a metre long pendulum, a quartz controlled master oscillator is used and instead of 30-second pulse, a more accurate 1/60-second pulse is used to drive slave clocks. The block schematic diagram of the same is shown in Fig. 1. The complete circuit diagram of master-slave clock is shown in Fig. 2.

Circuit description

The circuit can be divided into five parts as is clear from the block schematic.

(i) Quartz controlled master oscillator

(ii) Master clock

(iii) Slave clock

(iv) Display

(v) Power supply.

Master oscillator

The master oscillator uses an easily available quartz controlled oscillator cum divider IC, MM5369. The crystal used has a resonance frequency of 3.579 MHz. It gives an output of 60 Hz after 17 stages of division. The output is available at pin 1 of IC1. The pin configuration of the IC is shown in Fig. 9. Fine adjustment of the 60Hz frequency is done with the help of trimmer C3 or sometimes by suitably changing the value of C2. The circuit accepts the supply voltage between 5V and 15V. The drain current of the master oscillator circuit is about 4 mA at 12V supply.

Master clock

The circuit diagram of the master clock is shown in Fig. 2. The circuit shown is for driving one slave clock. Many more slave clocks can be connected by multiplying the five signal points Vcc (A), Vcc (B), reset, 60Hz output and ground. These five signals are terminated in one or two 5-pin stereo sockets mounted in the master and slave units as per requirement.

The clock uses IC LM8361 in a conventional way. Switches S1 and S2 are for fast set and slow set control and S3 is for seconds display. The master clock has an additional control for reset which activates three signals of master as well as all slave clocks, viz, fast set, slow set and seconds display (i.e. pins 34, 33 and 32) simultaneously through diodes D1 to D3(master clock), D8 to D10 (slave clock) and so on. When the reset switch (S4) is pressed, it resets all the clocks to either 12.00 AM or 0000 hrs, depending upon 12-hour or 24-hour mode of operation. The output from IC2 is fed to the display (DIS 1 to DIS 4) through limiting resistors of 1k each. Output for each segment is capable of supplying about 11 mA current. Limiting resistors R3, R5 and R15, while supplying current to more than one segments (depending upon the 12/24-hr mode), may be reduced to 560 or 470 ohms to equalise the glow of the segments.

Slave clock

The slave clock is identical to the master clock. It uses the same IC LM8361. Diodes D8 to D10 and resistors R28 to R53 are identical to D1 to D3 and R1 to R26. In slave clock, the

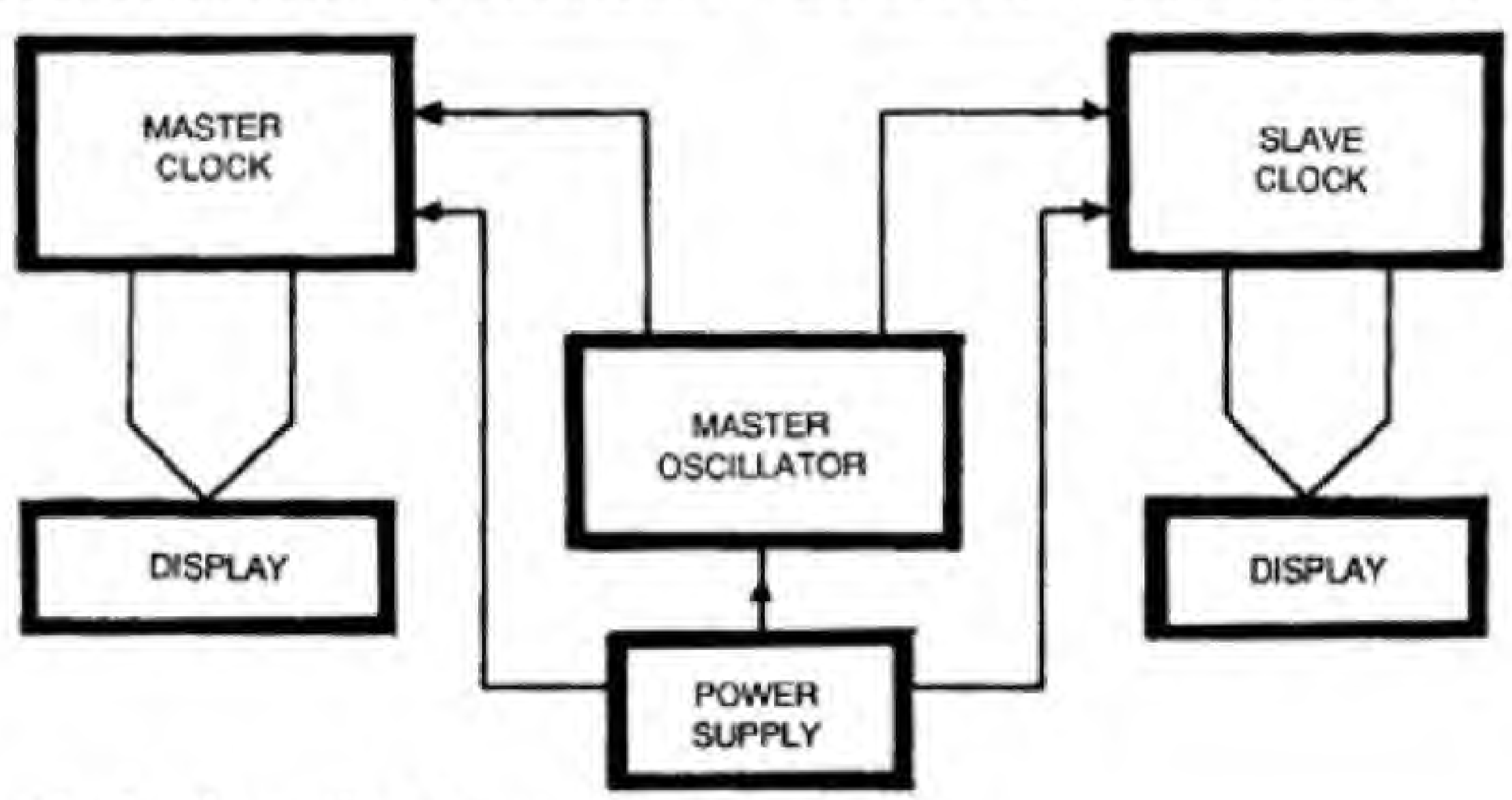


Fig. 1: Block schematic of master slave clock.

switch for seconds display is not needed.

More slave units can be connected in parallel with the master unit. The five signals, viz, Vcc (A), Vcc (B), 60 Hz output, reset and ground are given to these slave units through parallel connections. All the components for these slave units are identical. A 5-pin stereo socket is used to extend the signals from master to slave or one slave to another slave.

Display

Display uses four FND500 devices, giving 12 mm of LED display. Display DIS 1, i.e. 10's of hour, is mounted upside down to give the dot on the top left corner which will work as PM indicator in 12-hour mode. However, the connections of the other segments will not be affected. Cathodes of all the segments are grounded because all the segments are common-cathode type. Displays used for master and slave clocks are identical.

Power supply

The power supply is designed as a

PARTS LIST

Semiconductors:		
IC1	—	MM5369 quartz controlled oscillator
IC2, IC3	—	LM8361
D1-D3, D8-D10	—	1N4148 silicon switching diode
D4-D7	—	1N4001 silicon rectifier diode
Resistors (all 1/4W, ±5% carbon unless stated otherwise):		
R1-R25, R29-R53	—	1-kilohm
R26, R28	—	100-kilohm
R27	—	10-megohm
Capacitors:		
C1	—	470µF, 25V electrolytic
C2	—	15pF, ceramic disc
C3	—	0-22pF trimmer
Miscellaneous:		
X1	—	230V AC primary 12V-0V-12V AC, 500mA secondary transformer
S1-S6	—	Push-to-on switches
XL	—	3.579 MHz crystal oscillator
DIS 1-DIS 8	—	FND 500
-	—	9V Battery

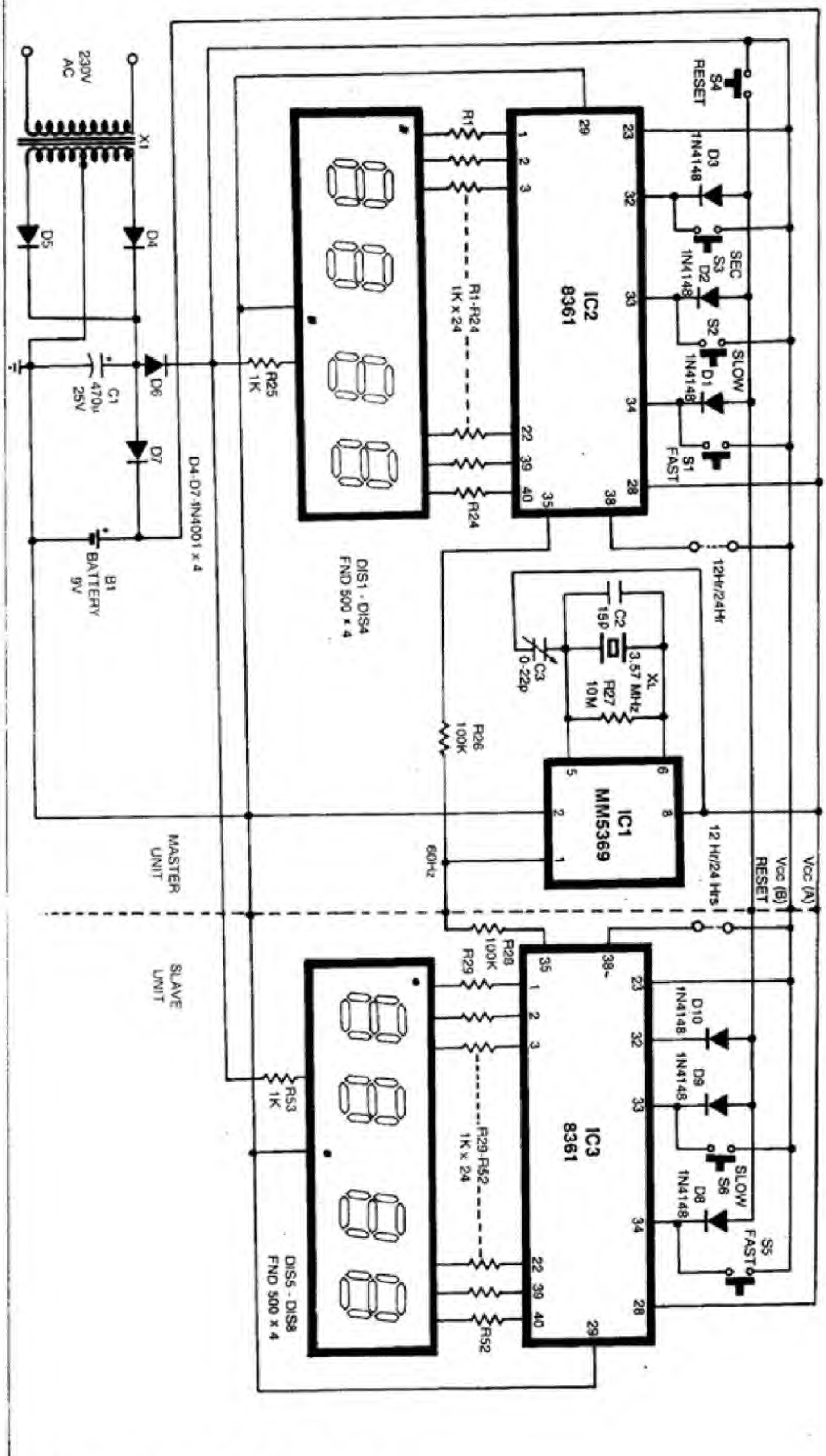


Fig.2: Circuit diagram of master slave clock.

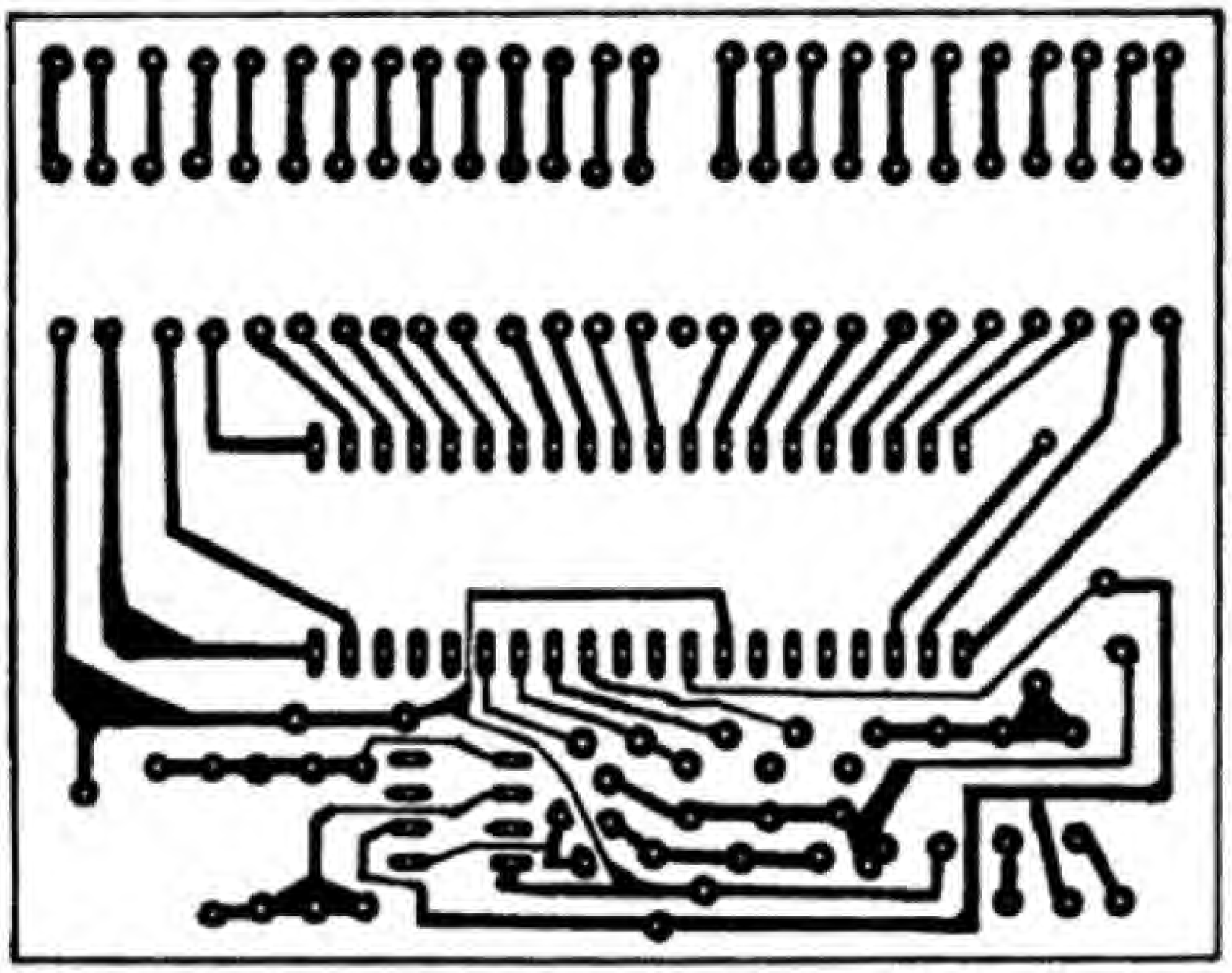


Fig.3: PCB layout for the master unit.

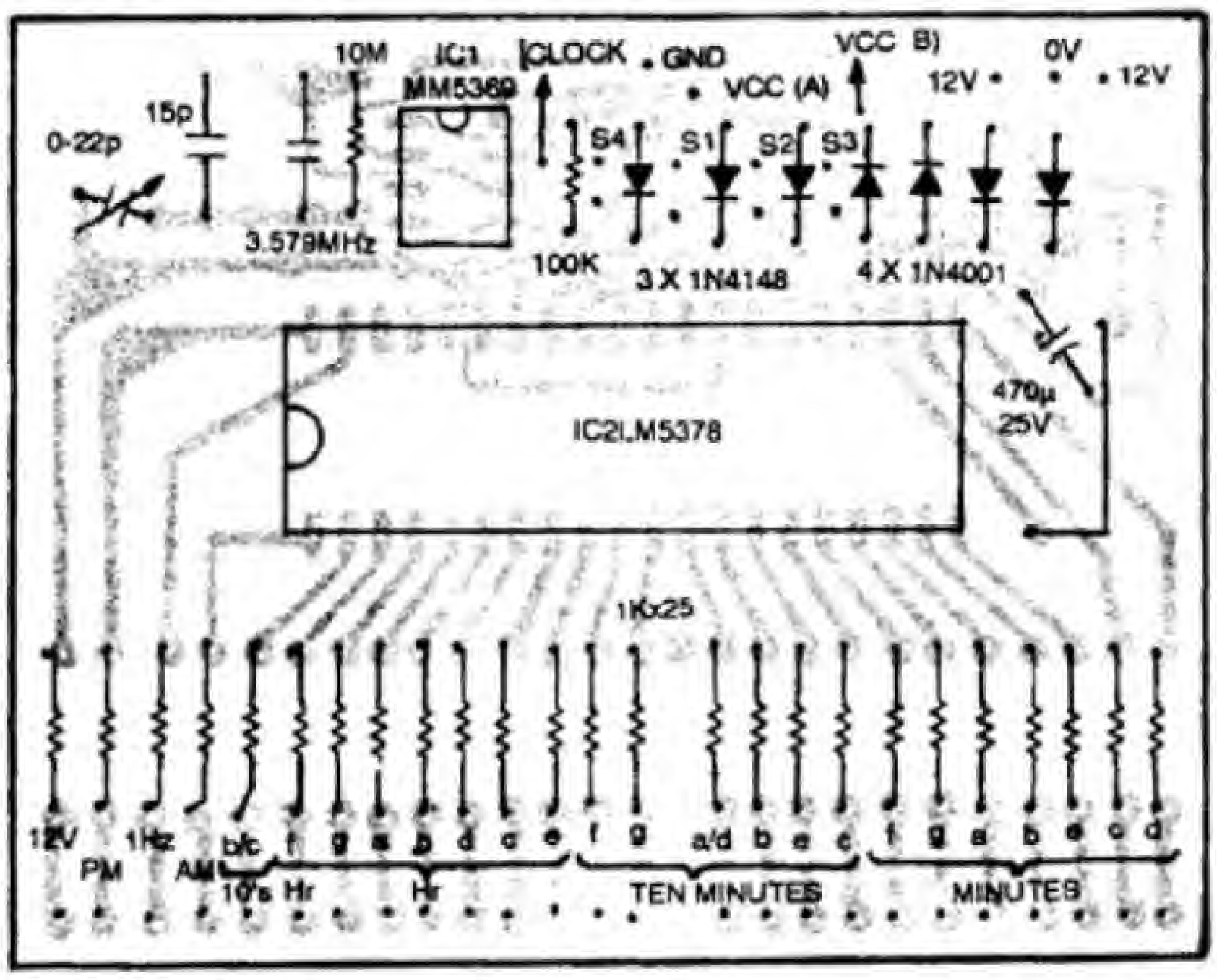


Fig.4: Components layout for the PCB layout shown in Fig.3.

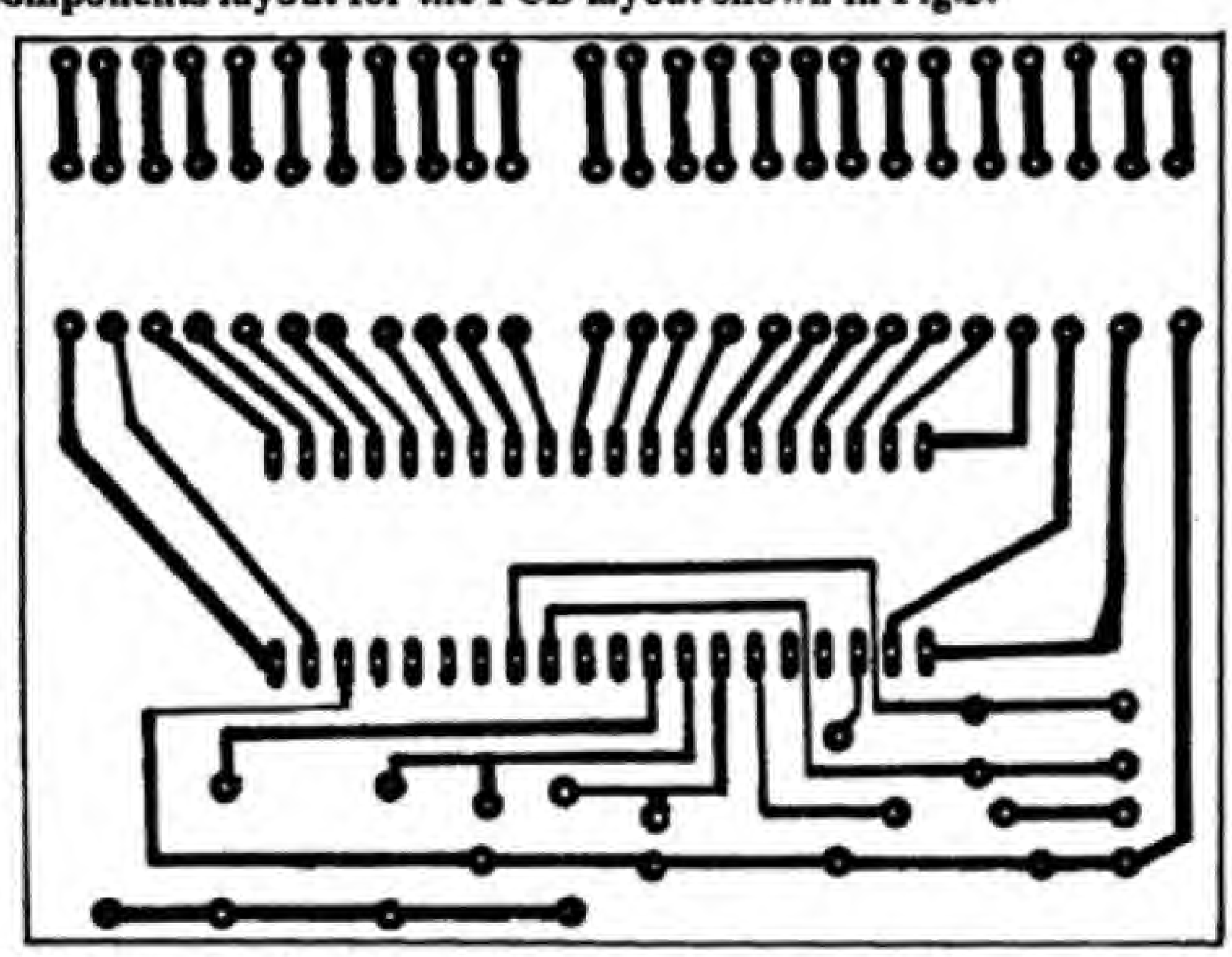


Fig.5: PCB layout for the slave unit.

common source for all the master slave units but is housed in the master unit. As the average drain current of each clock is around 125 mA, the 220V, 12V-0-12V, 500mA transformer will be adequate for one master and three slave clocks. In case more clocks are to be connected, the transformer capacity must be increased accordingly.

Diodes D4 and D5 are connected as a full-wave rectifier and C1 is the filter capacitor. The 9V battery works as the back-up during power interruptions. Vcc (A) is the +12V supply with battery back-up and Vcc (B) is the +12V supply without battery back-up. As the display is connected to Vcc (B), there is no display during power failure.

12-hour/24-hour mode

The display PCB is quite versatile in design. Fig. 10(a) shows the jumper details for 12-hour/24-hour mode and jumper details for 24-hour mode are shown in Fig. 10(b). Master-slave clock can be used in any mode of operation. Also, it is possible to display IST, GMT or any other time depending upon the application.

Assembly

The project will become easy to implement if the PCB layouts shown in Figs 3, 5 and 7 are used. The clock PCB either master or slave has to be connected to the display PCB through 26 flexible wires. While using the slave configuration, the components R28 to R53, D8 to D10 and IC3 have to be used in place of R1 to R26, D1 to D3 and IC2.

Testing

All the components should be checked before starting the assembly. After the assembly is over, first check the supply voltage and master oscillator frequency, i.e. 60Hz output. If 60Hz output is okay, the clock should display the time. If the display is blinking, use set switches S1 and S2 for constant display. Check the segments of all the four digits. If any segment is not glowing, check for the corresponding limiting resistor. Connect the slave

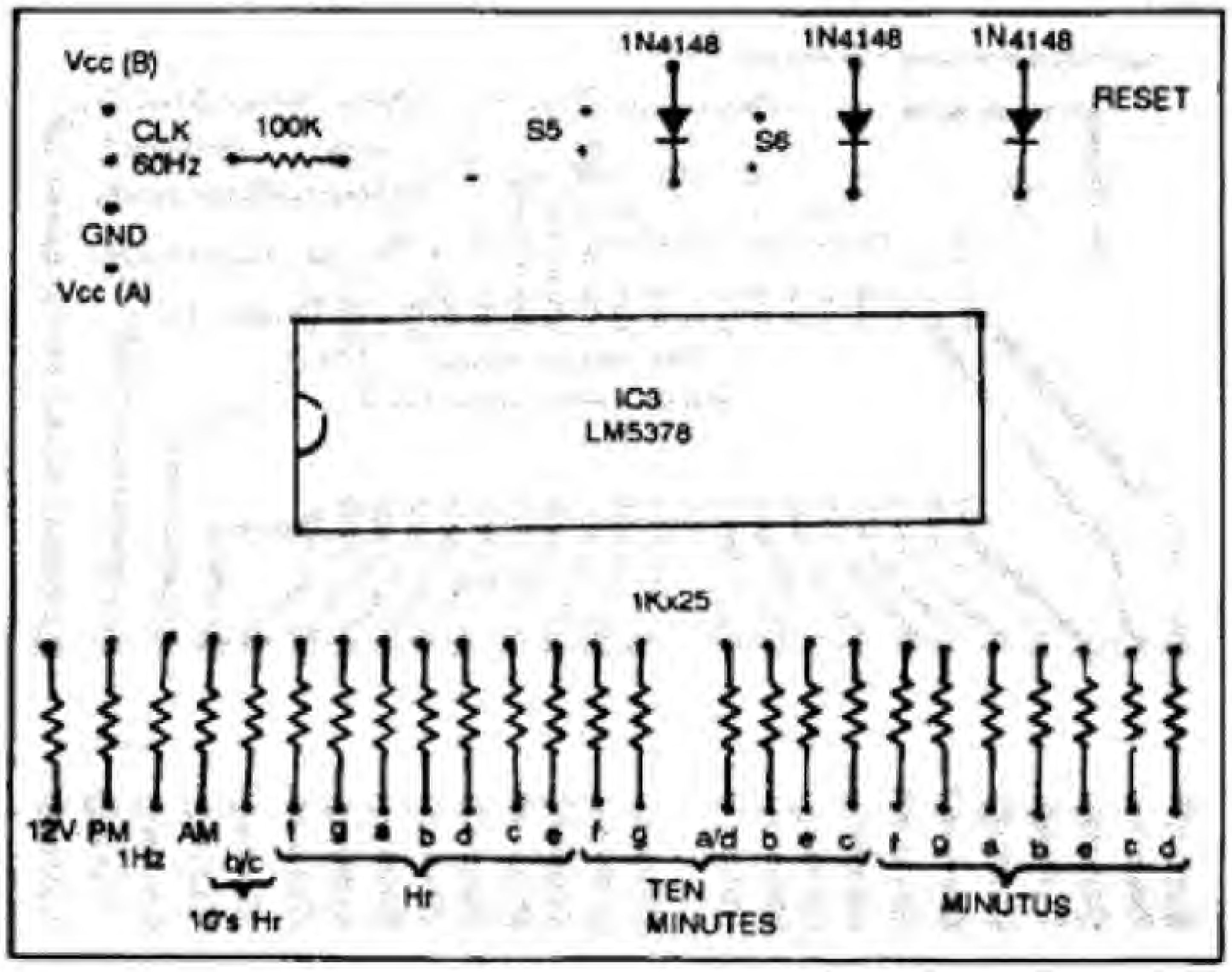


Fig.6: Components layout for the PCB shown in Fig.5.

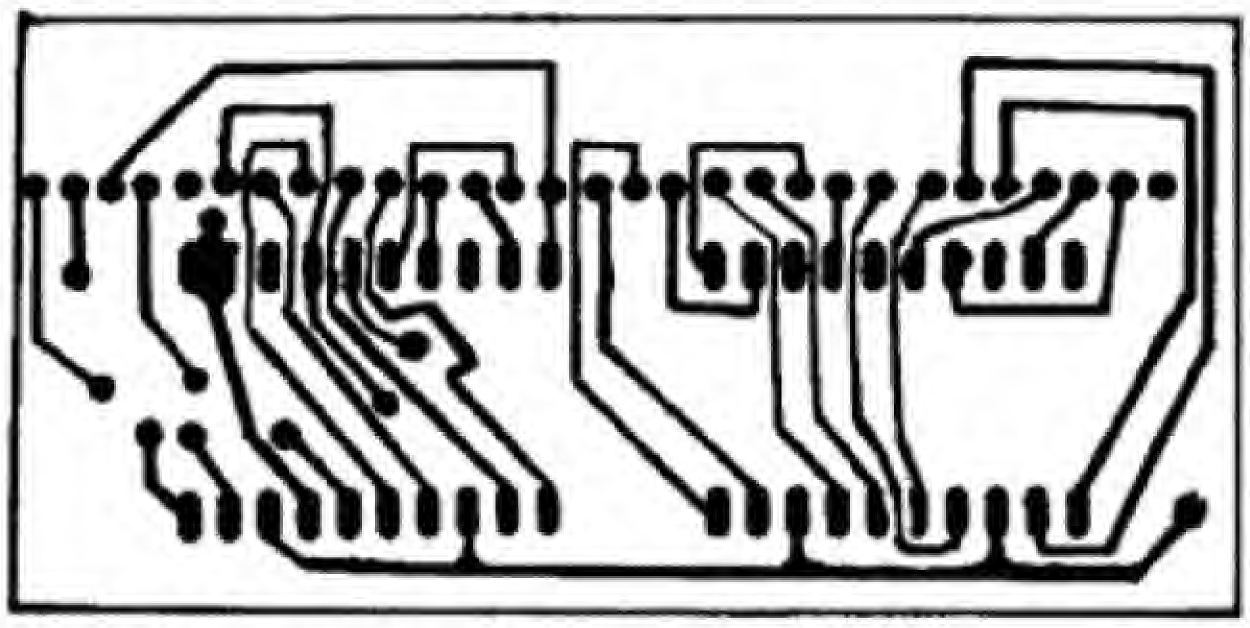


Fig.7: PCB layout for the display unit.

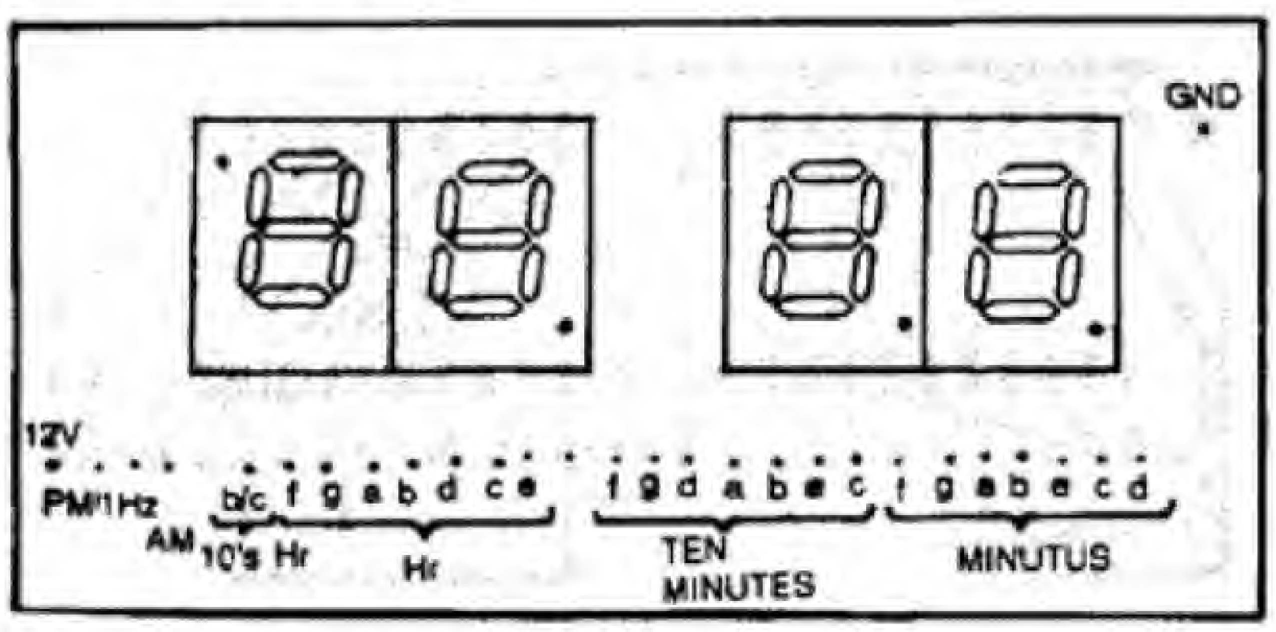


Fig.8: Components layout for the PCB shown in Fig.7.

clock to the master clock through a 5-pin stereo socket. The slave clock will display some arbitrary time. Before setting the time, press the reset switch. The master as well as the slave clocks will either reset to 12.00 AM or 0000 hour, depending upon 12-hr or 24-hr mode used. Now the master and the slave clocks can be used for the desired display. Irrespective of the time displayed on the master-slave clock, the transition of minute display is synchronised.

The master and slave clocks can be kept in separate rooms. Sometimes it may be desired to have a larger display, say 90mm for a big hall, and a small display, say 12mm for a small cabin. For such applications, the discreet LEDs are used. Five LEDs (5mm) are used in series for horizontal segments and four LEDs are used in series for vertical segments. The practical values for limiting resistors are:

Horizontal segments	- 100 ohms
Vertical segments	- 220 ohms
Colon (with 2 LEDs)	- 470 ohms

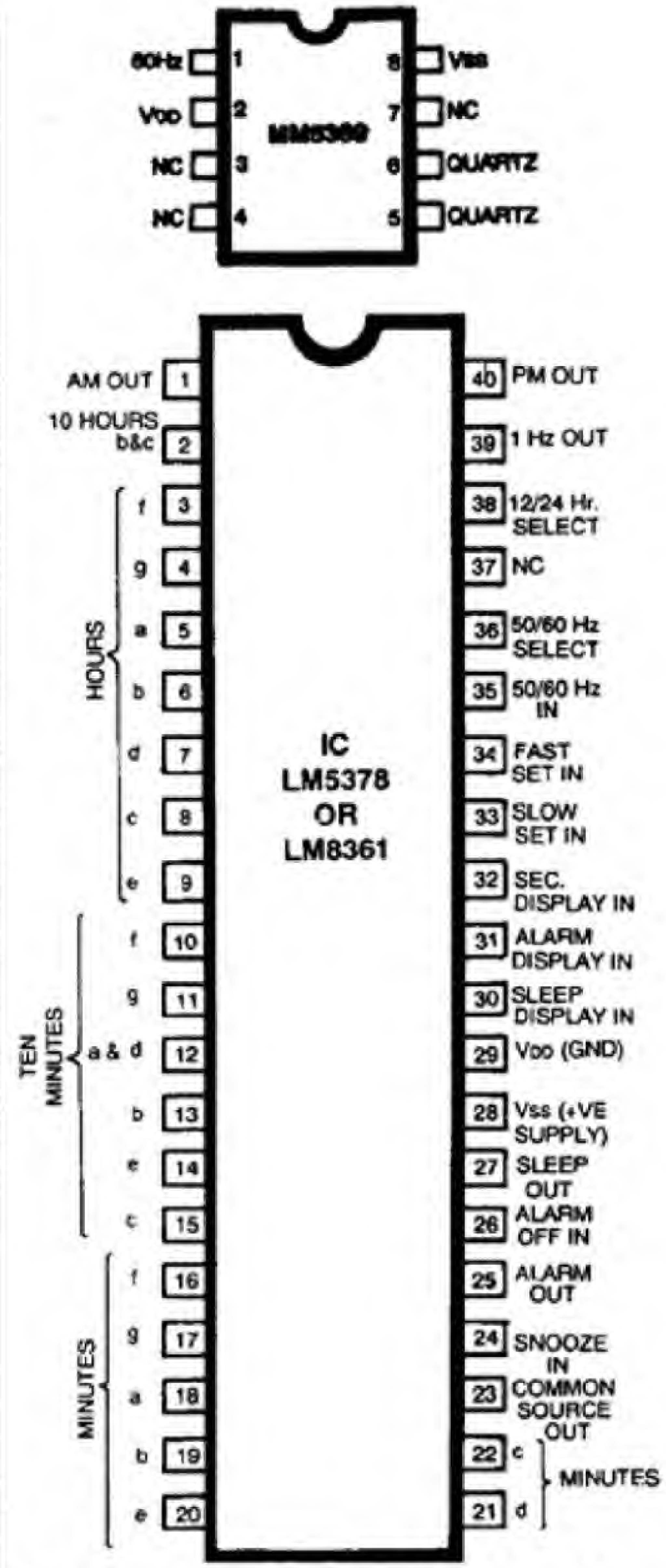


Fig. 9: Pin configuration of the ICs used in the master slave clock.

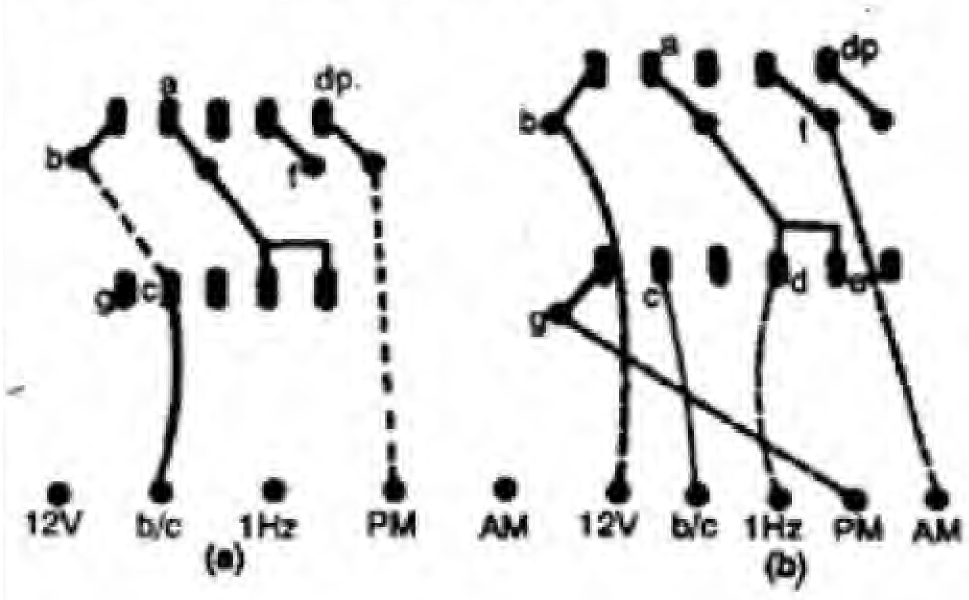


Fig.10: Jumper details for 12/24 hr mode.

Cabinet

Depending upon the display size, the clocks can be housed in a wooden/acrylic cabinets of desired colour. The layout is generally not critical. □

Readers' comments:

The Project is very useful. But in absence of 230V AC supply which DC source is to be used, and what will be its voltage and current capacity? Please also tell us about the life of that DC source and the current drain of the clock.

AMANDEEP KHOSA
Bhagu

❑ I have made the Master-Slave Clock on a general-purpose PCB. It is working very well. But can I add an alarm circuit to it?

SRAVAN KUMAR
Hyderabad

❑ A few months ago I wrote a letter to EFY with a request to publish a circuit on master-slave clock. I thought my request was left unattended, but when I saw the project in November issue I was overwhelmed. EFY does fulfill readers' requests.

Though the author claims that there is no limitation to the number of slave units connected to the master unit, what is the dB level of 60Hz pulse applied to each slave unit and the max. capacity of the pulse generator circuit? This factor may limit the number of slaves.

Kindly differentiate between the master linked to slave via segment multiplexed circuit and the circuit published here.

R. RAMJEE
Srirangam

❑ While thanking the author for this wonderful project, I request him to clarify the following doubts:

1. Can the master clock be used alone? If so, what is the function of slave clocks?

2. Referring Fig.2, how to change the mode of operation (12-hour/24-hour)? In Fig.10, are the jumper details for display ICs, FND500? If so, is it necessary to give internal connections for all the FND500's used?

3. In Fig.2, Vcc(a) is the +12V supply with battery back-up and Vcc(b) is the +12V supply without battery back-up. So, during power failure, the master clock section will be functioning properly and the slave section will also be displaying. But the author has mentioned that as the display is connected to Vcc(b) there is no display during power failure. The author is requested to explain.

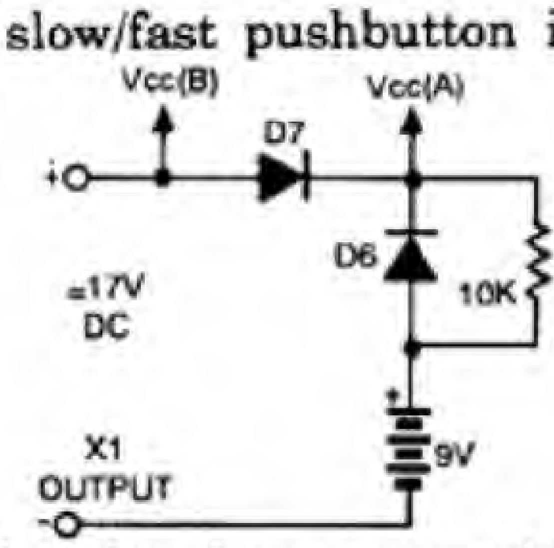
4. Are PCBs and other components (like the ICs and the FND500 displays of the master-slave clock) available in the market?

C. SAHAYA RAJ
Kanyakumari Dist

❑ The construction project is very useful indeed for factories and offices. I would like to suggest the following minor points:

1. Diode D6 is not required at all, but it should be placed in series with battery as under. Moreover, in the given circuit battery will get overcharged through D7. So D6 should be provided as shown here. If battery is required in charge position then 10k resistance should also be provided as shown.

As slow/fast pushbutton is pro-

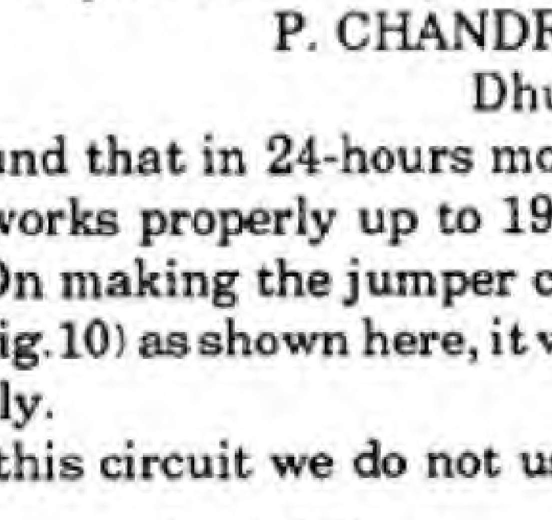


vided locally, the reset pushbutton should be provided locally.

P. CHANDRAPAL
Dhuvaran

❑ I found that in 24-hours mode the clock works properly up to 19 hours only. On making the jumper connection (Fig.10) as shown here, it worked properly.

In this circuit we do not use 12V



and 1Hz points given in Fig.10 (b).

Is it possible to show seconds with this clock?

CHANDRA PRAKASH GARG
Jodhpur

The author, Mr Suresh Batra, replies:

Regarding Mr Bhagu's query, information about DC current drain is already given in the article. The current drain of a clock is about 125 mA at 12 volts. A 9-volt battery source has been recommended as a back-up source. As the commonly available 9V battery source has capacity of the order of 100 mAH, it may not be possible to obtain 125 mA even for an hour. Therefore the display of the clock, which draws 11 mA per segment, is not supplied during power interruption. The internal clock circuit of the clock chip and the oscillator/divider IC is supplied with the battery current, which amounts to 10-12 mA and may last for about 10 hours. Rechargeable 9V battery (if available) avoids periodic replacement of the battery.

Mr Sravan Kumar's requirement of an add-on alarm circuit is in fact beyond the scope of this article as the clocks are normally meant for use in various rooms of offices etc.

As regards Mr Ramjee's clarification about the limitation to number of slave units, the limiting factor can obviously be the current handling capacity of the transformer, as an average drain of each display is about 125 mA at 12V. The voltage level of oscillator IC 5369 is immaterial as these circuits are current-operative. About 10μA current is adequate to maintain the normal operation of the internal clock circuit of 8361. Pin 1 of IC 5369 is connected through 100k resistor. If required, this resistor can be reduced to a slightly smaller value.

About Mr Raj's doubts:

1. Yes, the master clock by itself can be used as an ordinary clock. In offices having more than one room, the slave clocks can be added with the master clock. The special feature of Master Slave Clock system is that all the clocks will show the same time up to the last second.

2. Pin 38 of IC1 is kept 'open' for 12-hour mode, while it is connected to Vcc (b) for 24-hour mode. Tens-of-hour digit of display chip is shown in Figs 10 (a) and 10 (b) for 12-hour and 24-hour modes respectively.

3. Vcc (a), which is a 12V supply, with battery back-up supplies current to master oscillator as well as to internal clock circuits of all the clocks. The displays of all the clocks, through pin 23 of clock ICs, get the current through Vcc (b)—a 12V supply without battery back-up.

4. The PCBs for the projects are generally supplied by Kits 'n' Spares, 303 Dohil Chambers, 46 Nehru Place, New Delhi 110019, which is an associ-

ate concern of EFY. ICs and display chips are easily available in the shops dealing with electronic components, such as Visha Electronics and Vega Kits in Bombay, who advertise almost regularly in EFY.

Mr Chandrapal suggests an alternate way of battery connection. Readers may try the same. The reason for providing one reset is to ensure synchronisation among all the clocks.

Mr Garg faced some problem in the assembly for 24-hour mode. However, the circuit given for 24-hour mode is the recommended circuit by the manufacturer and it has been tested successfully. He has suggested an alternate connection for tens-of-hour of display digit which may also be tried.

The seconds display, along with the hours and minutes display, is beyond the scope of this article. In fact,this is an independent project in itself which has already appeared in EFY.

Add-On Devices for Double Cassette Recorder

T.S. Shankar

In view of the article 'Stereo Double Cassette Recorder' published in Feb '91 issue of EFY, it is felt that more auxilliary circuits like radio tuner, automatic level control and tone control should be included to the main circuit to make it a complete audio system.

These add-on circuits are specifically designed for stereo double cassette recorders, which can easily be added to the main circuit with slight modifications of the latter.

The main circuit was not provided with automatic level control (ALC) because ALC 'kills' the hi-fi nature of the recording by introducing too much hiss and noise when the audio signal falls below certain level or is completely absent momentarily. Also, it is not advisable to use ALC while recording from tape to tape or aux. to tape.

While recording through a microphone, it is almost impossible to adjust the recording level manually as the input signal to the recording amplifier varies widely in magnitude and manually tracking the signal level and attenuating it is just not possible.

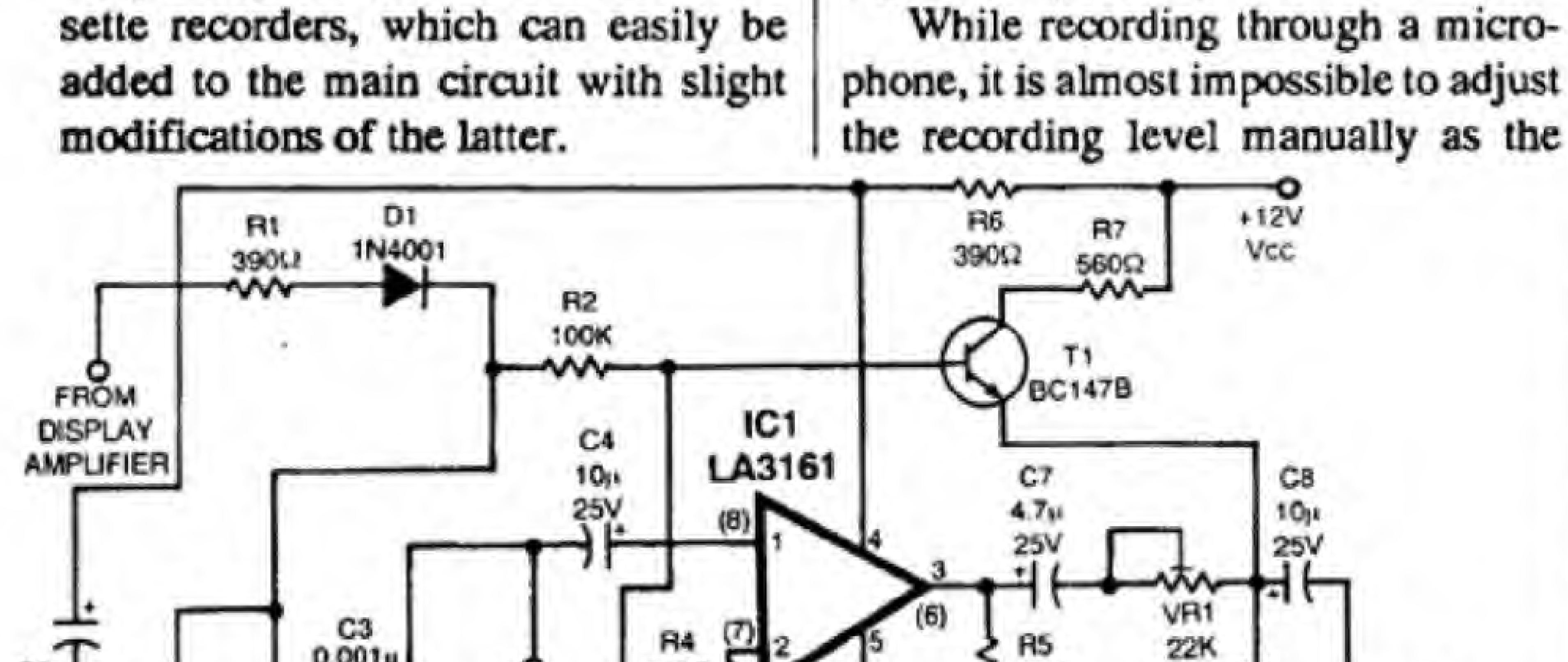


Fig.1: Microphone amplifier with AGC(ALC).

The ALC facility is provided in the microphone amplifier (Fig.1) which is wired around IC LA3161, a dual amplifier. IC LA3161 is usually used as a low-level amplifier by changing the feedback elements between the output and the input.

The two inputs are connected to two microphones, dynamic or electret or even condenser microphones (with proper biasing), with shielded wires. Signal from the microphone is amplified by IC1 and the amplified signal appears at the output. The output is attenuated to obtain a constant level.

The output of the display amplifier, which is fed to the display module, is rectified by diode D1 with limiting resistor R1 and filtered by C1 to obtain a DC voltage proportional to the average signal voltage. R3 and C1 form a RC network which provides delay for the ALC operation. The values of R3

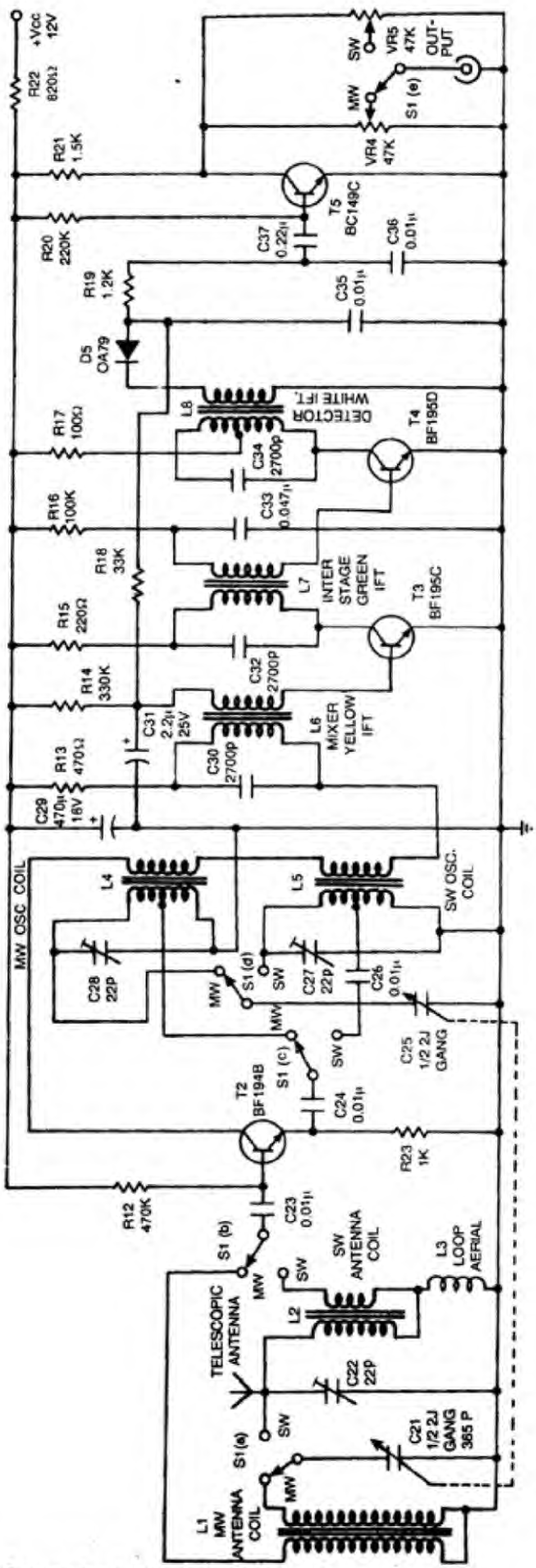


Fig.2: 2-band tuner for double cassette recorder.

PARTS LIST

Semiconductors:	
IC1	- LA3161, amplifier
IC2	- µA741 operational amplifier
T1	- BC147B
T2	- BF194B
T3	- BF195C
T4	- BC195D
T5	- BC149C
D1-D4	- 1N4001
D5	- OA79
Resistors:(All-1/4 watt ±5% carbon, unless stated otherwise):	
R1,R6	- 390-ohm
R2,R5, R16	- 100-kilohm
R3	- 8.2-kilohm
R4	- 120-ohm
R7	- 560-ohm
R8-R10,R19	- 1.2-kilohm
R11,R22	- 820-ohm
R12	- 470-kilohm
R13	- 470-ohm
R14	- 330-kilohm
R15	- 220-ohm
R17	- 100-ohm
R18	- 33-kilohm
R20	- 220-kilohm
R21	- 1.5-kilohm
R23	- 1-kilohm
VR1	- 22-kilohm preset
VR2,VR3	- 100-kilohm potentiometer
VR4, VR5	- 47-kilohm potentiometer
Capacitors:	
C1	- 100µF, 25V electrolytic
C2	- 0.47µF ceramic disc
C3	- 0.001µF ceramic disc
C4,C8,C13,C14	- 10µF, 25V electrolytic
C5	- 47µF, 25V electrolytic
C6, C17, C18	- 1000µF, 25V electrolytic
C7	- 4.7µF, 25V electrolytic
C9-C11	- 0.02µF ceramic disc
C12, C37	- 0.22 µF ceramic disc
C15, C16, C23, C24, C26, C35, C36	- 0.01µF ceramic disc
C19, C20	- 0.1µF ceramic disc
C21, C25	- 2J gang (365pF) air capacitor
C22, C27, C28	- 22pF trimmer capacitor
C29	- 470µF, 16V electrolytic
C30, C32, C34	- 2700pF (connected in IFTs)
C31	- 2.2µF, 25V electrolytic
C33	- 0.047µF ceramic disc
Miscellaneous:	
S1(a)-S1(e)	- Waffer type multiple band switch
S2	- Push-to-on switch
X1	- 230V AC primary to 12V-0-12V, 500mA secondary tansformer
L1	- MW antenna coil
L2	- SW antenna coil
L3	- Loop aerial
L4	- MW oscillator coil
L5	- SW oscillator coil
L6	- Mixer (yellow-IFT)
L7	- Interstage (green-IFT)
L8	- Detector (white-IFT)
	- Telescopic antenna

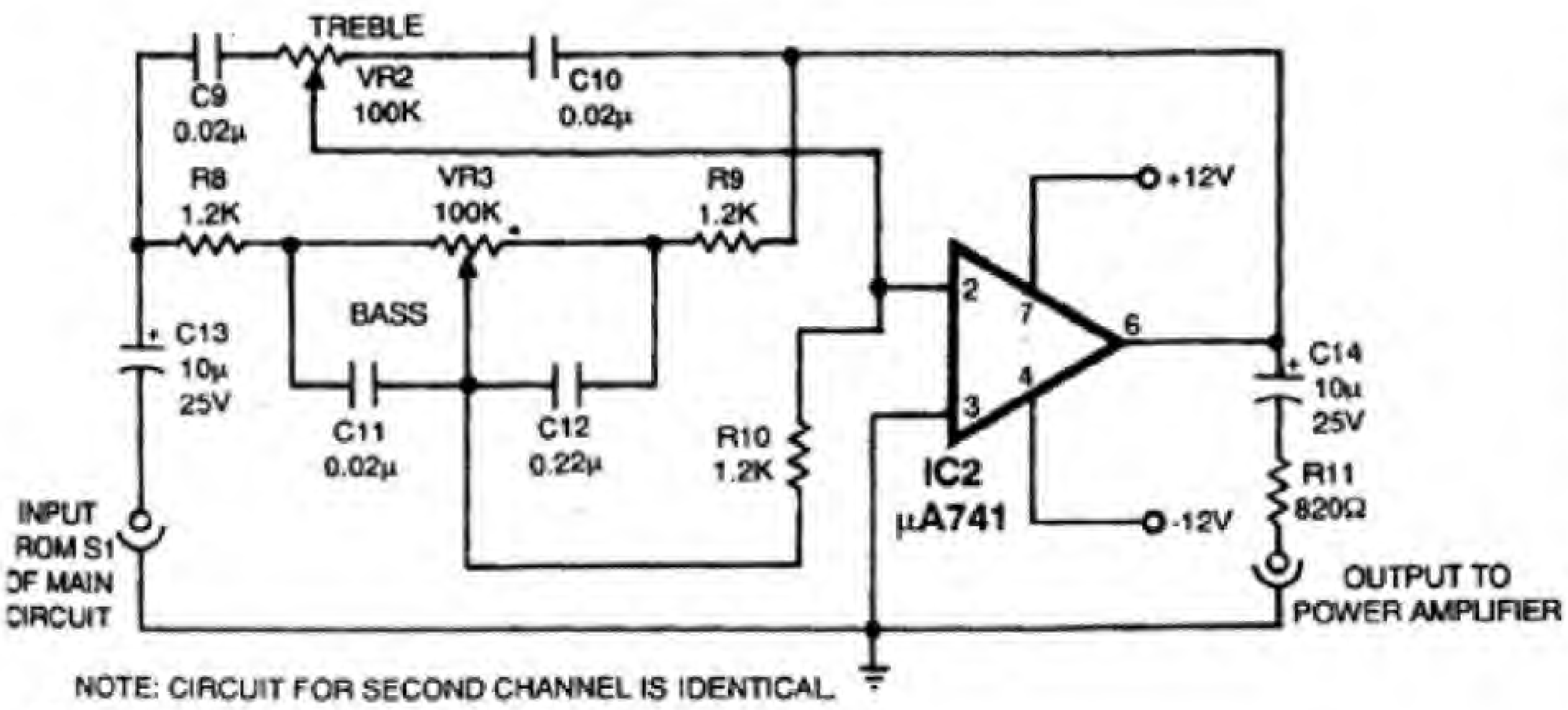


Fig.3: Active tone control.

and C1 may be changed to obtain required delays.

The voltage across C1 is applied to the base of T1 after passing through R2 and C2 filter. Transistor T1 is wired as a voltage-to-current converter which allows a current proportional to the constant level.

The output is decoupled by capacitor C8 and fed to the function selector switch S1 of the main circuit. Switch S1 should be a 2-pole, 6-way switch, to incorporate microphone and tuner facilities.

designed as a 2-band tuner and not as a 2-band radio. D5 and C35 detect the RF signal and the audio output is further filtered by R19 and C36. This filtered signal is fed to a single-stage transistor amplifier comprising T5, R20, R21, VR4 and VR5. The amplified signal at the collector is taken out through VR4 in medium-wave and VR5 in short wave range. The purpose of VR4 and VR5 is explained later. The output goes to switch S1 of the main circuit to both the left and right channels.

Fig. 3 gives the circuit for bass and treble control. Unlike circuits already published in EFY, the bass and treble control is achieved by active filters wired around the operational amplifier (IC2) µA741. The RC filters form a part of the feedback network for the in-

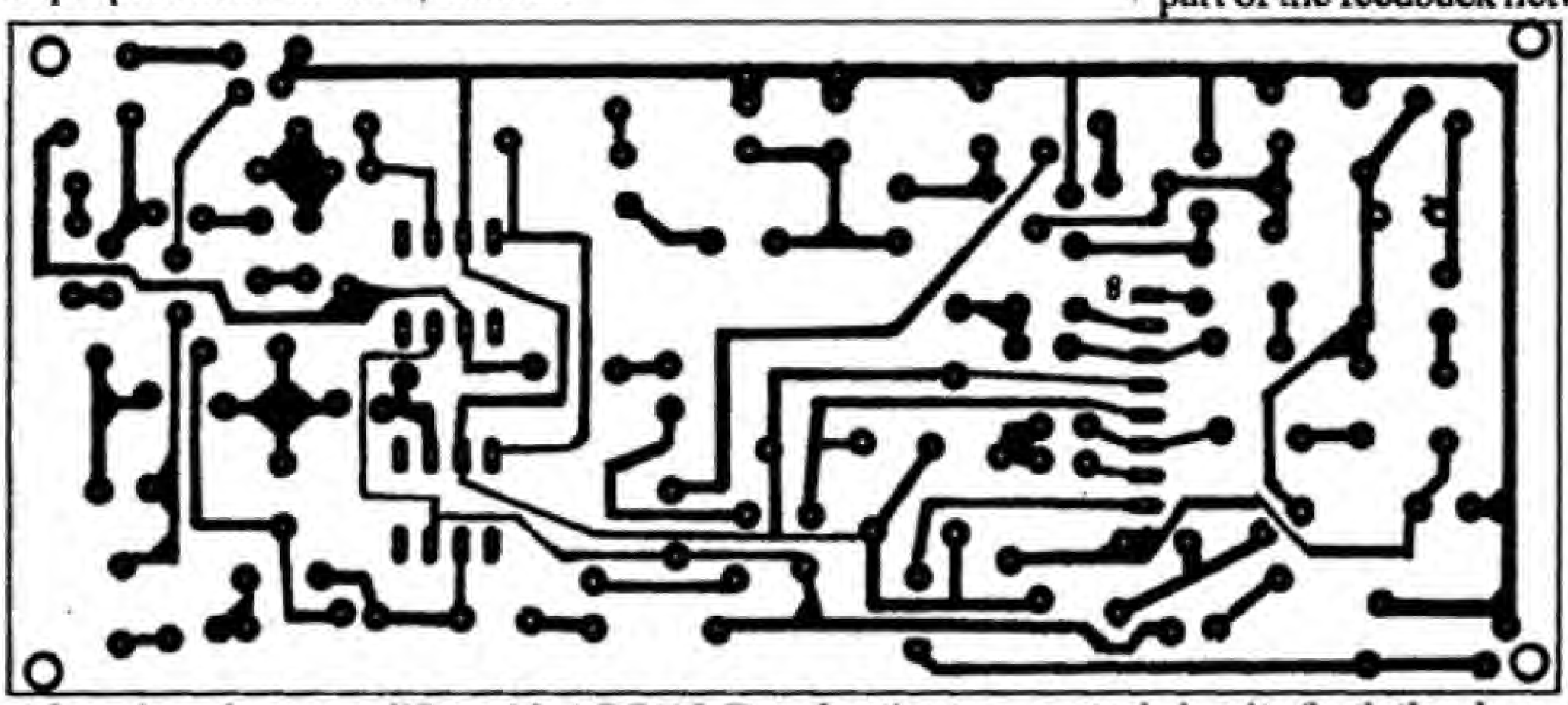
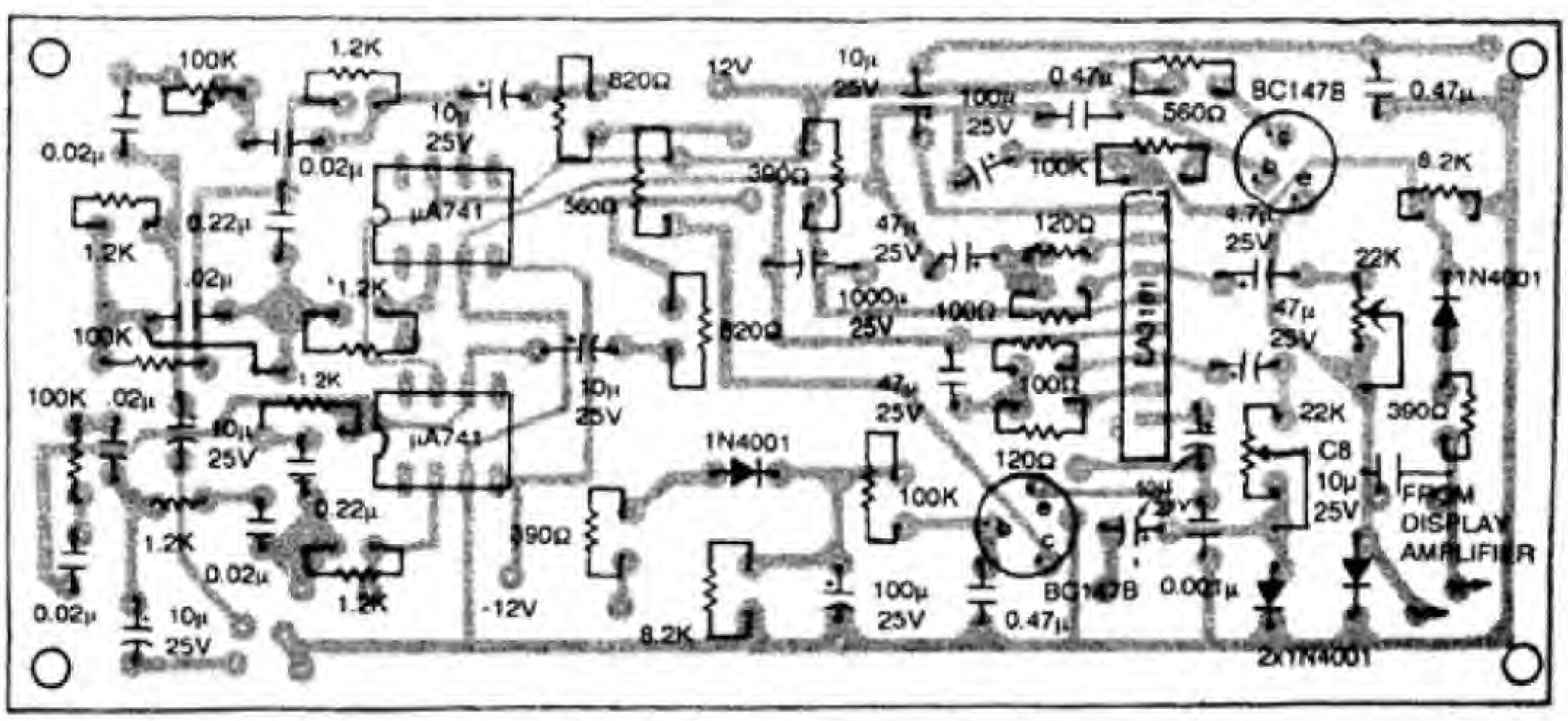


Fig.4: PCB layout for microphone amplifier with AGC(ALC) and active tone control circuits (both the channels).

input voltage at its base. Diode D2 forms a variable impedance element, the impedance being inversely proportional to the current passing through it. It attenuates the signal and keeps it at

A circuit for 2-band tuner is shown in Fig. 2, which is capable of receiving medium-wave and short-wave signals. This circuit is different from other circuits published in EFY because it is

verting amplifier (IC2). The main advantages of this circuit are that the boost and cut levels are more than that of passive filters. Also, there is no interference of bass on treble or treble on



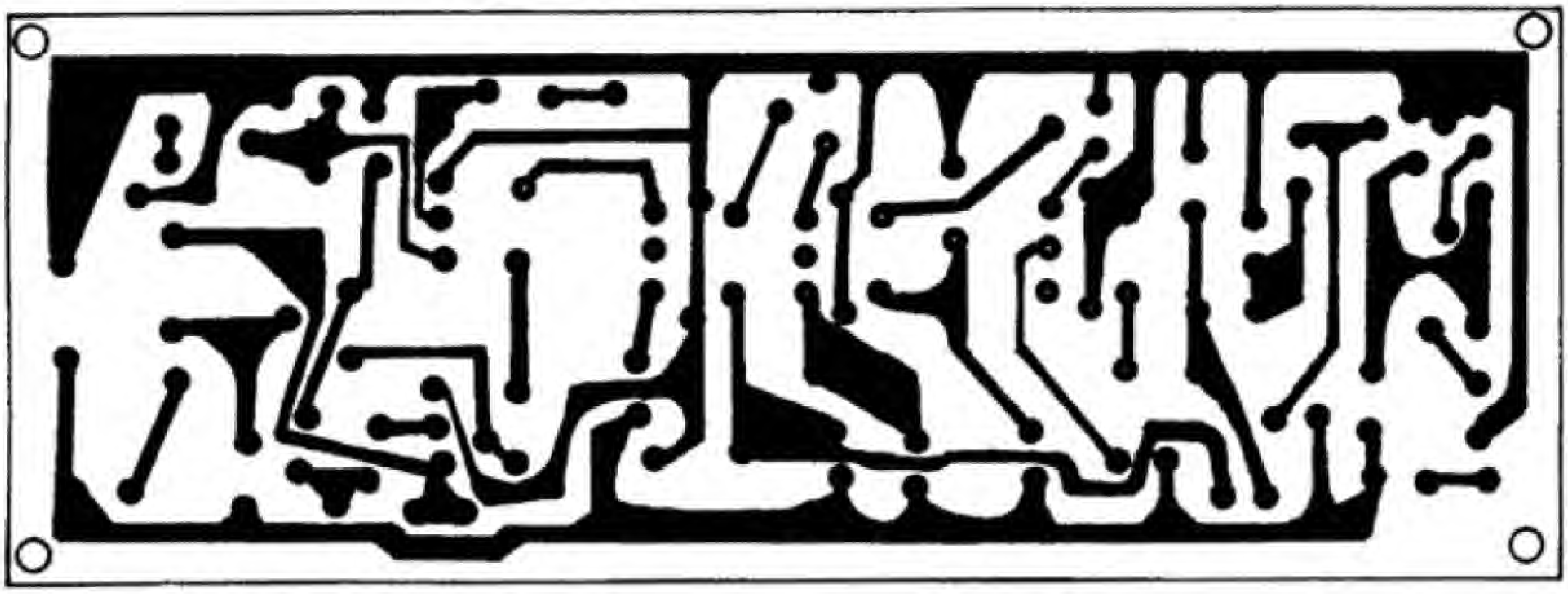


Fig.6: PCB layout for 2-band tuner.

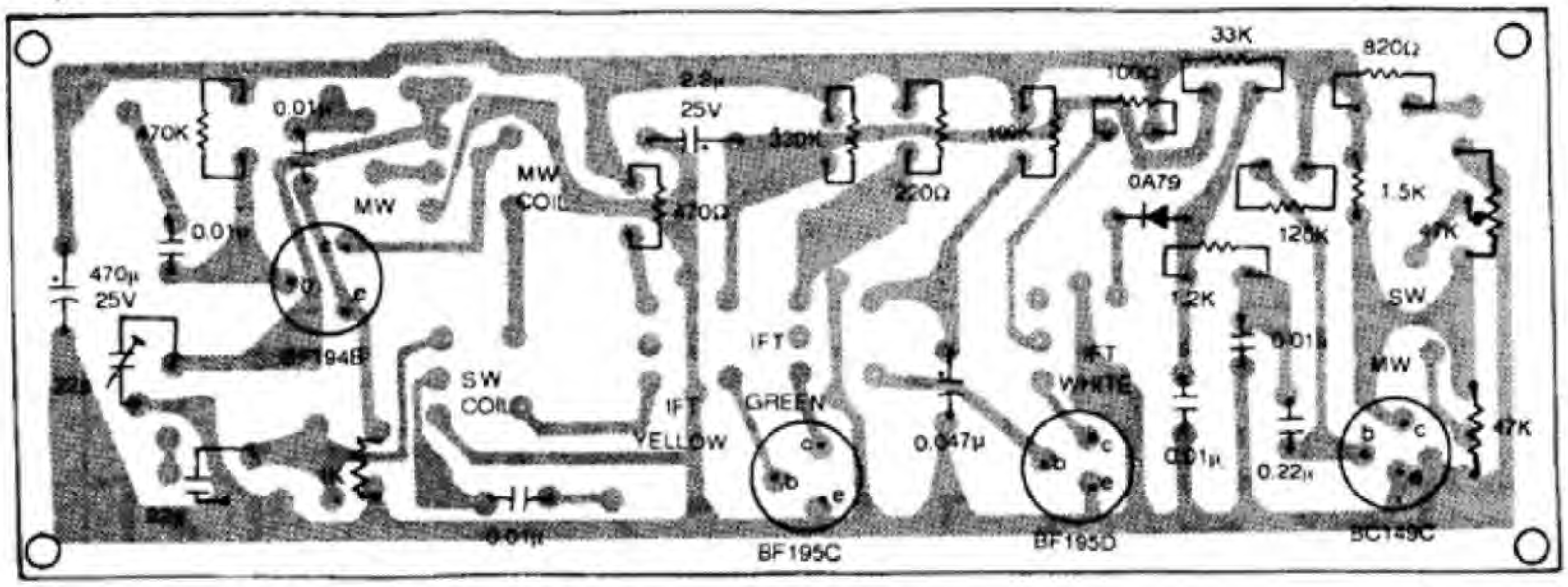


Fig.7: Components layout for the PCB shown in Fig. 6.

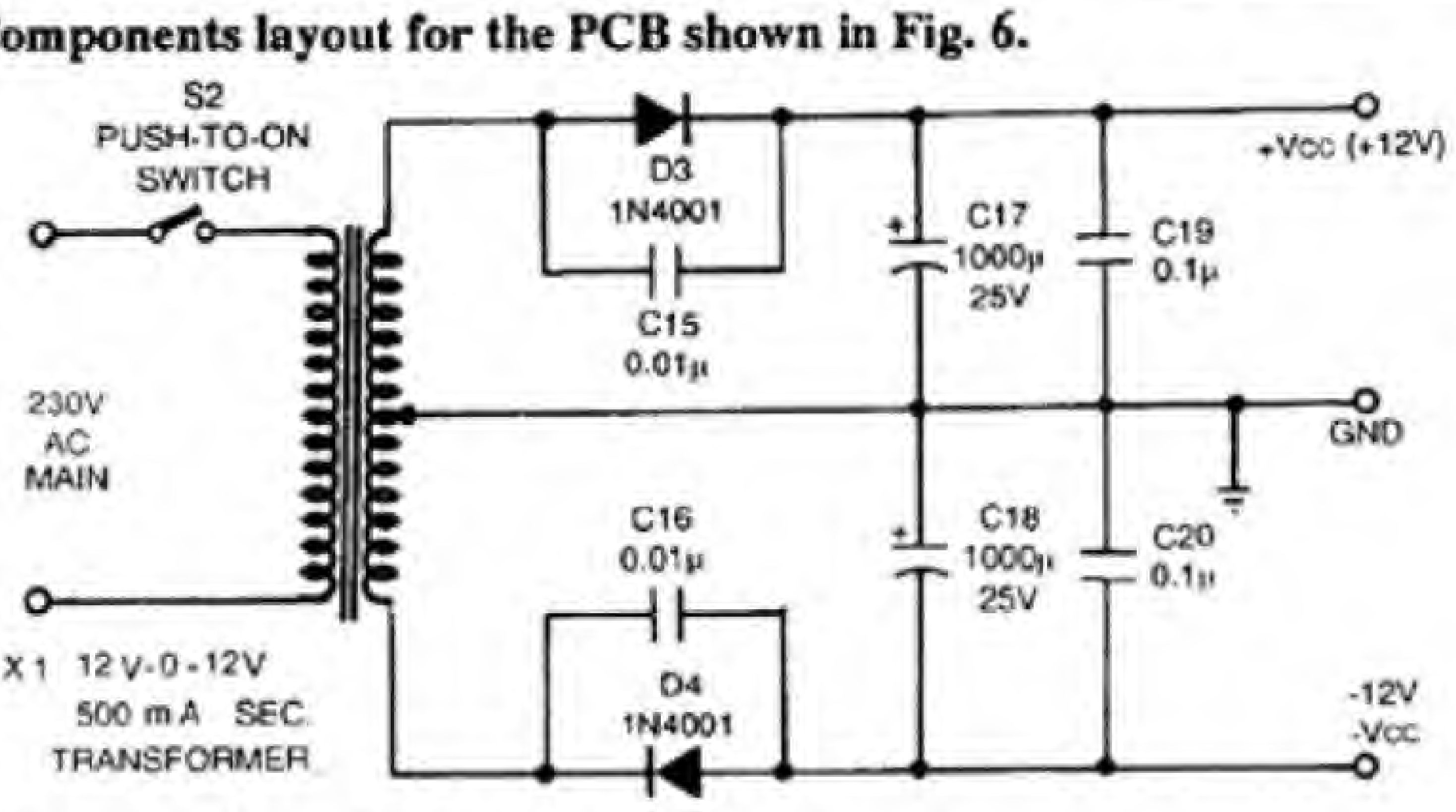


Fig.8: Power supply unit for the add-on circuits.

bass, as they are mixed at the virtual ground (pin 2) of the operational amplifier.

The input leads of the circuit should be connected to the poles of S1 and the output to the power amplifier.

Construction and alignment

All the circuits presented are quite simple and can be assembled on a general-purpose PCB. The ICs should be soldered directly on the PCB. Care should be taken, to ensure that the components are not over heated. It is advisable not to tap the Vcc from the main circuit as it may lead to ground loops, oscillations or unstable operation. Use of power supply circuit shown in Fig. 8 is recommended.

The microphone amplifier and tuner circuits need alignment, which is achieved by adjusting 22k preset in microphone amplifier and 47k preset in tuner circuits, to obtain 0 dB level in peak level indicator of the main circuit. For aligning the tuner circuit, tune to a good station in MW band and adjust VR4 to obtain 0 dB level in the main circuit. Similarly, tune to a station on SW band and adjust VR5 to obtain 0 dB level in the peak level indicator. After adjustment they need not be touched again.

All the above circuits, including the main circuit, may be enclosed in a metal cabinet. For better performance the cabinet may be connected to ground along with any other exposed metal work. This completes the stereo radio double cassette recorder incorporating all necessary features. ❑

Readers' comment:

In the PCB pattern of the circuit by my penpal, Mr T.S. Shankar, the connections of RF or IF transistors are shown as that of AF transistors.

Emitter terminal of BF series transistors now available (except CIL make) is between the other two terminals, i.e. emitter lead is at the centre.

If one solders these transistors on that PCB, the base and emitter terminals would get interchanged and the circuit will not work.

The 2700pF condenser connected across the primary windings of detector IFT should be avoided. Also, 0.04μF capacitors between IFT terminals have been missed.

PRADEEP G.
Alappuzha

❑ I have successfully constructed the 2-band tuner for double cassette recorder. It is giving high quality audio. There is no necessity of telescopic antenna as the 100p aerial is giving very good performance. I request the author to give an FM radio section also, employing Philips TEA 5570, TEA 5591 ICs.

S. RAVI KUMAR
Jagtial

❑ In the 2-band tuner circuit on page 107, the gang capacitors (C21 and C25) are shown identical, but no padder capacitors are used. They are connected in series with the oscillator section of the gang capacitor to maintain the difference between the frequency of the incoming signals and the oscillator frequency over the full band. Hence two ceramic capacitors — 360 pF for MW and 2500 pF for SW — should be used.

MOHD SAJID MIR
Srinagar

I would like to use a graphic equaliser. Can I insert it along with the active tone control or should I replace the tone control with the graphic equaliser?

KANNAN S.
Calicut

❑ For the active tone control in which IC μA 741 is used, can we use ANI741 instead?

My circuit using ANI741 does not work properly!

VIJAYANT SHARMA
Bareilly

The author, Mr T.S. Shankar, replies:

In the PCB pattern (Fig. 6) the holes provided for transistors T2, T3 and T4 are in a triangular fasion. So there is no problem of emitter-base interchange with long-lead transistors. There is no need to eliminate the 2700pF capacitor as suggested by Mr Pradeep.

I didn't try any FM circuit as some ceramic filters for 455 kHz and 10.7 MHz required in FM circuits are not available in Hyderabad.

Indeed the inclusion of a 360pF capacitor for MW and 3000 pF for SW coil is necessary for the circuit.

It is advised to use only tone control circuit or equaliser circuit at a time, instead of both the circuits with the circuit of double cassette recorder.

The LA3161 ciruit used as playback amplifier can also be used as microphone amplifier with slight modifications.

When used as mic amplifier, break the R-C. network of 47k resistor and 0.02μF capacitor between pins 2 and 3 (or plus 6 and 7) in the LA3161 circuit. Replace head connection with mic connections.

In the active tone control circuit ANI741 can be used instead of μA 741. In fact, any op-amp can be used in place of 741 if the former is pin-compatible with 741. There can be several reasons for Mr Sharma's circuit not working properly. He should check his circuit thoroughly for spoilt components etc.

I thank EFY readers for taking interest in my article and I am pleased to see the wide response from them.

Dynamic Psychedelic Lights

Amrit Bir Tiwana

This article describes the functional and constructional details of a four channel dynamic psychedelic lighting system. It is capable of driving 24 lamps of 100 watts each in tune with the music fed to the system from a tape recorder, record player or an electronic organ. The system is designed to keep the cost low.

The system drives 24 lamps comprising four channels of music controlled lamps, each of which lights up at a preset input (audio) level, and then continues to flicker along with the music. The entire system (excluding lamps) can be built at a nominal cost of Rs 200.

Working

The control circuit, as shown in Fig. 1, consists of two sections—an input signal comparator and a multichannel lamp driver. The input signal comparator uses an IC LM239, which contains four independent comparators each of which has one inverting input, one non-inverting input and an output. VR1 to VR6 along with R1 to R3 provide a reference voltage at the non-inverting input of each comparator. An audio signal is fed at the inverting input of each comparator, through R4 and VR7. Now each comparator compares the input signal voltage with its reference voltage. If the input voltage is less than the reference voltage, the output of the comparator remains high. If the input level exceeds the reference voltage level, the output of the

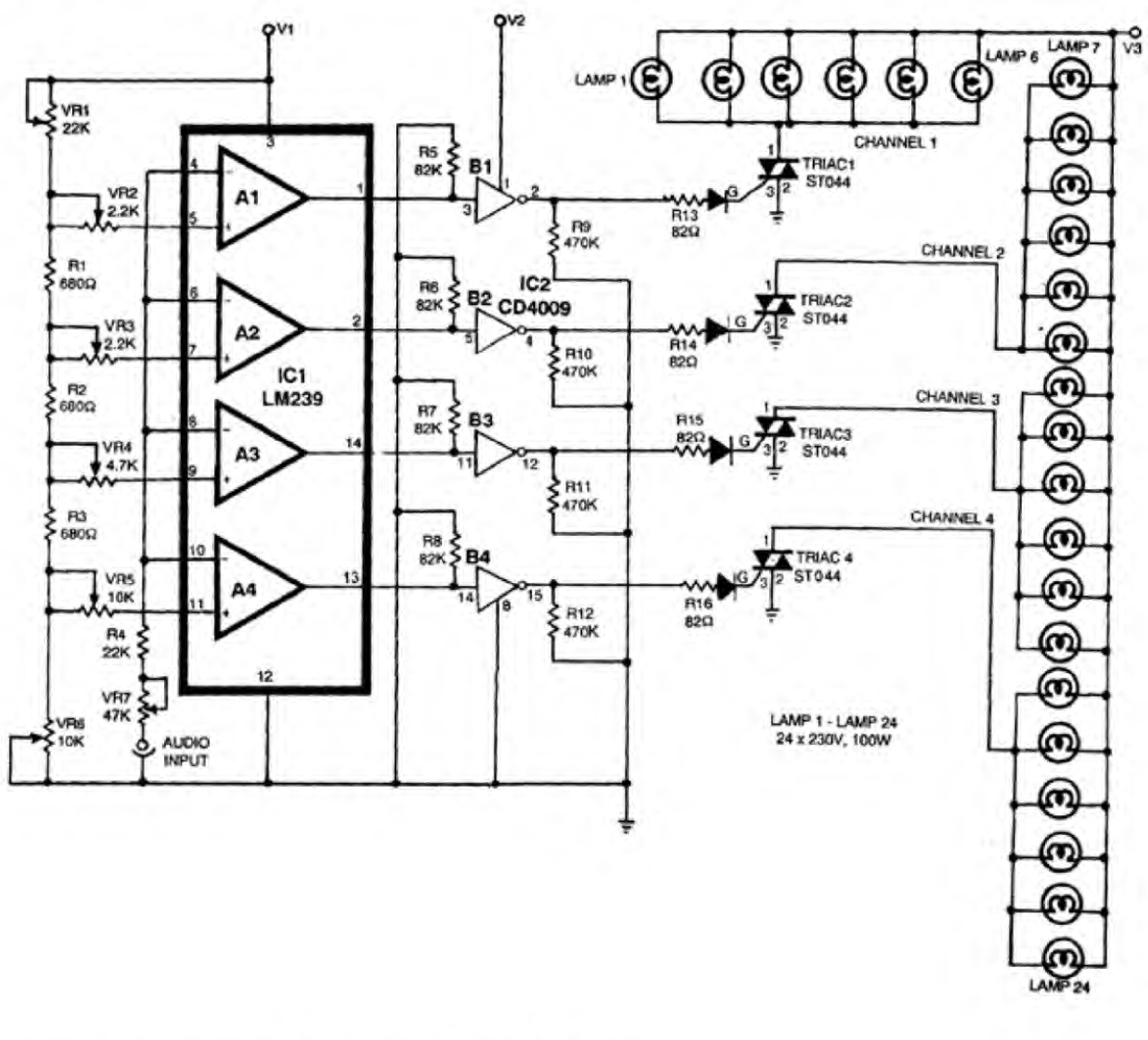


Fig. 1: Electronic control circuit for the dynamic psychedelic light.

corresponding comparator goes low. This output voltage is fed to the lamp driver circuitry.

Each lamp driver consists of a CMOS inverting buffer. The output of the buffer goes high when the output of the corresponding comparator goes low. When the output of the comparator goes high, a moderately filtered voltage V2 is fed at the gate of the corresponding triac. Thus, the triac conducts and lights up the parallel lamp combination connected to it. Since outputs of the comparators

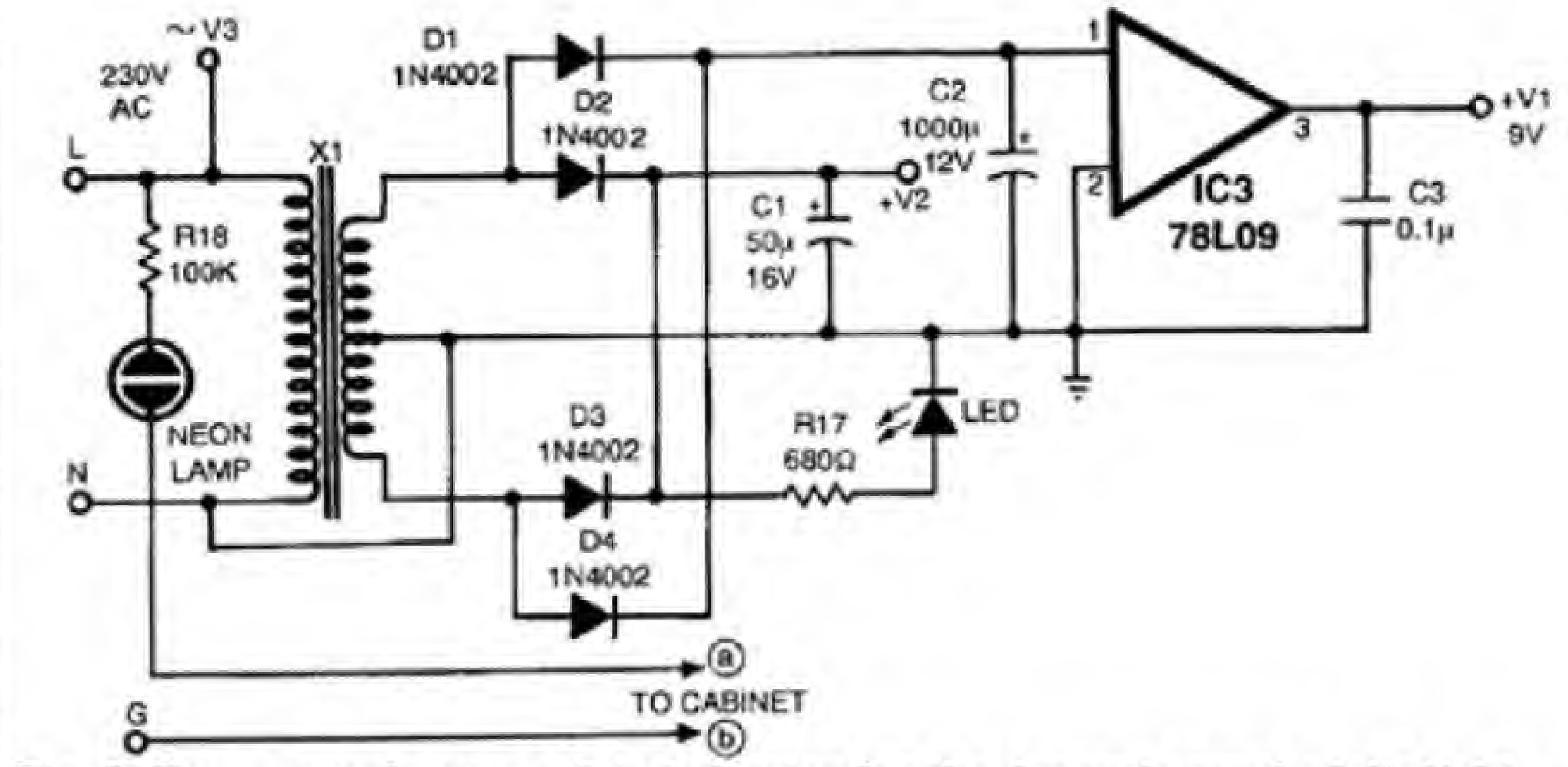


Fig. 2: Power supply cum safety indicator for the dynamic psychedelic light.

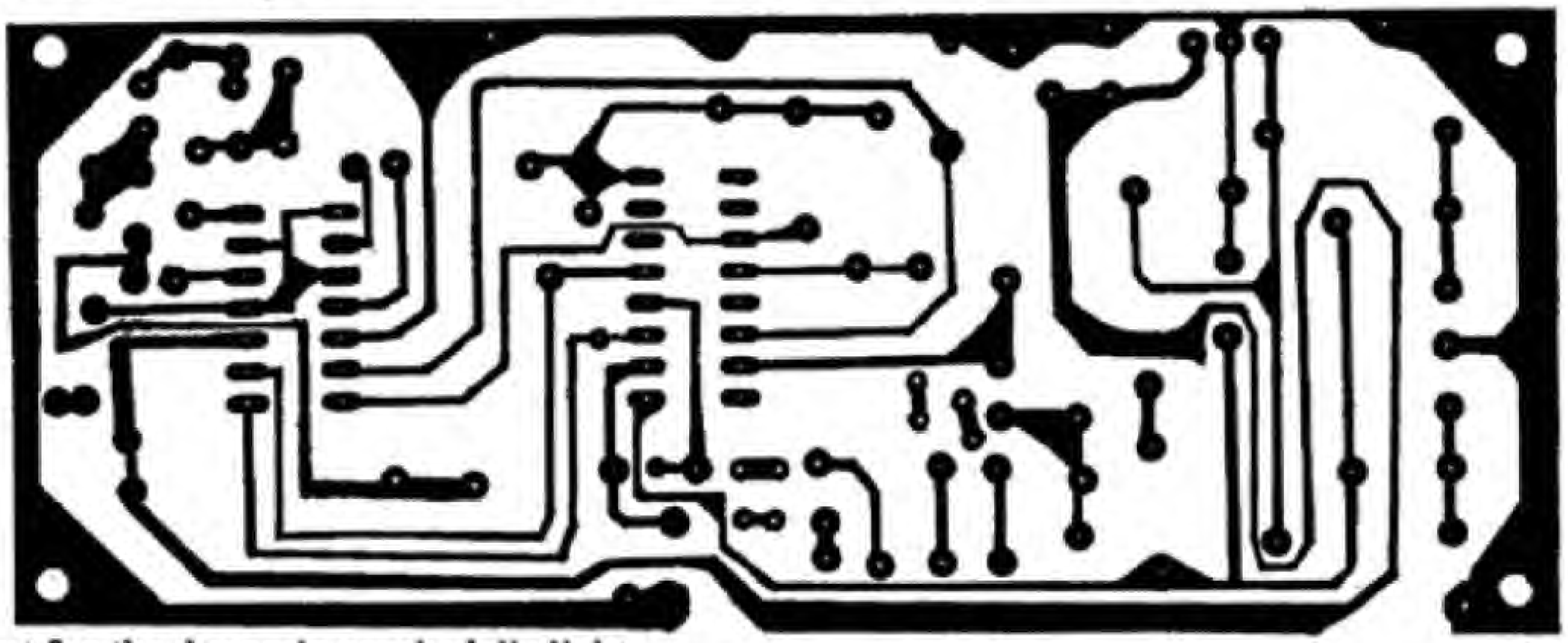


Fig. 3: PCB layout for the dynamic psychedelic light.

and the buffers change state (high/low) rapidly, the lamps seem to flicker. The four outputs of IC1 go low in succession. Hence, the four lamp channels light up in succession according to the input level. VR2 to VR5 can be used to adjust the reference voltage of corresponding comparator. VR7 is used to attenuate the input signal.

Power supply

The control circuit requires a well regulated 9V DC power supply for IC1, a moderately filtered 10V power supply for driving the triacs and a 230V AC mains supply for driving the lamps. The power supply circuit shown in Fig. 2 can be used for this purpose. It consists of stepdown transformer X1, a full-wave rectifier (D1, D4), filter capacitor C2 and 9V regulator IC3. Another full-wave rectifier (D2, D3) connected to the same transformer provides a 10V output which is moderately filtered by C1. The 230V AC supply is taken directly from the mains. Thus, the outputs of 9V DC, 10V DC and 230V AC are available at V1, V2, V3

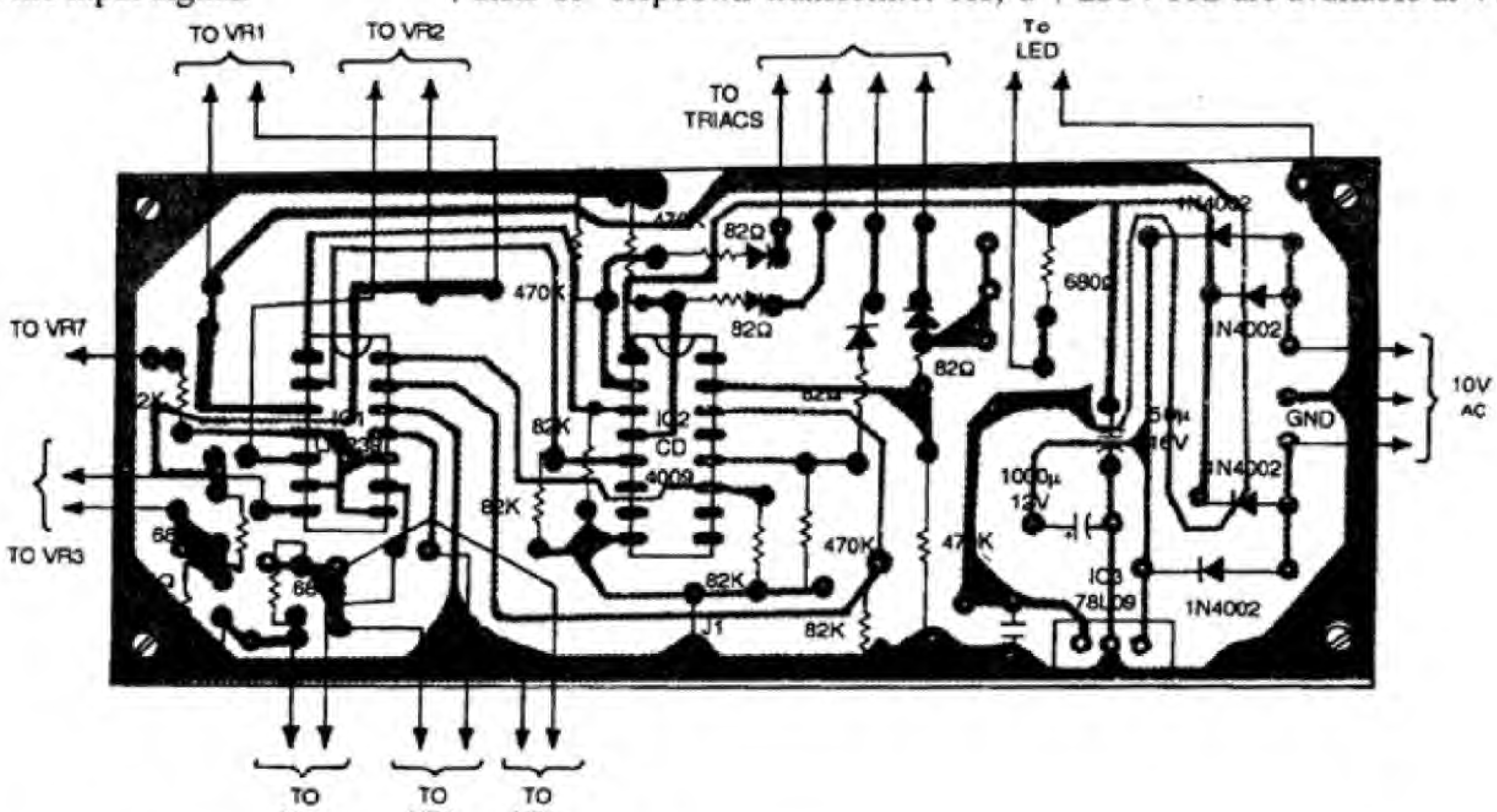


Fig. 4: Components layout for the PCB shown in Fig. 3.

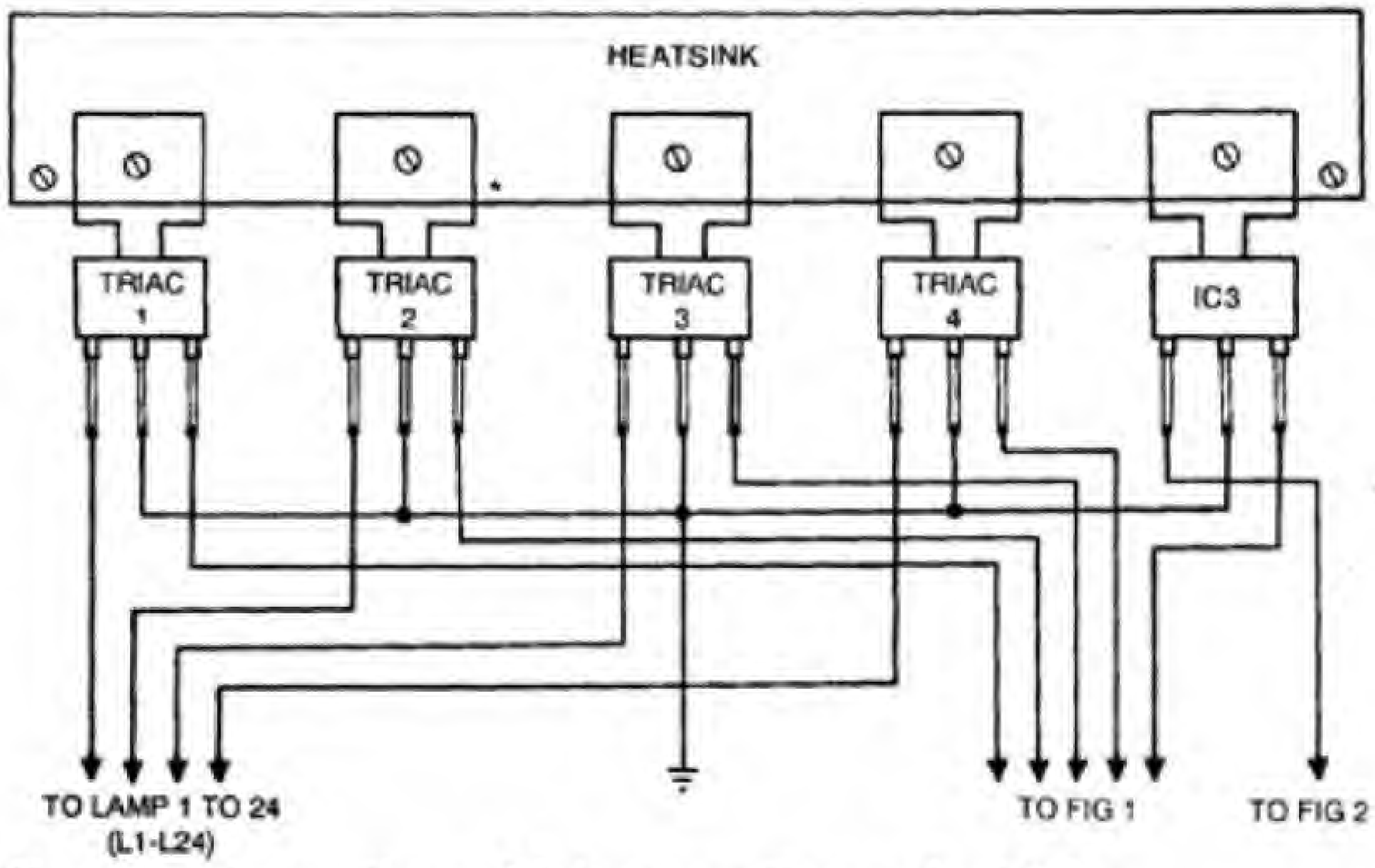


Fig. 5: Component mounting and interconnections on heatsink.

respectively. The LED indicates the presence of the mains supply. A safety indicator, built around the neon lamp and R18, has been incorporated to indicate proper earthing of the device.

Construction

The PCB and corresponding components layout are shown in Figs 3 and 4 respectively. Many components are kept out of the PCB. Wiring between the PCB and the components mounted on the heatsink should be done with utmost care. Thick copper wires must be used for carrying mains while the remaining connections may be done through a colour-coded multiway ribbon cable. IC1, IC2 and their associated circuitry may be wired onto the PCB as shown in Fig. 5. Care should be taken while soldering IC1 and IC2 as excessive heat can lead to their destruction. Use of an IC socket is recommended for IC2.

As triacs will dissipate a lot of heat during continuous operation, they should be provided with an adequate heatsink. The triacs and IC3 should be mounted as shown in Fig. 5 using mica washers for insulation. The wires may be soldered to the pins of the triacs and IC3 as shown in Fig. 5. Ribbon cables should be used for connecting triac gates and IC2, and insulated copper wires for the remaining connections.

After assembling the circuit, recheck it for any dry soldering or shortcircuits. Using a multimeter or continuity tester, it should be ensured that there is no electric connection between the triac, IC tabs and the heatsink.

After assembly, the circuits may be housed in a suitable cabinet. The heatsinks are fixed inside the cabinet using plastic washers and screws. Points 'a' and 'b' should be connected to any two points on the (metallic) cabinet. Finally, using a continuity tester it should be ensured that the heatsink and the live wire (mains) are not touching the cabinet anywhere.

Adjustments and application

After the circuit has been successfully assembled, the parallel lamp combination should be connected to the output terminals of the circuit using thick 2-way cables of suitable length. Now the unit can be connected to the mains.

Once the safety indicator (neon lamp, indicating that the unit is grounded) lights up, an audio signal can be fed from any tape recorder, record player or musical organ. Keeping all other controls in their maximum resistance position, adjust the overall input sensitivity using VR7. Adjust VR2 so that the lamps of the first channel glow and adjust VR1 and VR6 to make the lamps flicker with the music. Now increase the input signal level slightly and adjust VR3 so that the lamps of the second channel (L7-L12) start glowing and flickering in unison with music. The sensitivity of the other two channels is also set in a similar manner, after adjusting VR4 and VR5. Now VR1, VR6 and VR7 are readjusted so that the lamps of the four channels light up in succession along with the increasing audio input signal level.

PARTS LIST

Semiconductors:	
IC1	- LM 239 quad comparator
IC2	- CD4009 CMOS hex buffer/converter
IC3	- 78L09, 9V 100mA voltage regulator
D1-D4	- 1N4002 rectifier diodes
TRIAC1-TRIAC4	- ST044, 4A, 400V triacs
Resistors (All 1/4-watt, ±5% carbon unless stated otherwise):	
R1-R3, R17	- 680-ohm
R4	- 22-kilohm
R5-R8	- 82-kilohm
R9-R12	- 470-kilohm
R13-R16	- 82-ohm
R18	- 100-kilohm
VR1	- 22-kilohm potentiometer
VR2, VR3	- 2.2-kilohm potentiometer
VR4	- 4.7-kilohm potentiometer
VR5, VR6	- 10-kilohm potentiometer
VR7	- 47-kilohm potentiometer
Capacators:	
C1	- 50μF, 16V electrolytic
C2	- 1000μF, 12V electrolytic
C3	- 0.1μF ceramic disc
Miscellaneous:	
X1	- 230V AC primary to 10V-0-10V AC secondary transformer
LAMP1-LAMP24	- 230V, 100 watt lamps
	- Neon lamp
	- Heatsink

Useful hints

1. The system can drive lamps of higher wattage by directly replacing the 4A, 400V triacs with higher wattage triacs. No change in the circuitry is required. Only the size of the heatsink needs to be increased.

2. The system in its present form is sensitive to the input level. But it can be made sensitive to the audio frequency level by connecting suitable active or passive filters at the input of each comparator.

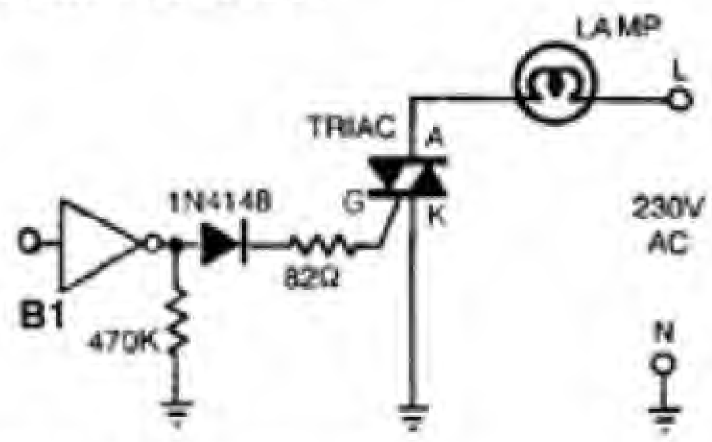
3. Lamps of each channel can be covered with a coloured celluloid paper, to make the effects more sensational.

4. For maximum sensitivity, the unit should be directly connected to the preamplifier's output. ❑

Readers' comment:

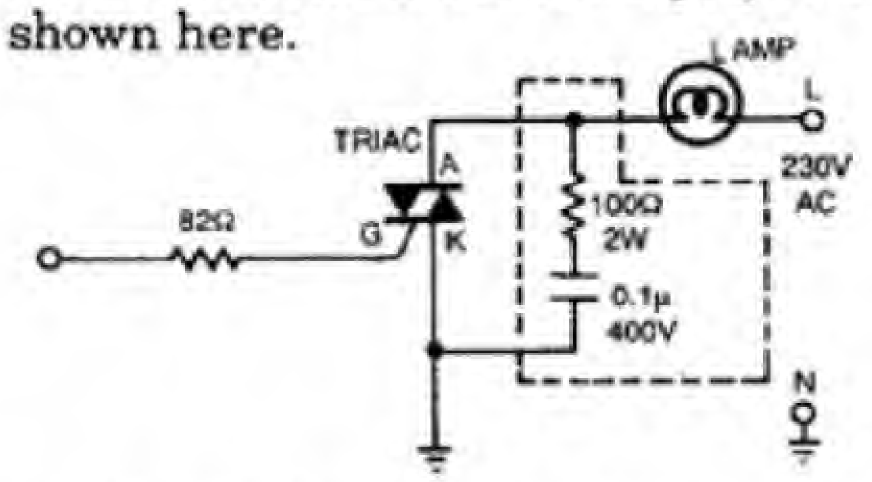
I wish to draw the attention of the author of 'Dynamic Psychedelic Lights' to the following:

1. The author must be knowing that triacs can conduct with gate positive as well as negative. Thus the triacs will remain on even if the output of buffers B1 through B4 is low. To avoid this diodes must be introduced as shown here.



Use of diodes with triacs.

2. Due to fast switching rate of triacs, it becomes essential to prevent the triac from dv/dt triggering. For this, snubber circuit must be employed as shown here.



Introduction of snubber circuit.

3. A simplification can be done by eliminating buffer IC CD4009. Each op-amp of IC 239 can provide gate bias to triac which will not exceed 10 mA with slight modification in the circuit.

KALPESH DALWADI
Bharuch

❑ IC3 is said to be 78L09, and a TO220 style package has been shown in Figs 4 and 5. This device is not available in such a package. Perhaps the regulator should have been 7809. Wouldn't it be advisable to isolate the audio input of this circuit using, for example, an audio input transformer. This would ensure that the input jack etc are not connected directly to the mains.

K.M. REDDY
Bangalore

The author, Mr Amrit Bir Tiwana, replies:

The wiring of tracks is correct. When logic transitions occur, the (say) 9V level will assume low level. In between the voltage level will fall to a level where the triac is not fired. Since the frequency of audio input will be fairly high, this procedure will repeat itself at a high frequency and thus result in the desired effect. This has been verified by me and the EFY lab too. Using or omitting the theoretically needed diodes will, as such, not make too much of a difference. These may, nevertheless, be added to make the effect definite to a bit higher extent.

Mr Dalwadi seems to be speaking on the basis of pure theory although differences between theory and practice are there. False triggering is not a frequently encountered problem. However, adding a snubber will certainly help, though it will increase the size of the ciruit.

The simplification suggested by Mr Dalwadi was tried by us but it failed to work in practice. CD4009 (costing Rs 7) guarantees uniform triggering by ensuring that the logic level is either zero or one and nothing in between.

78L09 is the low-current version of the 7809 regulator available in TO220 package. Both have the same pin configurations. 78L09 is rated to give only up to 100mA and costs much less.

No isolation other than the input resistance and the capacitance already used is needed. The design is absolutely perfect from the safety point of view, provided the wiring is done properly as instructed.

Digital channel selector

K. Sundararajan

Many audio amplifiers have two input channels. For selecting a channel, usually a SPDT switch is used in amplifiers. But this causes switching noise due to bouncing of the switch contacts. The noise is predominent when echo or reverberation effects are produced, which is undesirable in audio systems.

Some amplifiers have only one channel. To connect the second channel one has to unplug the leads of the first channel and plug them into the second channel. Even this produces switching noise which irritates the user.

The circuit presented here eliminates the switching noise by adopting electronic switching between the two channels. It allows the user to select between the two channels by pressing a push switch. This is best suited for frequent transfer between the two channels. Each channel has an LED to indicate whether it has been selected or not.

Circuit operation

Fig.1 shows the circuit diagram for the digital channel selector. The heart of this circuit is a quad bilateral switch, IC 4066. This CMOS IC contains four separate electronic analogue on/off switches. The on resistance of the switch is 50 to 250 ohms and off resistance is above 50 megohms. As these switches can transmit signals in either direction, this channel selector can be used either as input or output. Field effect transistors are employed as transmission switches. These switches are operated when corresponding control pin is pulled up to logic high and switched off when the pin is pulled down to logic low. The switch transmits signals of frequency ranging from DC to 40 MHz. The switches and their control pins are shown below:

Input/output terminal	Control terminal
Pins 1 and 2	Pin 13
Pins 3 and 4	Pin 5
Pins 8 and 9	Pin 6
Pins 10 and 11	Pin 12

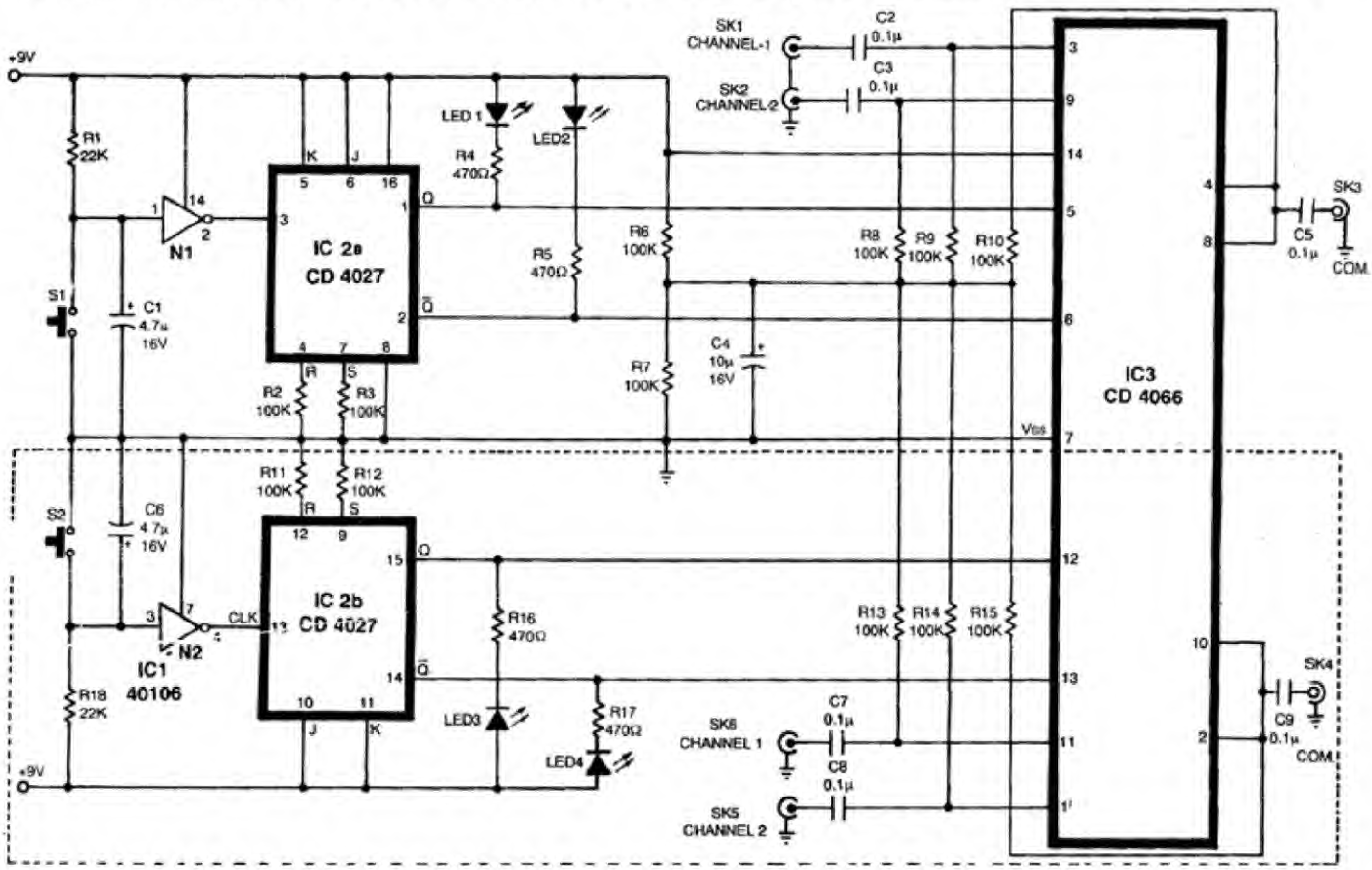


Fig. 1: Circuit diagram for the digital channel selection.

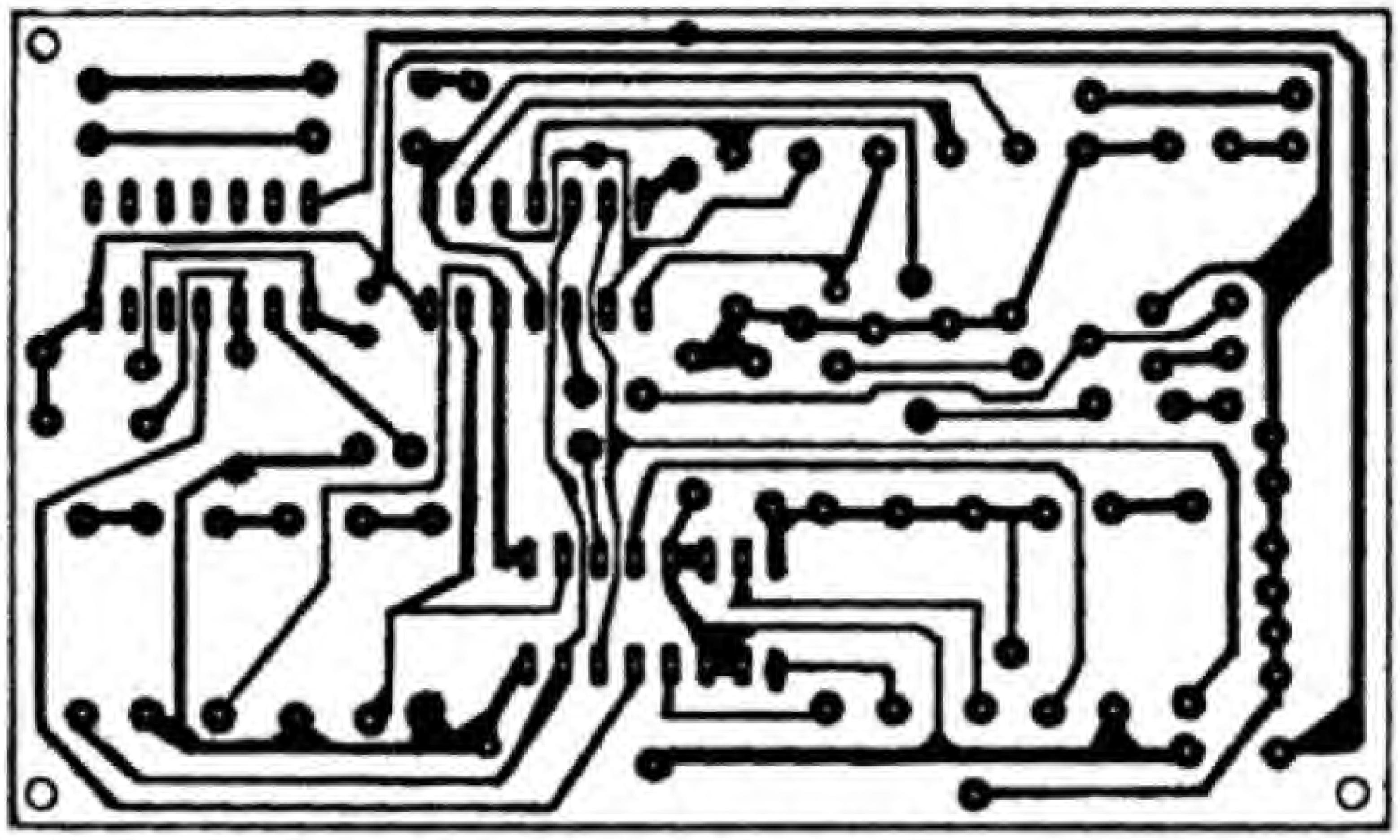


Fig. 2: PCB layout for the digital channel selector.

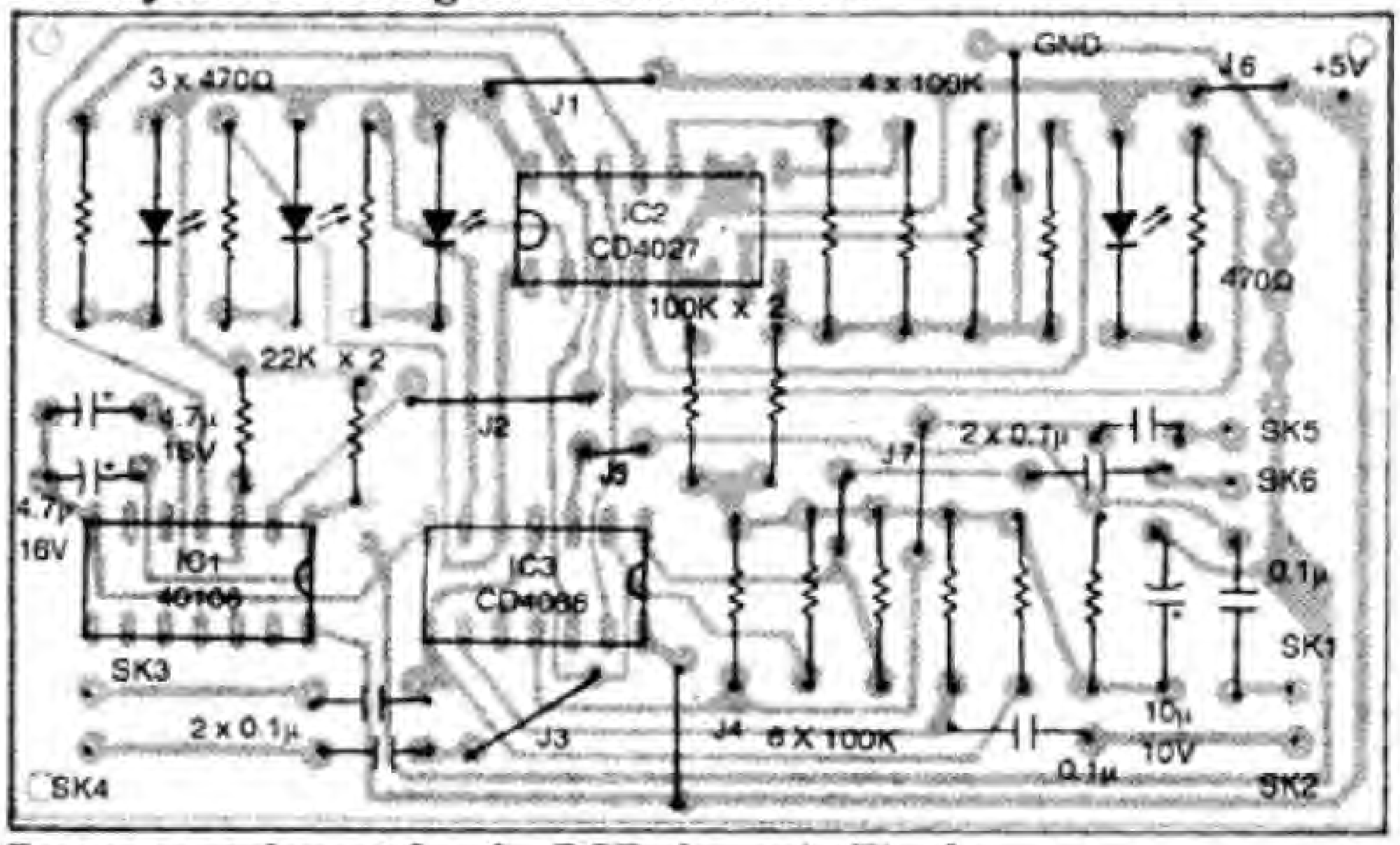


Fig. 3: Components layout for the PCB shown in Fig. 2.

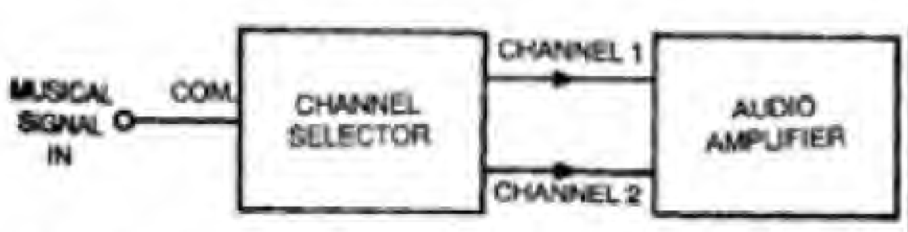


Fig. 4: Circuit for selecting input for an amplifier.

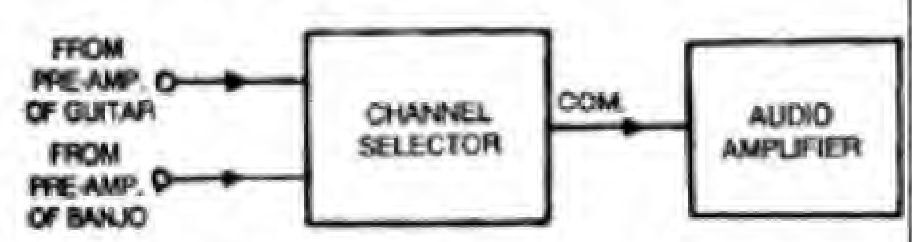


Fig. 5: Circuit for selecting any of the musical instrument.

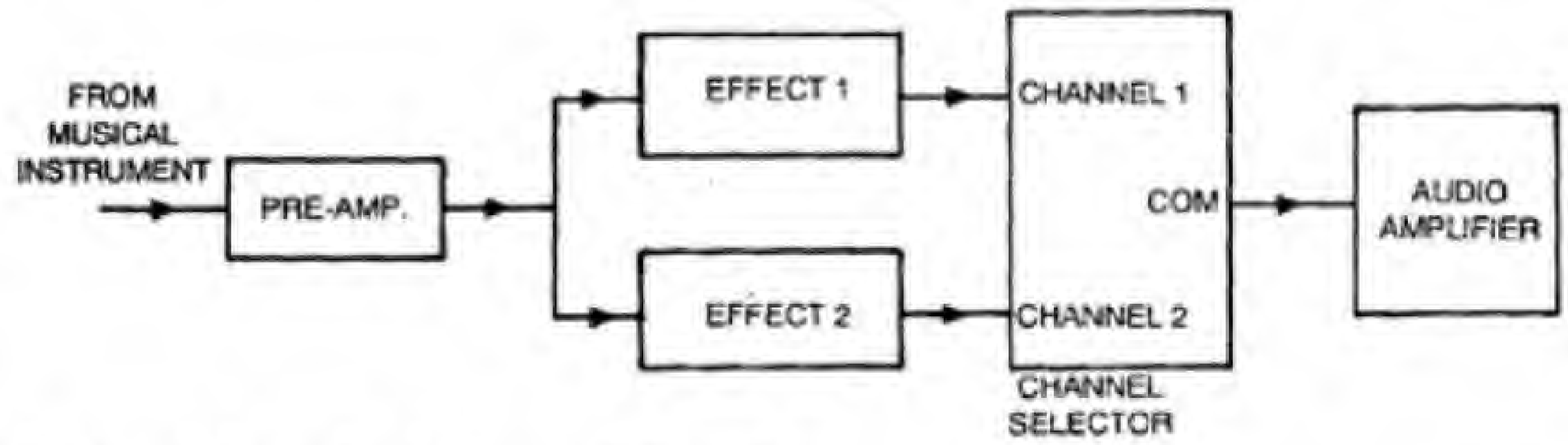


Fig. 6: Circuit for selecting any of the effects.

The circuit for channel selector is shown at the top half of Fig. 1. Rest of the portions of IC1, IC2 and IC3 are used to construct another unit of the channel selector, which is shown within dotted lines at the bottom half of the circuit. As both the circuits are identical, explanation is given for the top half of the circuit only.

When switch S1 is pressed, the high-to-low voltage transition at pin 1 of gate N1 produces a positive going pulse at pin 3 of IC2a. Thus gate N1 debounces push switch S1 and supplies a clean one-shot clock pulse to IC2a, a JK flip-flop. Since both the inputs (J and K) of IC2 are high, the flip-flop toggles every time a clock pulse is applied at pin 3 of IC2. Initially, on power up, Q (pin 1) of JK flip-flop (IC2) can be either low or high. Outputs at pin 2 ($\overline{Q}$) and pin1(Q) are always opposite. Let us assume that $\overline{Q}$ is high.

At the first clock pulse, Q goes high and $\overline{Q}$ goes low. As a result, pin 5 of IC3 goes high which in turn closes the switch at pins 3 and 4 and selects channel 1. When the output at pin 2 of IC2 is low and the other switches of IC3 are open, channel 2 gets disconnected. Under these conditions, LED of channel 1 starts glowing to indicate that channel 1 is selected. When S1 is pressed again, Q goes low and $\overline{Q}$ goes high and channel 2 is selected.

Sockets SK1, SK2 and SK3 accept the audio signal. As the supply voltage of IC3 is of single polarity, negative portion of the audio signal can cause problems. To overcome this, the CMOS switch inputs are biased at half of the supply potential through resistors R8, R9 and R10 and the potential divider R6-R7. Thus, maximum swing of the audio signal is achieved. Values of C2, C3 and C5 are sufficient for most of the audio applications. If necessary, these values can be increased.

Hence, this circuit permits a particular channel to be selected by switch S1. With this arrangement, a particular channel can be selected a number of times. The cycle is repeated with each succeeding push of switch S1.

Applications

There are many applications of this channel selector. Some of the simple arrangements in which the channel selector can be used are given below.

As already mentioned this channel selector can be used to select two channels of a dual channel amplifier (Fig.4). With this arrangement, any one of the channels is connected to the amplifier. If the switch is pushed on again, the channel is disconnected and the other channel is selected simultaneously.

Preamplifier of musical instruments can be connected to audio amplifiers through this channel selector, as shown in Fig. 5.

The channel selector can also be used to switch on and off the 'electronic

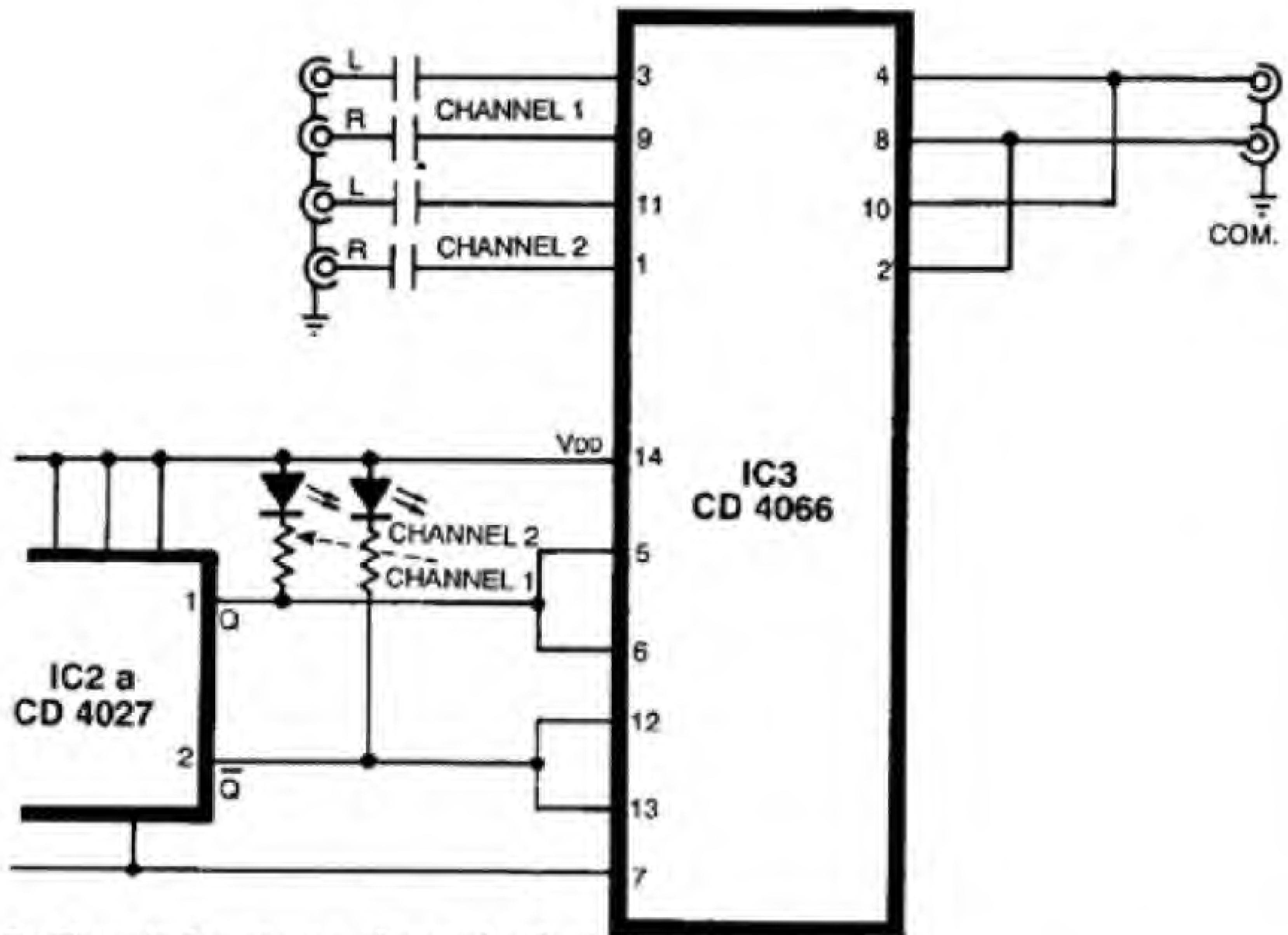


Fig. 7: Circuit for stereo channel selector.

effect' of musical instruments such as electronic guitar, electronic organ, synthesiser etc. Common types of electronic sound effects are treble, boost, tremolo, fuzz, wah-wah, sustained, reverberation etc. In this mode, the first push of switch S1 disconnects the effects and the channel selector connects the output of the preamplifier to the input of the power amplifier. On the next push of switch S1, the effect is again connected to the amplifier.

This unit can be used to select one of the two effects as depicted in Fig. 6. If switch S1 is pressed, the channel selector automatically disconnects one effect and introduces the other.

For stereo operation, the circuit can be modified as shown in Fig. 7. In such conditions, the bottom half of the circuit shown in Fig. 1 may be dispensed with. ❑

PARTS LIST

Semiconductors:	
IC1	- 40106 hex schmitt inverter
IC2	- 4027 JK flip-flop
IC3	- 4066 CMOS quad bilateral switch
Resistors (all 1/4-watt, ±5% carbon, unless stated otherwise):	
R1, R18	- 22-kilohm
R2, R3, R6-R15	- 100-kilohm
R4, R5, R16, R17	- 470-ohm
Capacitors:	
C1, C6	- 4.7µF, 16V tantalum
C2, C3, C5, C7-C9	- 0.1µF ceramic disc
C4	- 10µF, 16V ceramic disc
Miscellaneous:	
S1, S2	- Push-to-on switch
	- 6 sockets
	- LEDS

SECTION B :
CIRCUIT IDEAS

Electronic Switch For 3-Band Transistor

Pramod Kumar

In the market, 3-band transistor receivers with rotary type and many other types of band switches are available. Here is an interesting band switch circuit for 3-band transistor receivers. This is the electronic version of conventional band switch. In this system, a single pushbutton selects the desired band and LED indicates which band is in function.

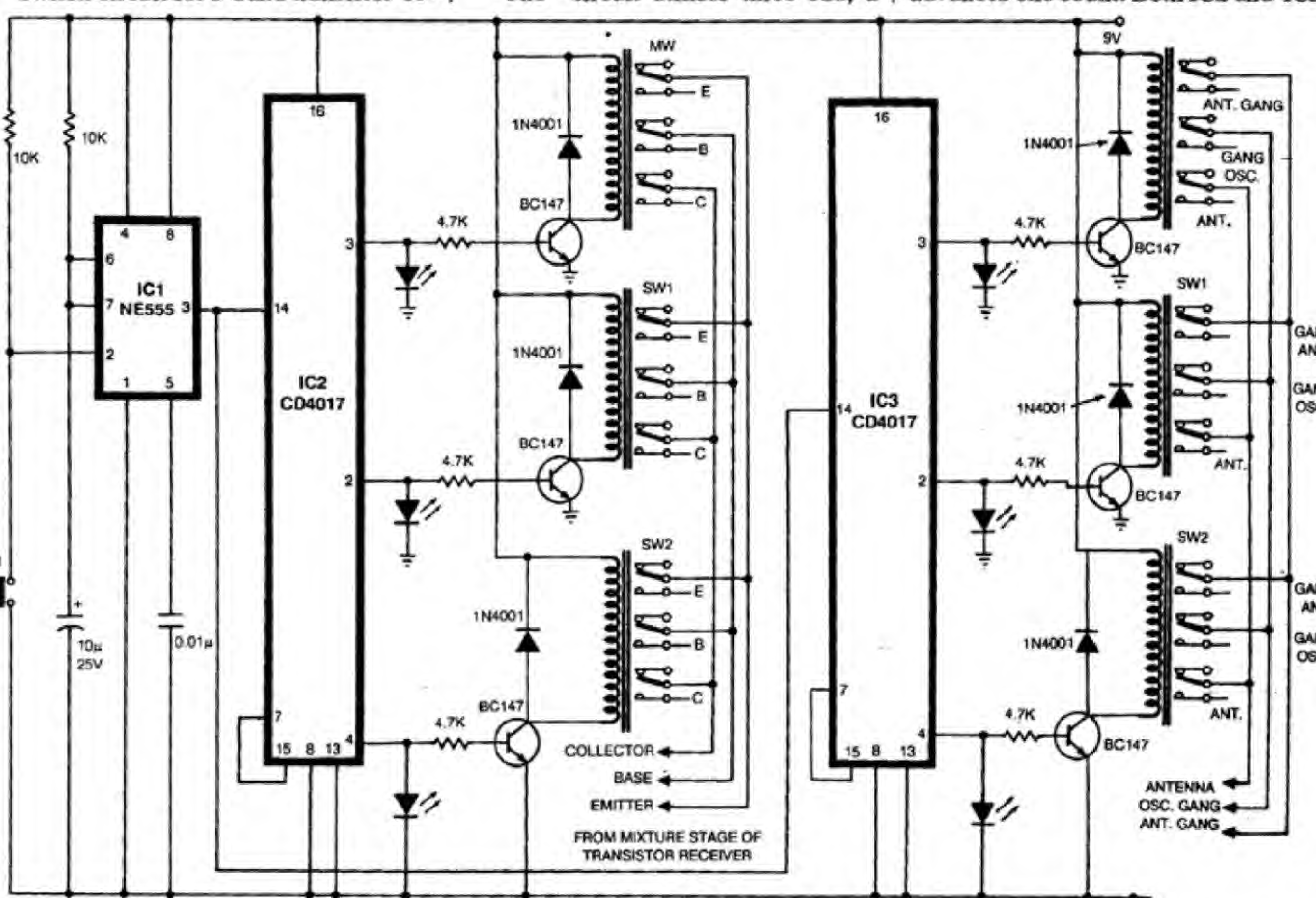
To change the band in a common transistor receiver, five connections have to be transferred from one pole to another simultaneously. These are emitter, base, collector, oscillator gang and antenna gang taken from mixture stage of transistor receiver circuit. This electronic version of band switch does it perfectly.

The circuit utilises three ICs, a timer IC 555, and two decade counter CD4017 ICs. IC1 (555) is wired in monostable multivibrator mode. By pressing pushbutton S1 once, the output pin 3 of IC1 goes high for 0.11 second and then comes back to low, so that its output generates one full clock pulse to input pin 14 of IC2 and IC3. High logic time duration is kept for 0.11 second by using time constant formula.

IC CD4017 is wired so as to give three counts, viz, Q0, Q1 and Q2 sequentially by pushing S1. Each push advances one count. Both IC2 and IC3 are wired alike. Transistors T1 to T6 are wired in switching mode.

The transistor gets switched on when its base receives high logic. When it is switched on, the related relays operate and the corresponding band becomes functional. LEDs indicate which band is in function. S1 is used to select the desired band.

Triple-pole and double-touch relays



NOTE: ALL RELAYS - 100Ω, 9V (TRIPLE POLE) are used here. Normally-open poles of relays are wired to antenna coils, oscillator coils and gangs.

Caution must be taken that Qn outputs of both IC2 and IC3 are used for the same band wave. Q0 outputs of both counter ICs are used for medium wave, Q1 outputs for short wave I and Q2 for short wave 2.

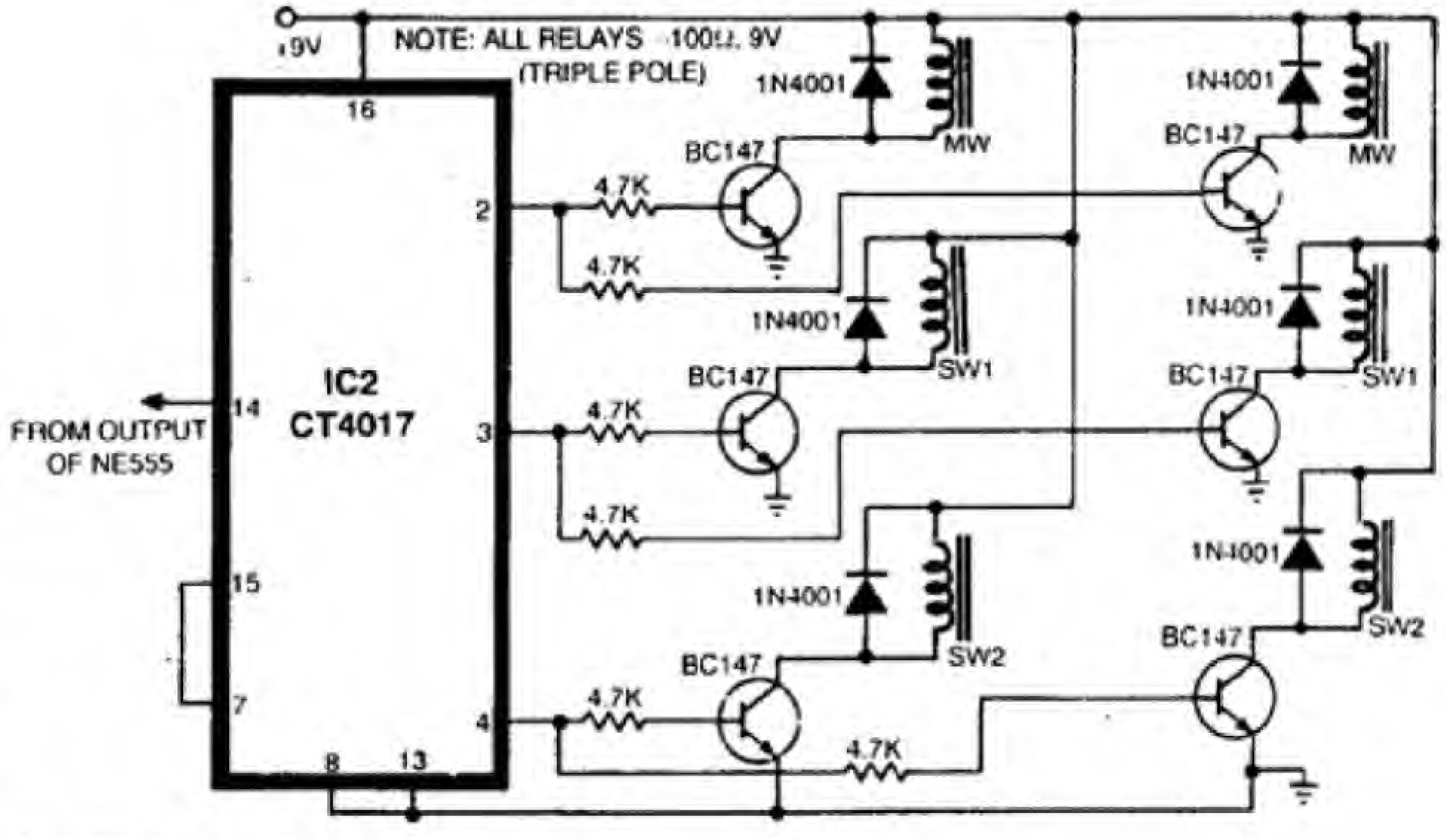
Emitter, base and collector should be taken from mixture stage of transistor receiver circuit. In contrast, all connections should be made according to common band switch wiring of 3-band transistor receiver. Wiring will be same but instead of the conventional types of band switches, relays are used here for connection.

Readers' Comments:

In the circuit two CD 4017 ICs have unnecessaarily been used. I made the circuit using one 555 and 4017 IC.

Inputs for the three relay driving circuits in the right-hand part of the circuit can also be taken from IC2. The simplified circuit is shown here. If the relays are not energised properly, omit all three LEDs.

PRADEEP G.
Alleppey (Kerala)



Simplified circuit diagram.

Electronic Number Lock

S.S. Palanimurugan

The electronic number lock described here is an electronic unit operated as a mechanical number lock. Here three selected numbers are operated one by one so that the relay connected to the circuit is actuated. When the relay is actuated, any external unit connected to it, whether electrical, electro-mechanical or electronic, starts operating.

Fig. 1 shows the block diagram of the electronic number lock. In this system, three switching circuits are used with SCR. Each circuit is switched on one after another. Each switching circuit consists of a pushbutton called "number", while the other switches (numbers) are connected to the "wrong use of system" circuit. Any three different numbers can be selected. Its connections are as shown in Fig. 2.

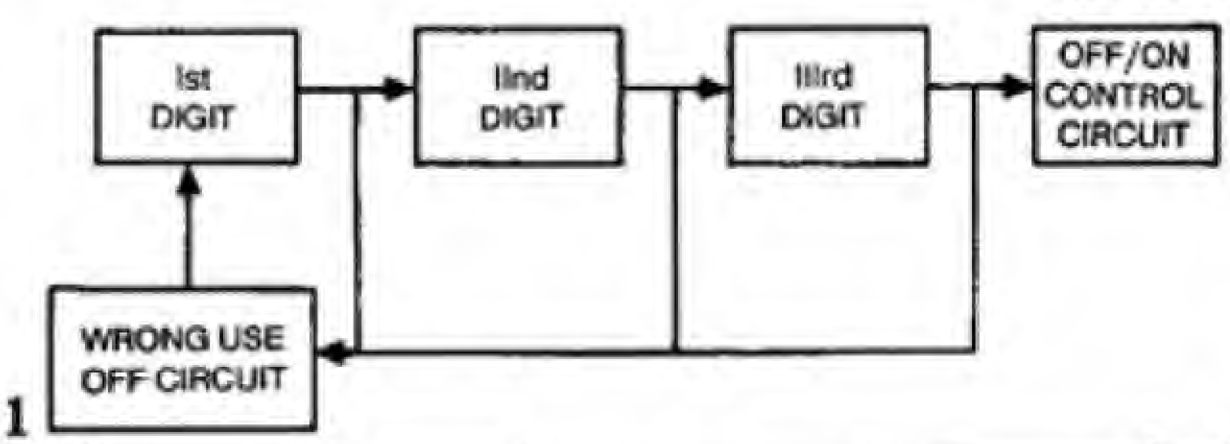


Fig. 1

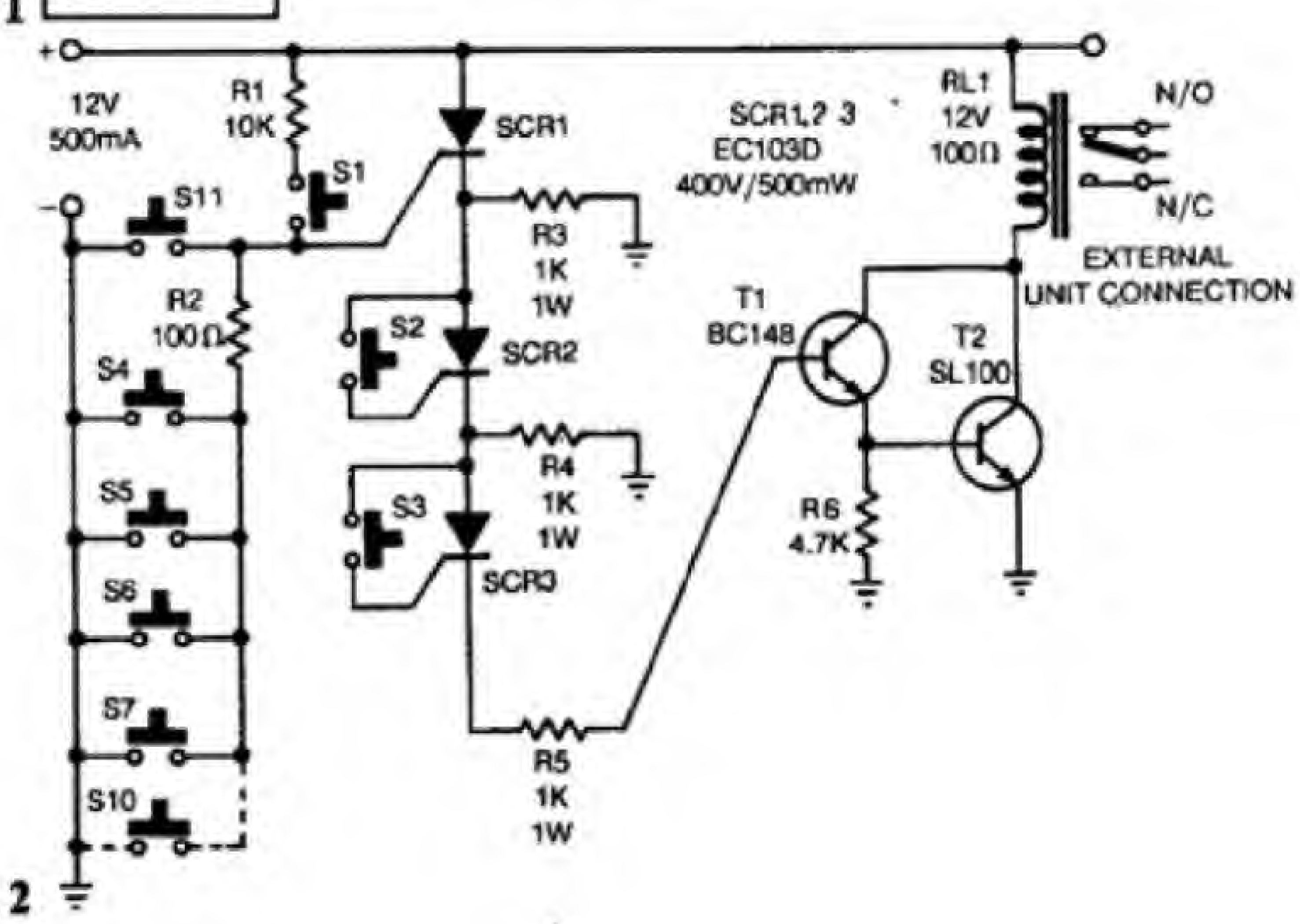


Fig. 2

When the three switching informations are given one by one, the control switch circuit turns to 'on'. Otherwise any switching information may be changed totally, such as first, second or third switch, and the circuit turns off. Again press the first digit.

Fig. 3 shows the general circuit of SCR forward biasing system. A 12V battery is connected between anode and cathode of SCR. R1 is load resistor or any load. The gate terminal is connected to anode in series with a pushbutton switch and a resistor Rg (for gate triggering).

To turn on the system, switch SA is switched on so that the anode gets positive voltage. Pressing pushbutton switch SG on provides positive current at the gate, so that the SCR turns on. Now load current I1 passes through load R1.

Two methods are used to turn off the system:

1. Mostly when the anode voltage is switched off, the SCR is also turned off.

2. When the gate has a high negative current, the SCR turns off. This is possible only when I1 is very small.

In this circuit, three SCRs are connected in series and the SCR anode and

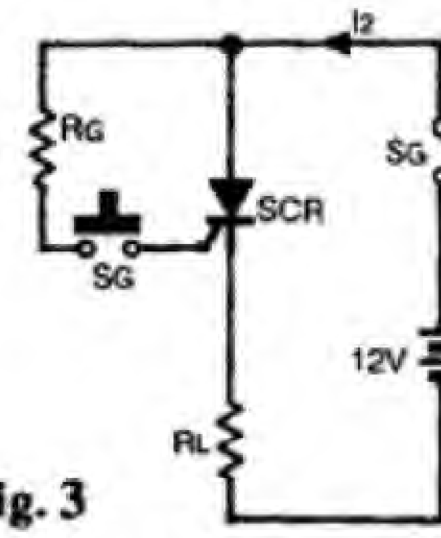


Fig. 3

cathode junctions are connected to the negative by resistors R3 and R4, which work as loads for SCR1 and SCR2 respectively. These resistors also work as load for the SCR circuit and a very small amount of current passes through the resistors. SCR3 is connected to base of T1 in series with resistor R5. The collector and emitter of T1 are connected to collector and base of T2 respectively.

Relay RL1 is connected between positive and collector of T2. The emitter of T2 is connected to negative.

The three selected switches S1, S2 and S3 are connected at gate terminals of SCR1, SCR2 and SCR3 respectively, while other switches are connected between SCR gate and negative in series with resistor R2.

When S1 is pressed, SCR1 gate terminal gets positive current through resistor R1 and SCR1 turns on. When switch S2 is switched on, SCR2 gate gets positive current from SCR1 cathode and SCR2 is turned on.

Finally, when S3 is pressed, SCR3 gate gets positive current and SCR3 is turned on. The cathode of SCR3 is connected to base of T1 which gets positive current. At the same time, T1 and T2 are turned on because the base of T2 gets more positive current via T1. R1 is activated by T2. The external control connections activate and the relay conducts.

At the same time, the switching operations may be wrong, i.e. any number may be changed so that SCR1 gate gets more negative current via resistor R2. So, SCR1 is turned off, and the next circuit of SCR2 and SCR3 is turned off as its anode voltage goes to zero. Also, SCR3 anode voltage goes to zero.

At lock working time, switch S11 is switched on, SCR1 gate gets more negative current and SCR1 turns to off state. There is no power consumption when SCR1 is in off state.

Three-in-One Circuit

P.P. Chandrapal

Nowadays most households possess washing machine, TV, refrigerator and cooker where under/over voltage protection or timing is required. Here is a circuit with under/over voltage protection and a timing circuit which can be used for washing machines. By providing an additional switch, it can be used with TVs for under/over voltage protection. Moreover, this circuit can also be used in kitchen or elsewhere as a timer.

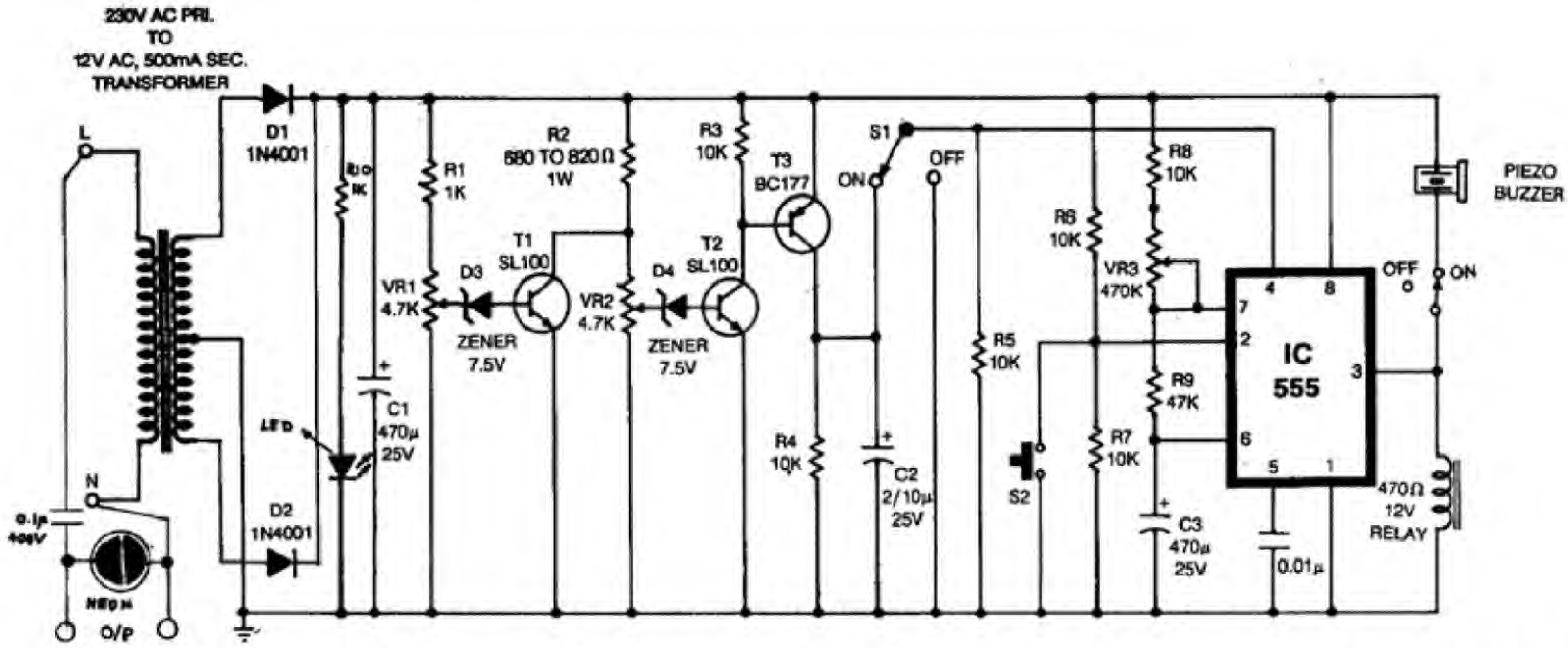
This circuit mainly comprises two parts: under/over voltage protection circuit and the timer circuit.

Under/over voltage protection. This is a simple circuit in which zener diodes D3 and D4 control the over/under voltage according to the settings of presets VR1 and VR2. At low supply, voltage on zener D4 terminal will be reduced, resulting in non-conduction of transistors T2 and T3. This grounds pin 4 of IC 555 timer, stopping its output at pin 3. Relay RL will de-energise and the supply for the gadget will stop.

At high supply, voltage at zener D3 terminal will increase and transistor T1 will conduct, grounding preset VR2. This will result in non-conduction of transistors T2 and T3 as usual and shut off the supply.

Timer circuit. For this circuit, IC 555 is used as a monostable. Its output is controlled by the status of pin 4, i.e. when its voltage goes to positive, IC555 functions according to the voltage condition at pins 2 and 6. When the voltage at pin 2 is 1/3 Vcc, the output will be at pin 3. With 2/3 Vcc at pin 6, there will be no output at pin 3.

At normal voltage, when supply is turned on and switch S1 kept in 'on' position, an alarm will be heard but



supply will not be switched on till pushbutton S2 is pressed. Now, reset the circuit by pressing S2 so that pin 2 will be grounded. Also, the output at pin 3 is reset, i.e. output supply switched on.

At the same time, pin 7 stops grounding internally and capacitor C3 starts charging through R8, VR3 and R9. When voltage at pin 6 reaches 2/3 Vcc, there will be no output at pin 3, while pin 7 is grounded internally and C3 is discharged through resistor R9.

An alarm will be heard while switch S1 remains in on position till output supply is switched on by pressing reset switch S2. Delay timing can be adjusted by VR3 as required.

To use this circuit for TV or refrigerator protection, timing circuits are opened out by providing a switch at point A as shown. Now output supply remains on till S1 is turned off.

Match Box Size Radio

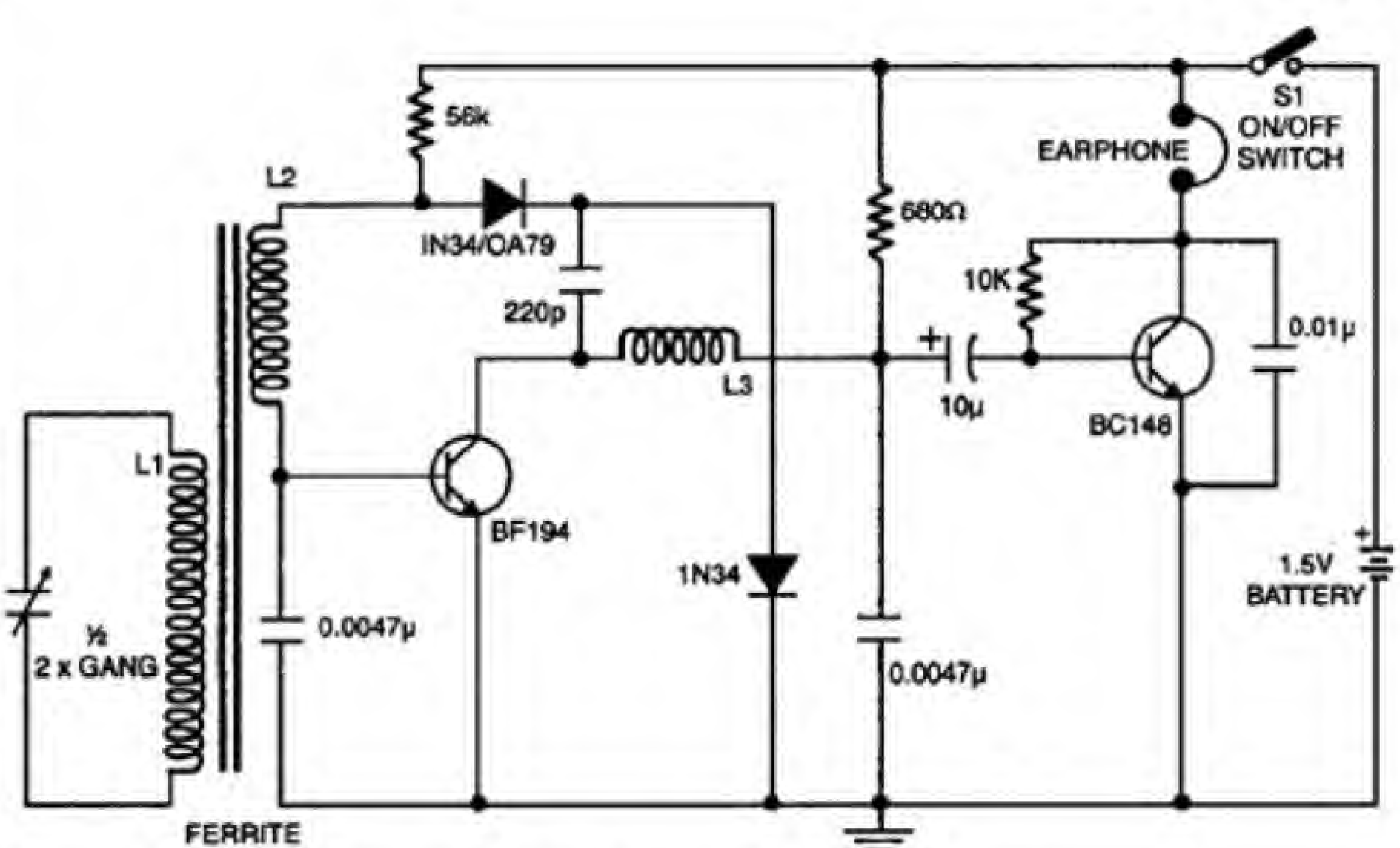
Pradeep G.

Using the circuit described here, one can make a very compact MW radio receiver. This circuit uses two transistors and some passive components only. All the components can be easily placed in a small match box size cabinet. For compactness, a small pen torch cell (1.5V) may be used.

L1 consists of 100 turns of 40SWG insulated wire. Wind L2 over L1 which is 10 turns of the same wire. For L3 wind 56SWG (approx.) over ordinary IFT former without using core and metal cover. Counting of turns is not necessary. Wind the wire completely over the former pulley. It may be fixed on the PCB using wax.

After making all connections, switch on S1 and plug the earphone to your ear. Now rotate the gang's knob slowly till you can hear programmes from the local MW station.

This circuit does not need an aerial.



L1 - 100 TURNS OF 42 SWG OVER FERRITE
L2 - 10 TURNS OF 42 SWG OVER L1
L3 - WOUND 56 SWG THIN INSULATED WIRE UNIFORMLY OVER IFT's CENTRE CORE

Placing of the unit near mains wiring is also not necessary. If clear result is not obtained, check the connections once again. If they are alright, adjust antenna coil over ferrite rod. This circuit will work very well with miniature speakers also.

Readers' comments:

The small size radio circuit is very interesting and useful for students. However, please clarify: (a) can L3 also be wound with 40-42 SWG wire like L1 and L2; (b) should the earphone's resistance be high or low; and (c) can I replace the gang with a condenser to catch Vizag station?

A. NAGA BABU
Karapa

❒ Thanks for publishing such a wonderful circuit in the perspective of renewed interest in radio listening—on the backdrop of Gulf War!

I would like to add one more transistor stage to drive a small speaker of 8 ohms in place of the earphone in the circuit. Will the author kindly help?

NITIN BANERJEE
Port Blair

❒ Please convey my thanks to Mr Pradeep G. for his circuit in EFY Jan.'91. The author has used single RF stage transistor in a very interesting way which must be complimented. What is the impedance of the recommended speaker?

AMRIT BIR TIWANA
Ambala Cantt

❒ Instead of L1 and L2 if we use medium wave antenna coils with ferrite rods, the circuit works very well. For L3 we can use an IFT of large number of turns (Philips IFT) without metal cover.

MAHAVIR D. CHHAJED
Pune

The author Mr Pradeep G. replies:
I am thankful to all the readers who have taken keen interest in my circuit idea.

In my prototype, I used 2 X type MW antenna coil as L1. L2 was wound over one of the ends of L1 using 40-42 SWG wire. As I have already mentioned in the text, very thin 56SWG enamelled wire was used for L3.

I tested the circuit with an 8-ohm earphone and an 8-ohm, 5cm speaker. The output sound can be increased by adding one more transistor in amplifier stage, wired as darlington pair.

My prototype was tested successfully at a distance of about 15 km from Alleppey MW station. It has also been tested in EFY lab.

Static Audio Wattmeter

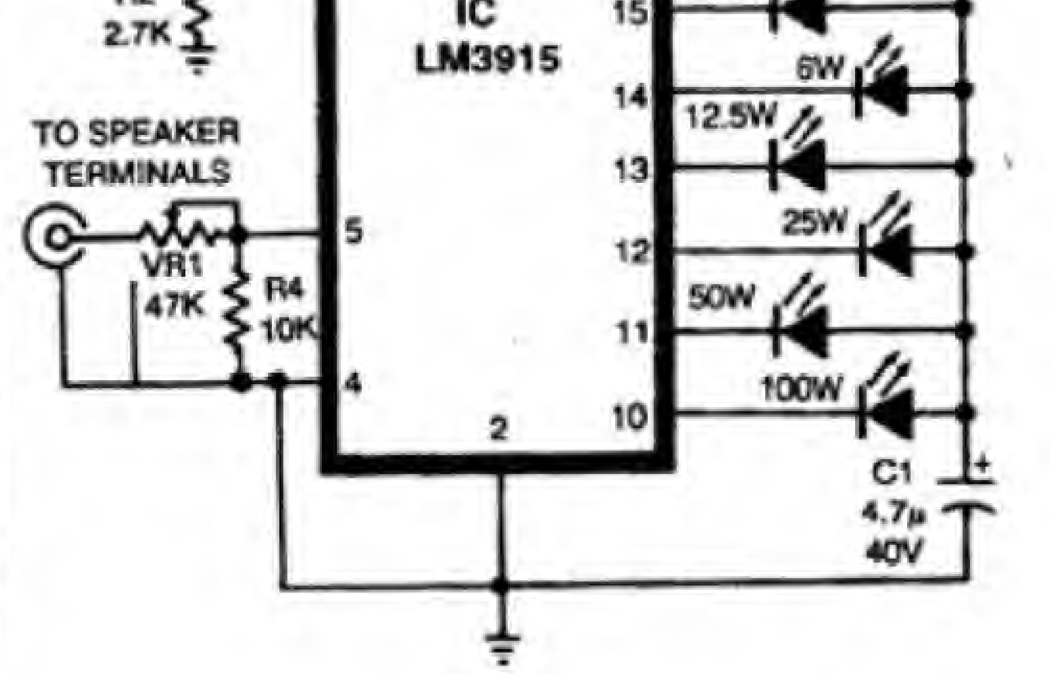
Amrit Bir Tiwana

This static audio wattmeter indicates the output power on a bright, luminous 10-step LED display. Unlike most other electronic power indicators, which only give an approximation of the power level, this meter actually measures the output power (in watts).

With 11 op-amps, (to which the chip is equivalent) the circuit seems to be fairly complicated, but all complexities are reduced to a single chip—the LM3915 (from National Semiconductors). In addition to the IC and LEDs, the circuit requires just four resistors, a preset, and a capacitor.

The LM3915 is a monolithic IC that is capable of driving 10 LEDs directly, providing a 3dB/step analogue display. The IC can operate in dot or bar mode of illumination. The LED current drive is regulated and programmable, hence the need for several current limiting resistors is eliminated. A simple, unregulated power supply is enough for the circuit.

When the audio signal is fed to the input through series attenuator VR1, the IC compares the input level with the preprogrammed voltage level in the IC. This programming is done through two external resistors at reference terminals. As the input level rises, the bar graph also moves forward.



For +V marked level, the LEDs light up in a particular order, forming an array. C1 is used to help maintain a steady display. Although the LEDs can be any red type, type TIL209 from Texas Instruments is specifically recommended.

All components should be soldered horizontally except the LEDs which are soldered at a height of about 10mm. A socket should be used for the IC. The LM3915 costs about Rs 60.

Variable Switching Power Supply

Biju Mon Janardhanan

The circuit given here is an inexpensive variable power supply for medium power applications. It can be used to provide up to 300 mA. It is variable between 6V to 13V.

The circuit around IC 555 forms a monostable with a time period of approximately 0.2ms. The zener diode forms the reference voltage and potentiometer VR1 is used to vary the output voltage.

Transistor T1 forms an emitter-follower, where the emitter voltage is equal to the voltage at the varying point of VR1. T2 is used to sense the output voltage, while T3 triggers the monostable in accordance with the output voltage level.

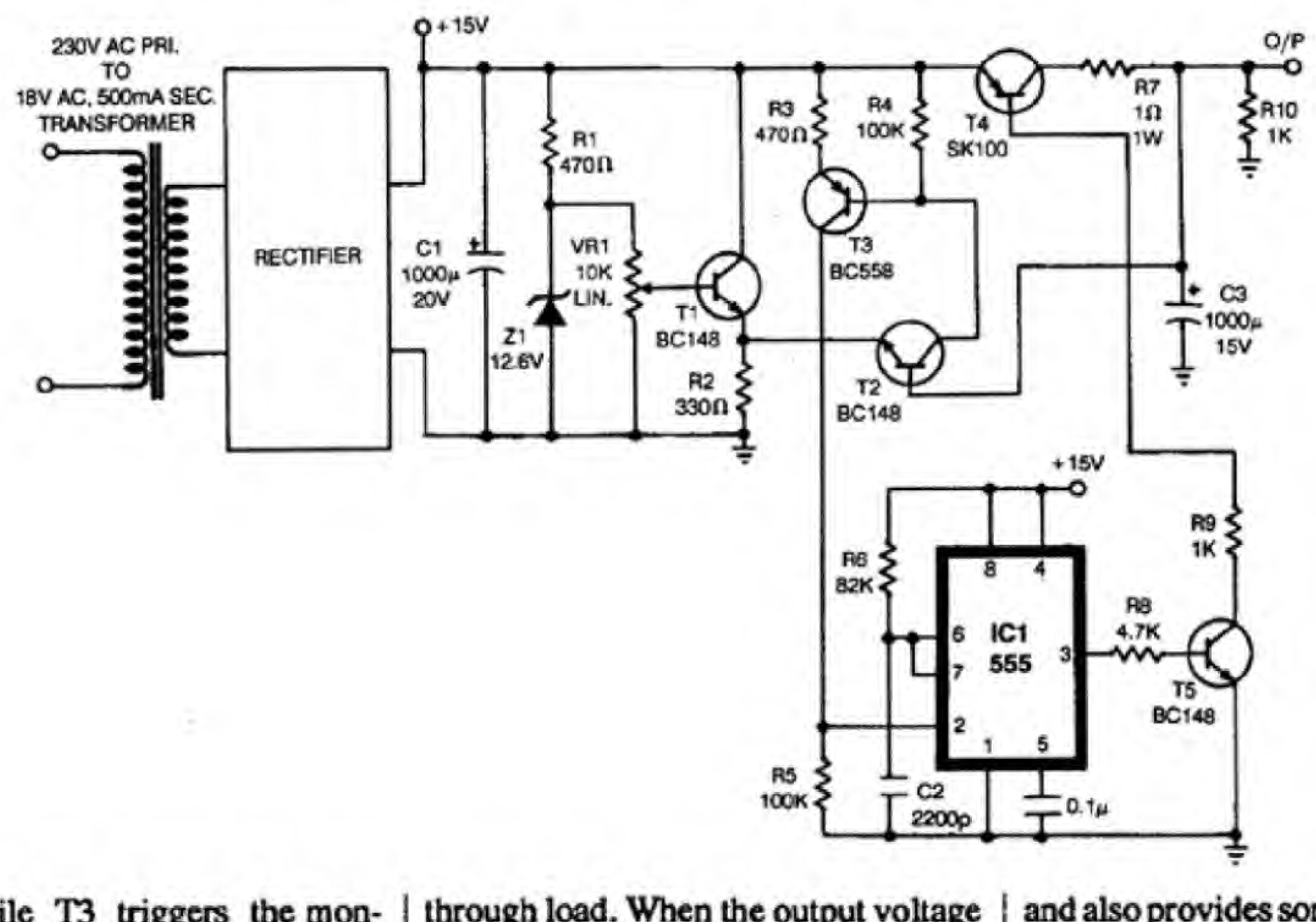
When the circuit is switched on, the voltage at T1 is equal to the voltage at the centre point of VR1 (say, 5V). Therefore, the emitter of T2 is at 5V and base at zero. As it is in the off state, no voltage is developed across R4 and T3 continues in the off state.

Pin 2 of the IC is grounded through R5, and its output triggers to Vcc. This switches on transistor T5 so that it goes into saturation, while C1 gets charged when the voltage across it reaches 5.6V.

T2 turns on and develops a voltage across R4. This turns T3 on and voltage at pin 2 becomes more than Vcc/2. So, the output of the IC goes low after 0.2ms and the capacitor C3 discharges through load. When the output voltage decreases from 5.6V, T2 goes off, also forcing T3 to turn off. This produces a negative trigger at pin 2 of IC 555. Its output goes high, turning T4 on. This process is repeated continuously. As T4 operates only in saturation and cut-off modes, power loss is very low.

There is a possibility that the capacitor may get charged due to leakage current, increasing the output voltage on load. The 1k resistor at the output is provided to avoid this. The current capacity of the circuit can increase by using a high power transistor instead of SK100 or by adding one more SK100 in parallel. (The author used this with an AC128 transistor and heatsink to drive a stereo set.)

Here IC 555 is used as a comparator and also provides some delay to output change. If the output ripple is high, decrease the value of C2 or omit it altogether.



Tubelight Without Choke And Starter

A. John Joseph

A choke in a tubelight has two functions: It gives a high ionising voltage to the tube with the help of starter. After the gas is ionised, starter goes out of the circuit and a portion of the mains voltage is dropped across the choke. The tube requires only about 60V to 70V to sustain ionisation of the gas. But a tube can also work without these costly components. All that a tube requires is a high starting voltage and a low working voltage.

Here is a circuit for the troublesome tubelight and dim incandescent lamp which works on voltage as low as 70V AC. It provides enough light intensity without much financial strain. Another important factor is that the choke—the costliest component in a tube fitting—can be eliminated. Most of the tubes burn out due to short circuit of the spark suppressing condenser inside the starter. This project does not need either of these components.

This circuit works quite satisfactorily from 70V to 270V AC. You need only a few easily available components and a basic knowledge of tubelight connections.

The heart of the system is a bridge rectifier using diodes D1 to D4 and two capacitors C1 and C2. When connected to a tube as shown in Fig. 1, the diodes get nearly 110V AC with a 100W 230V bulb in series. C1 and C2 connected on the phase line of the power supply magnify the voltage, giving a high ionising potential of the order of 600V DC. This allows the gas inside the tube to ionise instantaneously.

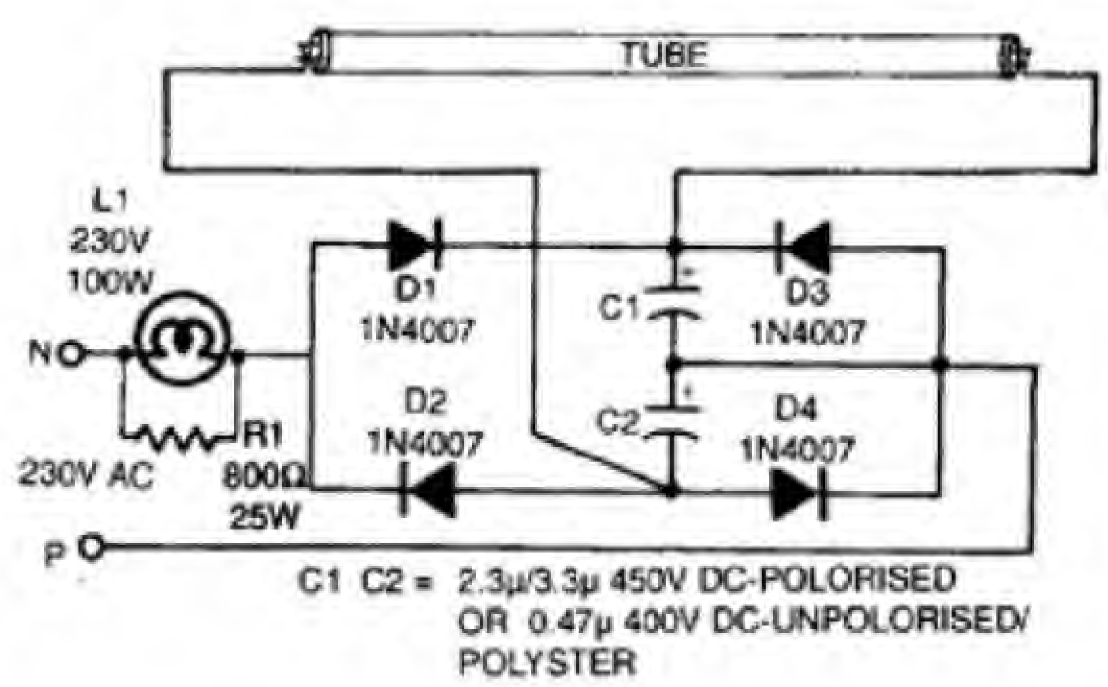


Fig. 1

After the gas is ionised, the tube gets a pulsating DC of 100Hz ripple frequency (110V DC). Current flow through the ionised gas depends on the actual requirement of the tube to sustain ionisation. At normal mains voltage, the series lamp draws very little current and gives a dim light.

In series connection, the low current drawing component is the controller of current in that circuit. So here the tube draws less current than the series 60W or 100W bulb and hence the brightness of the tube does not vary with mains power variations.

A choke can also be successfully used in place of the bulb. But there is a possibility of the choke being burnt off if continuously used at full mains voltage.

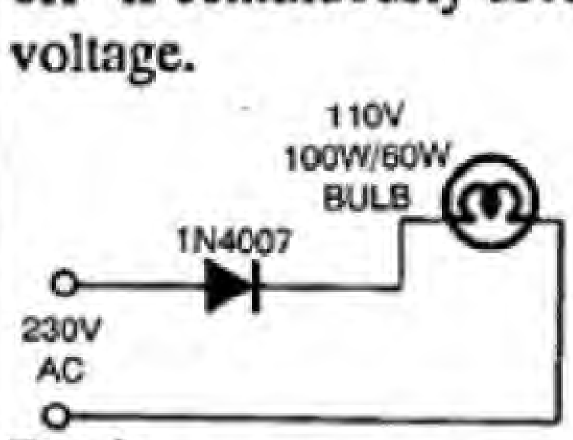


Fig. 2

Another advantage of this circuit is that even a weak or filament-open tube can be used because ionisation of the gas takes place by applying a high frequency voltage across the tube. This effect can be generated by the application of a voltage at a higher frequency. Two pins at each end should be shorted as shown in Fig. 1.

In most places, voltage at peak load hours is so low that a 60W or 100W lamp is not much better than an ordinary lantern. An additional diode to the bulb holder using 150V bulb can rectify this fault (Fig. 2).

The diode works as a half-wave rectifier. Only one half of a cycle of supply is allowed to pass through the diode. Here the bulb gets a DC voltage (140V) at a ripple frequency of 100HZ.

The principle of operation here is that the bulb has a heating filament which gives out light when current is passed through it. The heating effect of DC is more than that of AC, and even if the mains voltage drops to a very low value, this arrangement will give sufficient brightness. Even at full mains voltage, the maximum voltage that a bulb gets will be less than 140V.

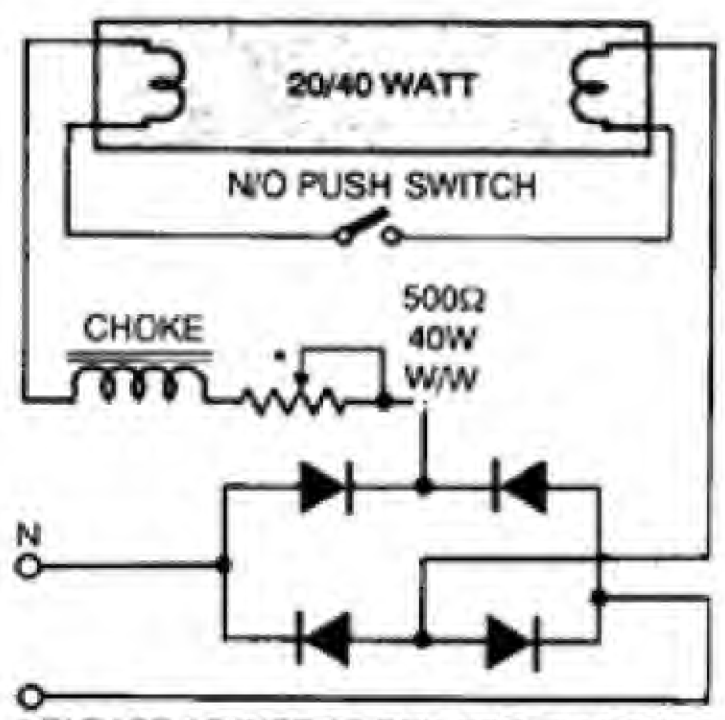
The diode can be connected in any polarity.

Readers' Comments:

The idea of lighting a troublesome tubelight without the choke and starter was fantastic.

Using a choke in place of the 100W bulb in the circuit is not advisable but, if desired, it can be used with a slight modification in the circuit (see figure). In this case filaments at both the ends of the tubelight should be intact; it will give illumination when switch is closed.

The circuit that was shown in Fig.2 can also be used by replacing the 110V bulb with a conventional 230V bulb in series with diode 1N4007. The circuit can be used for illumination of areas where full brightness is not essential.



* PLEASE ADJUST AS PER REQUIREMENT TO OBTAIN OPTIMUM ILLUMINATION

R.K.DAS
Pipe Line Engineer (T&I)
Indian Oil Corporation Ltd
Haldia

❑ I tried the circuit with a condemned tubelight and a 60W bulb and it worked satisfactorily. The tube will give full light if a 100W bulb is used as a series load.

On using 2.2/3.3μF, 400V electrolytic capacitors for C1 and C2 a lot of flickering and radio interference is observed. When I used two 3.3μF, 400V polyester capacitors the tubelight started working normally, without flickering. Even a condemned tubelight can be used in this arrangement, provided at least one of its filaments is intact.

K.H.DINESH
Belgaum (Karnataka)

Automatic Star-to-Delta Converter

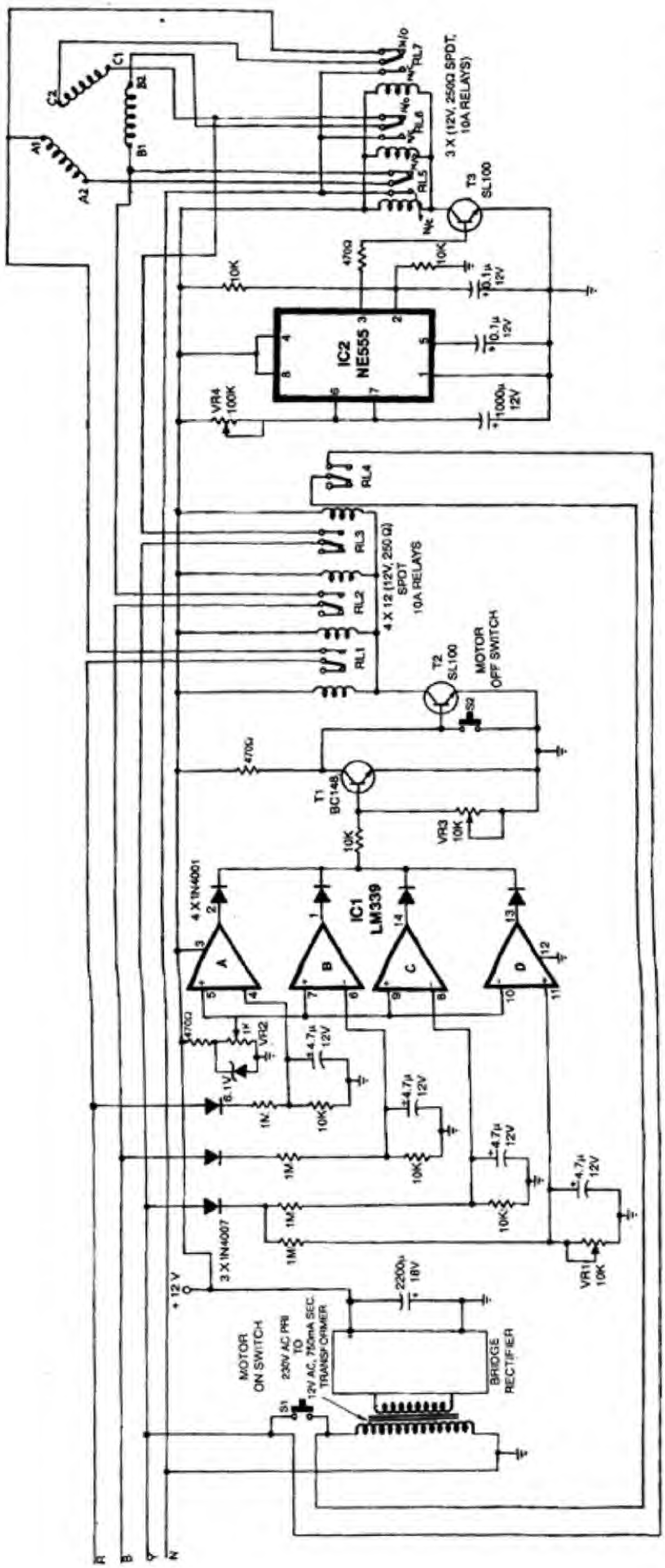
Biju Mon Janardhanan

The armatures of a 3-phase motor are connected as star at the time of power-on and then converted to delta when it reaches 3/4 of the full speed, in order to handle more power. Most converters used are electro-mechanial and have to be manually switched to delta after some time.

Here is a circuit which incorporates a timer to convert the star connection into delta after a predetermined time. The timer is adjusted such that it switches over when the motor achieves the required speed. Also, it has low power handling switches for on and off operations.

IC1 and the circuit around it provides single phase prevention and under/over voltage cut-offs. Comparators A, B and C are used for single phase prevention and under voltage cut-off while D is used for over voltage cut-off. (It is assumed that over voltage will be present in all phases together.)

Each phase is rectified and divided to get 2.25V when there is 230V between phase and neutral. The di-



vided voltage is filtered and supplied to negative terminals of the comparator. A reference voltage is derived from the circuit supply using a 6.1V zener diode and a 1k preset. The preset must be adjusted such that it is just below 2.25V.

Similarly, in order to provide high voltage cut-off, use the same reference voltage and a similar voltage divider but the derived voltage is a little less than the reference voltage.

Outputs of all comparators are connected to a diode or gate using four 1N4001 diodes and connected to the base of BC148 in order to invert the voltage level. SL100 is used as a switching transistor to switch on the relays.

One switch is placed parallel to a relay, on pressing which the transformer turns on and supply is provided to the control circuit. In normal conditions, all four outputs of the comparators are low. So BC148 is off and SL100 gets enough base current through the 470-ohm resistor to drive the four relays (collector current of SL100 is 200 mA). One of these four relays is also energised and N/O contact is connected. But this relay is in parallel to the on switch, so that even after releasing the pushbutton, the circuit remains on.

If there is low voltage at one phase or it fails, the voltage at the negative input of the comparator falls below the level at the positive terminal. The output of one comparator goes high, turning T1 on. Now the voltage at the base of T2 becomes low and de-energises the relays. Relay RL4 also de-energises and cuts off the supply to the control circuit, turning the motor off. Relays RL1, RL2 and RL3 are to turn the motor on.

IC2 is wired as a monostable multivibrator. The supply reaches pin 2 at low voltage, a moment before charging the 0.1µF capaictor. The 100k potentiometer and 1000 µF capacitor are the timing elements while transistor SL100 and relays are used for switching the motor from star to delta.

When the circuit is switched on, the monostable gets a negative trigger and its output goes high. So, the relay energises, connecting the motor in star configuration. Both sets of relays (switch-on and converting) have a delay. So the motor gets supply only after connecting it in star mode. After a specified delay, the monostable switches off and remains in that state. When T3 goes off, the relay de-energises and goes to N/O state (normally off connections are wired as delta type).

After wiring the circuit, keep VR1 as low as possible and press S1 on. Adjust VR4 to get sufficient delay before switching the motor in delta mode. Also adjust VR2 to get under voltage cut-off and VR1 for over voltage cut-off as required.

VR3 is provided to keep transistor T1 off when output of comparators is low (sometimes because of the irregularity of the circuit, a low voltage may occur at the output).

Cassette Copier

P.N. Shaji

Here is a simple circuit for copying audio signals from your tape. It employs four npn transistors (Fig. 1). The line-out connection from the tape is connected to the line-in of this circuit. A 100k potentiometer should be connected to the input of this circuit to control the recording level. The audio signal is amplified by the transistors, mixed with the RF signal and recorded on the cassette.

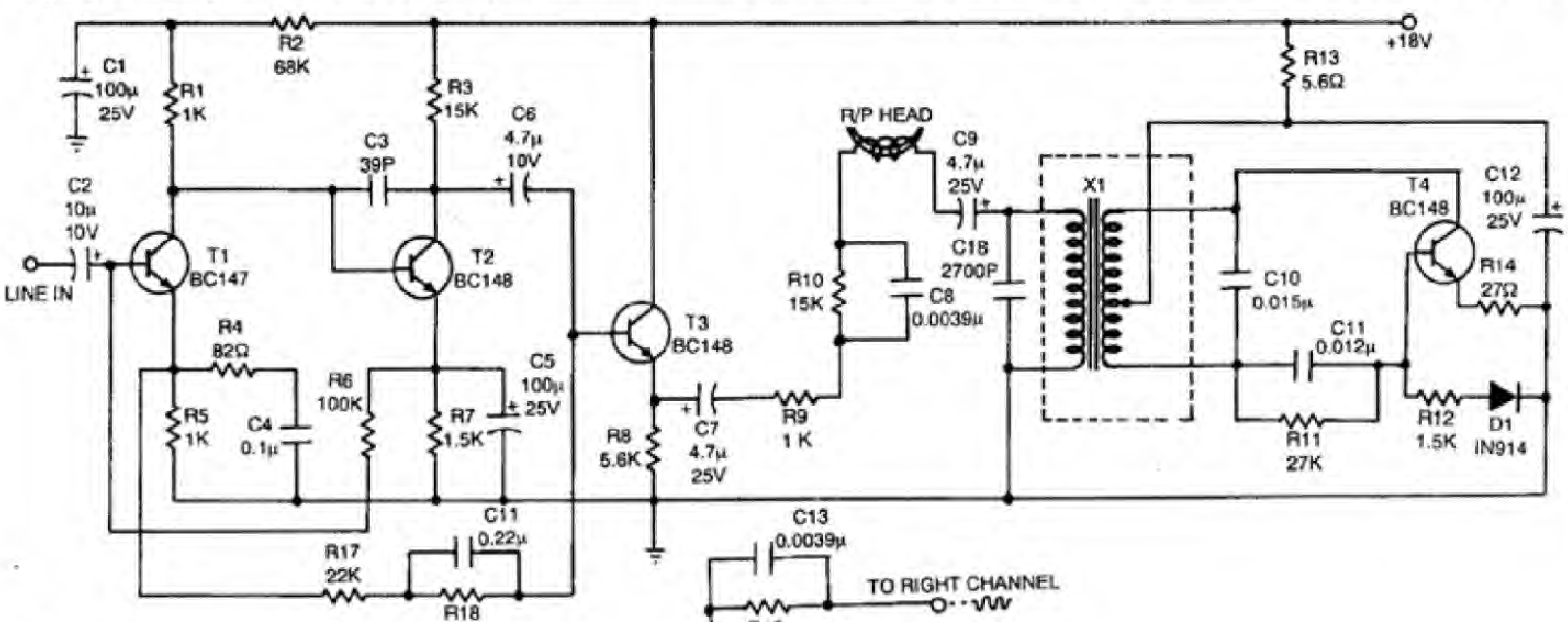


Fig. 1

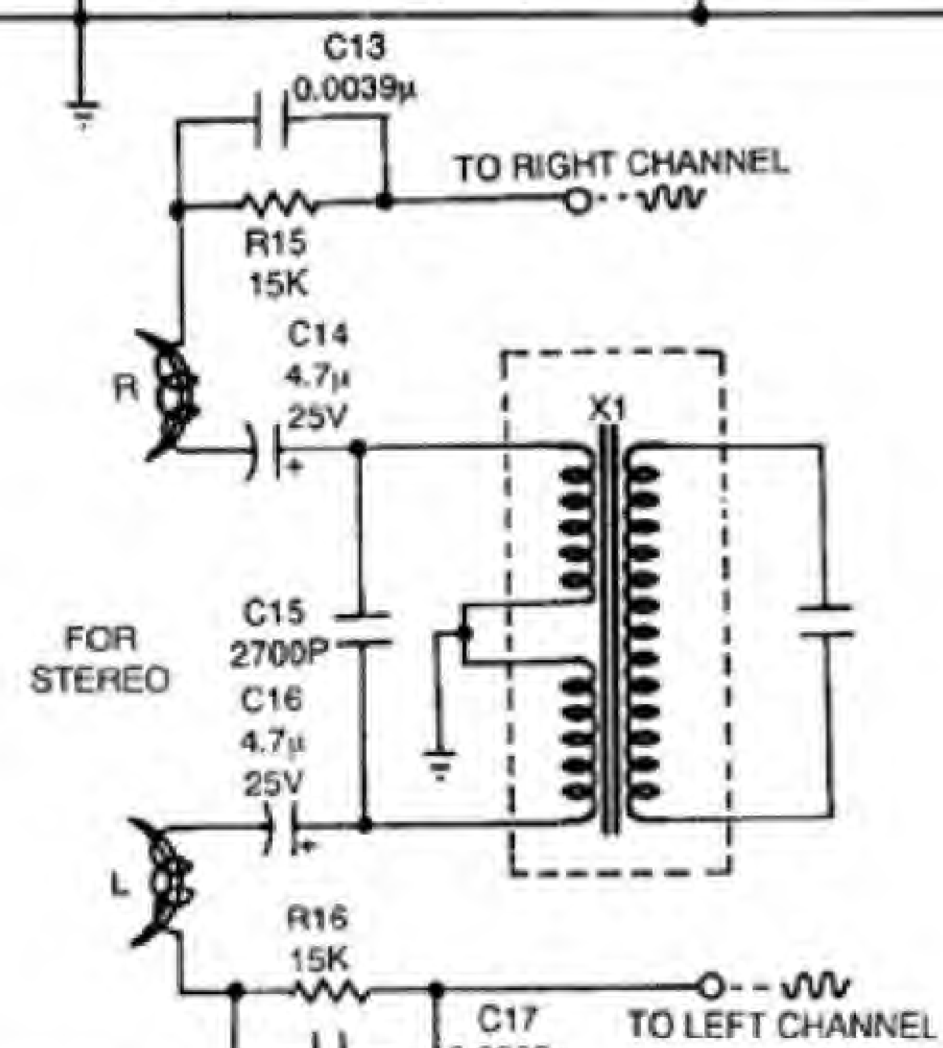


Fig. 2

Two transistors amplify the incoming signals to a proper level, while the third is used for impedance matching. The fourth transistor is used to produce an RF signal for biasing to get best clarity to the audio signals. X1 is an IFT of a radio receiver (without capacitor).

For stereo, a second similar circuit is required. In the RF oscillator, the secondary of transformer X1 (2-terminal side) needs two windings. So wind a wire with same thickness and length (from another IFT) on the same core and connect that wire serially to the previous winding. The joint should be earthed (Fig. 2). The other two ends are connected to the two channels of the recording head. The metal case of the IFT must be earthed.

Readers' comments:

The circuit is fantastic but while the circuit needs 18V supply the skeleton needs 6V. Please suggest a suitable arrangement to meet these requirements and confirm whether BEL 1895 IC can be used to replace transistors T1 and T2?

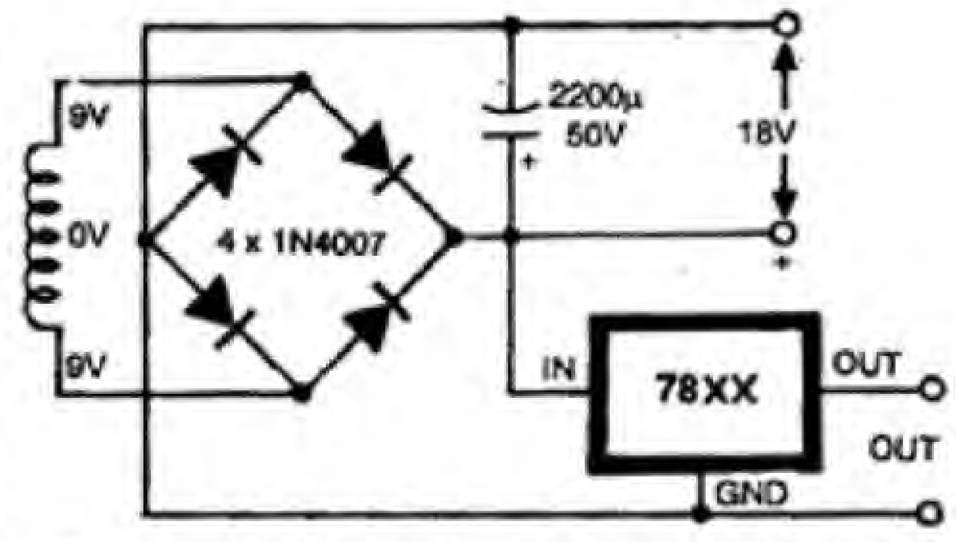
A.N.BABU
Rajahmundry

❒ For the Cassette Copier circuit, please specify: (a) which IFT is to be used in the circuit; (b) which head is to be used; (c) what is the biasing frequency of the circuit; and (d) can chromium and metal cassettes be copied using this circuit?

R.MANOJ
P.O.Pampady West (Kerala)

The author, P.N.Shaji, replies:
As regards Mr Babu's letter, I would recommend use of a 9V-0-9V transformer and a 78xx series voltage regulator IC, as shown here. However, it is too difficult to use the suggested BEL 1895 IC.

Regarding Mr Manoj's doubts, a radio receiver's IFT having black coloured core would be most suitable. If a third IFT is used, the 2700pF



Power supply recommended for cassette copier.

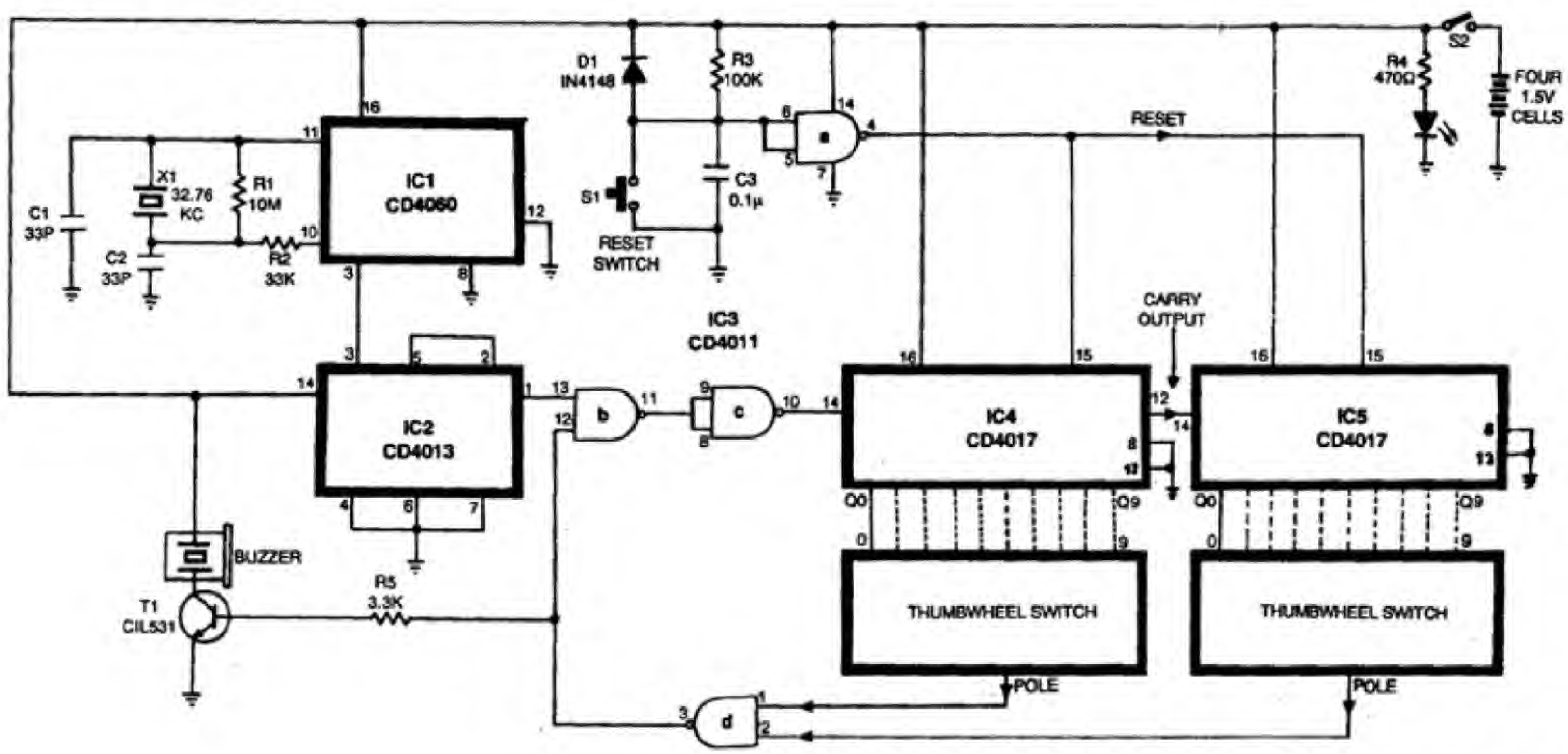
capacitor should be removed from the circuit. I used a National AX head in my copier. With a small adjustment of biasing amplitude we can use a Philips BT62 head. Biasing frequency of this circuit is 75 kHz.

A Precise Timer

V.K. Parmar

The circuit for a 99-second presettable timer described here is centered around easily available 32.768kHz (2^{15} Hz) wrist-watch crystal and CMOS 14-stage ripple-carry binary counter/divider and oscillator type IC CD4060B.

The divide-by-2^{14} output available at pin 3 of CD4060B is further divided by 2 in D type flip-flop CD4013 to get 1 PPS (pulse per second) square wave. The 1PPS pulse train is subsequently subdivided in a chain of two



CD4017 decade counters. The ten decoded outputs available from each CD4017 are connected to a pair of thumbwheel switches (decimal to decimal) to facilitate time setting up to 99 seconds.

Each thumbwheel switch selects any one output of the corresponding decade counter and the outputs of the thumbwheel switches are connected to the two input NAND gates of IC CD4011. The output of this NAND gate goes to 0 whenever the count reaches the value preset by the thumbwheel switches, thus disabling the input clock of the counter chain. It also starts the 'time-up' beeper. The timer can be restarted by a pushbutton located on the front panel. Power-on reset circuit has been included so that the timer will beep after a selected time at every power-on.

The circuit is powered by four penlight cells. Because of CMOS circuitry, the current consumption is quite low and batteries last longer.

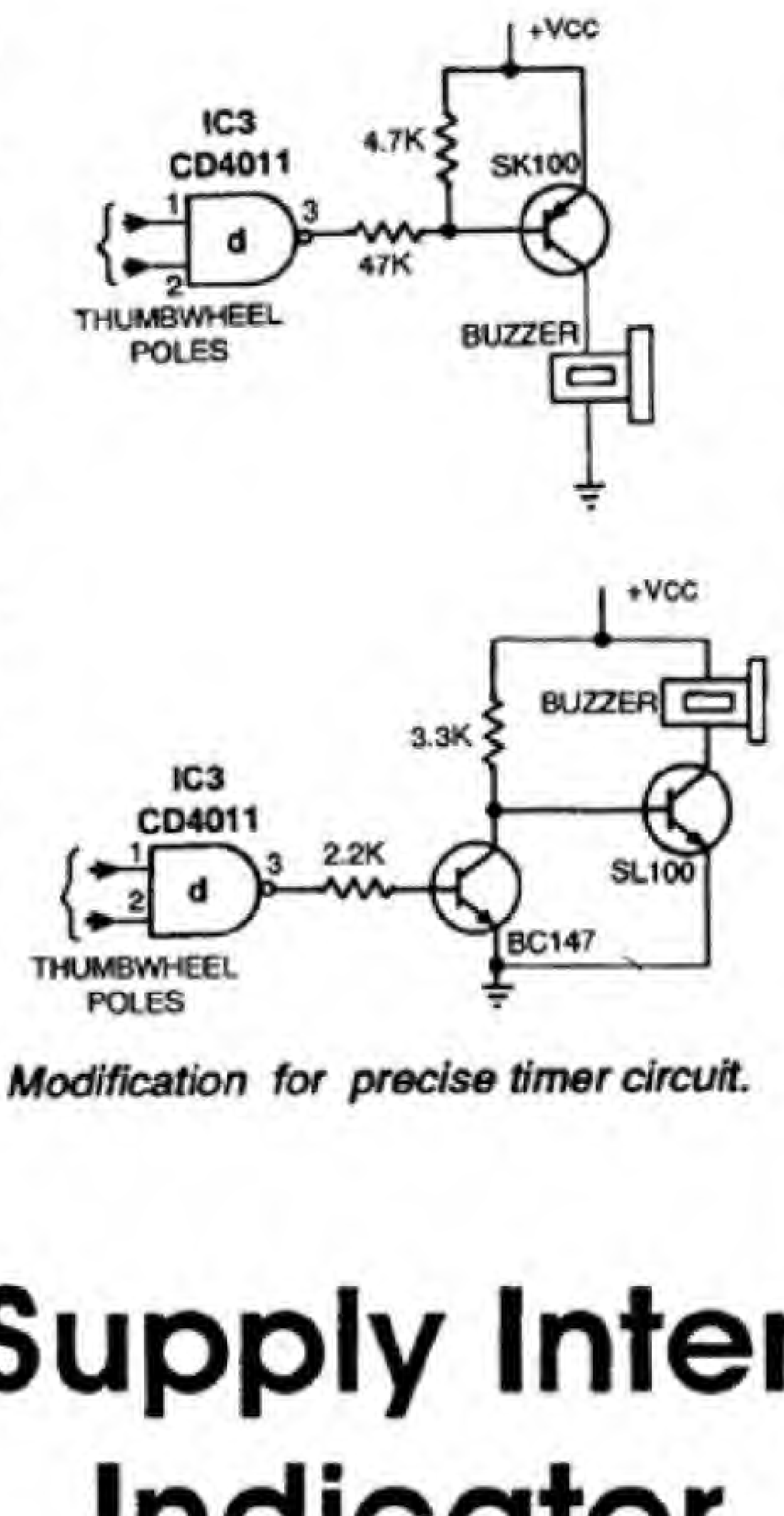
Readers' comments:

Precise Timer circuit in EFY Feb'91 needs to be corrected.

The author has mentioned that "The output of the NAND gate ('d' in the circuit) goes to '0' whenever the counter reaches the value preset by the thumbwheel switches, thus disabling the input clock of the counter chain. It also starts the 'time-up' beeper."

When the output of the NAND gate (d) goes to '0' it disables the clock and also the beeper according to the circuit here. Because immediately on power-on the output of the NAND gate 'd' is 1, the beeper starts beeping. When the NAND gate 'd' goes to '0' after preset value, the beeper stops.

Therefore, for the 'time-up' beeper the following should be added to the circuit.



Modification for precise timer circuit.

With this modification the circuit works just as mentioned by the author.

M. JAMES VICTOR RAJ
Coimbatore

The author, Mr V.K. Parmar, replies: **Please note that the timer has been designed to give a busy signal during its operation and therefore the extra inverter suggested by Mr James Victor Raj is not needed. However, the changes may be incorporated for modifying the unit for normally off and time-up indicator beeper.**

Mains Supply Interruption Indicator

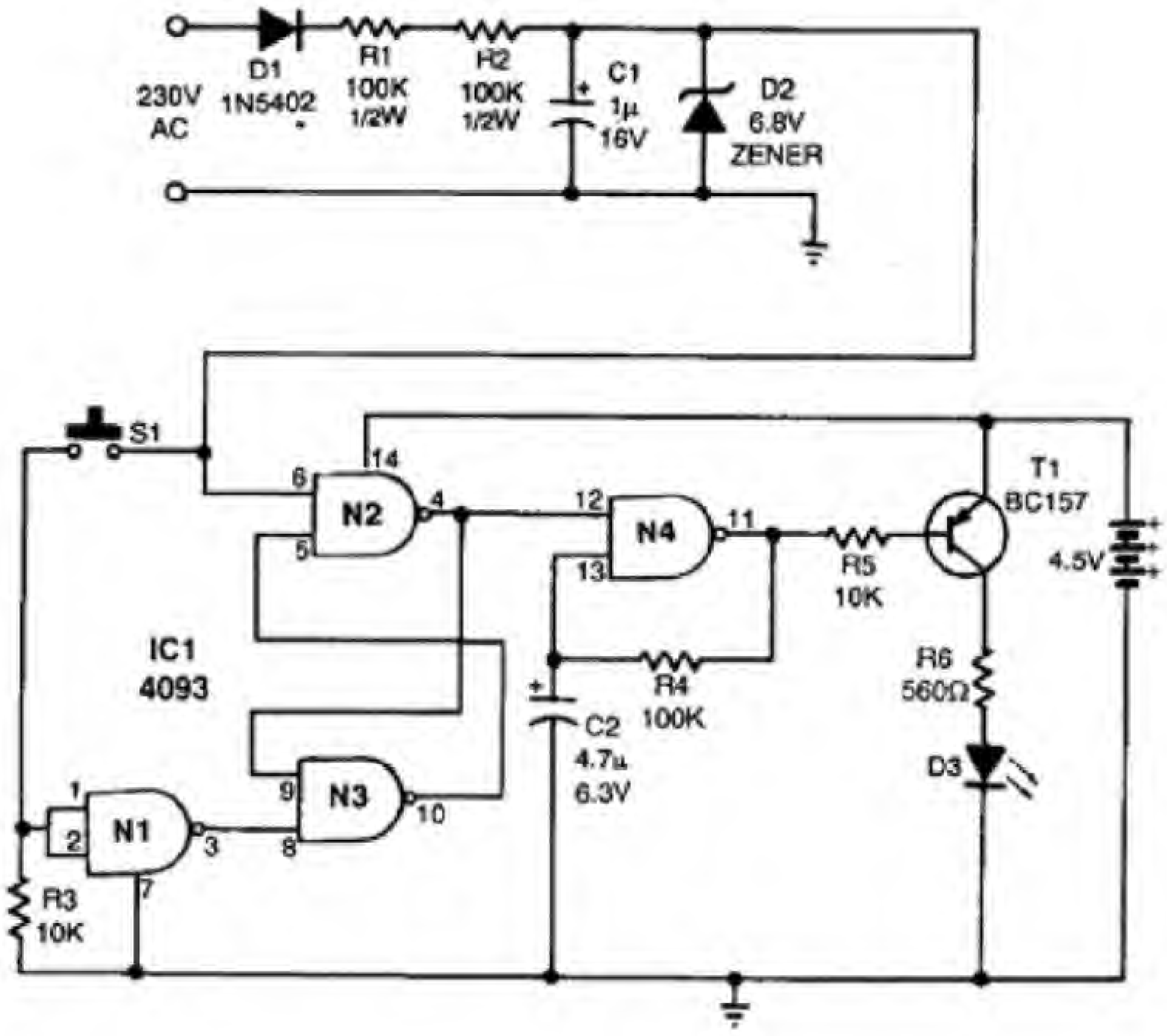
K.M. Reddy

This circuit can be used in applications where it is necessary to know whether the mains supply has been continuous or not. This circuit will be useful for monitoring mains supplies to recording equipment, especially in the recording of computer software tapes, where the slightest interruption in the mains supply will cause an error in the data being recorded. It can also be used with digital clocks working on mains. An interruption in the mains supply will cause an LED to flash as a warning that the mains supply was interrupted.

The circuit is very simple and straightforward as it is based on just one CMOS IC. IC1 contains four NAND schmitt trigger gates. This IC has been chosen to keep the current consumption and component count to a minimum.

N1 has been wired as an inverter with its input connected to the reset switch. The reset switch will operate only when the mains supply is present. N2 and N3 form a simple S-R latch.

One of the inputs of N2 has been connected to the low voltage DC supply derived from the mains. The output of the latch is connected to the



oscillator formed by N4. The output of the oscillator has been connected to an LED. The LED and IC are powered off a 4.5V supply derived from three 1.5V cells.

The oscillator is enabled whenever the input of N2 is low, i.e. the mains supply is absent, causing the LED to flash. The LED continues to flash even after the mains supply has resumed until the reset button is pressed.

The circuit may be assembled on a general-purpose PCB. Care should be taken while testing the circuit as many parts of the circuit are at mains potential. If an audible alarm is desired, the LED can be replaced by a buzzer after making suitable changes in the value of R6.

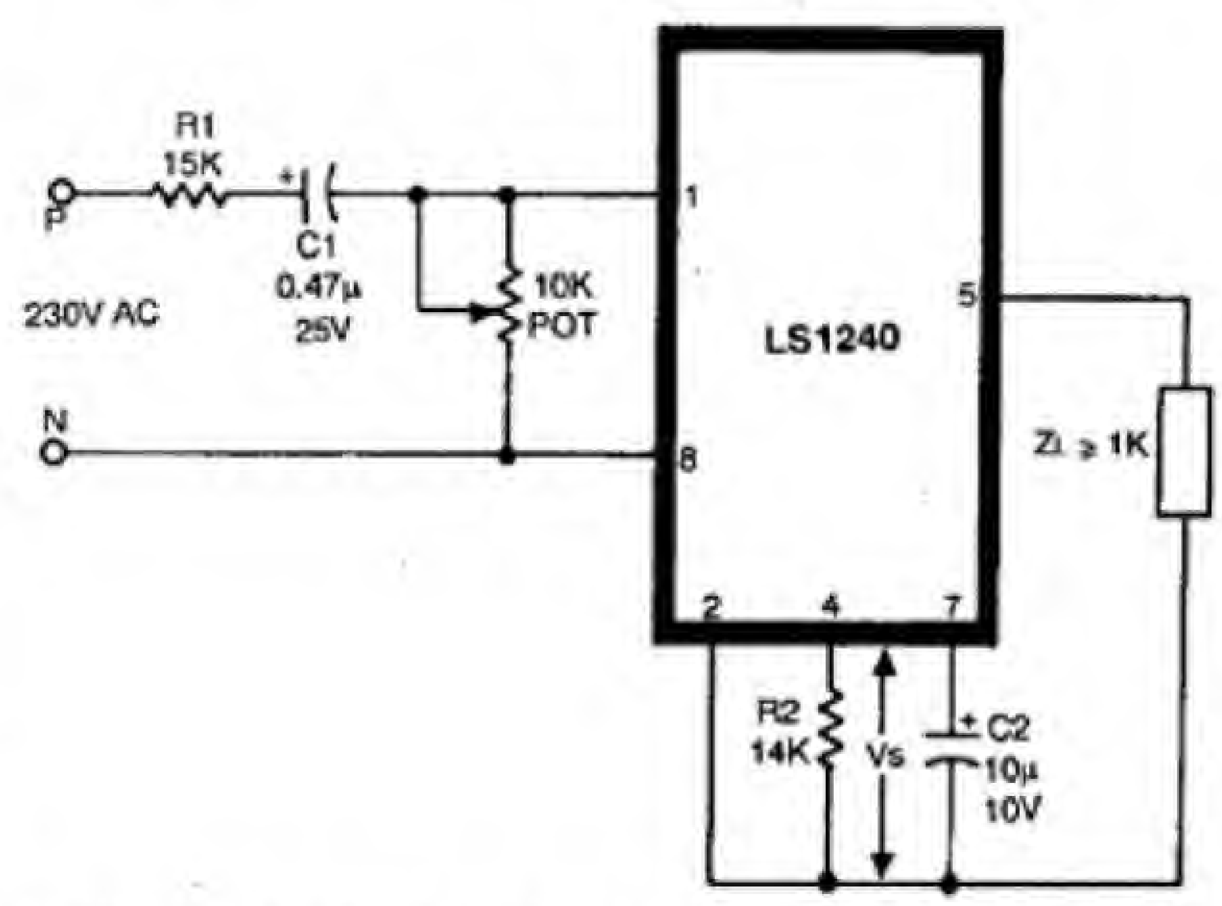
Single Chip Crossover Detector For Line Over-Voltage

J. Jayasankar

Here is a circuit which can give audible indication when the mains line voltage exceeds a particular level. It is based on dual tone ringer telecom chip LS1240 (SGS).

AC voltage can be applied across pins 1 and 8 of the chip as shown. A built-in rectifier bridge within the chip provides DC voltage (V_S) across terminals 7 and 2. The 10µF capacitor filters out ripples.

The voltage V_S should not exceed 26V DC which is the maximum guaranteed rating of the IC. A load of not less than 1k impedance has to be connected between pins 5 and 2 for an audible tone. Hence the load should be either a piezo-ceramic buzzer directly connected across pins 5 and 2 or a dynamic speaker across the same pins, in which case an output transformer is necessary for impedance matching.



To get dual tone like that of a telephone ringing, a 100nF capacitor between pins 3 and 2 can be connected. Once oscillations start, note that the output will be sustained as long as V_S remains above 8.2V.

The RC combination at the input must be set such that the chip develops activation voltage when the line voltage just crosses the expected limit.

The circuit can also be used as a doorbell.

Electronic Car Horn

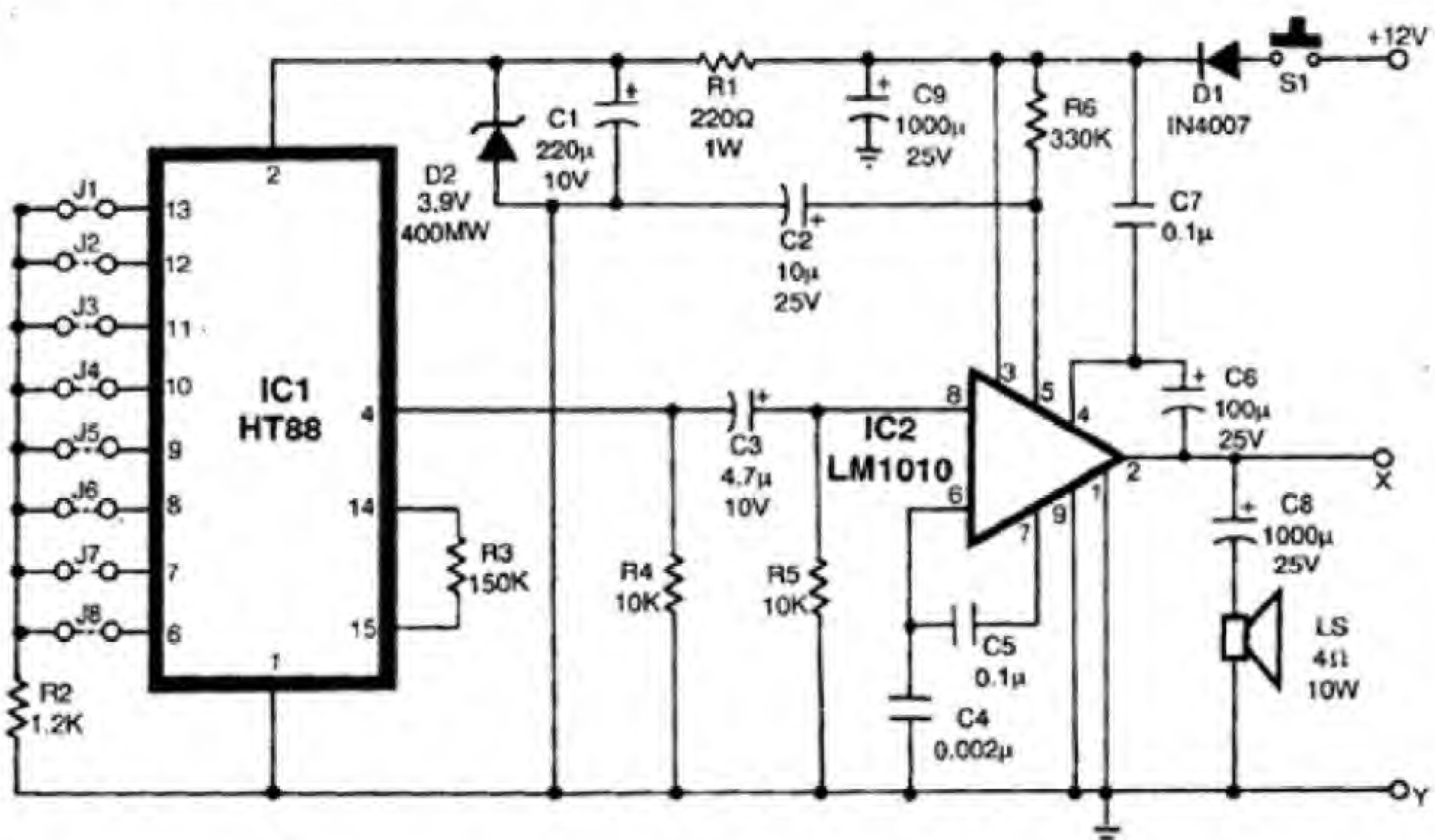
Amrit Bir Tiwana

This circuit for a modular electronic horn is primarily designed for use in cars. It delivers up to 10W of musical output power. The horn can produce many types of (preselectable) sound effects ranging from simple automatic rise and fall siren sounds (three types) and dual tone melodies/ bi-tonal sounds to complex bombing and ringing sounds.

The module can effectively be used as a normal doorbell or with an alarm clock as well. Modular construction ensures reliable operation and is flexible enough to operate off supply voltages ranging from 6V to 18V DC.

IC1, an HT88 music synthesiser ROM, forms the heart of the circuit. Available in an 18-pin DIL package, this IC is a monolithic LSI chip which, in addition to the masked sound effects, contains an on-chip oscillator, a preamp, envelope etc. A particular tune can be accessed by bringing the corresponding control input at logic 0. R1-D2 step down the 12V supply to about 3.9V for IC1.

The output of IC1 is fed to IC2 (LM1010) around which the amplifier section is built. Available in a 9-pin DIL package, LM1010 can deliver up to 10W to a 4-ohm speaker. C3 and C8 act as the input and output coupling capacitors, respectively. C1 and C9 are the supply decoupling capacitors.



The horn module can operate off voltages between 6V and 18V. When used as a car horn, it may be directly powered by the 12V car battery. If used with a scooter or any other vehicle having an AC power supply system, a simple full-wave bridge rectifier filter network may be used. In some cases, reverse polarity protection prevention diode D1 may be sufficient.

The module should be fitted at any convenient place, away from the heat of the engine (in case it is used in a car). A suitable weather-proof speaker should be used with the unit. It can be mounted on the top of the car's bonnet. If wired as a reverse horn, wiring should be through the brake switch instead of the main horn switch.

The complete horn would cost around Rs 65.

Readers' comments:

The circuit idea for 'Electronic Car Horn' in EFY Feb'91 issue by Mr Amrit Bir Tiwana is very interesting. But I have a few queries.

What is the significance of X and Y markings across the output terminals? What is the cost of IC HT88 and from where I can obtain this IC? Can I replace LM1010 amplifier circuit with other power amplifiers (eg. TBA810) operating on 12-volt supply?

PRADEEP G.
Alleppey

The author, Mr Amrit Bir Tiwana, replies:

HT88 is available for Rs 35 from Gala Electronics, 20 Kalpana Building, 357 Lamington Road, Bombay. LM1010 is compatible with TDA1010, SG1010 and TDA1010A. To replace it with a TBA810, the readers may refer to a UM66 based horn article published in EFY Aug'89 issue (by Mr Pradeep G.). This would however mean lower volume and lesser audibility.

Point 'X' is in fact at the C3-R5 junction and this is where an equivalent amp should be connected to replace IC2, if so desired.

Small weather-proof speakers (cheapest range) are horn, shaped speakers that cost about Rs 30. These are available in most cities easily and through most mail order firms that advertise in EFY.

Indicator Bell

S. Vadivazagan and
S. Rajmohan

Here is a simple circuit which indicates 'IN' when the door in not locked and 'OUT' when locked if the calling bell is pressed. The working of the circuit is simple.

When the door is not locked, the supply is through the N/C contact and the circuit indicates 'IN'. When the door is locked the relay operates the N/O contact close and indicates 'OUT'.

The main connection of this circuit is the lock connection (Fig. 1). Two pieces of flexible flexible metal plates (from condemned flexible metre tape or from spectacles cover or two wires insulated properly) are fixed in the door framed as shown and the wires soldered. When the door is locked, the flexible plates bend inwards and the circuit is completed via the tongue of the lock.

To indicate 'IN' and 'OUT', 14 LEDs are soldered easily on a vero board (as O, U, T, I and N) and mounted outside the door (Fig. 2). This costs only about Rs 14 compared to the five 7-segment displays which cost a lot.

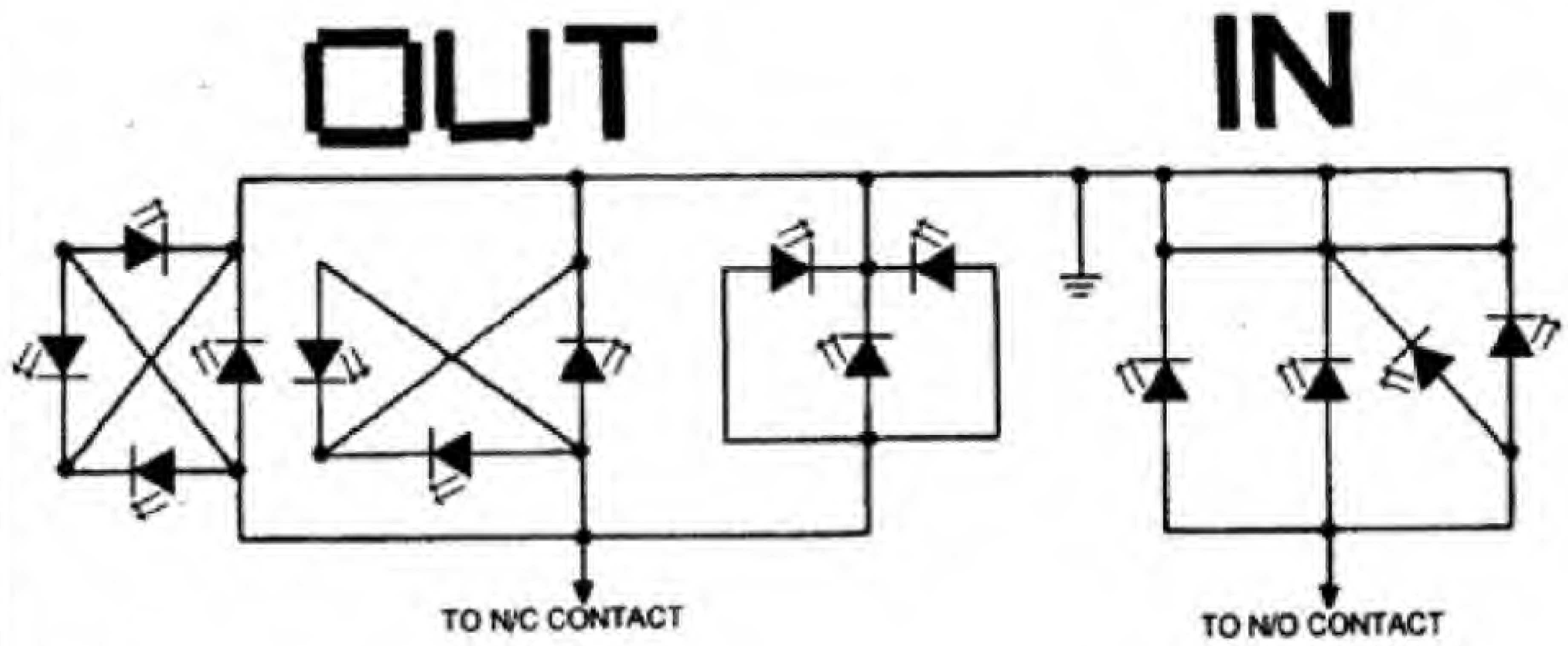


Fig. 2

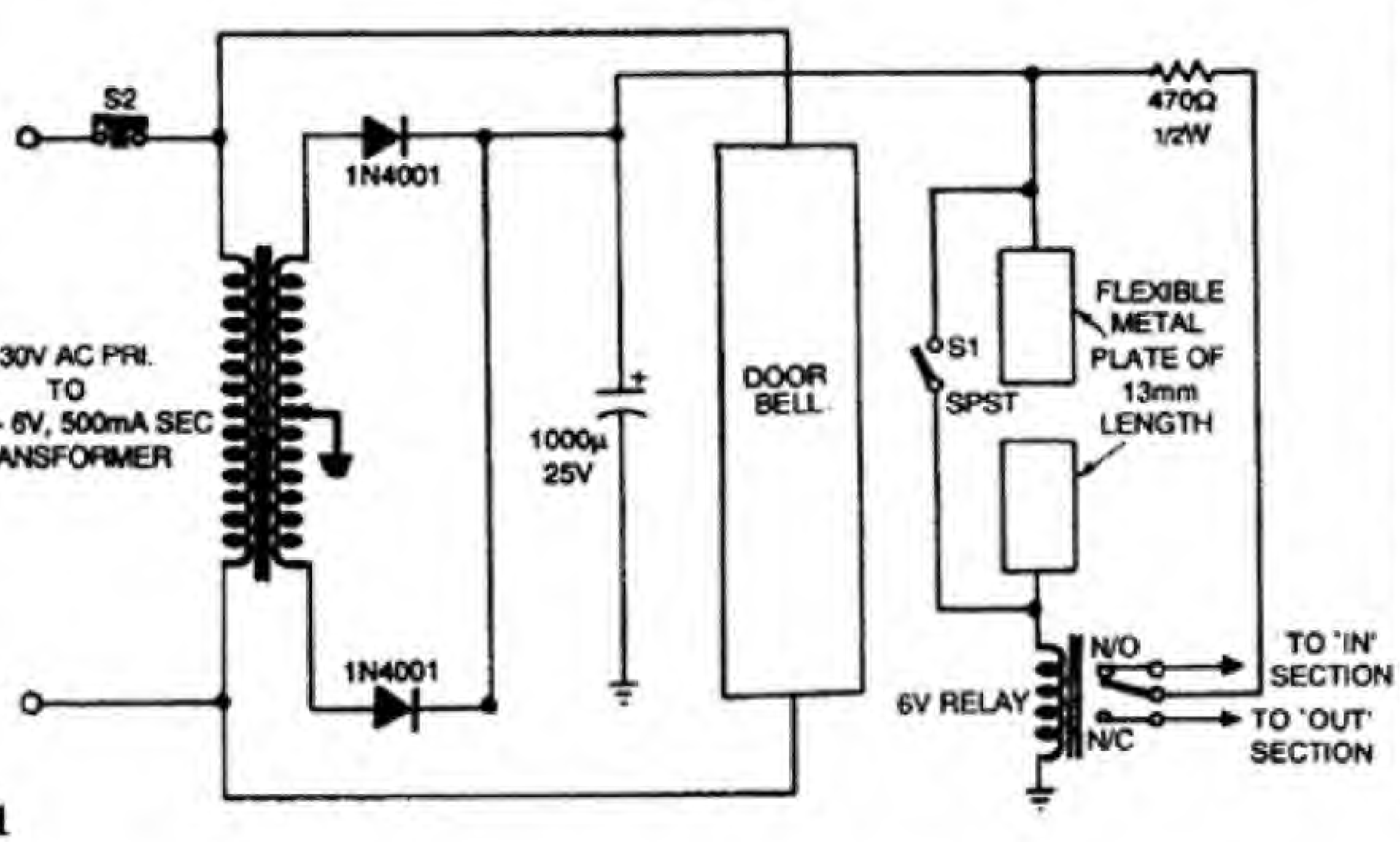


Fig. 1

Readers' comments:

The indicator Bell Circuits is very good but can it be ensured that the bell doesn't work when the user is 'out' and that is rings only when he is 'in'?

A. NAGA BABU
Rajahmundry

The co-author, S. Vadivazagan, replies:

Mr Naga Babu's suggestion can be accomplished easily by using another set of contracts available in the relay. The bell connection, instead of going directly, can be given via N/C section, so that when 'on' is indicated the bell works but when 'out' indication appears, the N/C contracts being open, the bell doesn't ring.

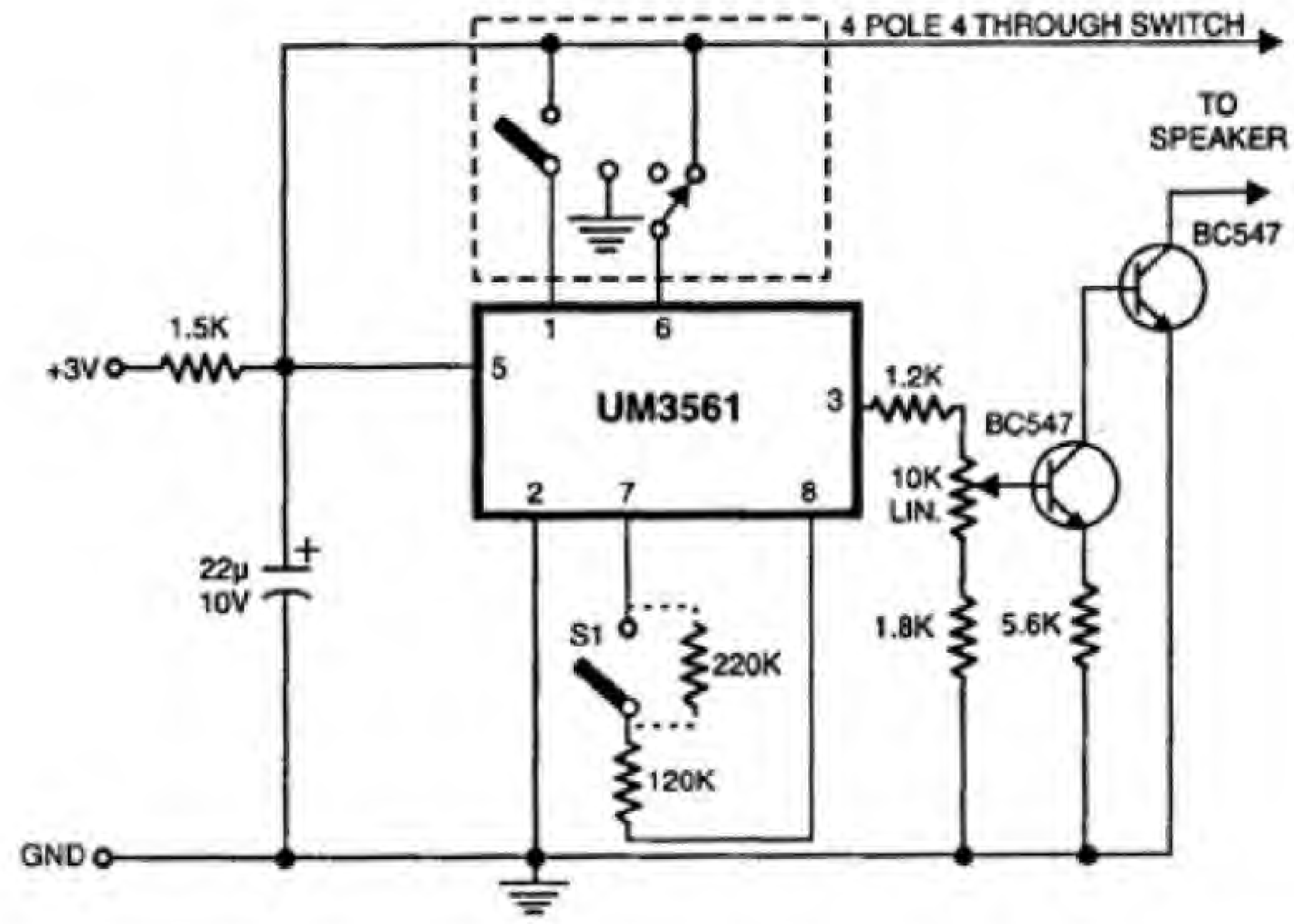
Multi-Tone Generator

Kamal Wason

The circuit described here generates eight types of tones which are divided by two channels. Each channel contains four tones. The volume is controlled by a 10k on-off volume control.

The heart of the circuit is IC UM3561 which is a tone generator. The output of the IC is given to transistor BC547 for amplification. The amplified signals are then passed to the transistor BC547. BC547 acts as a driver transistor for another BC547. Selection of beats is done by switches S1 and S2. The circuit works on +3V battery.

The cost of the circuit is approximately Rs 50 without speaker and power supply. The different tones produced are bell, ambulance siren, whistle, machine gun sound, jingle, police siren, birds and dual sound.



AM Transmitter

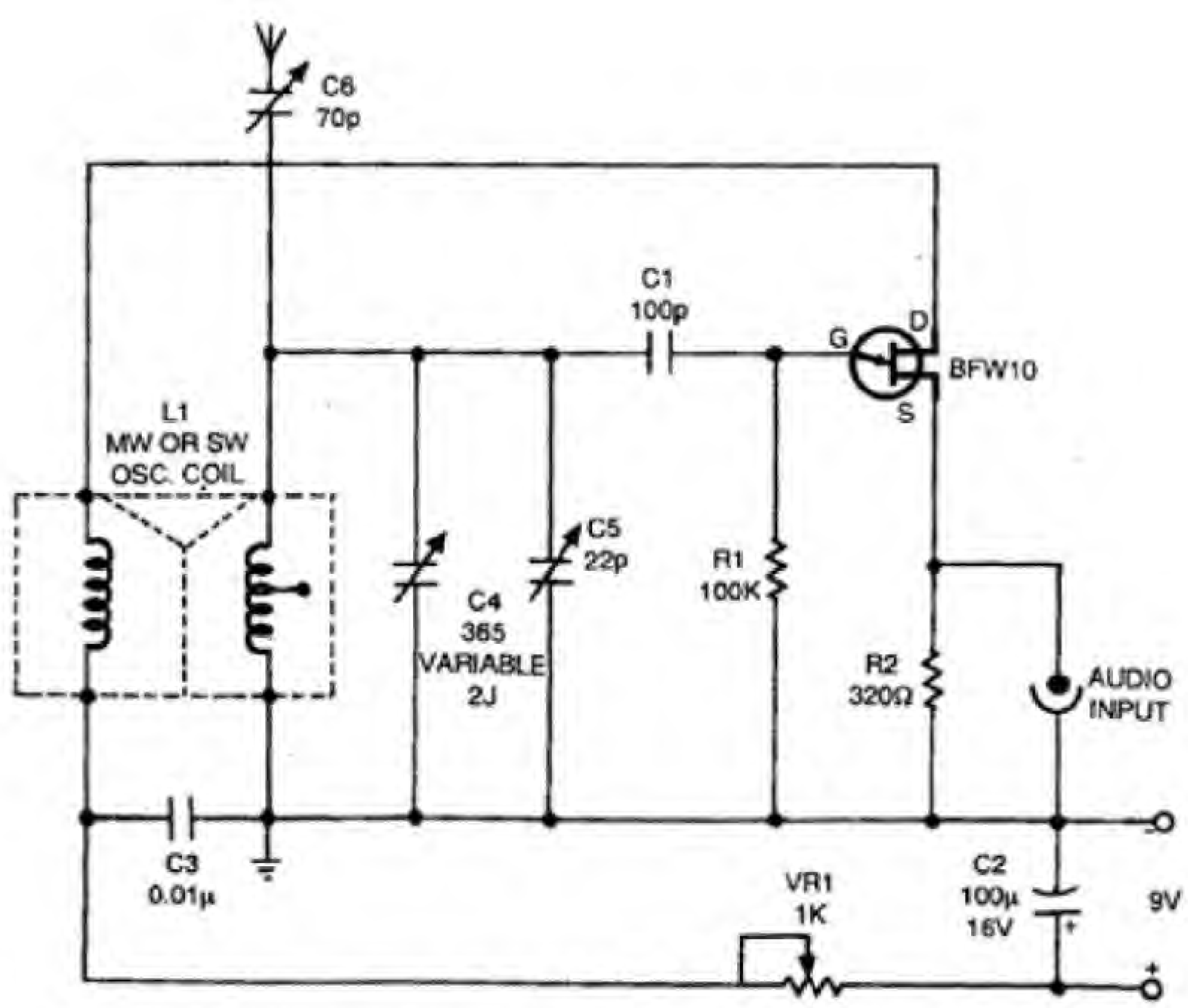
S. Sounderrajan

This is a low-cost, good-stability RF transmitter which uses only one FET. The heart of this transmitter is a FET BFW10 which works as a trickler feedback oscillator. The frequency of the RF signal can be determined by the oscillator coil L1 and variable capacitor C4.

The audio signal from an amplifier or any audio device such as cassette player, organ, TV etc whose output impedance is 4 ohms to 16 ohms is fed to the source of FET.

The amplitude of the RF wave can be varied by 1k preset VR1. The frequency adjustments are made through the coil and capacitors C4 and C5. The output of the transmitter is taken through trimmer C6 to a telescopic or indoor wire antenna.

Turn the radio receiver to the transmitter carrier frequency and adjust the volume control of audio input device, VR1 and C6 to get clear undistorted sound in the radio receiver as well to achieve better modulation percentage.

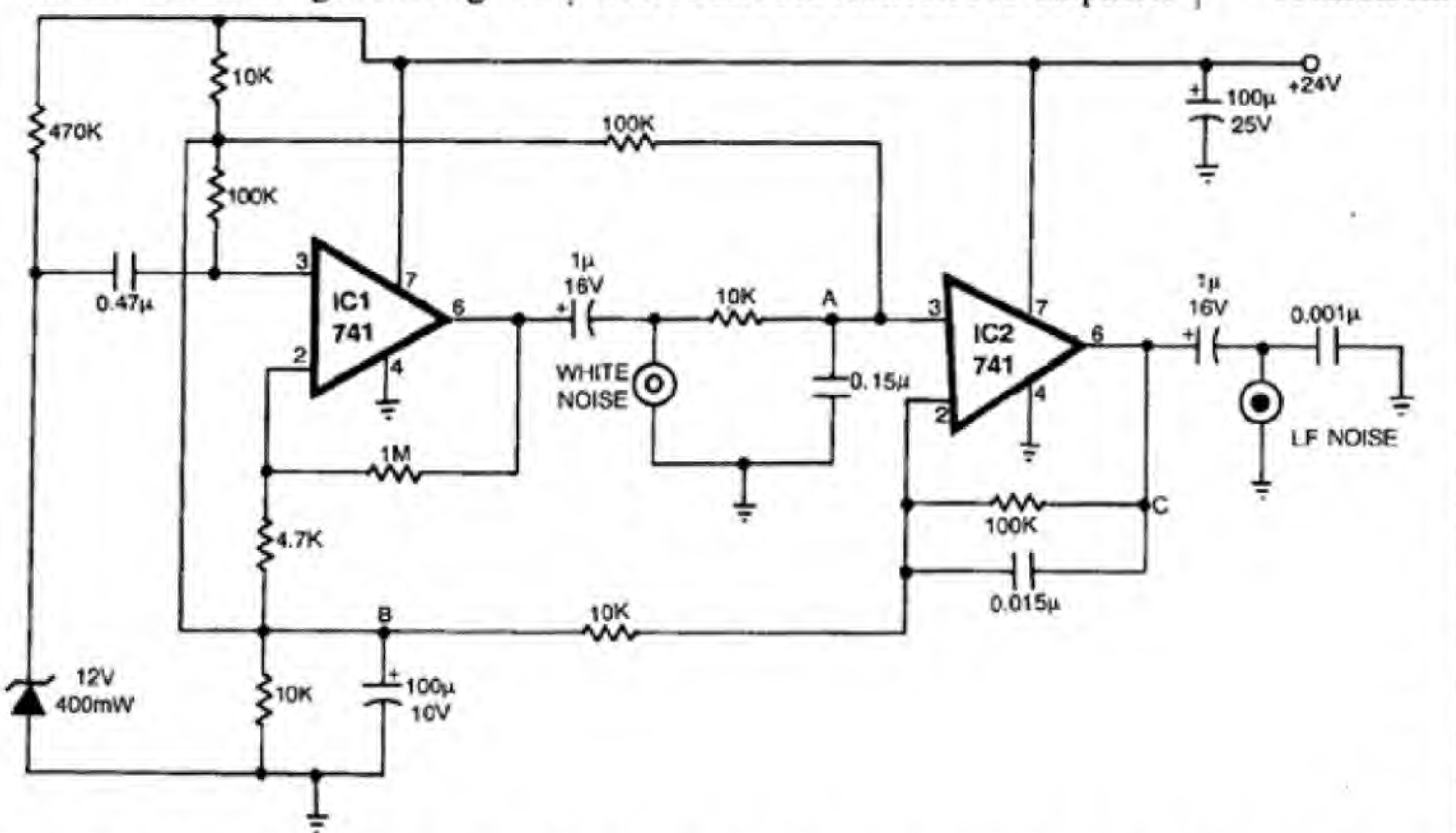


White/LF Noise Generator

C. Sanjay

Every musician today is in need of a noise source, particularly those who practice with a group or use a synthesiser.

This white noise generator gives



an output to be fed to an amplifier. The white noise generated by the 12V zener diode is amplified 200 times along with the noise of the 'noisy' 741 IC. The output is thus very 'noisy' with plenty of white noise.

The output of IC1 is given to a low-pass filter which cuts off high frequencies. Point A is connected to amplifier IC2. The feedback network of IC2 includes a 0.15µ capacitor which reduces the gain at high frequencies.

The 0.001µF capacitor at the output of IC2 also loads the output at high frequencies and reduces them. Thus the resultant output has a large amount of low frequency (LF) noise.

A small amount of white noise due to the IC itself is produced at the output, but it can be ignored. Point B is an artificial centre point created for IC1 and IC2. Point C is connected to the capacitor which reduces the gain of IC2 at high frequencies.

The power supply can be taken from a 12-0-12V, 100mA transformer. The outputs of this generator must be given to an amplifier as these are not sufficient to drive a loudspeaker.

This circuit costs around Rs 50 excluding the power supply.

Indoor Advertising Board

B. Ravi Prasad

This is a simple circuit to display a one-word or one-sentence message for advertising purposes. Although it is not microprocessor based, it is a moving display which attracts attention. It works on a power supply of +5V and +12V. While the unit has been designed as an indoor advertising board, with simple modifications it can also be used for outdoors.

The main part of the circuit is IC 74HCT164, a shift register (Fig. 1). It shifts the input data from one pin to next for every clock pulse. The clock pulses are produced by NOT schmitt triggered gates. The pulse width of this astable multivibrator is given by

T=T1+T2=1.4RC.

One 74HCT164 IC can accommodate up to eight characters. If the length of the word or sentence is more than eight characters, cascade configuration can be used. Cascade configuration for two or more ICs is

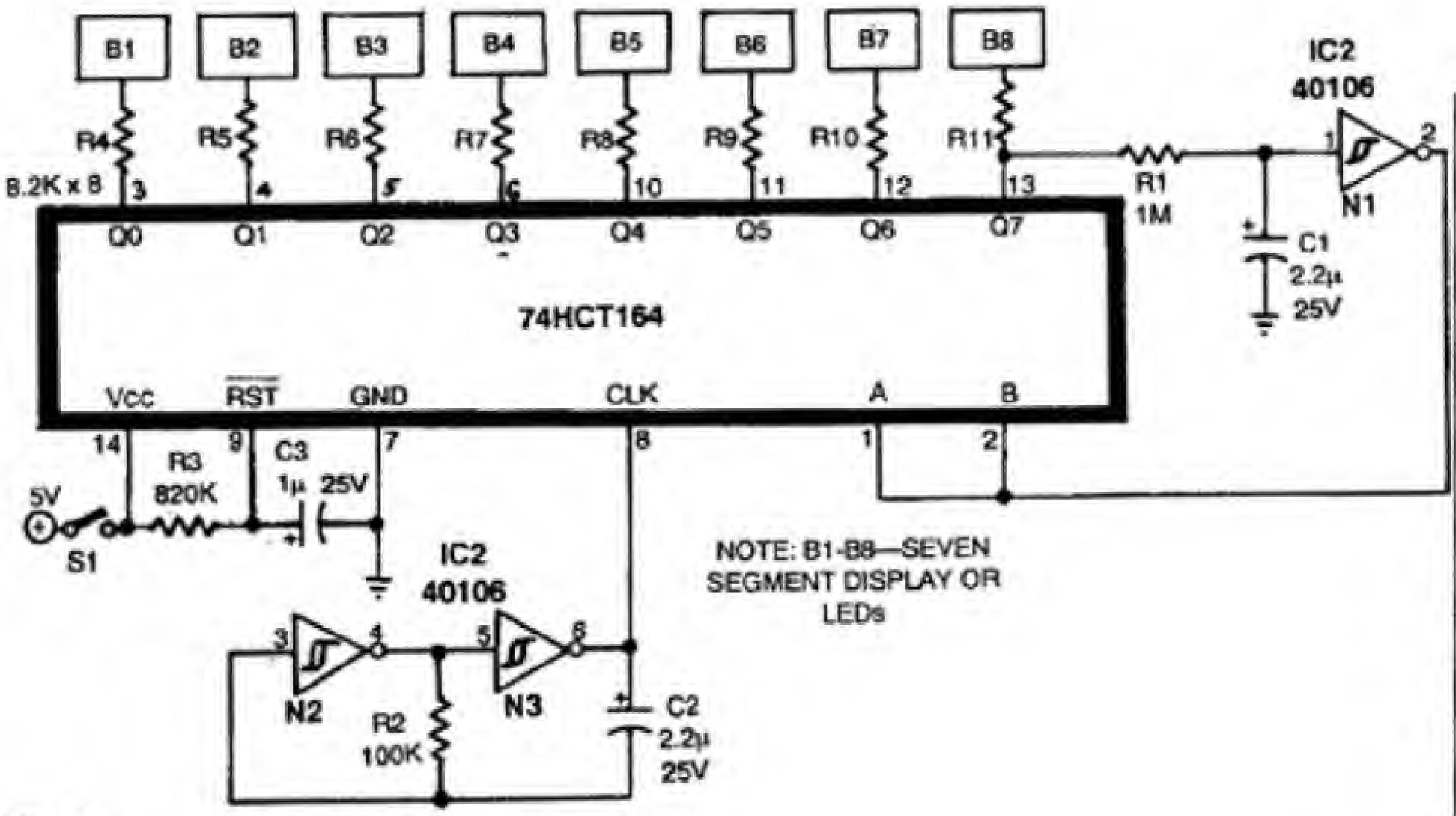


Fig. 1

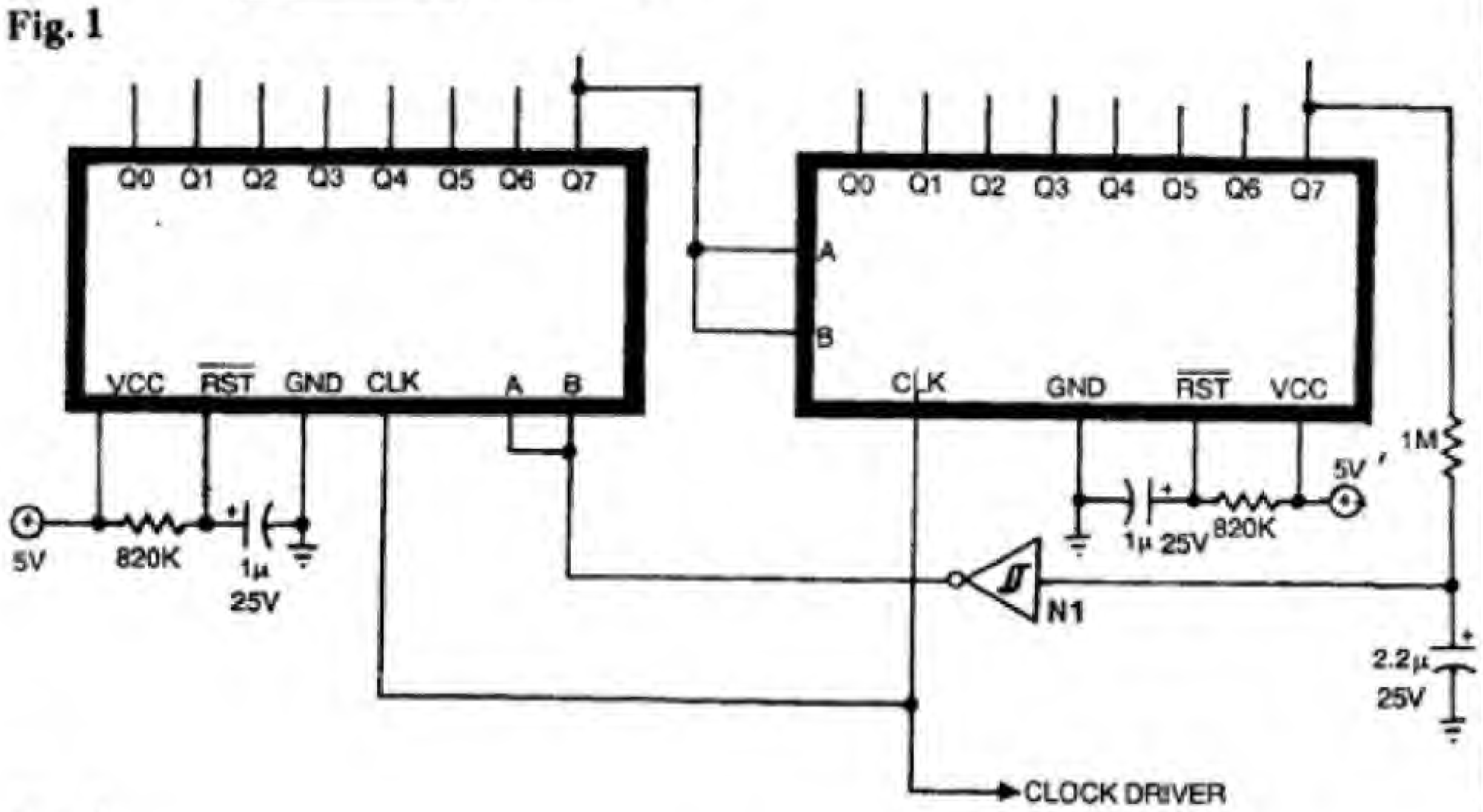


Fig. 2

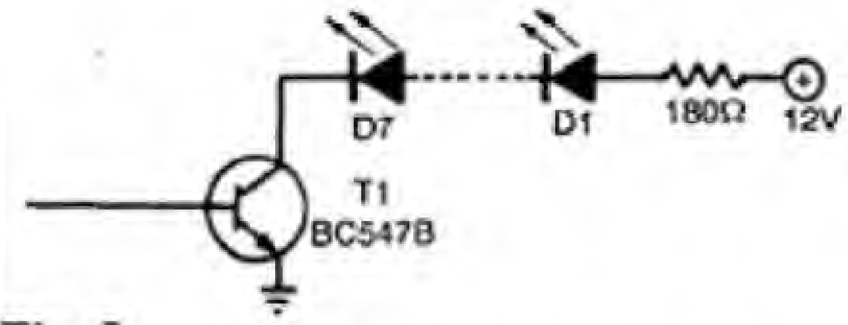


Fig. 3

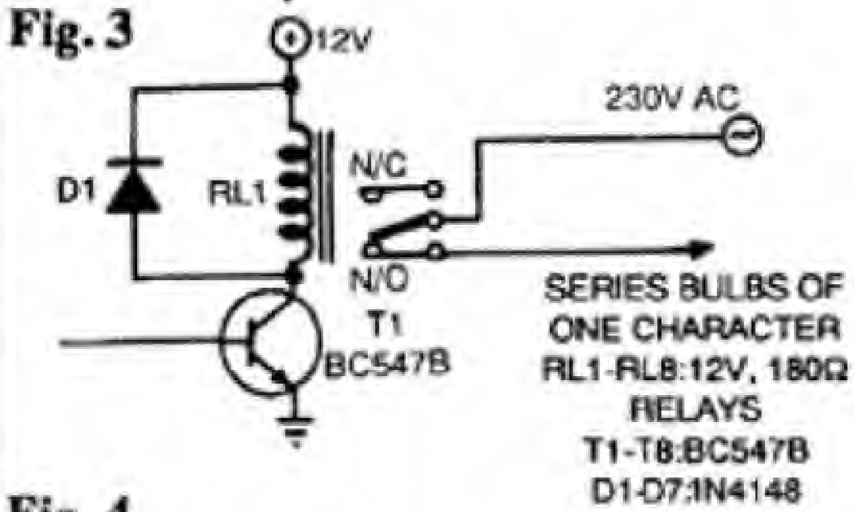


Fig. 4

shown in Fig. 2. Seven-segment LED displays or LEDs can be used to display the advertisement. By connecting relays in place of LED block, it can also be converted into an outdoor advertising board. Relays are used to control the series bulbs which are connected to the mains supply.

By closing switch S1, the IC is reset so that it is ready to shift date. Initially pin Q7 is at logic low. This is inverted by gate N1, and this logic high is applied to the input pins. By applying the clock pulses simultaneously, the date is shifted from Q0 to Q7. As long as the date reaches pin Q7, i.e. logic high, capacitor C1 charges through resistor R1. After some time delay, gate N1 toggles so that it goes to its previous state of 0, i.e. logic low. Hence, the input at pins A and B is low.

By applying the clock pulses, this low date is shifted from Q0 to Q7, i.e. the transistor connected to that particular pin is turned off. Table I illustrates the switching procedure.

In this manner, advertising is continuously visible. The series resistance R_{se} should be changed in accordance with the number of LEDs. Fig. 3 shows the indoor circuit, while Fig. 4 illustrates how the circuit can be converted into an outdoor unit. Diodes D1-D7 protect the relays from reverse emf generated during the operation of the relays.

The only major disadvantage is that the unit cannot display various advertisements simultaneously as it is designed for only one advertisement at a time. The width of the clock pulse may be altered as required.

TABLE I

Number of clock pulses	Date input	Pins at logic high
0	1	No pin
1	1	Q0
2	1	Q0, Q1
3	1	Q0, Q1, Q2
4	1	Q0, Q1, Q2, Q3
5	1	Q0, Q1, Q2, Q3, Q4
6	1	Q0, Q1, Q2, Q3, Q4, Q5
7	1	Q0, Q1, Q2, Q3, Q4, Q5, Q6
8	1	Q0, Q1, Q2, Q3, Q4, Q5, Q6, Q7
After some time delay		
1	0	Q1, Q2, Q3, Q4, Q5, Q6, Q7
2	0	Q2, Q3, Q4, Q5, Q6, Q7
3	0	Q3, Q4, Q5, Q6, Q7
4	0	Q4, Q5, Q6, Q7
5	0	Q5, Q6, Q7
6	0	Q6, Q7
7	0	Q7
8	0	Nil
After some time delay		
1	1	Q0
2	1	Q0, Q1
3	1	Q0, Q1, Q2
:	:	continues

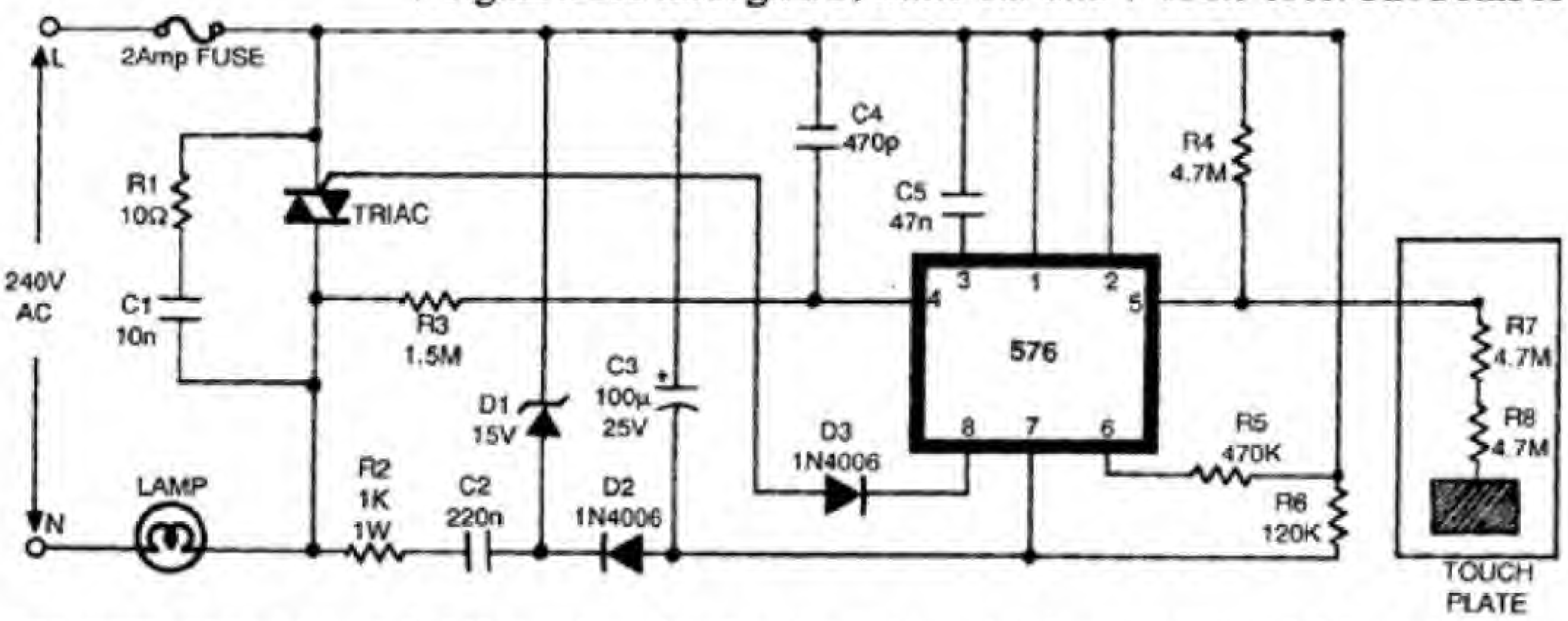
Simple Touch Dimmer Using Triacs

R.S. Krishnan

Firing a triac could never be simpler! The heart of this touch dimmer is the S576 which provides an uncomplicated and elegant method to fire the triac.

The IC is not very sensitive to power glitches and works on the 15V dropped by R2 and C2. Zener D1 clamps the voltage at 15V, while D2 and C3 smoothen the supply. Interference is reduced by the RC snubber. Resistors R7 and R8 are necessary and provide the touch plate. The triac firing signal is fed through D3, while R3 and C4 synchronise the circuit to mains frequency.

When the touch plate is touched briefly for 50-400ms, the lamp or load toggles between on and off. When the plate is touched for longer periods, the load (i.e. the lamp) cycles between maximum and minimum power in a period of 6.5 secs. The 50ms lower limit is set to avoid false triggering by picking up interference. The circuit can handle any amount of non-inductive power if the amperage of the triac is changed.



Charging Reminder for Emergency Lights

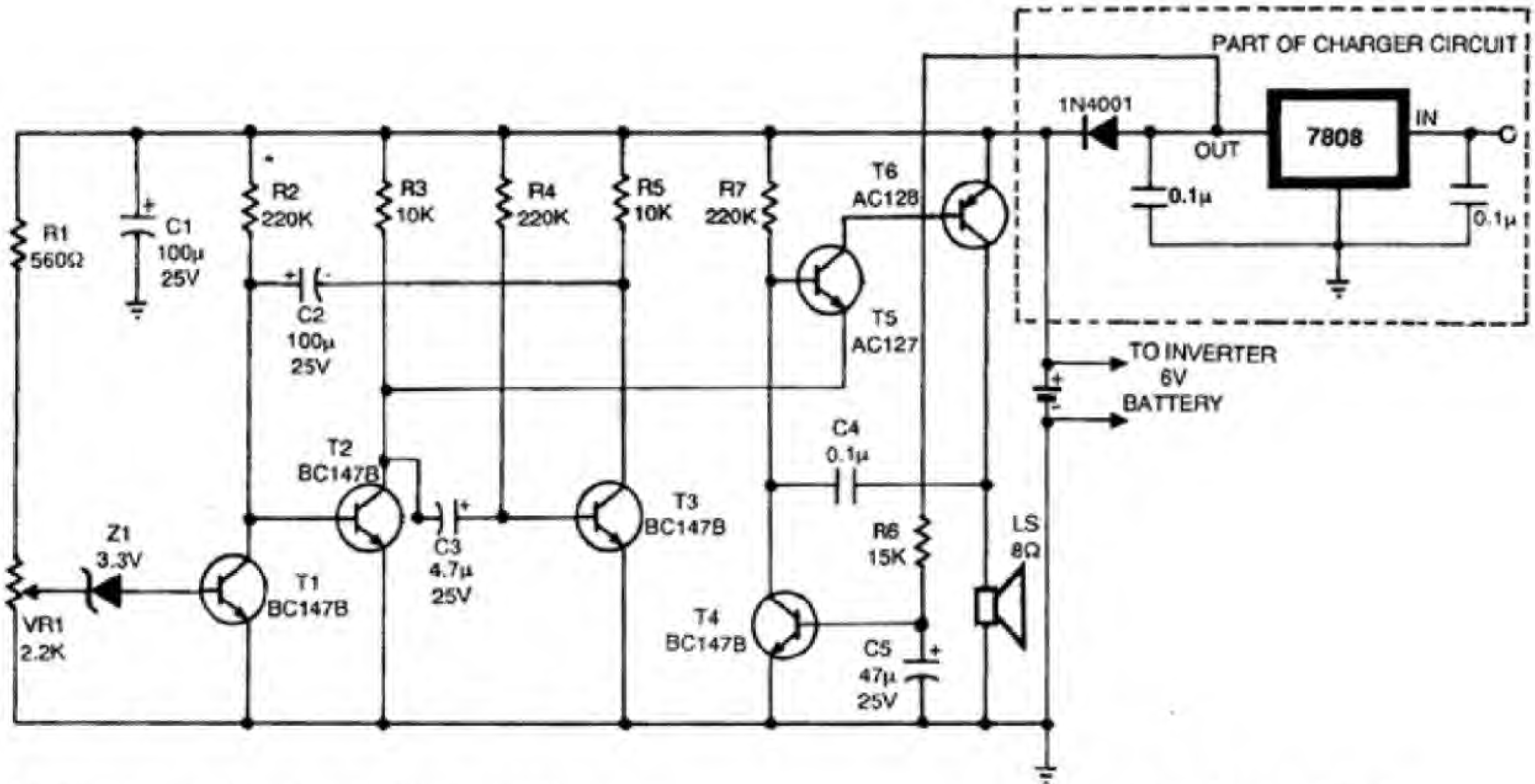
M.S. Nagraj

Emergency light comes to the rescue of its user whenever there is power failure or power shut-down. However, when the power supply is regular, the user has a tendency to disregard the need to recharge the batteries of the emergency light. Even when not put to use, the battery will discharge itself.

When the battery is kept in the discharged state for a long period, an irreversible chemical reaction takes place reducing the capacity of the battery so that eventually the battery becomes useless. No protection circuit can stop self-discharge of the battery and only trickle charging can compensate for it.

Here is a circuit to inform the user that the battery has discharged itself below the safe level. The discharge characteristics of a dry battery, as supplied by its manufacturer, indicate that the battery should not be discharged below a level of 1.7V per cell. This circuit is developed to give an audio alarm for about one second after a gap of about 30 seconds when the battery voltage falls below 5.1V. This kind of discontinuous alarm is not annoying and yet can catch the attention of the user.

Transistors T5 and T6 along with R7 and C4 form an audio oscillator for driving a miniature speaker. This oscillator is enabled for a period of about 1 second and disabled for 30 seconds by the output of the astable multivibrator formed by transistors T2 and T3 along with C2, C3, R2, R3,



R4 and R5. Transistor T1 along with R1, VR1 and Z1 form level detector to sense the battery voltage.

When the emergency light is plugged into the mains supply, the battery charger drives a current into the base of transistor T4 via R6. The saturated transistor T4 pulls down the base of transistor T5 and disables the audio oscillator.

While testing, this alarm circuit was found to work for a battery voltage as low as 1.3V. When the oscillator is enabled, the current drawn by the circuit is about 25 mA at a battery voltage of 4V. As the oscillator is enabled only for 1 second in every 30 seconds, the loading effect of this circuit on the battery is negligible.

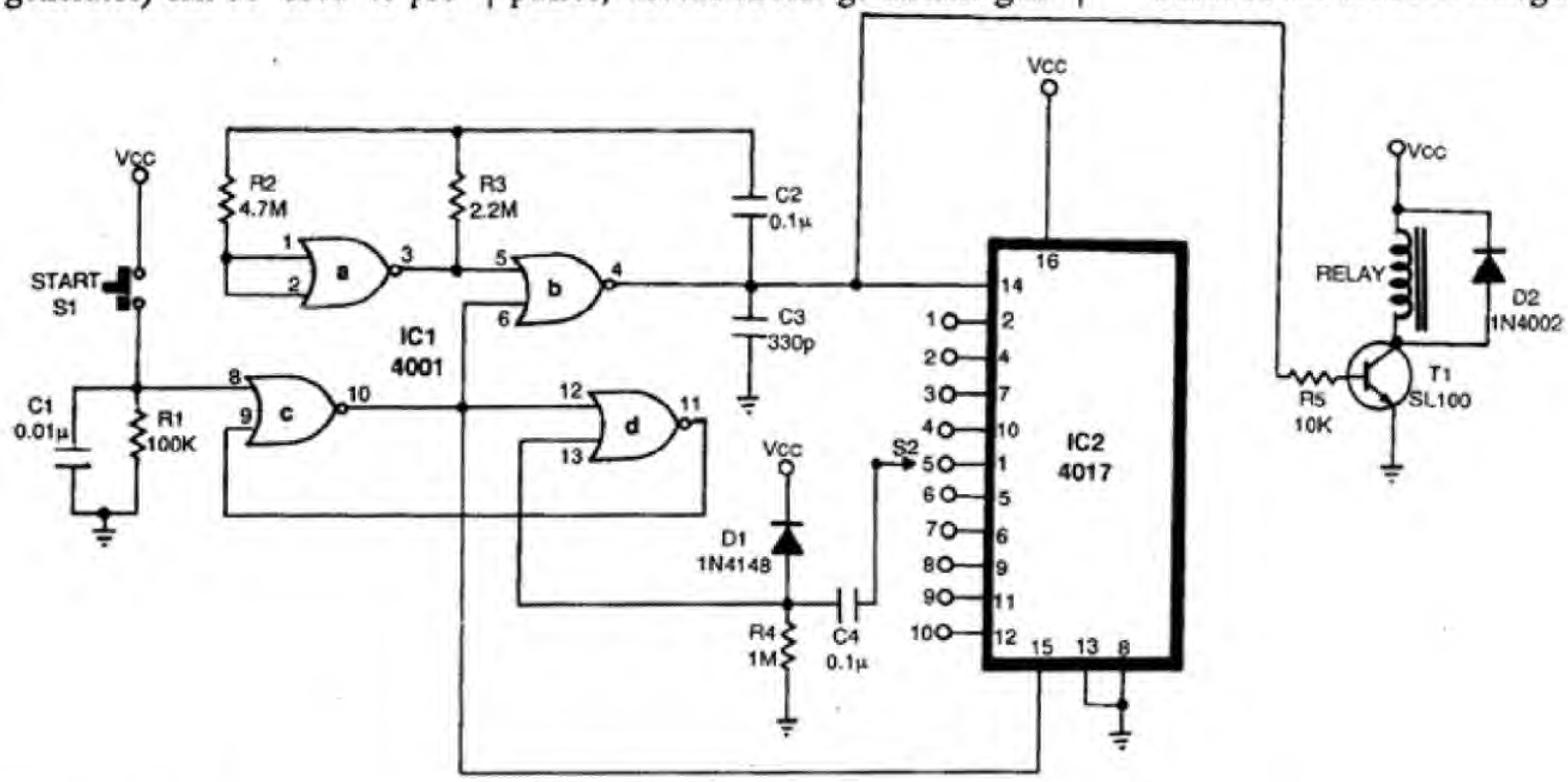
For testing and calibrating the alarm circuit, disconnect it from the charger and replace the battery by a variable DC supply. Adjust preset VR1 such that the audio oscillator is disabled for DC supply voltages of 5.1V and above. Reconnect battery and the charger. The circuit is now ready for use.

1 To 10 Pulses From 4017 Counter

M.V.S. Sharma

The 4017 counter (programmable pulse generator) can be used to program pulses from 1 to 9, viz, nine pulses, but the circuit given here generates up to 10 pulses.

Gates A and B of IC1 will generate



pulses when pin 6 is low. Gates C and D form an R-S flip-flop. Capacitor C3 ensures that any spikes on the generated pulses are removed. Pushbutton S1 gives the start signal.

IC2 counts trailing edge of the pulses at pin 14. Outputs 1 to 9 and carry are wired on a 10-way switch S2. The output of S2 can thus be selected. This pulse is differentiated by C4, R4 and diode D1.

The processed pulse is now applied to pin 13 of IC1. This will reset the flip-flop and stop the clock generator taking pin 6 high. It also resets the counter at pin 15.

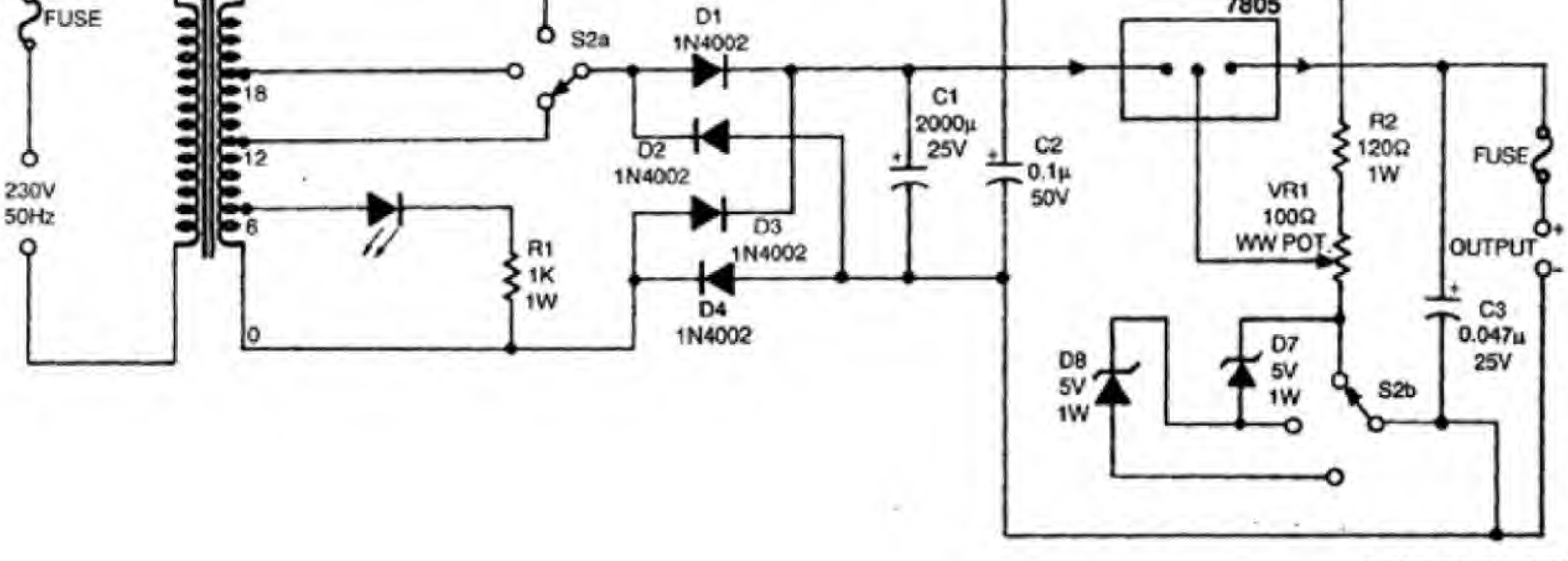
The output at pin 4 of IC1 will drive a relay through transistor T1. The contact of the relay can be used for outputing the pulses. Suitable spark quench may be wired across the contact to avoid contact errosion while driving heavy currents.

5V to 20V Regulated Power Supply

Dinakar Shastry

This power supply unit uses 5V fixed voltage regulator IC 7805. By continuously adjusting the potential at centre pin of the IC (i.e. ground pin), a continuously variable output voltage is achieved. Switch S2 is employed to keep the minimum dissipation in the IC at low voltage outputs.

In the first position of S2a, only 12V is used to supply a continuously variable 5V to 10V. In second position, 18V is used to supply 10V to 15V. This is achieved by using a 5V zener in series with the ground pin. In third position, 24V is used to supply 15V to



20V.

The transformer used is input power amplifier transformer with 12-6-0-6-12 windings. The rating of the transformer is 24VA. If the body of IC is connected to the body of the power supply unit so that the latter acts as a heatsink, care should be taken to avoid direct contact of negative supply with the body. This is because the body will always be at 5V less potential than the ouptut in such cases.

This circuit offers very good line and load regulation. Due to minimal dissipation, only a small heatsink is sufficient.

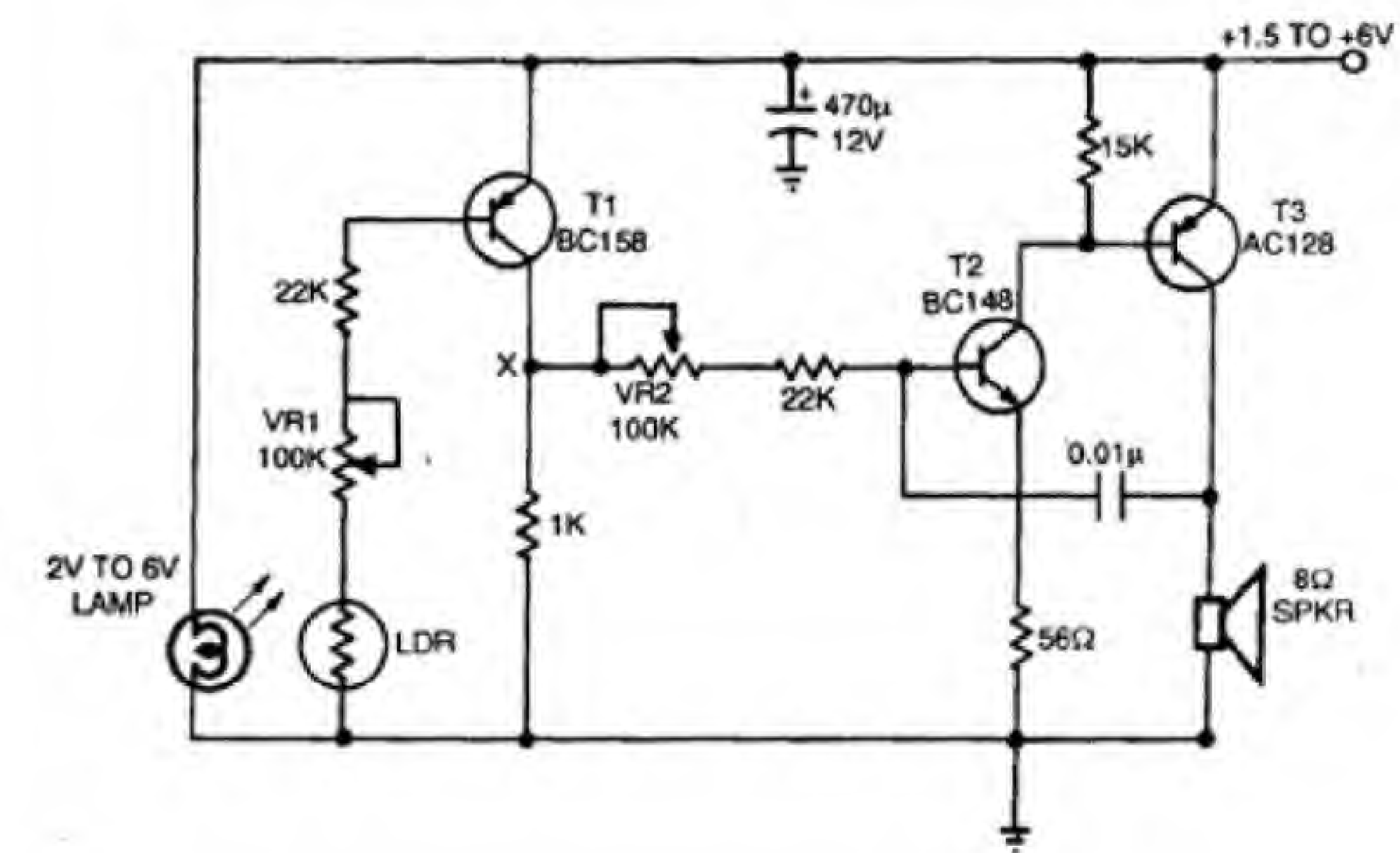
Smoke Alarm

Pradeep G.

The circuit shown here can be used very effectively as a professional smoke alarm.

It employs three general-purpose transistors. These transistors can be easily replaced with their near equivalents. The circuit wired around transistors T2 and T3 is the most popular AF oscillator using a complementary pair of transistors. But the base bias of T2 is not directly from positive line. The base bias resistor is connected to the collector of the pnp transistor T1 as shown.

The only precaution to be taken for this circuit is that the bulb should be directed towards the LDR. When the high intensity light from the bulb falls on the LDR, the conduction of T1 will be maximum and the circuit will be quiet. But when smoke is present between lamp and the LDR, the intensity of light decreases and the alarm is activated. An 8-ohm, 10cm loudspeaker emits comparatively loud sound. So there is no need of an extra amplifier.



This circuit will be quiet at high intensity or very low intensity of light. For proper results, adjust the distance and position of lamp and LDR.

Adjust VR2 slowly where the circuit just generates sound so that at low values of VR2, the circuit does not emit sound. When smoke appears between lamp and LDR, the resistance of LDR is decreased along with the voltage at point X and the alarm sounds. In the absence of smoke, the positive voltage at point X is high. Adjust VR2 if the alarm does not sound.

Readers' comments:

The Smoke Alarm Circuit is very interesting and can be useful in case of a fire. **The author is requested to confirm if the circuit can be revised replacing the speaker with an actuating relay.**

G.D. RAJPATE
Ghaziabad

The author, Mr Pradeep G, replies:
As transistor T3 (AC128) is always in conduction, a relay cannot be used in place of a speaker. If a relay is used it will energise in presence or absence of smoke! It will de-energise only when thick black smoke appears between lamp and LDR, i.e. LDR should be completely darkened.

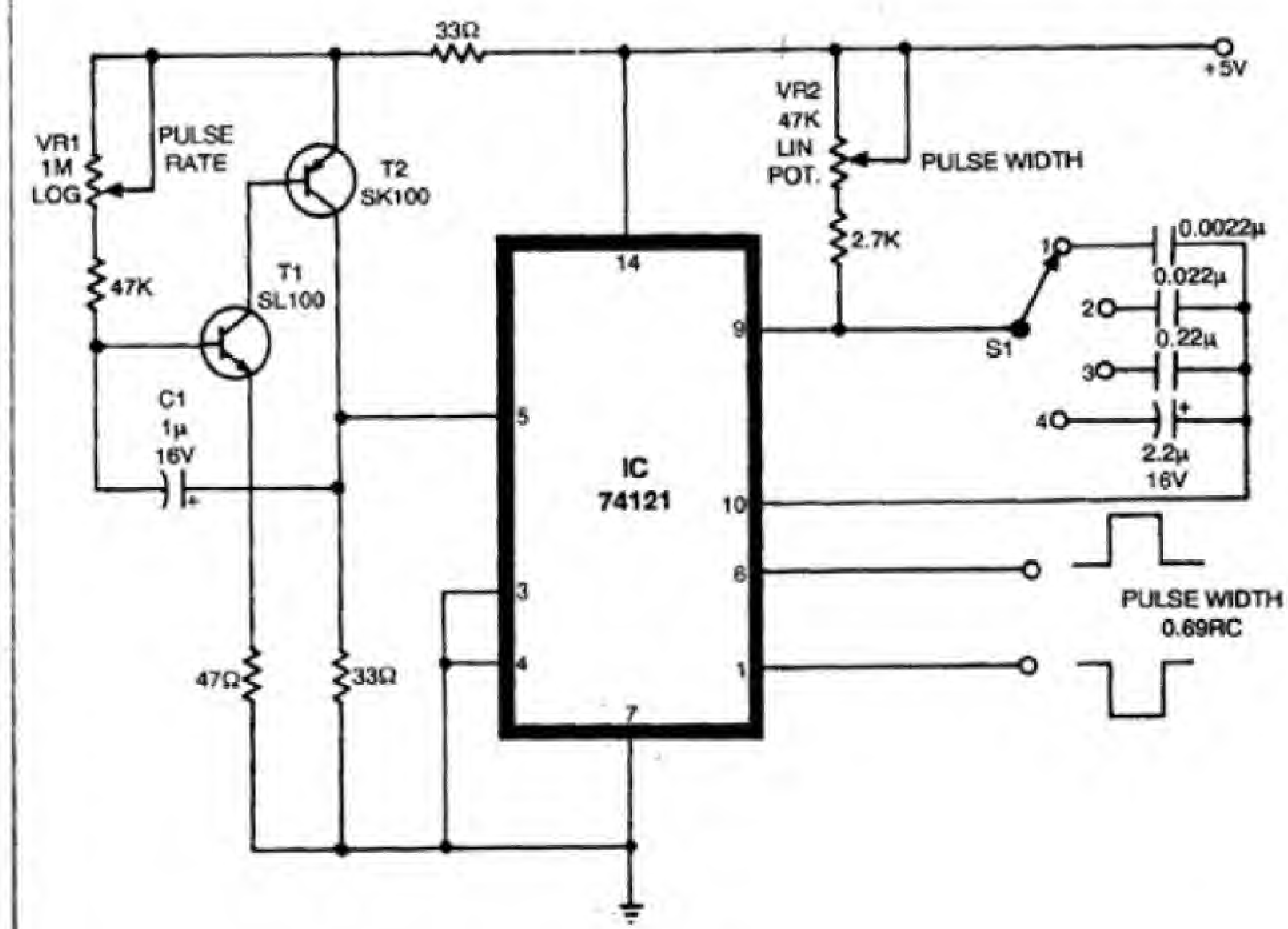
Pulse Generator

D. Deepak

This circuit is used to provide positive going pulses. The pulse width varies from 10µs to 100ms at the rate of 20 pulses per sec to 1 pulse per sec, and adjusted by a 1-megohm potentiometer. Transistors T1 and T2 form a relaxation oscillator circuitry. The frequency of oscillator depends on C1 and VR1.

The pulse width is varied by a 47k potentiometer. Any required pulse width range is selected by switch S1 as shown below:

Position of S1	Pulse width
1	10µs to 100µs
2	100µs to 1ms
3	1ms to 10ms
4	10ms to 100ms



Automatic Voltage Stabiliser

Amrit Bir Tiwana

Voltage fluctuations in the mains supply lines, which is a very common phenomenon, can lead to irreparable damage to costly electronic equipment. This necessiates the use of a device which aids in the stabilisation of the mains voltage. As such devices have to operate almost round the clock, a manual voltage stabiliser is practically useless, since it is not possible to keep a watch ove, it continuously. An automatic voltage stabiliser is suitable for such applications.

Although automatic voltage stabilisers are commercially available, most of them, in addition to their high costs, suffer from drawbacks such as unstable reference voltage and single step operation (which reduces absolute toleration limits), thus hampering their

20V.

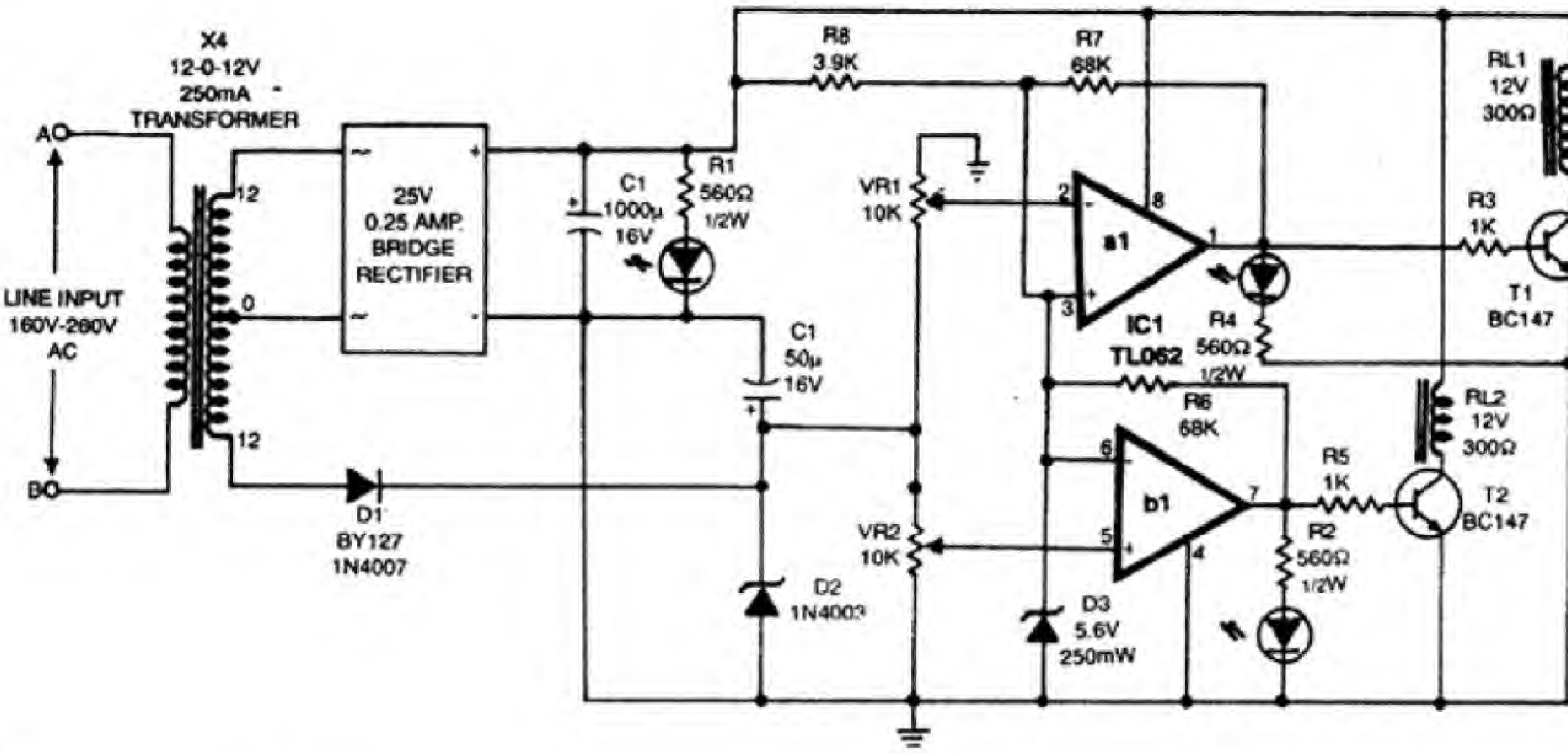


Fig. 1

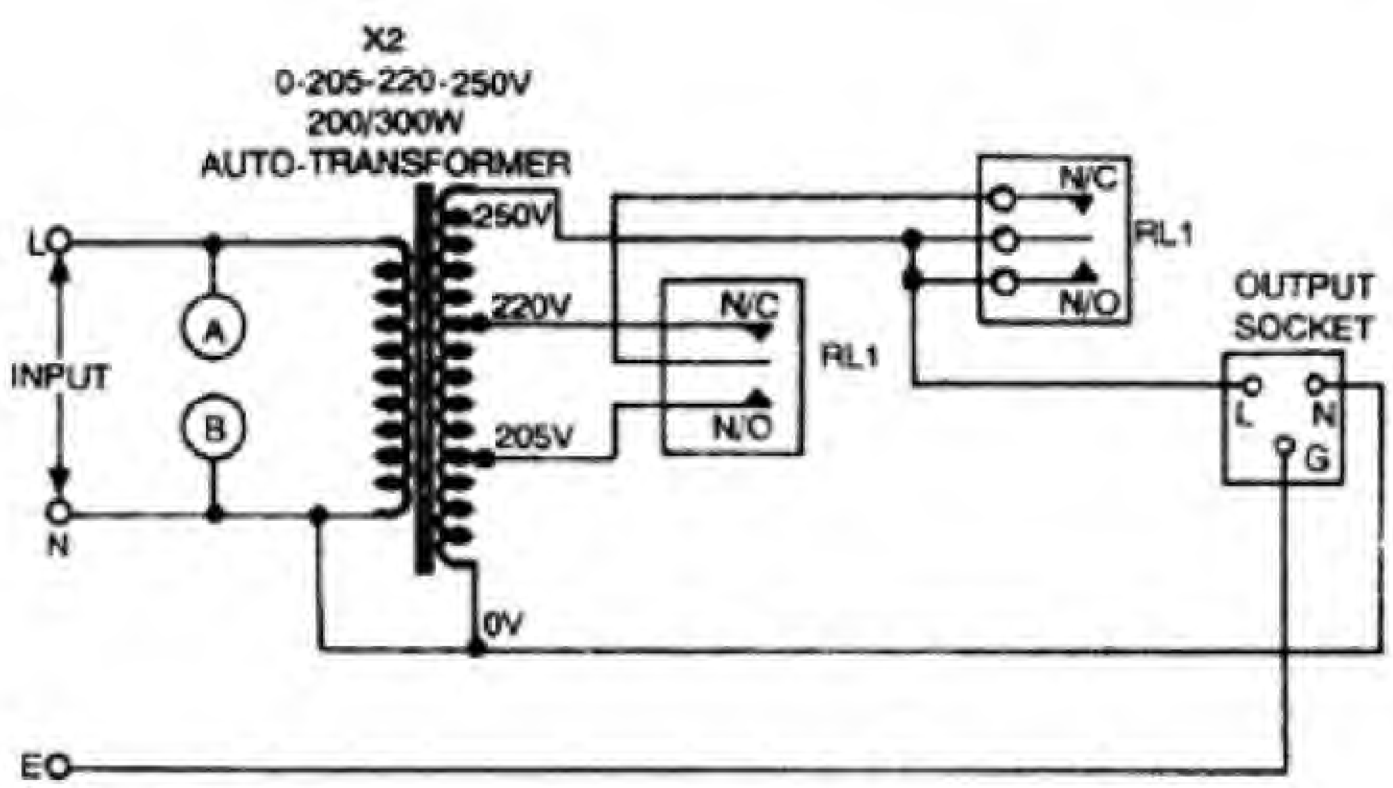


Fig. 2

precise operation. Most of these are fitted with moving coil type meters, which require frequent adjustments, and give misleading readings. In certain cases at low voltages, the control circuitry itself ceases to operate.

Here is a circuit for a highly precise, yet cost-effective automatic voltage stabiliser which can provide an output of 220V with an accuracy of about ±8 per cent. The circuit utilises a solidstate, long life (over 11 years) LED voltage level meter, which retains the case of interpretation of an analogue display. The circuit provides 2-step control and has a highly stable inbuilt reference source. The entire circuitry is built around a single integrated circuit. It is very rugged and offers a high degree of stability.

The complete circuit is built around a J-FET dual op-amp IC TL062 (IC1). Each of the two op-amps is wired as a comparator (Fig. 1).

Zener diode D3 provides a reference voltage of 5.6V to the inverting input of b1 and non-inverting input of a1. The diode is selected for its low temperature coefficient and to ensure stability even at low supply voltages.

The output of a1 goes high when the mains input voltage goes low. The output of b1 goes high when the mains input goes higher than the preset level. Transistors T1 and T2 are used to drive relays RL1 and RL2. VR1 and VR2 acts as potential dividers, and aid in setting the voltage limits at which the output states of the comparators change.

Separate transformer windings are used to fulfil the power supply requirements, one for obtaining the supply voltage for the control circuitry and the other for deriving the sample voltage. A common winding is not used for both purpose as unstability occurs on energisation of the relay. Relay contacts are used to select the most suitable trapping of the auto transformer (Fig. 2). The LEDs indicate the inflow of the mains voltage.

The circuit can be wired onto a general purpose PCB or vero board. A suitable low profile socket should be used for the IC. All external connection should be made using ribbon cable. The LEDs should be fitted in suitable holders.

It is preferable to use a flat wound transformer in order to reduce the size. But his would limit the current handling capacity.

Keeping VR1 and VR2 in maximum resistance position, apply an input of 220V from a variable AC voltage source. Now decrease the voltage to about 180V and adjust VR1, to activate RL1 so that the LED glows. Now increase the input voltage to about 280V and adjust VR2 to activate RL2 and the LED glows again. Now bring the input voltage to normal (220V) and readjust VR1 and VR2, so that the relays remain de-energised. The output will now remain stable at 220V, +/-8 per cent, irrespective of the input voltage (limit: 180-280V AC).

The stabiliser is now ready for use. The complete unit, including a cabinet would cost around Rs 180.

Readers' comments:

Thanks to the author for his circuit for Automatic Voltage Stabiliser.
In that circuit no reverse biased diodes are connected across the relays to protect the BC147 transistors from high reverse emf generated during de-energisation of relays.

PRADEEP G.
Alleppey

The author, Mr Amrit Bir Tiwana, replies:

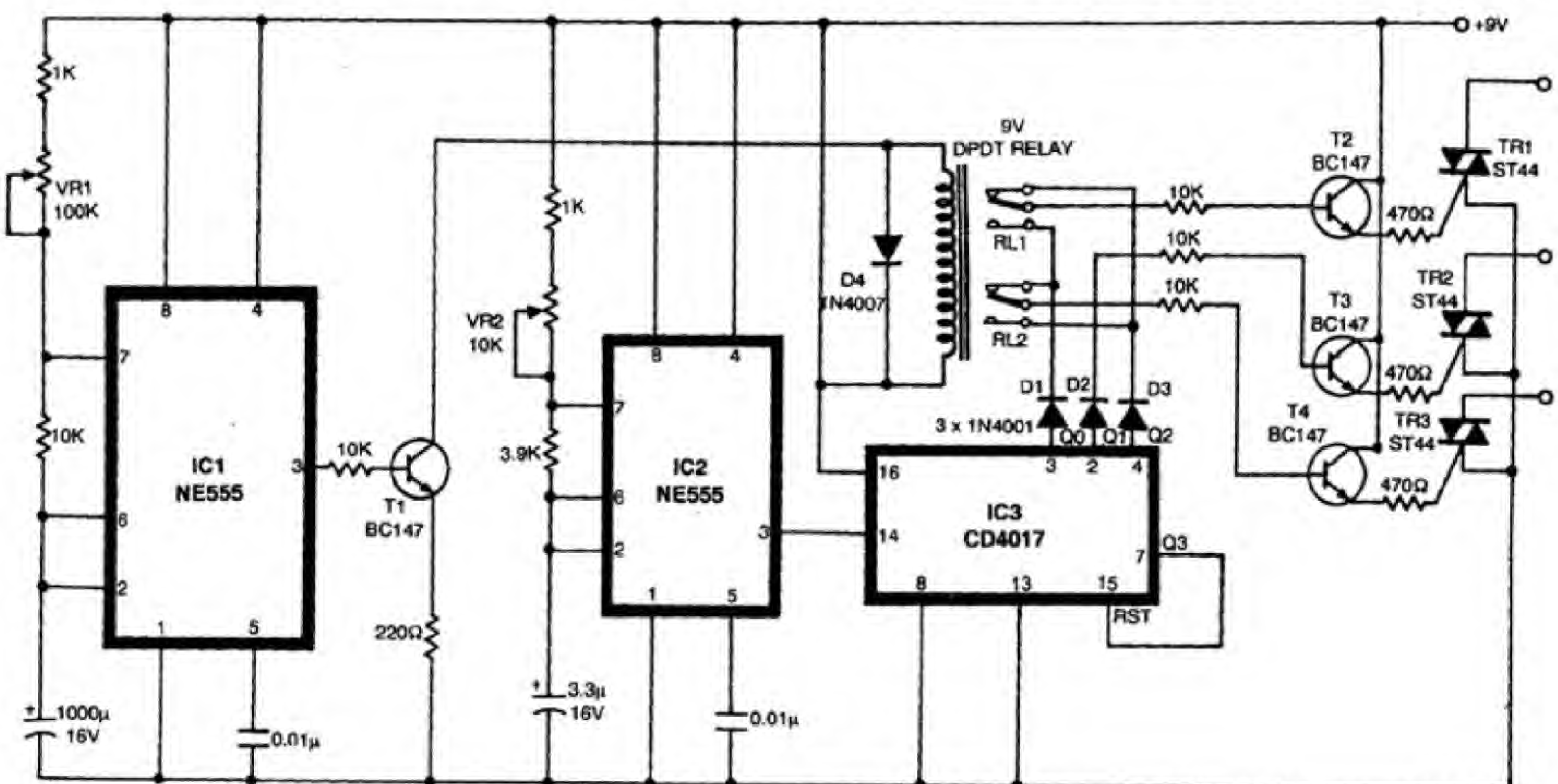
Using reverse diodes is essentially an 'Orthodox' convention as chances of a negligible (volt. and current) reverse EMF damaging hardware is as low as one in a million or not even that!

It does no harm using them either and hardly any by leaving them out.

Automatic 2-mode Running Light

Pramod Kumar

Running light projects are not new for the electronics hobbyists. But an interesting 2-mode running light circuit is presented here, using which the light moves in two directions alternately.



Although this circuit is a simple, 3-channel running light system, it has an unique feature whereby the light changes its direction of running automatically. The light first runs from right to left for some time and then from left to right.

This circuit uses three ICs, two 555 timer ICs and a decade counter IC 4017. IC1 is used to operate the relay. The output of this IC goes to base of transistor T1 which is used as a relay driver. IC2 is used to provide clock pulse to input of IC3. The relay is used in order to change the direction of running lights.

At each clock pulse, IC3 starts counting. Since its reset pin is wired to output pin Q3, counter is reset after three counts from Q0 to Q2. Three sequential outputs are sufficient for a running effect. Outputs Q0, Q1 and Q2 are wired to base of T2, T3 and T4 respectively, so that all transistors turn on sequentially at each clock pulse at input of IC3. Transistors are used to switch on the triacs. The cost of this circuit is under Rs 100.

MW Voice Transmitter

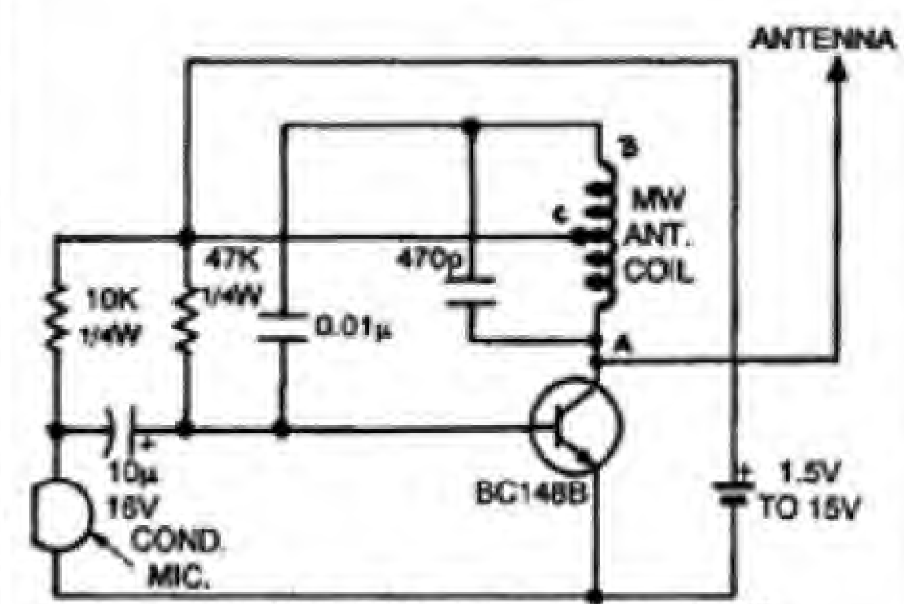
(Pen Cell Sized)

Narpat Singh Rana

Here is a circuit for a medium wave transmitter which can be assembled within a MW antenna coil. It is so small that three such transmitters can be housed in a match box (Fig. 1).

The modulation in this transmitter is purely AM during transmission. It works on any MW receiver and runs from 1.5V to 15V or on a single watch cell. In open area where HT (250V-440V) lines exist, the range of signal reception is more than 500 metres if power is supplied via a battery eliminator. The power supply circuit shown in Fig. 2 may be used to power the transmitter.

The transition frequency of transistor BC148B lies above the MW frequency range. The condenser mic gets electrical sound pulses which it applies to the base of the oscillating transistor BC148B. Here the sound signal is amplified, modulated on the carrier frequency and transmitted by the antenna.



NOTE: 1. ANTENNA SHOULD BE OF 1 METRE LONG INSULATED WIRE.
2. NO PART OF THE CIRCUIT SHOULD BE TOUCHED WHEN AC MAINS POWER SUPPLY IS USED.

Fig. 1

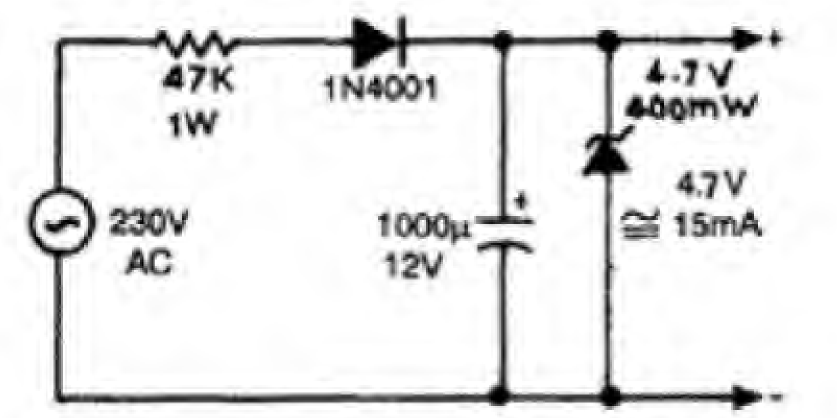


Fig. 2

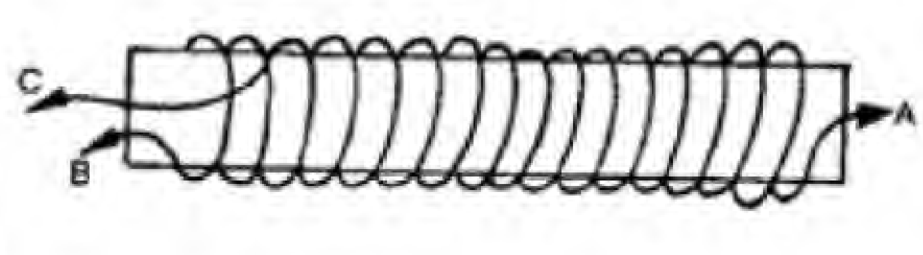


Fig. 3: Details of MW antenna coil.

The total cost of this transmitter is around Rs 15.

Readers' comment:

I have gone through all the letters sent by readers in response to my circuit. Here I am giving my general comments.

My main aim was to house the whole transmitter within a MW antenna coil. That is why I have made the tank circuit fixed.

Also, with 470pF and MW antenna coil alone, no harmonic other than the fundamental frequency exists in the MW band. I have already conducted several experiments on the tank circuit.

The frequency of the transmitter can be calculated with the help of the relationship:

$$f = \sqrt{\frac{25330}{LC}}$$

where f is in MHz, L is in µH, and C is in pF.

A pocket radio set, which has lesser sensitivity than the bigger sets, does not give a good range of reception.

Whether the transmitter is powered with cells or a battery eliminator, or with the power supply given with the transmitter circuit, a minimum of one metre wire antenna connected to the collector of BC148 should be kept near the AC mains.

The transmitter works very well even on a single watch cell.

If the transmitter frequency interferes with any local station, connect a 10pF capacitor in parallel with 470pF.

There is no need of any ferrite rod in this transmitter.

The fundamental frequency is not 250 kHz; it is between 900 kHz and 950 kHz without ferrite and every component inside the antenna coil. Only harmonic in the lower frequency range may lie on 250 kHz.

One of the readers from Bangalore reported that the same transmitter is giving a range of 1500 metres, i.e. one and a half kilometres, on connecting the antenna with the grounded wire of the AC mains.

NARPAT SINGH RANA
Patiala

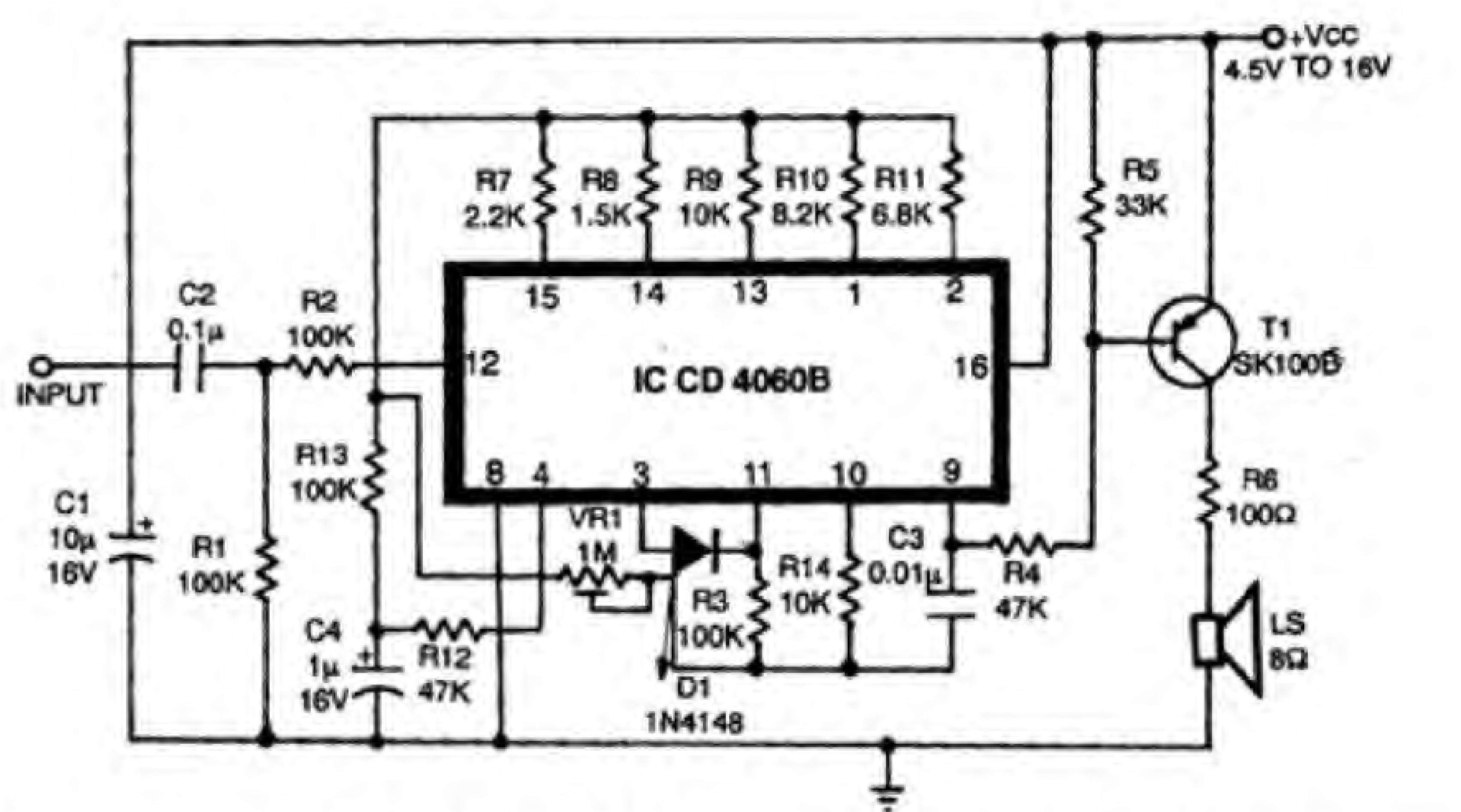
Low Power Alarm With Automatic Switch-Off

George Varughese

Here, a 4060 timer IC is used as an alarm circuit. This IC also offers automatic switch-off after a fixed time.

When input gets a high going pulse, the circuit in IC starts oscillating. Value of resistor R14 determines frequency of oscillation of the built-in oscillator. The output frequency shifts about this frequency after a particular internal oscillation stops. R14 should be chosen according to the frequency required, minimum value being 10k.

R3, R14 and C3 are the frequency determining components of the internal oscillator. At switch on, pin 3 is low, diode 1N4148 is reverse biased and the internal oscillator oscillates. R7-R11 form a voltage divider network or, more precisely, a D-A converter.



As counting progresses, voltage of their common terminal also varies. Voltage across C4 also affects this. As this voltage is applied to the oscillator through VR1, oscillation changes frequency. As soon as pin 3 goes high, oscillator switches off since diode D1 becomes forward biased.

Since the unit draws very low quiescent current, no power on/off switch is needed. An advantage of using IC 4060 instead of UM series musical IC is the wide supply range of 4060.

Simple Electronic Sand-glass

George V.

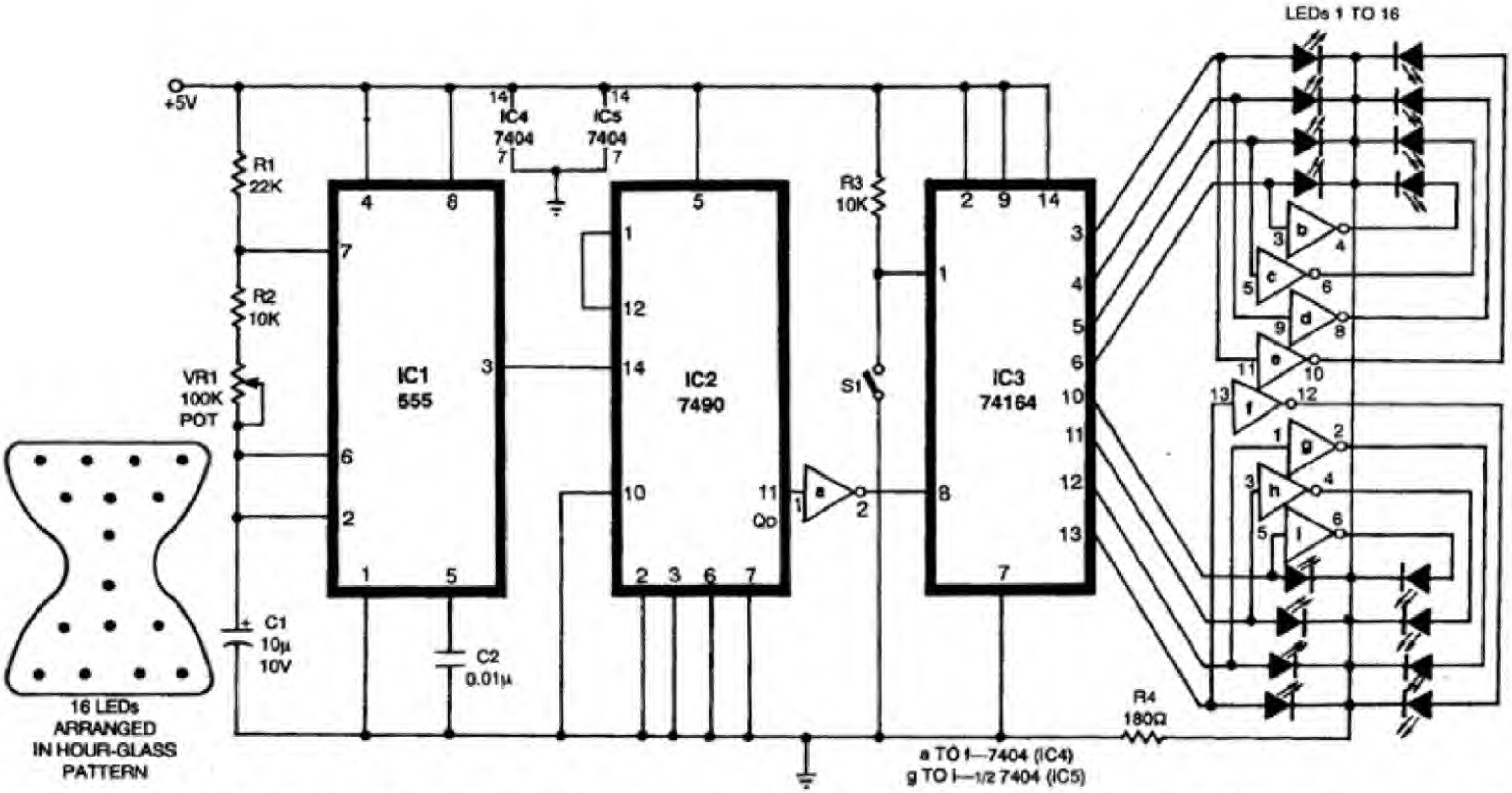
In this circuit IC 555 is wired in the astable mode such that its frequency can be varied by the 100k potentiometer VR1. IC 7490 connected as MOD 10 counter divides the frequency by 10.

After nine clock pulses, a clock pulse from QD is inverted by gate 'a' (1/6 7404) and fed to clock input of shift register IC3 (pin 8). Inversion is done as IC 74164 is positively triggered. To make it negative edge triggered like 7490, an inverter is added.

Thus when QD is high after nine counts, a pulse is provided to IC 74164. This loads a high state in shift register if S1 is open throughout the register.

S1 must be a mercury or toggle switch, so that after the lower LEDs are lit when the device is inverted, the switch makes contact with ground and logic 0 is loaded. The effect is simulated by using inverters to drive LEDs on the other side.

Thus for each clock pulse, as a logic 1 is loaded when S1 is open, the corresponding inverted LED turns off, sim-



ultating the falling effect of sand grains.

Although 16 LEDs are used here, the number can be easily increased to 32 by connecting another 74164 in series with the one used, besides using corresponding inverters as well. VR1 can be adjusted for a frequency such that lower LEDs are all lit in about 1, 3 or 5 minutes.

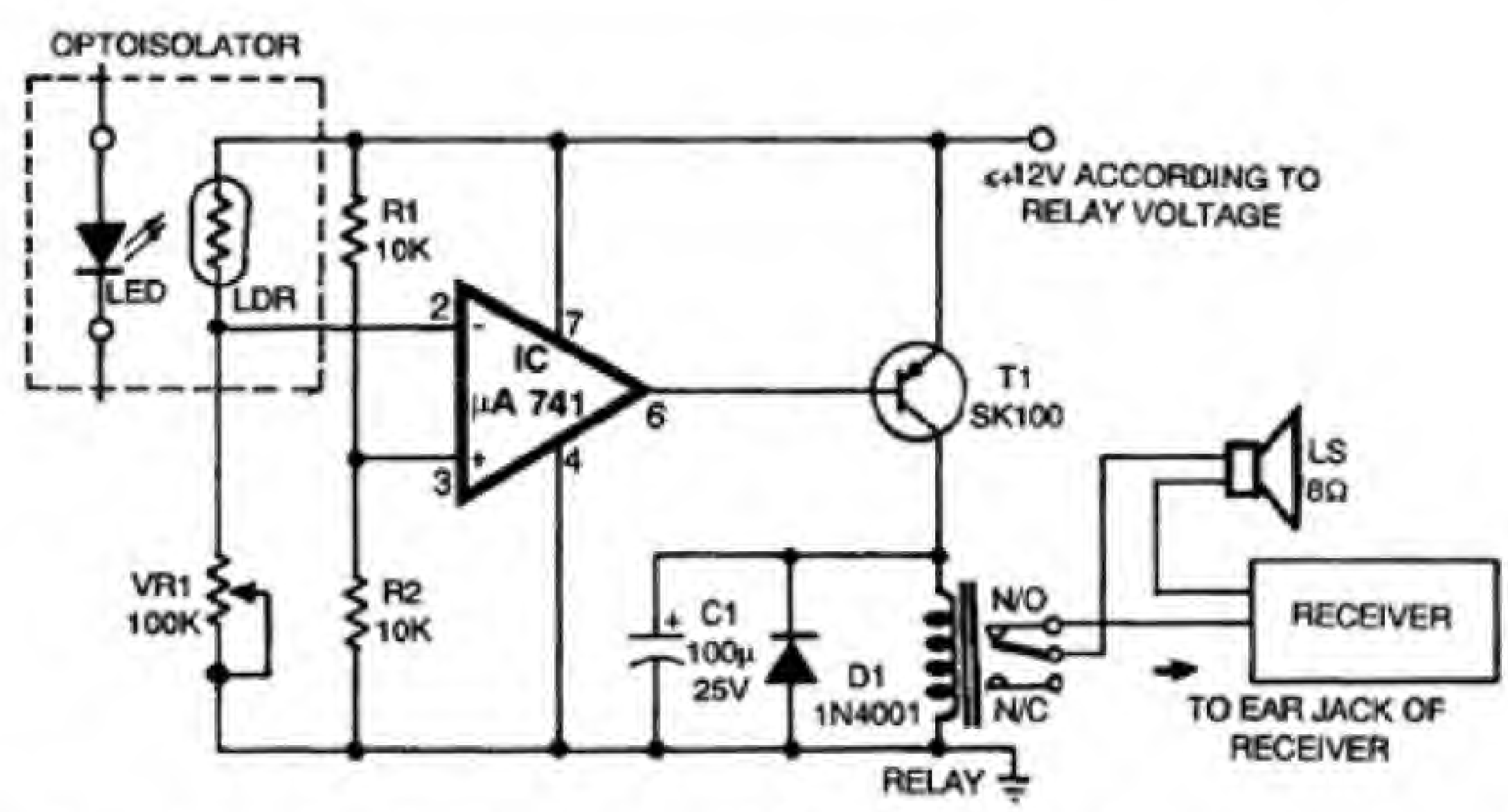
FM Communication System

M.M. Dharmapurikar

A real communication system is one that works 24 hours a day. In such a system, the receiver must be 'on' all the time so as to catch the signals any time. But for an ordinary hobbyist, such a large circuit used for commercial sets exceeds his needs.

Here is a circuit which mutes your FM receiver when signal is absent and switches on the speaker automatically, when signal is received. Using this circuit, the hissing sound is completely eliminated because the receiver speaker is disconnected when there is no signal.

The circuit incorporates a simple light operated switch which turns on when the tuning indicator LED of the receiver starts glowing. When a strong signal is caught by the receiver, the LED lights up and the switch turns on.



When there is no signal, the LED as well as the switch are off and the speaker is disconnected.

The circuit consists of an active device IC 741 used as a comparator. The non-inverting pin 3 is given constant voltage via R1 and R2. VR1 sets the sensitivity of the circuit. Transistor T1 (SK100) drives the relay which further operates the speaker. T1 must be provided with a heatsink for safe operation.

The LDR is coupled with the tuning LED by taking out the LED from the cabinet of the receiver. Alternatively, the LDR can be mounted directly on the LED on the cabinet. In both cases, However the coupling should be perfectly opaque, so that only the light from LED falls on the LDR.

The supply voltage can be taken from receiver power supply. D1 protects the circuit from back emf generated by the relay. C1 makes the operation of the relay smoother. The output of speaker is taken directly from the receiver via either the jack pin or by cutting the speaker leads. Connection can be made with either external or internal speaker.

Mains Wiring Fault Detector

Amrit Bir Tiwana

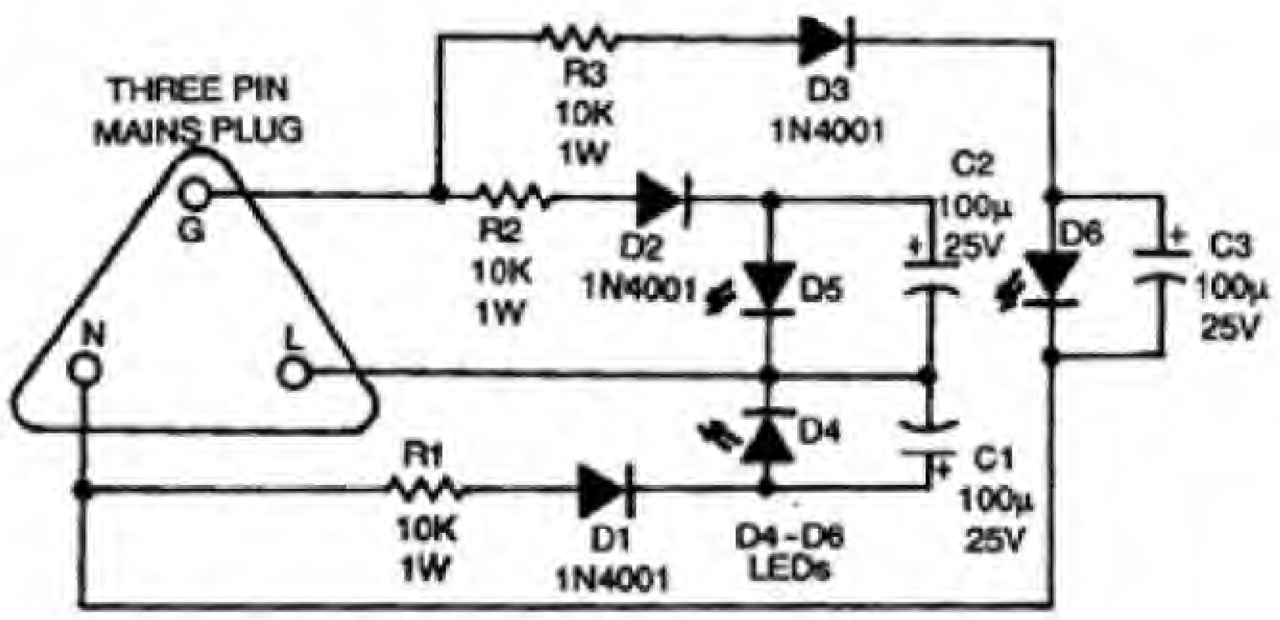
The circuit described here is for a low-cost mains wiring fault detector which would enable the user to instantly isolate the fault in the mains wiring. When plugged into the mains, the unit assumes one of the six possible states given in Table I, and indicates the probable fault against the corresponding state number.

Resistors R1-R3 drop the mains AC voltage, and diodes D1-D3 convert this voltage into DC. This voltage is then used to drive the LEDs, D4-D6. Capacitors C1-C3 help in maintaining a steady glow. A particular combination of LEDs (i.e. a particular state) lights up according to the fault in the mains wiring.

The circuit is quite compact and may be enclosed in a 3-pin mains plug. The circuit would cost around Rs 10.

TABLE I
Fault Detection Table

State of LEDs			State	
D4	**D5**	**D6**	**Number**	**Portable Fault**
On	On	Off	1	All safe
Off	Off	Off	2	Live wire disconnected, fuse blown, power failure, switch off
On	Off	On	3	Live and neutral wires interchanged
On	Off	Off	4	Ground wire open
Off	On	Off	5	Neutral wire open
Off	On	On	6	Live and neutral wires interchanged



Programmable Organ

Pramod Kumar

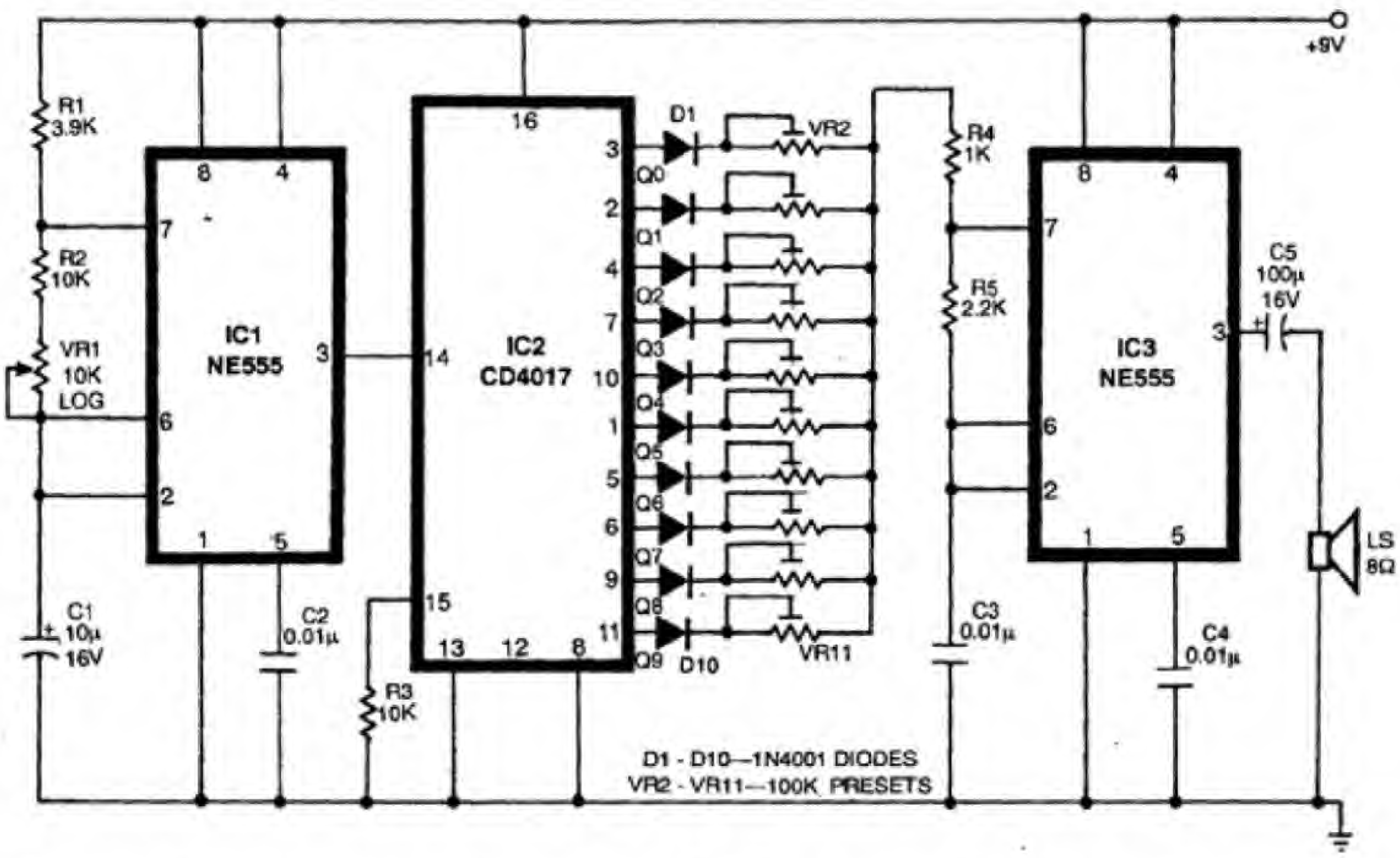
Most electronic hobbyists are familiar with the audio frequency oscillator. This circuit is actually an audio frequency oscillator, where the frequency can be programmed. Besides being interesting, this organ will give a new kind of preprogrammed music.

The circuit is capable of producing ten different musical notes. All ten notes may be programmed, resulting in a melodious repetitive music. The device may be used as a doorbell or a musical organ.

The circuit uses two timer NE555 ICs and a decade counter IC CD4017. Timers IC1 and IC3 are used in astable multivibrator mode. IC1 provides clock pulses to input of decade counter IC2, while IC3 is used to produce audio frequency. Frequency depends on the value of presets VR2-VR11. When resistance position of VR2-VR11 is changed, the frequency also changes.

As IC1 provides clock pulses to input of IC2, at each clock pulse IC2 starts counting from Q0 through Q9. All ten presets are wired between Q outputs of IC2 and pin 7 of IC3.

As a result of counting from Q0 through Q9, all ten presets function one by one and produce an audio frequency. Frequency depends on the resistance position of the corresponding preset. All presets may be marked for different resistance positions to produce music. The music can be pro-



grammed by keeping all presets at different resistance positions. The speed of producing music can be controlled by potentiometer VR1. The output of IC3 can either be fed to power amplifier or directly to the speaker.

This circuit can be assembled on a veroboard for around Rs 60.

8-Tone Multipurpose Sound Generator

K.S. Umesh

Many different types of musical projects have been published earlier in EFY but the one described here generates eight different types of sound for a wide range of applications in toys, as horns for cycle or car etc.

The heart of the circuit is HT88, an 18-pin DIL CMOS monolithic LSI sound generator. So, an 18-pin IC base should be used for the chip. The chip contains a programmed masked ROM which produces eight different types of sounds (Table I).

Since the chip itself contains oscillating and selector circuit, a few additional components are sufficient. A zener diode drops the voltage to 3.3V between pins 2 and 1. The sound output from pin 4 is amplified by a darlington pair T1 and T2.

The desired sound is selected by switch S1. Switch S2 is used to produce the selected sound. The oscillating speed is set by a 47k variable resistor VR1.

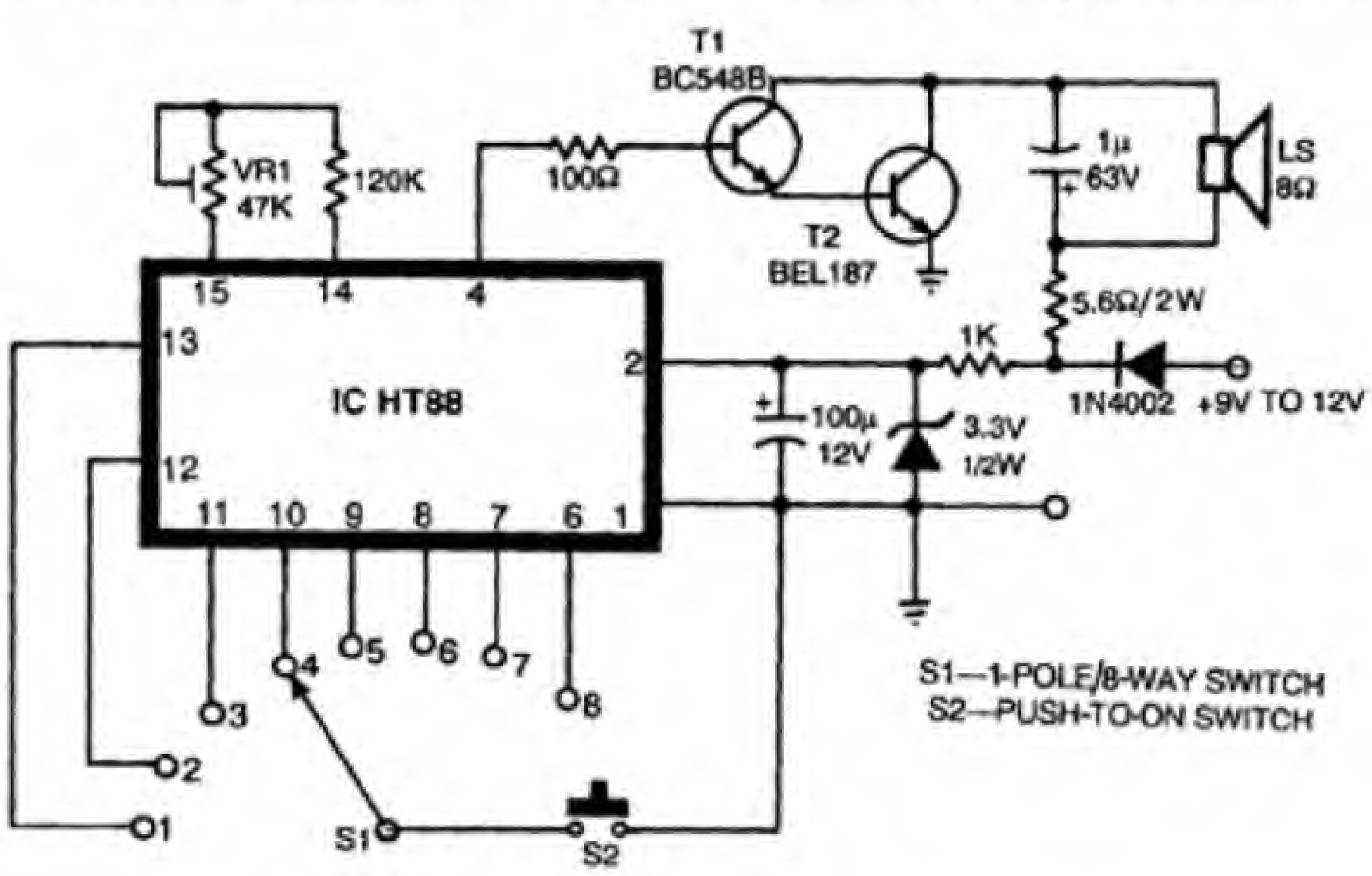


TABLE I

Position of switch S1	Sound
1	Rifle sound
2	Dracula sound
3	Game sound
4	2-tone sound
5	Bombarding-I
6	Bombarding-II
7	Machine gun-I
8	Machine gun-II

High/Low Voltage Cut-Out

P.S. Shine

Many such circuits have appeared earlier in EFY, but this is a very simple and very sensitive circuit.

The heart of the circuit is the popular IC 555. The over/under voltage is set by presets VR1 and VR2. X1 is a step-down transformer that steps down 220V AC to 12V AC. This voltage is rectified and filtered by D1, D2 and C1, C2.

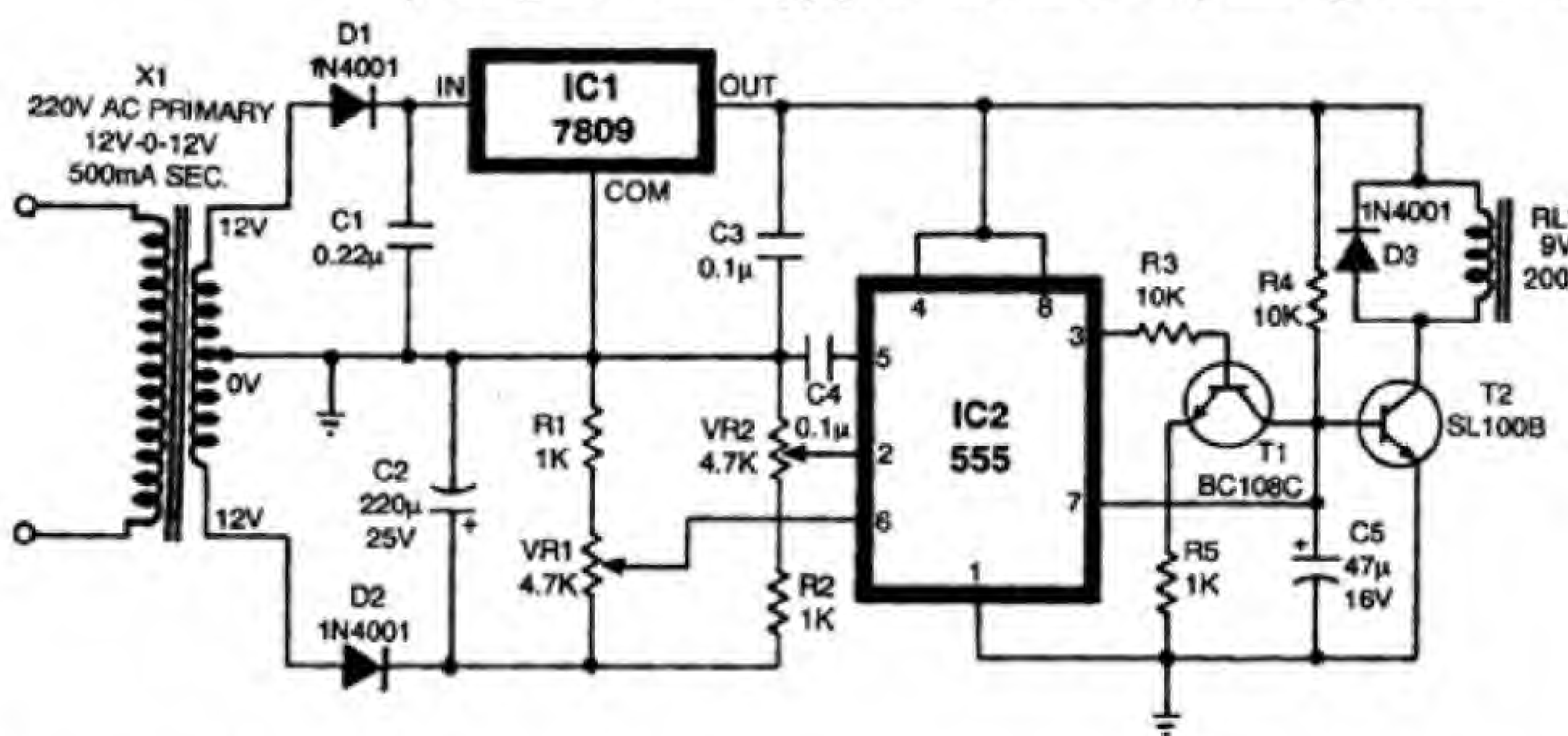
One side of the secondary voltage is reduced to 9V by regulating IC 7809 to give constant voltage to IC2. The other winding is used for referencing the voltage fluctuations. This output voltage is not regulated. It will be proportional to the input.

When the voltage is increased, the voltage at pin 6 of IC2 will also increase. As a result, pin 3 of IC2 will go high, T1 starts conducting and base of T2 is grounded. Then the relay is de-energised and supply to the load is switched off.

When the voltage is decreased, the voltage at pin 2 is low and pin 7 of IC2 will be grounded. Thus the base of T2 is again grounded and the relay is again de-energised.

When the voltage is normal, pin 3 will be in grounded position, resistor R4 will turn on transistor T2 and energise the relay.

Capacitor C5 acts as a timing capacitor. By changing the value of C5, timing can be varied. The cost of the circuit is less than Rs 50 excluding power supply.



Digital Stop Watch

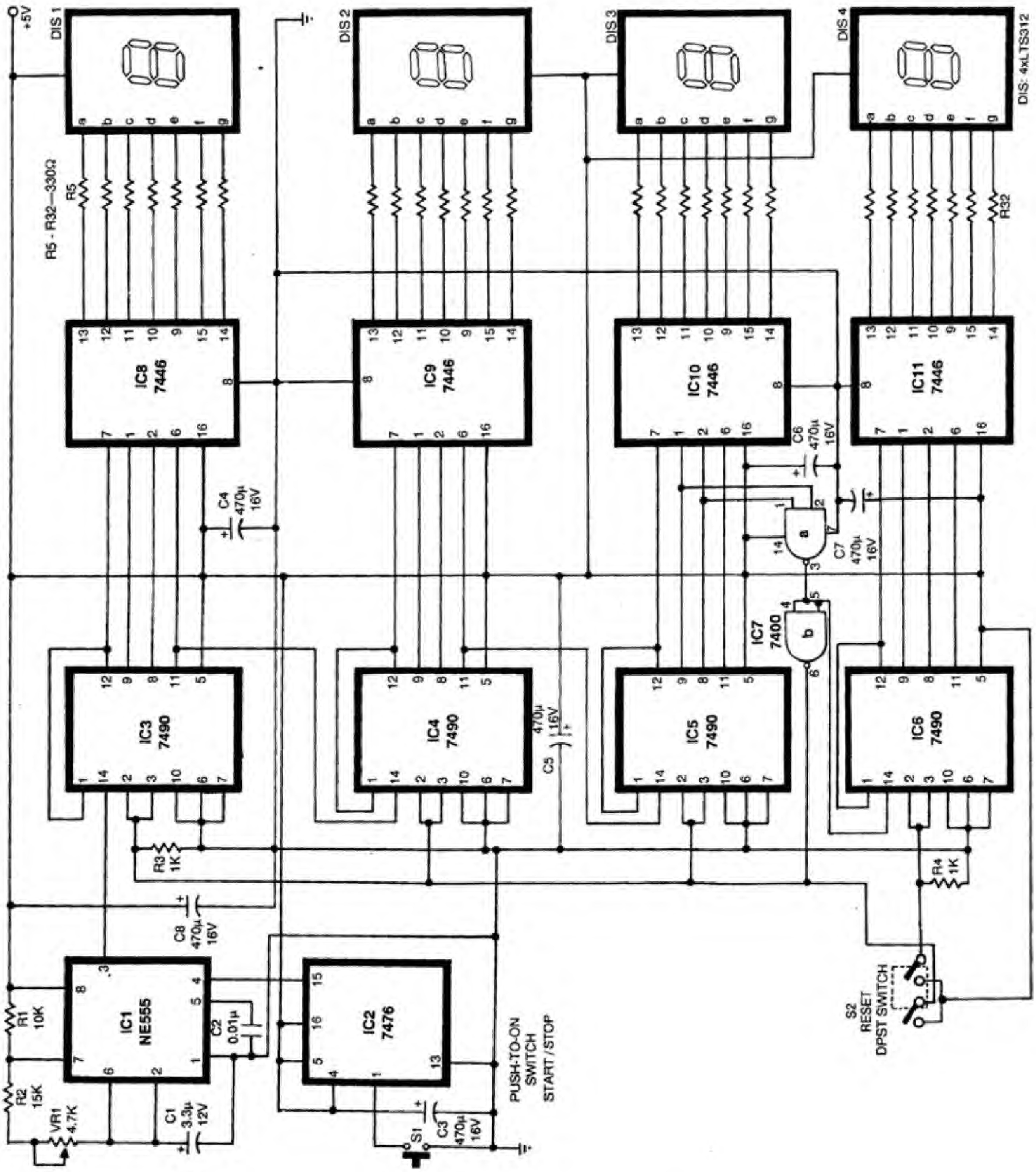
Satheesan K.

This circuit of a digital stop watch uses four 7490 counter ICs. It counts time from one instant to another in digital mode and displays it.

IC 7476 is a J-K flip-flop. Its J and K inputs are given a high level, so that the output toggles at each trailing edge of clock pulses. Here clock pulses are given by switch S1.

For each switching, the output changes to high and low states alternately. This is used to enable or disable IC 555 which is wired as an astable multivibrator for giving clock pulses to the counters. When pin 4 of IC 555 is high, it produces pulses. When it is low, there are no pulses.

The frequency of astable multivibrator is kept at 10 Hz, i.e. 10 pulses/sec. The first display shows one-tenth of a second, the second display shows unit seconds, the third displays tens, and the fourth display shows one minute.


+5V
DIS 1
DIS 2
DIS 3
DIS 4
DIS: 4xLTS312
R5 - R32—330Ω
IC8 7446
IC9 7446
IC10 7446
IC11 7446
IC3 7490
IC4 7490
IC5 7490
IC6 7490
IC7 7400
C4 470µ 16V
C5 470µ 16V
C6 470µ 16V
C7 470µ 16V
C8 470µ 16V
R3 1K
R4 1K
IC1 NE555
IC2 7476
R1 10K
R2 15K
VR1 4.7K
C1 3.3µ 12V
C2 0.01µ
C3 470µ 16V
S1
PUSH-TO-ON SWITCH START/STOP
S2 RESET DPST SWITCH

The pulse produced by the multivibrator is given to the first counter. When its count reaches 9 (1001 in binary), the second counter starts because it gets a trailing edge when the first display goes from 9 to 0. So it reads 1 (1.0 sec). When the second display count reaches 9, the third display counts (10.0 sec).

When the count of the third display reaches 6 (59.9 sec on the display), both the inputs of NAND gate a of IC7 become high so that its output becomes low. This appears as a trailing edge for the fourth display and it counts at the same time the output of gate a is inverted (low becomes high). This is applied to the reset pins of 7490 ICs, so that all counters (except fourth) reset to zero. The display shows 1.00.0, i.e. one minute and zero second.

IC 7446 is used to convert BCD into 7-segment form.

This stopwatch is capable of counting up to 9 minutes and 99.9 secs.

The frequency of astable multivibrator is given by

$$f = \frac{1}{1.44[R1 + 2(R2 + VR1)]C1}$$

If R1 = 10k, C1 = 3.3μF, R2 = 15k, and f = 10 Hz, VR1 would have a value of 1.81k. So VR1 could be a 4.7k preset.

If you want to display one-hundredth of a second, cascade one more counter section. Display it at the top and change the frequency to 100 Hz.

If you want 10-minute cascade, add one more counter section at the bottom but do not change the frequency (keep it as 10 Hz). Now you can count up to 99 minutes and 99.9 secs.

Frequency Measurement on Multimeter

Arun Sehgal

At one time or another, every hobbyist faces some circuit problems where he needs a frequency meter. Such an instrument is quite expensive and most hobbyists cannot afford it.

Here is a simple circuit using a recently introduced IC with frequency-to-voltage conversion. Its output voltage is measured to give an indication of frequency being fed/tested.

The circuit is based on LM2907 or LM2917 frequency-to-voltage converter designed to operate a relay, lamp or any suitable output indicator when input frequency reaches or crosses a certain selected rate. It uses a charge pump technique and output swings to ground for a zero frequency input.

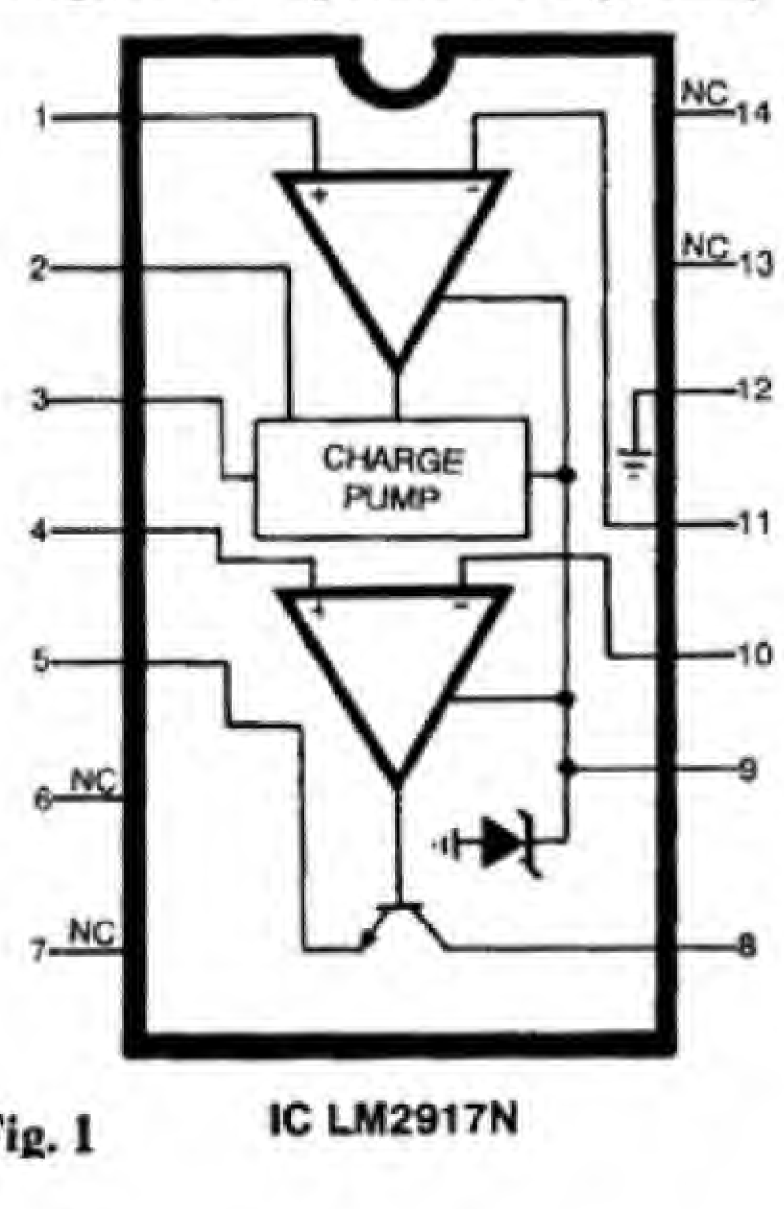


Fig. 1 IC LM2917N

This device can sink or source 50mA current to operate relays, solenoids or LEDs and also has built-in hysteresis. Electrical characteristics and pin layout are given in Table I and Fig. 1 respectively.

This IC is extremely easy to use as it works on following formula:

$V_{out} = f_{in} \times V_{cc} \times VR1 \times C2$

$= f \times V_{cc} \times VR1 \times C2$

where VR1 is resistance between pin 3 and ground, C2 is the capacitor between pin 2 and ground and f is the frequency of the input signal.

As the maximum supply voltage to IC is 28V, it can be used for measuring frequency at lower end of multimeter DC voltage range. Most multimeters have this range but it can also be used for any range less than 28V.

For example, if we want to use this circuit to measure frequency with a multimeter on 10V range, we have V_{out} = 10V, V_{cc} = 10V (supply voltage), C2 = 0.01 μF and VR1 = 10k.

TABLE I
Electrical Characteristics

Supply voltage	6V to 28V
Supply current	25mA
Differential input voltage tachometer	28V
Op-amp/comparator	28V
Input voltage range for tachometer or op-amp	0V to +28V
Hysteresis	30mV
Zener series resistor	470Ω (for LM2917 only)

From the equation,

f = 10 kHz or 10V = 10 kHz.

or

f = 1 kHz or 1V = 1 kHz

With reading of 5V, f will be 5 kHz.

Similarly, the formula can be adapted for the range of 200 mV, 2V, 10V and 20V generally available on most multimeters, analogue or digital.

The complete circuit is shown in Fig. 2. VR1 can be changed to various values of resistances for various input frequencies. Calibrate it with a frequency meter or a known frequency for accurate reading. Accuracy will depend on multimeter and calibra-

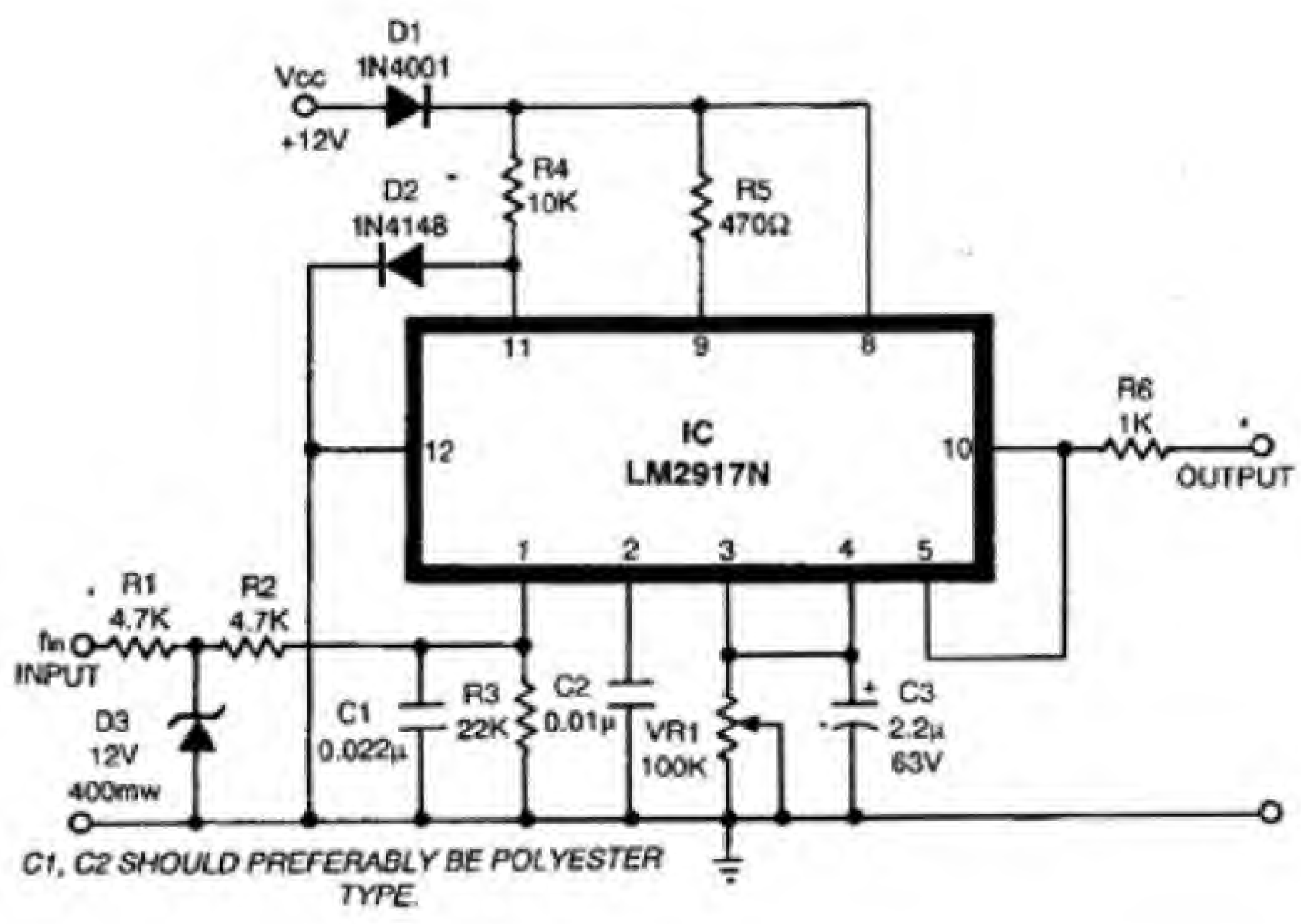


Fig. 2

tion.

Use VR1 of less then 10 megohms and C2 of more than 100 pF for accurate operation. Use of LM2917 with built-in zener is recommended. The IC costs around Rs 45.

This IC can also be used for over-speed indicator, breaker point dwell meter, speed switch and hand-held tachometers. Variable reluctance magnetic input devices can also be used at the input. It can be used to drive 20 LED display revolution counters using two LM3914 or any other suitable display unit. Output indicating device can be a relay, an LED or a meter depending on the application the IC is being put to.

A Simple Intercom

Pankaj Goel

Various circuits of 2-line intercoms have been published earlier but this is the simplest as well as very low cost.

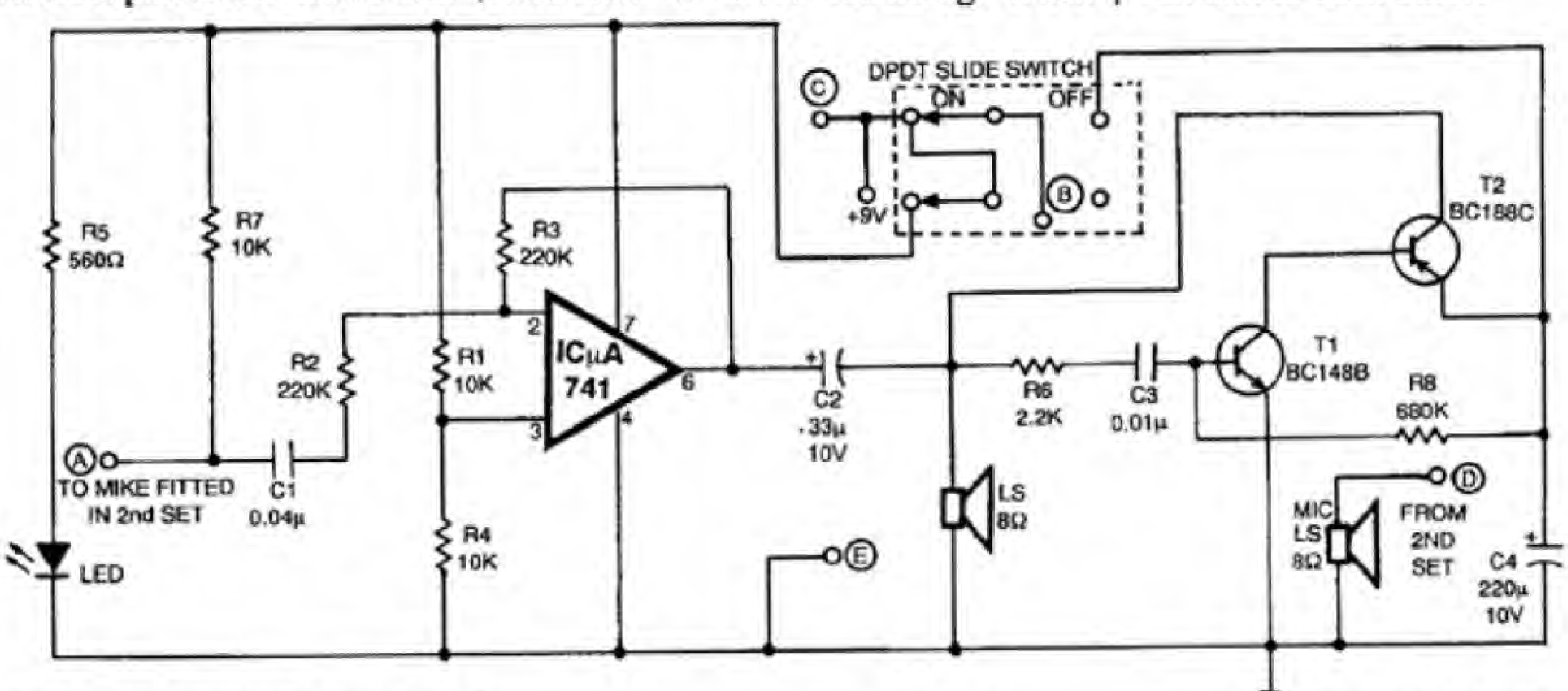


Fig. 1

The main component of the circuit is op-amp IC 741. The bell facility is also available. The components used in both intercoms are the same.

The bell facility is obtained by using two transistors in both sides. Small condenser microphones generally used in tape recorders for recording and 8-ohm, 5cm speakers are used.

If one side, say A, wants to talk to the other side B, the switch of intercom A should be turned on. Now, the bell on intercom B starts sounding. When intercom B is switched on, both sides can talk to each other.

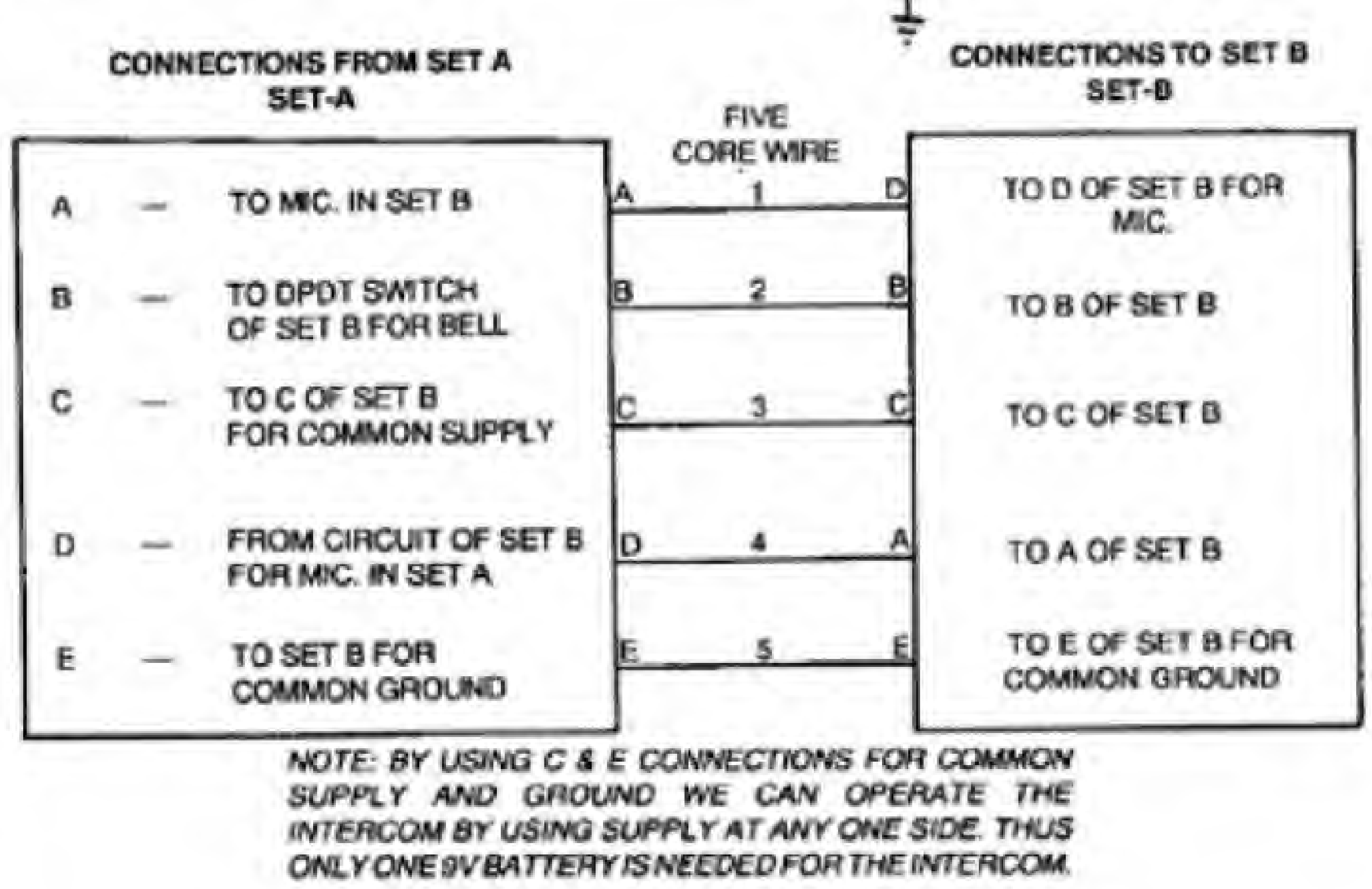


Fig. 2

The two sets are connected by a single 5-core wire. The ICs should be fitted on 8-pin IC sockets for good handling. Intercoms separated by a wire up to 90 metres has been tested although longer wires can be used.

These intercom sets can be assembled in toy telephones or fancy geometry boxes. It can be operated with 9V battery or battery eliminator. As very small current is used, the battery lasts longer. The cost of intercom without battery, cabinet and connected wire is about Rs 60.

Mini Chaser

C. Sanjay

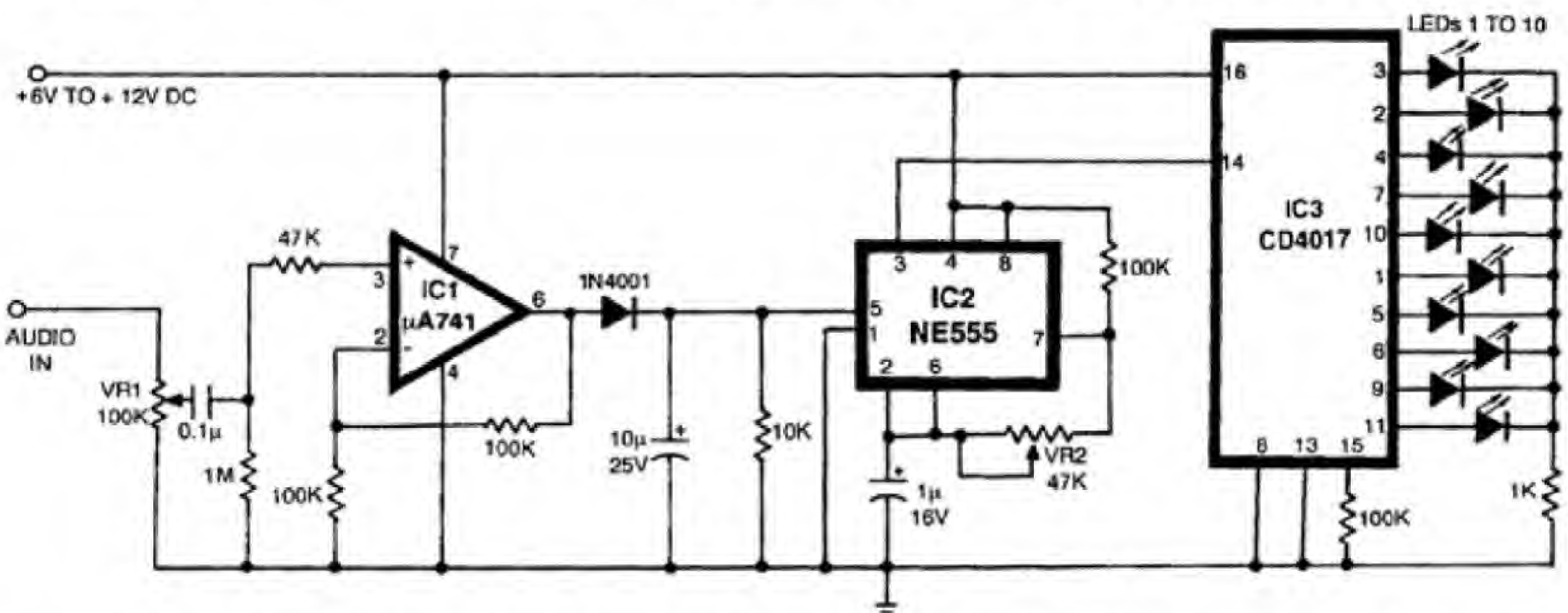
This mini chaser circuit displays a moving light, whose speed varies according to the audio input.

The audio input is amplified by IC1 and the output is converted to DC by the 1N4001 diode and the capacitor at its output. This DC is fed to pin 5 (control voltage) of IC2 whose frequency is adjusted by VR2.

The output of this oscillator is given to a counter IC which counts to ten. When the input changes, the DC level at pin 5 changes and the frequency of oscillation also changes, varying the speed at which the LEDs turn 'on' and 'off'. The LEDs can be mounted on a bright panel and arranged in any attractive arrangement.

For extra brightness add two LEDs in series. For each LED, a separate resistance is not needed; a common 120-ohm resistor is enough. The supply can be between 6V and 12V. This circuit consumes only about 15mA.

Do not add LEDs in parallel at the output of the IC3 as it cannot provide the current. Change in supply voltage will slightly affect the 'running' speed of the LEDs. So a stable supply must be provided if the change in speed is not much. Adjust VR1 to give better results.



Mains Voltage Indicator

K.M. Reddy

It is often desirable to have an indication of the mains voltage, especially before expensive equipment is connected. This circuit uses four LEDs to indicate the mains voltage. These LEDs are lit according to the corresponding mains voltage (Table I).

The circuit uses LM324 quad op-amp, as this IC can work on a single power supply. The IC is also inexpensive and easily available. All op-amps in IC1 are wired as comparators. The outputs of the op-amps are connected to the LEDs through suitable current limiting resistors.

Zener diode D3 provides a stable reference voltage which is divided by the potential divider comprising four resistors. The mains voltage is stepped down by X1 which has a current rating of 500 mA or more. The mains voltage is reduced by a potential divider, rectified and fed to the inputs of the op-amps. This voltage is compared with

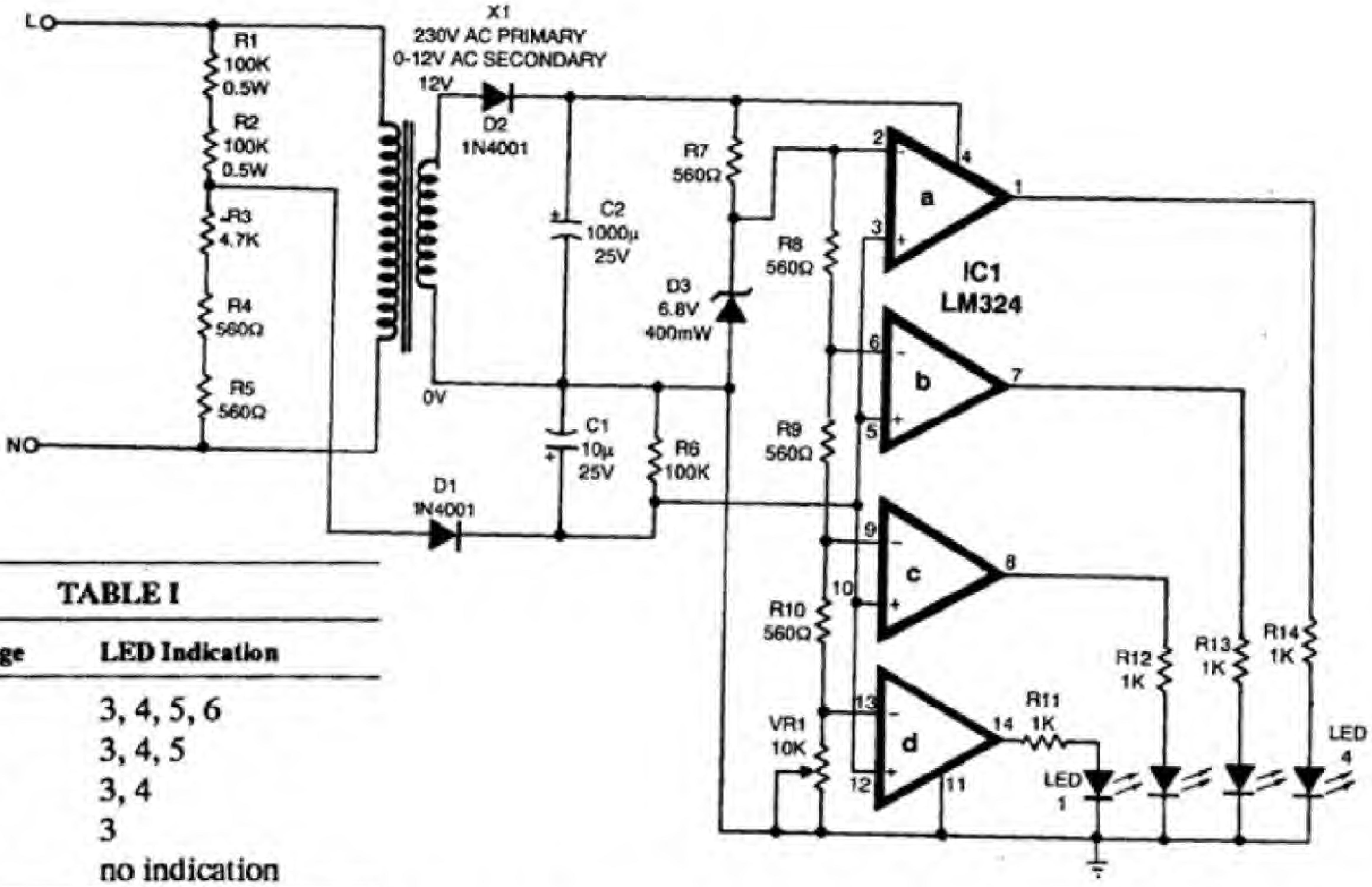


TABLE I

Mains Voltage	LED Indication
> 240V	3, 4, 5, 6
> 220V	3, 4, 5
> 200V	3, 4
> 180V	3
< 180V	no indication

the reference voltage by the op-amps.

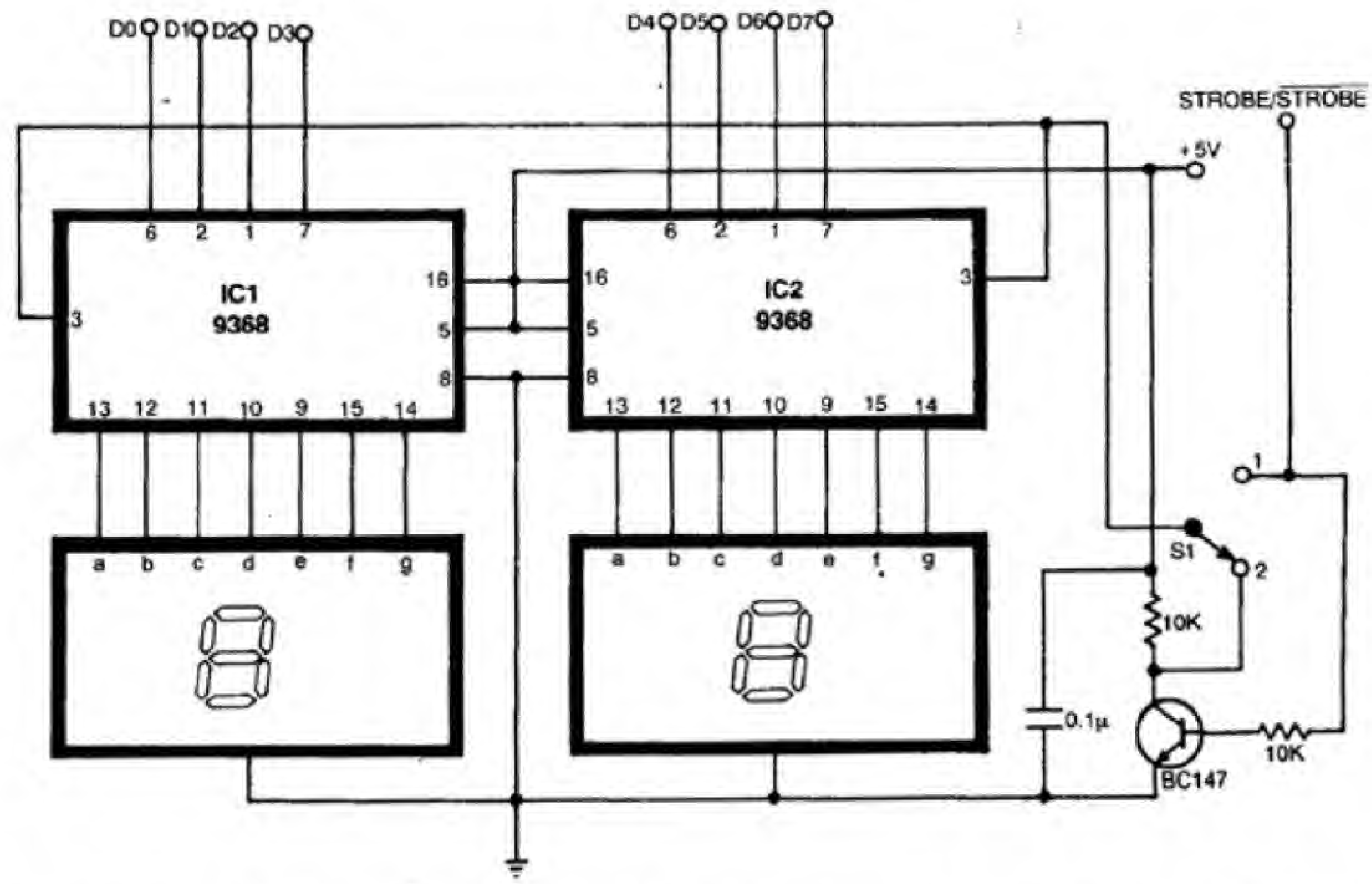
The circuit is very simple and can be easily constructed on a general purpose PCB. The circuit is calibrated by setting VR1. If precision is not required, VR1 can be set to its centre. Care should be taken while testing the circuit as many portions of it are at mains voltage.

ASCII Keyboard Tester

C. Sanjay

ASCII keyboards are the most versatile interfaces of computers. As data is entered, and the computer is programmed using the keyboard, any fault in the keyboard will lead to wrong programs and wrong calculations.

This ASCII keyboard tester, when connected to the output of the keyboard (D0-D7 and strobe), can display any 8-bit character like 4C, 3D etc directly through 7-segment displays. The



two 9368 ICs are responsible for the conversion of the 4-bit binary into a hexadecimal character. Thus an 8-bit word is divided and displayed as two 4-bit words.

To test a keybaord, connect the tester and press any key. The tester should display the respective hexadecimal code. The strobe output of a keyboard may be $\overline{\text{strobe}}$ or strobe. Accordingly, switch S1 should be set in position 2 for $\overline{\text{strobe}}$ and 1 for strobe.

This tester can also be connected to the data pins of an EPROM to check the data. □

Pocket Radio Circuit Using ZN414

T. Surendra

ZN414 is an unique IC incorporating an RF circuit and earphone driver. It is best suited for pocket radios, both in size, reception and noise rejection. This IC is also available in the market as YZ414. A simple receiver circuit is

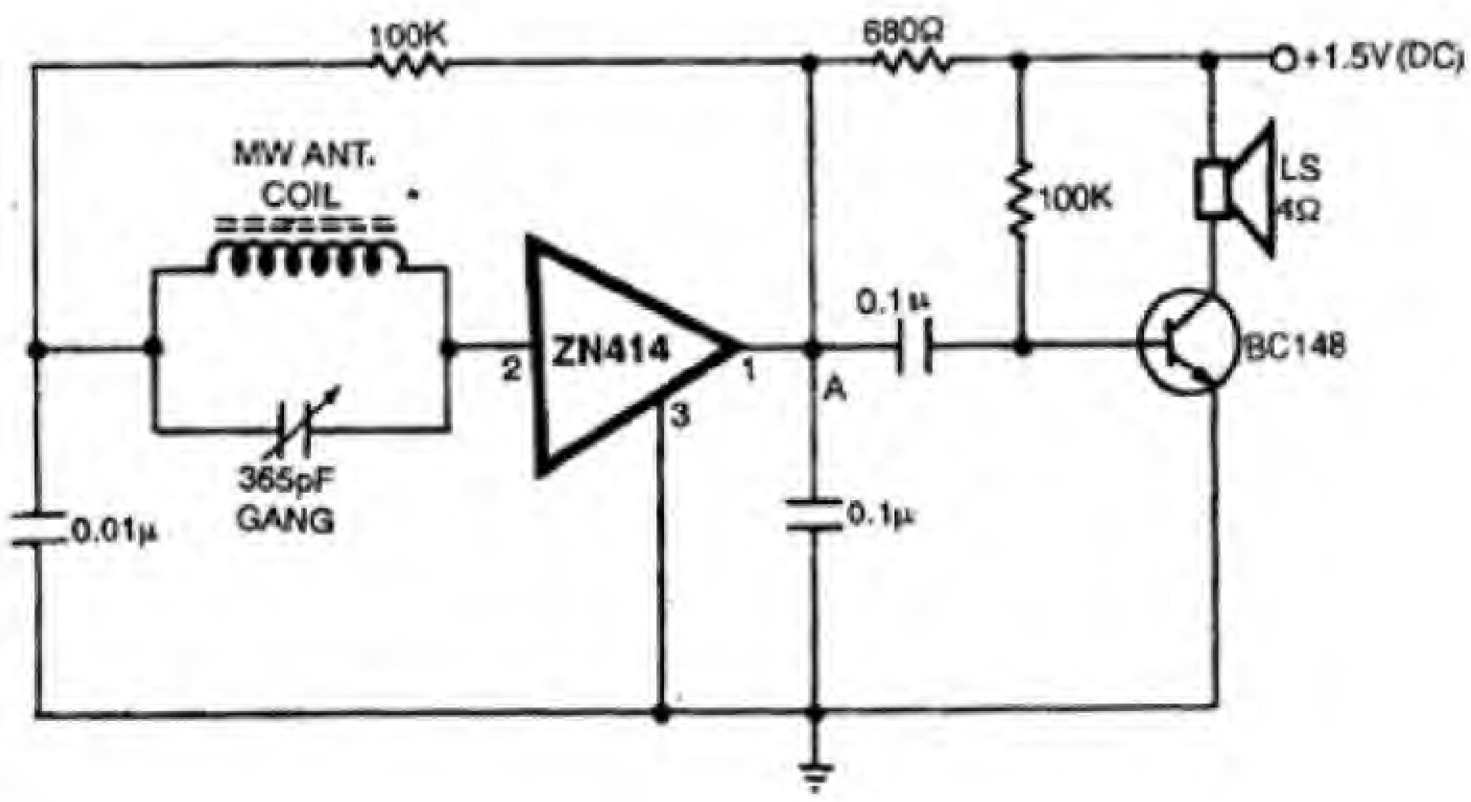


Fig. 1

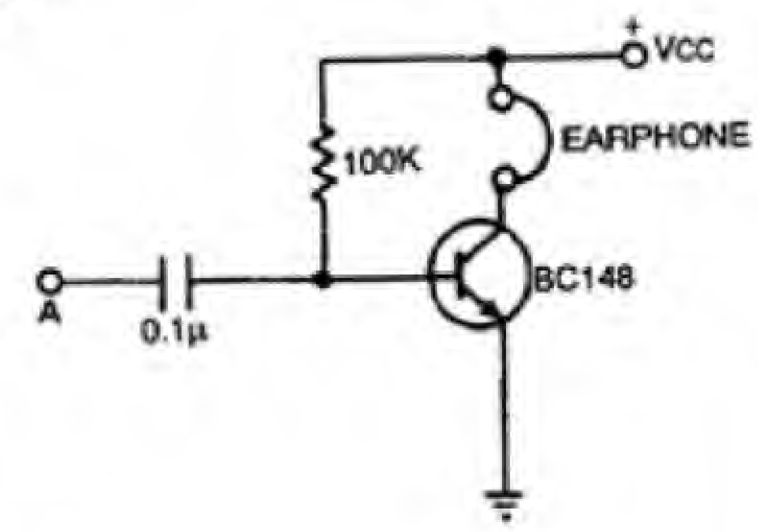


Fig. 2

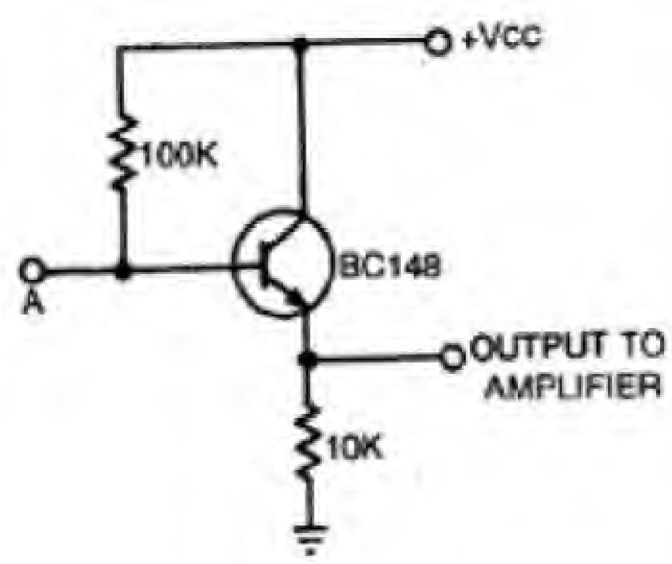


Fig. 3

given in Fig. 1.

To make the output more audible outdoors, single transistor amplifier as shown in Fig. 2 may be employed. The entire circuit operates on a single pencil cell battery.

To use the circuit as a table receiver, the output should be connected to the coupling circuit (Fig. 3), such that impedance is matched. The impedance provided by the circuit shown is approximately 8 megohms. The antenna coil used should be of good quality.

□

Compact Audio Cassette Duplicator

Abhijit Prosad Basu

The Circuit of Audio cassette duplicators usually consist of two stages: (i) a playback amplifier stage, and (ii) a recording amplifier stage.

In stage (i), a deemphasis of about 25dB is given to the high frequency component of the signal for equalisation. In stage (ii) a preemphasis of about 30dB is given again to the same high frequency component of the signal. But in the circuit described here, both of the above equalisations are provided in the same playback stage by means of an LCR network. This is a short cut process which saves at least two amplifying stages, thus the circuit becomes simpler and the noise figure improves.

Moreover, instead of weak and unstable coil bias oscillators, this circuit employs IC 555 oscillator for bias and eraser. This oscillator is free from RF interference and can deliver higher current than the former. So the value of the blocking resistance in series with AF amplifier output is much reduced, (from > 33k in common recorders to a

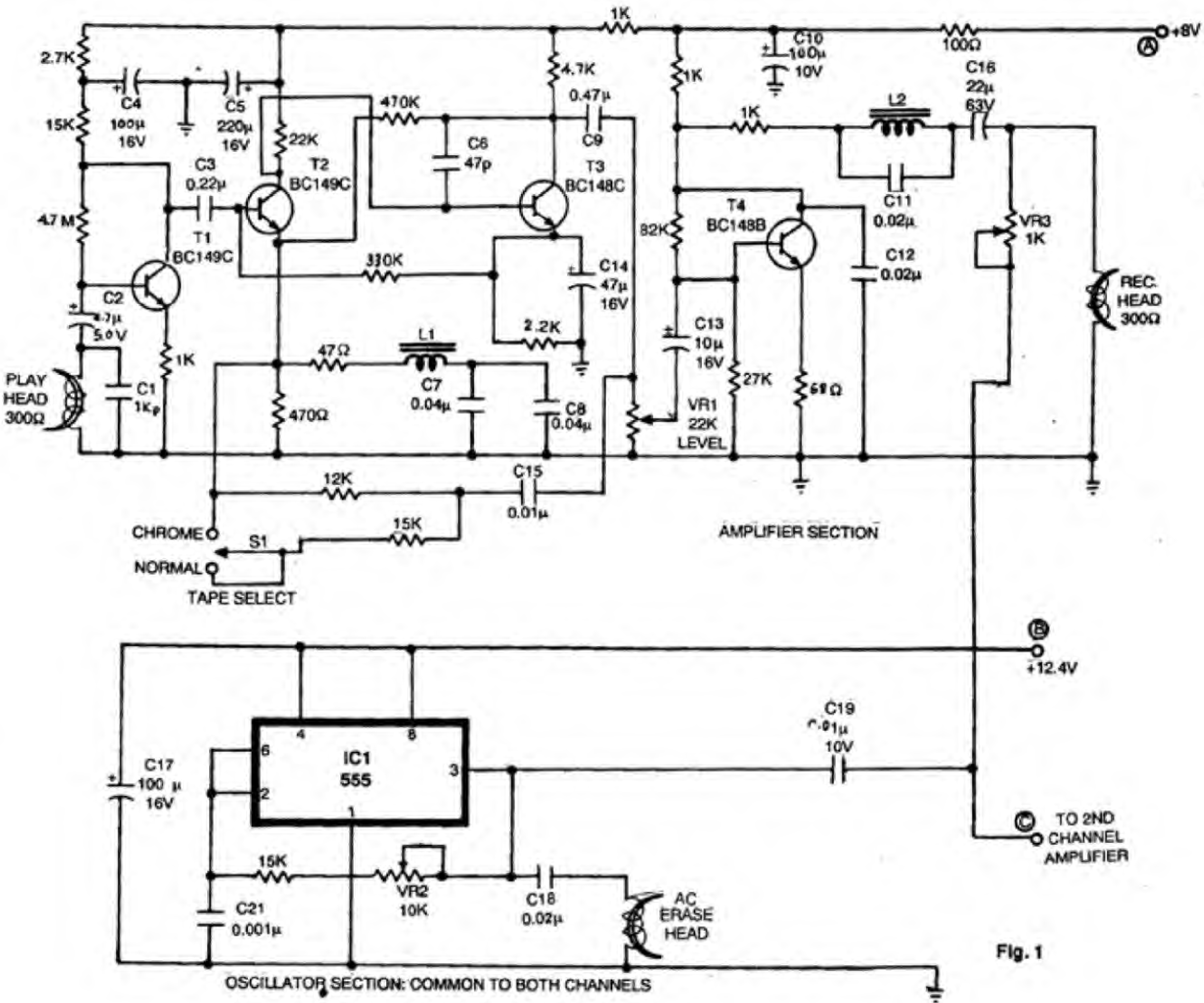


Fig. 1

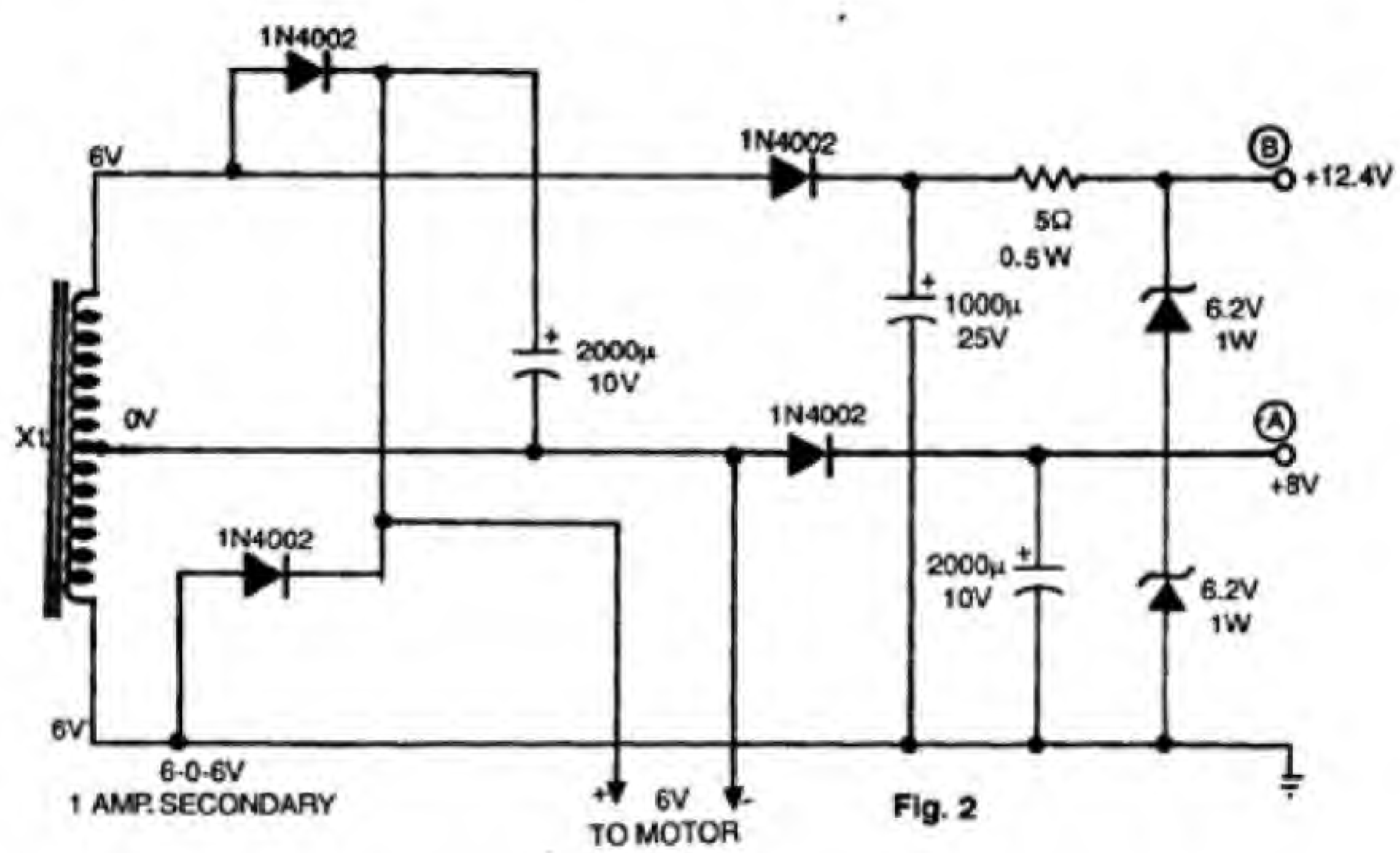


Fig. 2

mere 1k) which allowes a higher current through the recording head at a comparatively lower voltage. Thus, the need of a high output amplifier is eliminated, which simplifies the circuit further.

The amplifier section of this circuit is built around four discrete low noise transistors. Since the maximum rms voltage across the recording head will be about 1.2V, hence op-amps, which are comparatively noisier and costlier devices, are not used here. The input impedance of the circuit is >300k (ordinary tape preamps have an input impedance of about 20k), which ensures a good reponse at frequencies >10kHz.

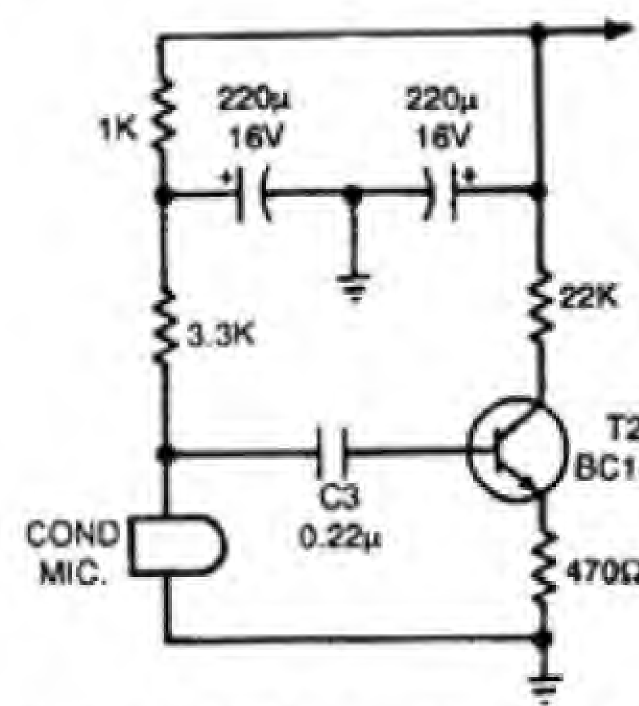
The input signal from playback head is amplified by T1. C1 peaks high frequency response at about 10kHz. T2 and T3 form a direct coupled amplifier stage. The feedback network from the collector of T3 provides equalisation while T4 forms the recording amplifier. This part of the circuit needs an 8V DC supply. IC1 is the bias oscillator whose frequency can be varied from 30kHz to 60kHz by VR2. VR3 sets the bias level. For optimum performance of the circuit, VR2 and VR3 should be correctly adjusted to suit the recording head and cassette tape used. To keep the oscillation stable, a 12.4V regulated supply is provided for this part of the circuit.

To suppress induced noise, the audio circuit should be perfectly shielded by earthed metal foils placed under and around the PCB used. For better fidelity, the amplifier should be mounted under the playback mechanism and the oscillator under the recording mechanism. For carrying the signals, shielded wires are used.

COILS: L1 is a 10kHz peaking coil; 50 turns of 39 SWG copper wire around a ferrite bead used in radio IFTs. L2 is a bias Reflector Coil. Its fabrication is same as L1.

Readers' comment:

Having gone through the readers letters sent to me for my comments, I'd first like to point out the two corrections required in my circuit diagram: (a) C1 is shown as 0.1μF whereas it should be 0.001μF, 50V; and (b) a 0.015μF capacitor should be added in series with VR3 to suppress AF loss through the oscillator. To record through condendser mic., short C15 (0.01μF) and disconnect C3 (0.22μF) from the collector of T1. Now connect the mic. to C3 as shown.



Gain can be varied by the 12k feedback resistor, keeping S1 in normal position.

When the presets are set such that VR2 offers nil resistance and VR3 offers 1k, the treble response is maximum. But non-linear distortion occurs when the recording level is high. And when VR2 offers 10k and VR3 introduces nil resistance, the treble is maximum but high-level recording is possible. The constructor can find out a compromise which is specially suitable to himself. For cheap cassettes it is advised to keep VR2 at mid position and set VR3 only.

Costly deck mechanisms should be avoided. While TN57 deck would be a good choice, cheaper 'flat decks' with low flutter, mounted with conventional glass heads, should be adequate. In any case, two separate mechanisms and heads would be required for the play and recording modules.

I regret my inability to supply a PCB design for the circuit. However, the circuit is not very complicated and can be constructed over a large vero-board.

ABHIJIT PROSAD BASU
Calcutta

Super Simple Interruption Counter

George V. Jr

When there is sufficient light, LDR resistance is low and current passes through LDR. The transistor SL100 does not get any base drive. However, when the beam is cut off, LDR resistance increases and transistor SL100 starts conducting. The voltage at collector of the transistor drops. This low voltage at the collector of the transistor SL100 triggers IC 555 connected in monostable mode to give a 100ms pulse. This pulse is used as clock input for IC2(7490). IC2 is used as mod 10 counter, i.e. output QA and pin 1 of IC 7490 are shorted. 7447 decoder is used to register the number of counts. When count exceeds 9 it goes back to zero, i.e. QD of IC2 changes from logic 1 to logic 0. IC 7490 being negative edge triggered and QD of IC2 being connected to input A (pin 14) of IC3 makes it count upward. Thus three 7490 ICs are cascaded to get a count of 999. This number can be increased by cascading 7490 ICs and using corresponding 7447 decoder ICs to decode the circuit.

The 330-ohm at common anode of LT542 limits current through it and can be varied to alter the intensity.

We can change the sensing part of

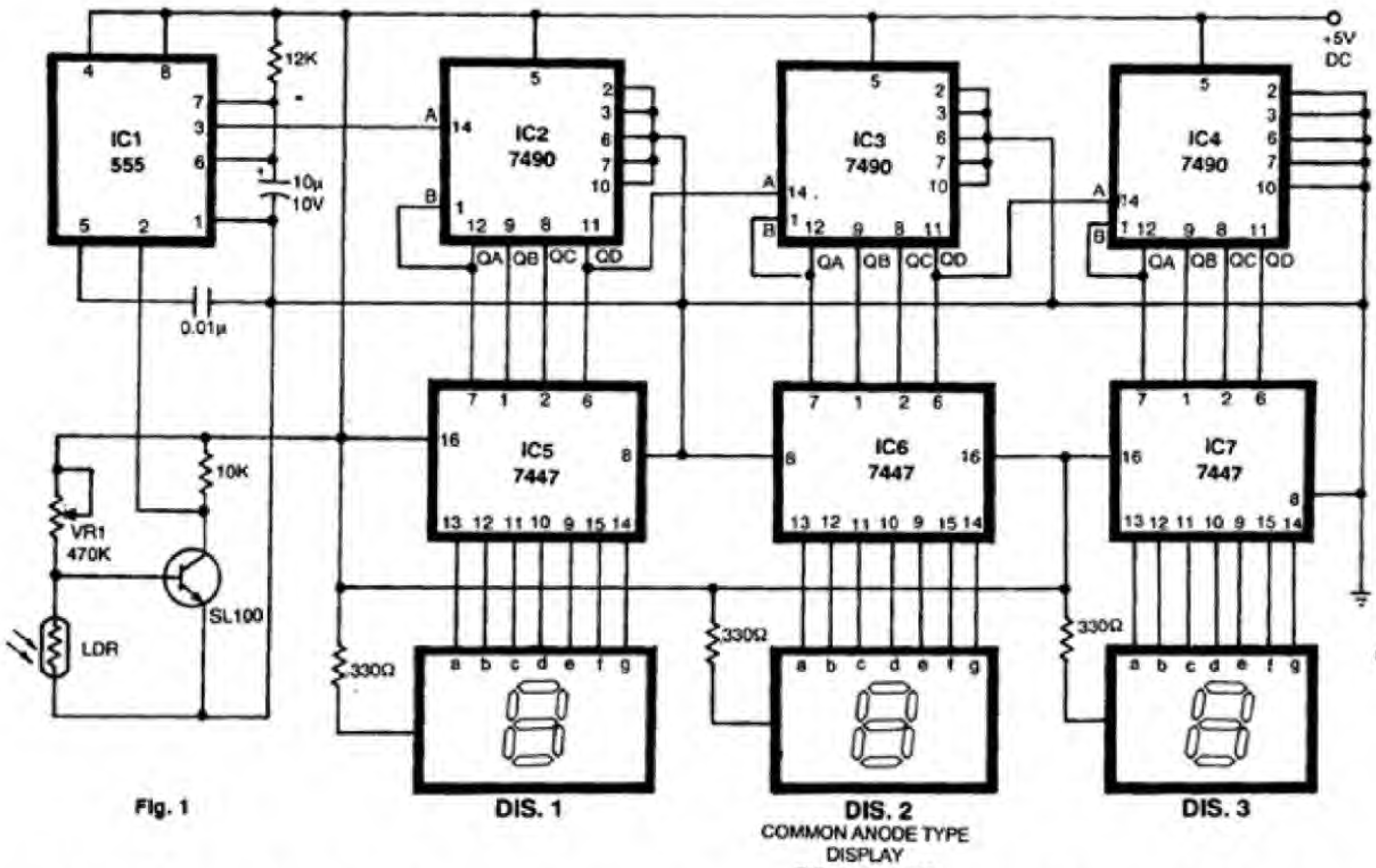


Fig. 1

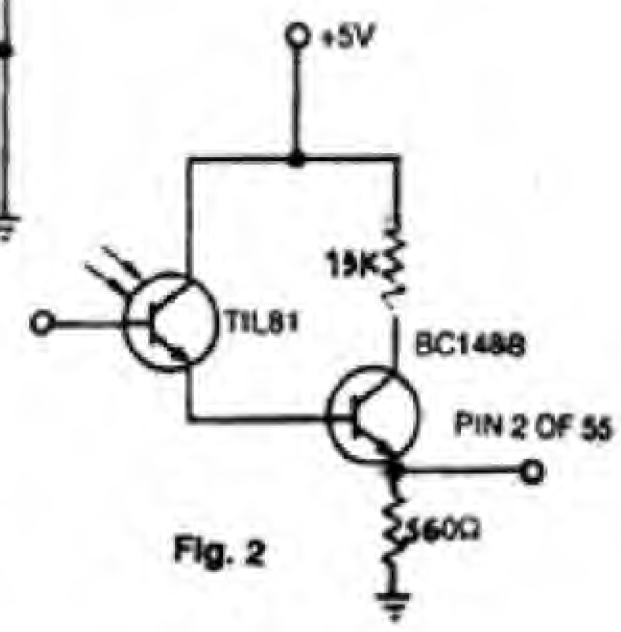


Fig. 2

the circuit so that it can detect interruptions of infrared light using IR photo transistor as shown in Fig. 2.

This circuit provides a novel way to count objects or people by focussing a beam of light (infrared beam) on LDR (IR photo transistor). Each time the beam is cut, the count increases by one.

The 470k pot can be used to adjust the level at which the circuit is to be triggered.

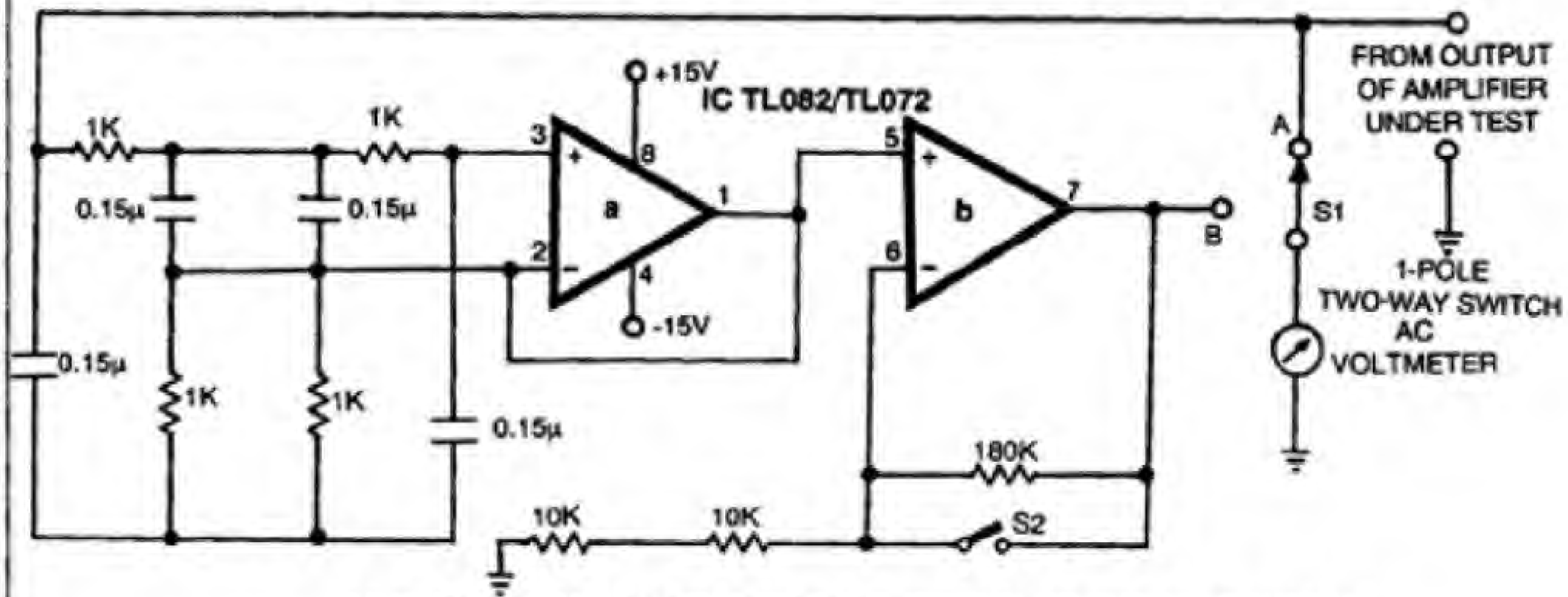
Harmonic Distortion Meter

C. Sanjay

Here is a description of a simple harmonic distortion meter that can tell you if the specifications of the amplifier you just bought is correct or not! This circuit will enable you to measure the total harmonic distortion (THD) of an amplifier at 1 kHz. The value indicated by this meter is accurate when the distortion is more than or equal to 0.1%. The amplifier, whose distortion is to be measured, must be capable of giving an output swing of at least 0.5V.

The harmonic distortion is measured by cutting off the fundamental frequency. This is performed by op-amp "a". The circuit around op-amp a is a twin-T network and serves as a bootstrapped buffer. The Q of the filter being more than 50, makes it possible to cutoff the fundamental frequency sharply and the attenuation is more than 50 to 60 dB. Op-amp 'b' acts as an amplifier when the the distortion is very low, so that the distortion can be measured.

To measure the distortion, connect the output of the amplifer to the input of the circuit, and keep the output level at 1V. Now keep S1 in position A and adjust the output of the amplifier so that the AC voltmeter shows 1V. Now connect a sinewave generator to the amplifier and change S1 to position B. Switch on S2. Adjust the frequency of the oscillator so that the meter shows minimum deviation. Now the distortion is given by voltmeter reading (in volts) × 100%. When the distortion is too small, switch off S2 and then adjust the frequency of the sinewave generator for minimum deviation. Now the distortion is given by voltmeter reading (V) × 10%. The harmonic distortion of the generator should be less than .05%. The amplitude of the signal from the generator should not change with frequency. It is better to use a voltmeter which has AC voltage range around 1V or even less. If the output of the amplifier is less than 1V, the total harmonic distortion can be calculated using the following formula:



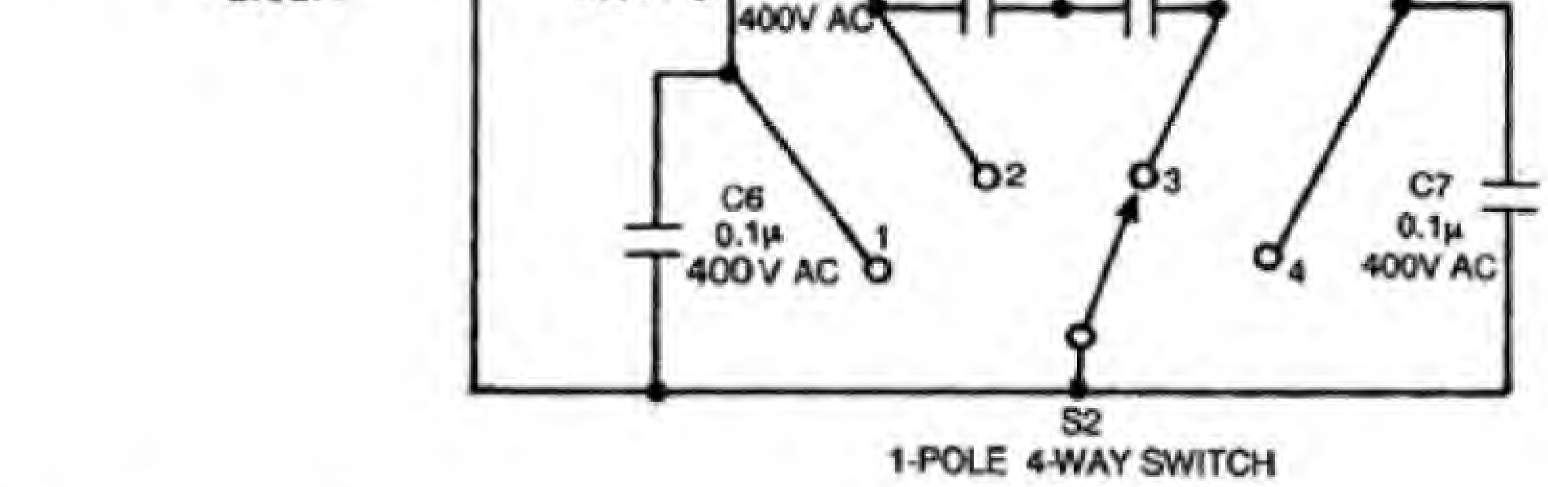
a,b are NE5532. ANY OTHER LOW DISTORTION DUAL OP-AMP CAN BE USED IN PLACE OF NE5532

Condenser Lamp Dimmer

V. Brindavanan

This lamp dimmer is very efficient because no power is dissipated in the resistive elements. In SCR lamp dimmers the firing angle is controlled as a result of which the waveform is distorted. But it is not so with this circuit. The load in this case always works with sine wave irrespective of power delivered to the load or the type of load. The brightness of the lamp can be controlled in many steps. Two lamps, each of 230V, 25W, can be operated together. If wattage of the load is more, the capacitors need slight adjustments. Using suitable values of capacitors any type of load can be controlled. Further, the load is protected from transients.

In this circuit, L1 and L2, two incandescent lamps each of 230V, 25W are connected in parallel. C1, C2 and C3 are chosen, so as to give 1/4, 1/2 and 3/4 of the total power to the load. The capacitors C4-C7 absorb transient voltage and protect the lamp. Unlike SCR lamp dimmers this circuit does not need any triggering circuit. If needed, fuse of suitable rating can be included in the circuit.



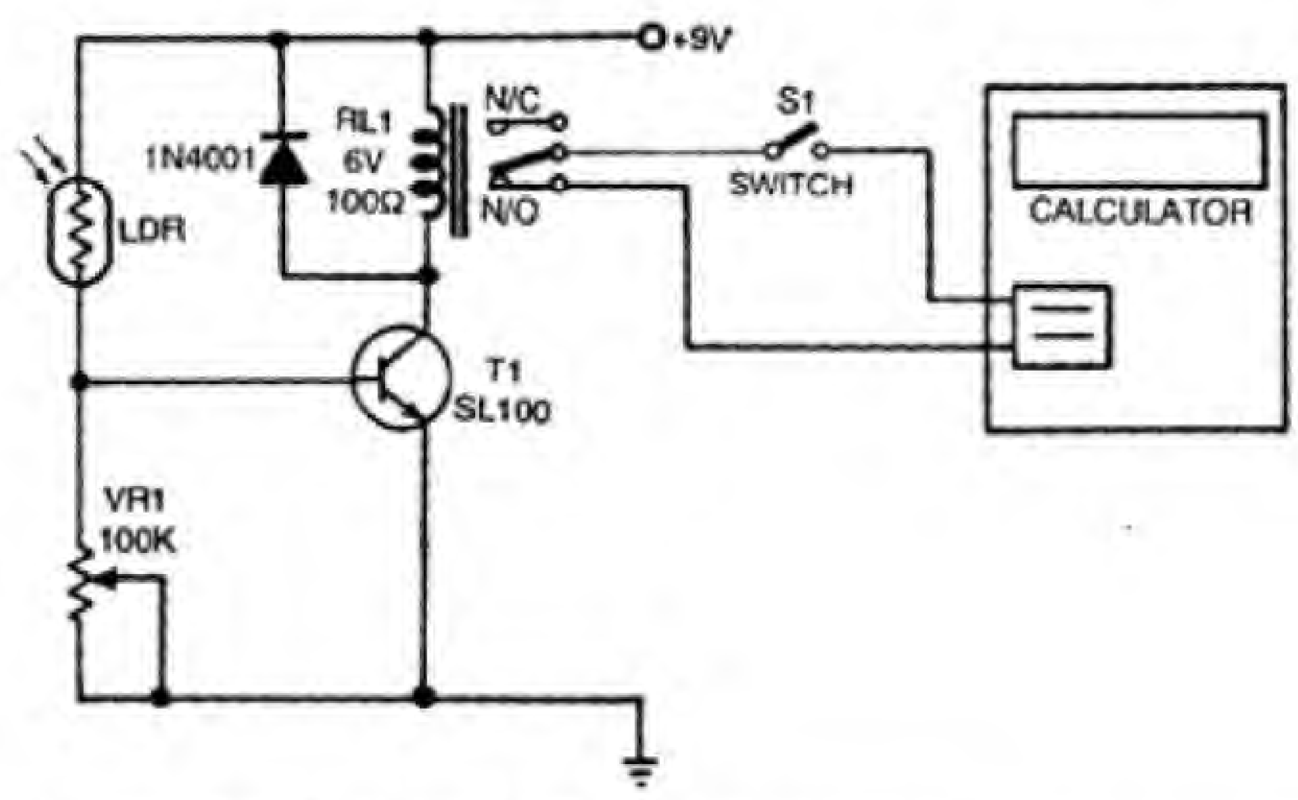
Simple Counter Using Calculator

Sunish Issac

The circuit of a Counter Using Calculator had appeared in EFY (Electronic Projects Vol. I). Though the circuit was cheaper than most commercially available counters, it was more complicated than the given circuit. This circuit dispenses the use of one relay by using a suitable calculator. All the components are easily available and can be assembled even by a beginner.

Two leads are taken from the contacts of the key with '=' sign. The calculator to be used should be one in which pressing '1', '+' and '=' sign gives 1 and each press of equal key after that would result in the increment of the number by '1'. The calculator used in the prototype was LED display calculator of Texas Instruments. The two leads taken from the calculator are connected as shown in the figure.

When light falls on the LDR the resistance becomes low and activates the relay (RL1) with the help of relay driver transistor T1 (SL100).



The sensitivity can be adjusted by the 100k potentio. The number of objects that can be counted depend on the number of digits in the calculator. To set the counter, it is necessary to press '1', '+' and '=' signs, and only then the leads from the calculator should be connected to the relay. Otherwise, pressing other keys would be in vain since the '=' key is in the on position by the relay (S1 is provided for disconnecting the contacts). Suitable enclosures may be used to mount the LDR, calculator and other components.

The same circuit can be modified for many other purposes such as twilight, car dipper, LED driven relay etc.

Note: Memory function of a calculator can be used instead of using '=' key. In this case leads are taken from 'M+' key and initially '1' and 'M+' are pressed. It was tried in a Sanyo calculator model CX 8136 NE and it worked well. To find out the number of objects counted, press 'MRC' if necessary.

Multioutput Regulated Power Supply

V. Brindavanan

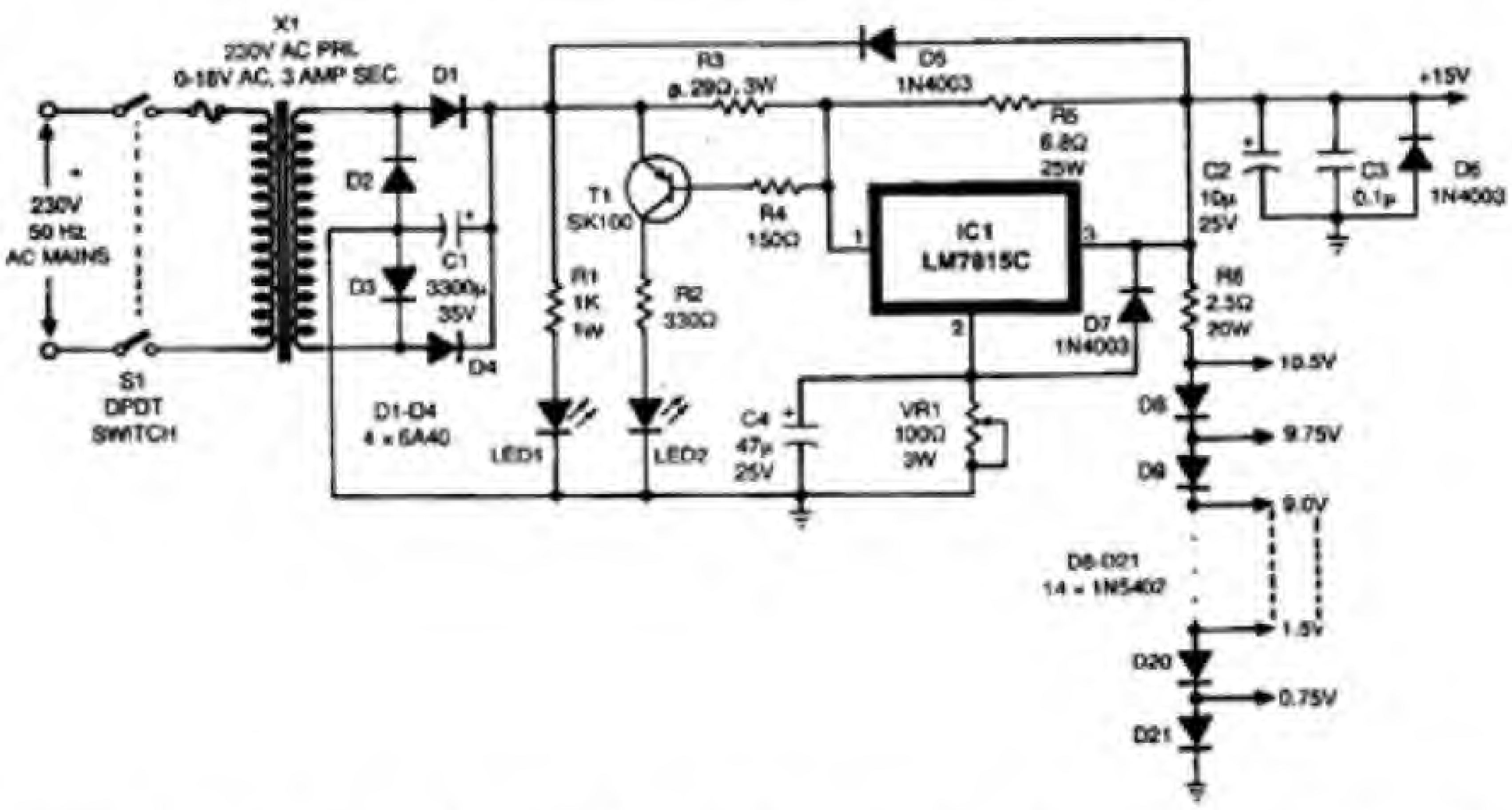
The circuit given here plays an important role when many different values of output voltages are needed simultaneously. The circuit is built around the 3-terminal regulator LM7815C and a chain of 1N5402 diodes. The diodes D8-D21 used here provide simultaneously 0.75V, 1.5V, 2.25V, 3.0V, 3.75V, 4.5V, 5.25V, 6V, 6.75V, 7.5V, 8.25V, 9V, 9.75V and 10.5V. These ouputs, in addition to 15V, have comparable current ratings and load regulation with LM7815C. Each output can supply continuous load current up to 1200 mA individually or in combination.

Additional series diode circuit is used so that the output of LM7815C is not degraded. The LM7815C can deliver 1000 mA load current normally. The output voltage of the regulator can be trimmed around 15V, if needed, using VR1. 1N5402 diodes are used for better regulation.

Capacitor C1 provides filtered DC input to LM7815C. The shunt resistor R5 biases the 1N5402 series didoes and so the regulator is normally not loaded. Each diode can provide 0.75V additional voltage with respect to ground and dissipates approximately 1350 mW. Initially the voltage will be slightly more but after few seconds it will attain a steady value.

Diode D5 protects IC1 from overvoltage feedback, if any, and D7 bypasses the negative voltage feedback. Diode D6 discharges capacitor C4 safely under short-circuit conditions. Capacitors C2 and C3 improve ripple rejection.

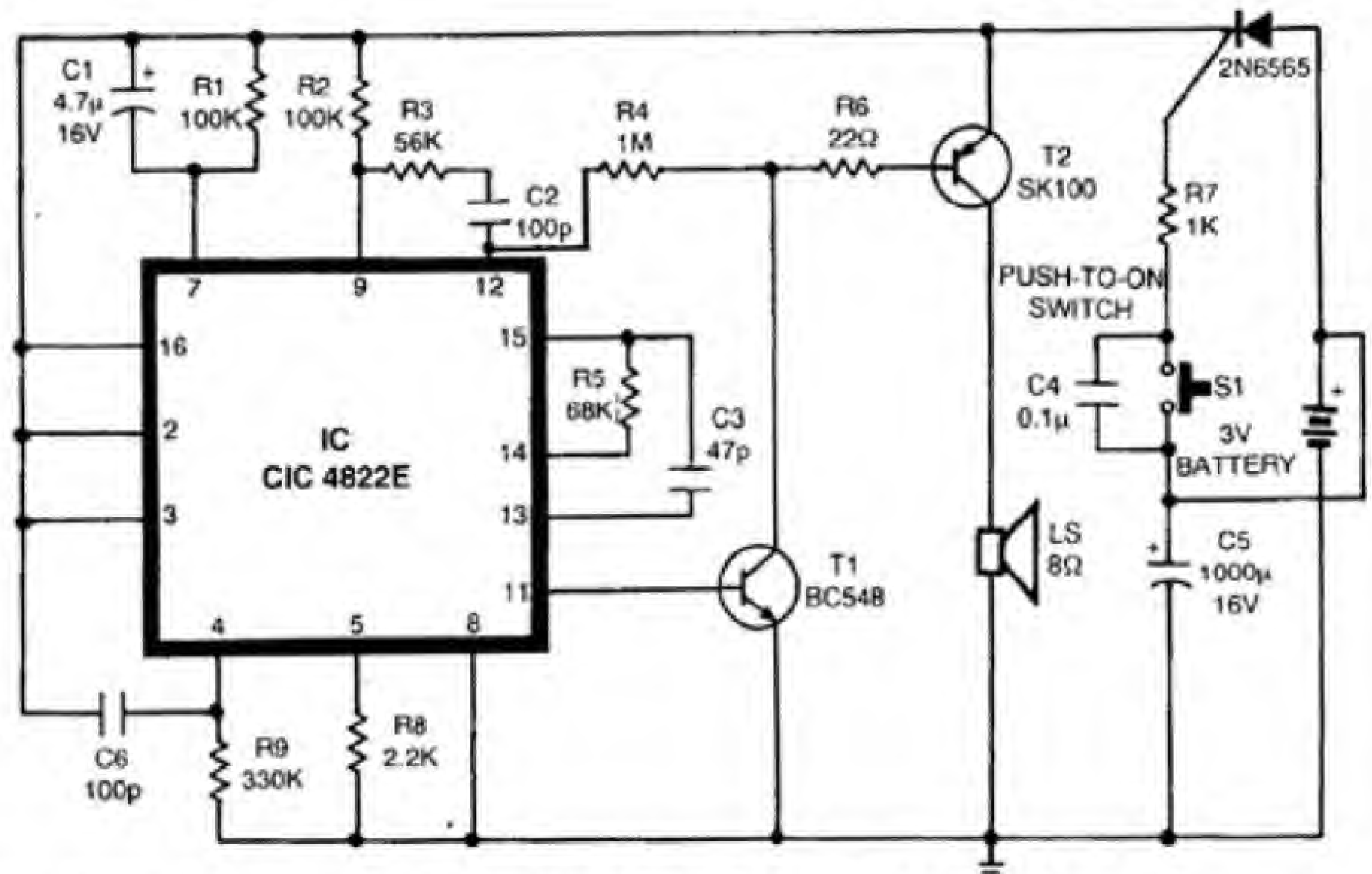
The circuit has complete protection against overload or short circuit which is indicated by the LED2. T1 is switched on to indicate overload whenever the load current exceeds 2000 mA. The regulation is typically around 1.3 per cent at 6 volts for full load current. The ripple voltage will be less than 5 mV or



so. This is valid for all the outputs at full load but the regulation will be better at half loads. Thick wires should be used for all output terminal connections. Diodes D8-D21 should be mounted such that they are not overheated.

Improved Melody Doorbell

Chiranjib Karmakar



Generally, doorbell circuits using ICs and operating on AC mains use step down transformer, for louder sound. Since the circuit has to be kept on all the time, this warms up the apparatus used (transformer etc) and wastes some amount of energy. This circuit operates on 3V DC battery which gives good quality sound. When left idle, the power is electronically shut-off to stop the drainage of standby current, thus increasing the battery life. Another feature of the circuit is that the music has an echo effect which is quite enchanting and pleasing.

The circuit is gated by a thyristor which acts as an efficient electronic switch. When push switch S1 is pressed momentarily, capacitor C4 starts charging. Surge current from the speaker keeps the thyristor on. As soon as a particular melody stops, the thyristor automatically stops conducting, making the current from the battery undetectable.

Transistor T1 amplifies the processed signal from pin 11 of the IC. The signal is modulated by R4 and given to pin 12. It is also modulated by C2 and R3 and given to pin 9. The output signal from T1 is further amplified by T2 and given to the speaker.

The decay period for the echo stroke of the melody is determined by R1 and C1. R5 and C3 at pin 15 set the speed and tone of the melody. Transistor T2 warms up during the operation but cools down as soon as melody stops; so no heatsink is required. The suggested values of the components are optimum.

The circuit is highly efficient in energy conservation. The IC may be replaced by an UM348X.

Voltage-Window Comparator Follows Reference Voltage

M.S. Nagaraj

The use of window comparators are essential in the test circuits which perform the 'GO-NOGO' tests for the various electronic components like resistors, capacitors, zener diodes, transistors, relays etc. The upper and lower threshold voltages are set for the window comparators depending upon the values and tolerances of the components to be tested. Here is a window comparator circuit in which the window width is automatically adjusted to be a fixed percentage of the input reference voltage. The circuit receives reference voltage V_{ref} proportional to the nominal value of the component under test and produces an upper threshold voltage V_{ref}-Hi and lower threshold voltage V_{ref}-Lo. The two threshold voltages are equally spaced around the reference voltage.

For example, consider a case of testing a zener diode having a nominal value of 10 volts with a tolerance of five per cent. The reference input is adjusted to 10 volts and the tolerance selection switch is placed in five per cent position. The circuit generates upper threshold voltage of 10.5 volts (five per cent more than V_{ref}) and lower threshold voltage of 9.5 volts (five per cent less than V_{ref}). The LEDs indicate whether V_{signal}, which is proportional to the actual zener voltage, is within or outside the voltage-window.

Comparators b and c form the window comparator. Op-amp a forms a non inverting amplifier. The gain of op-amp is set by resistors R1, R2, Rf and VR. When the values of R1 and R2 are equal, upper and lower threshold voltages are given by

$V_{ref}\text{-Hi} = V_{ref}\,(1 + (T/100))$ and

$V_{ref}\text{-Lo} = V_{ref}\,(1 - (T/100))$

where T is the percentage tolerance selected by the switch.

It can be seen from the circuit that $(R2/(R2+Rf+VR)) = T/100$. Therefore, $(Rf+VR) = (R2(100-T))/T$. The values of resistors, forming the voltage dividers for different positions of switch S1, are shown in Table I for different tolerances. The LED indications for the values of V_{signal} relative to upper and lower threshold voltages are shown in Table II.

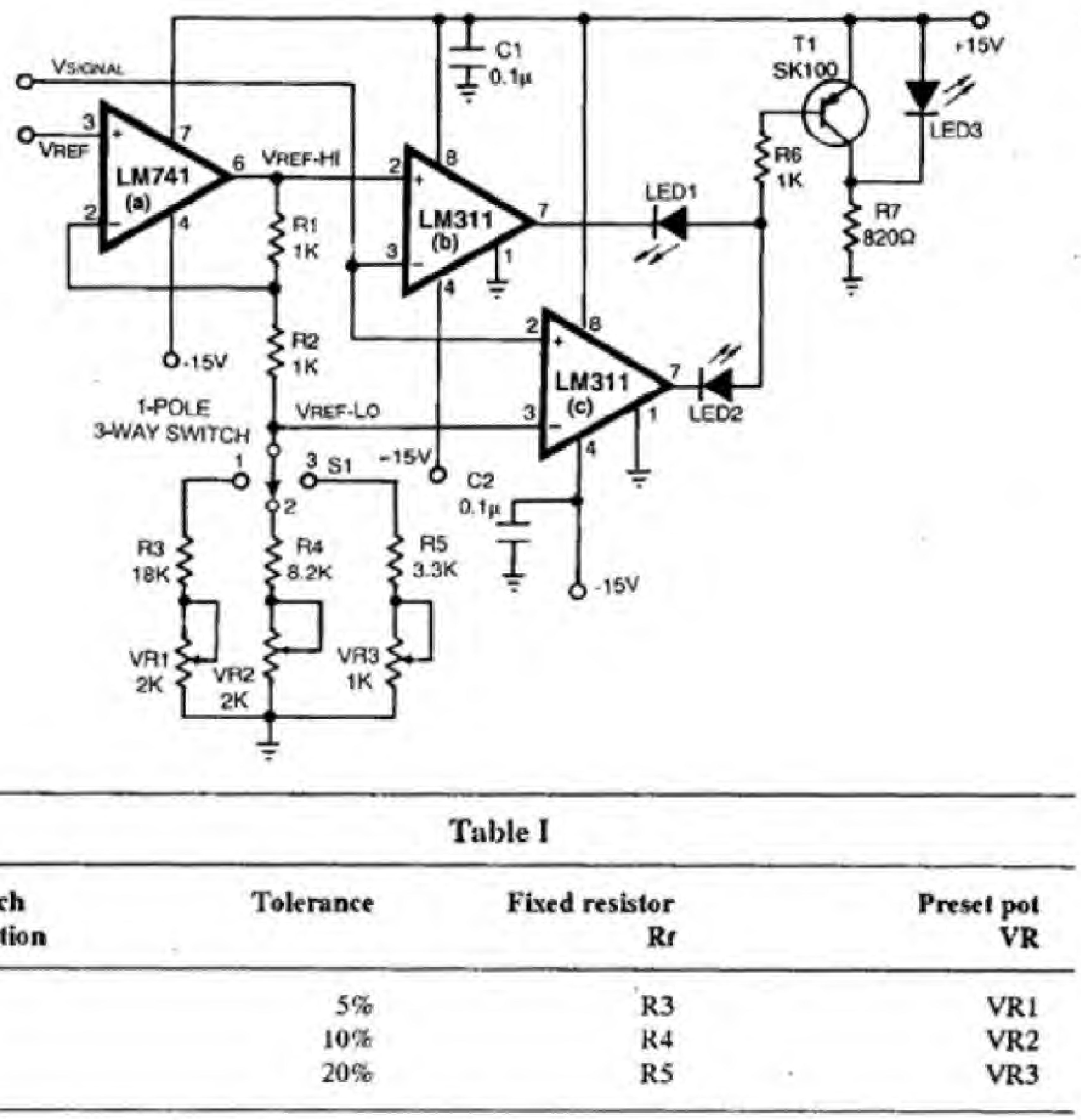


Table I

Switch position	Tolerance	Fixed resistor Rf	Preset pot VR
1	5%	R3	VR1
2	10%	R4	VR2
3	20%	R5	VR3

Table II

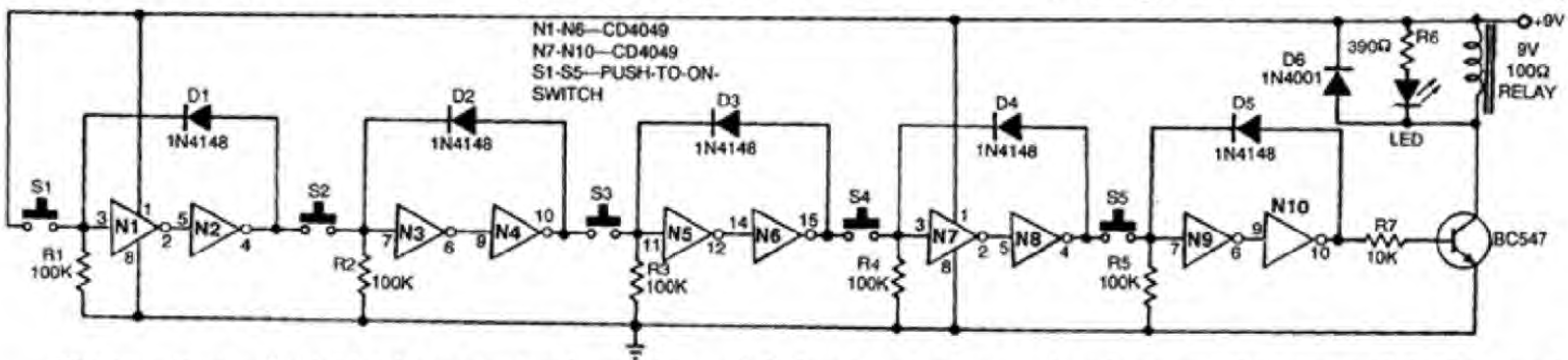
Glowing LED	Indication
LED1	$V_{signal} > V_{ref}$-Hi
LED2	$V_{signal} < V_{ref}$-Lo
LED3	V_{ref}-Hi > V_{signal} > V_{ref}-Lo

Low Cost Digital Code Combination Lock

Kalpesh T. Dalwadi

Many such circuits have been published earlier in EFY, one of which employed five 555 ICs.

This circuit uses only two ICs and it is easier to construct and understand. It can be used as a car lock or any other system for security.



The circuit uses digital latches constructed using CMOS inverters.

N1, N2 along with D1 form a latch. When S1 is pressed momentarily, output of N2 is at logic 1. This makes D1 forward biased and feedback is provided at the input of N1. Now, even if S1 is released, output of N2 is held at logic 1. Logic 1 at the output of N2 triggers the next latch comprising N3, N4 and D2.

Thus, pressing switches S1 to S5 one by one activates the relay. This is indicated by the LED. As soon as the relay activates, LED starts glowing.

This circuit can be used as a car code lock by connecting the relay contacts between the battery and the ignition system of the car.

Prepare a matrix of 0 to 9 numbers. From the matrix any desired 5-digit code can be obtained. Using this code in the switches S1 to S5 the code lock can be made. The lock would have 100,000 possible combinations!

For using it as a car lock, it is recommended to operate the circuit at a voltage lower than the 12V battery voltage, so that, even if the battery is discharged by 2 or 3 volts, the relay still operates.

The circuit can easily be constructed on a general-purpose PCB. The circuit would cost around Rs 45 excluding power supply.

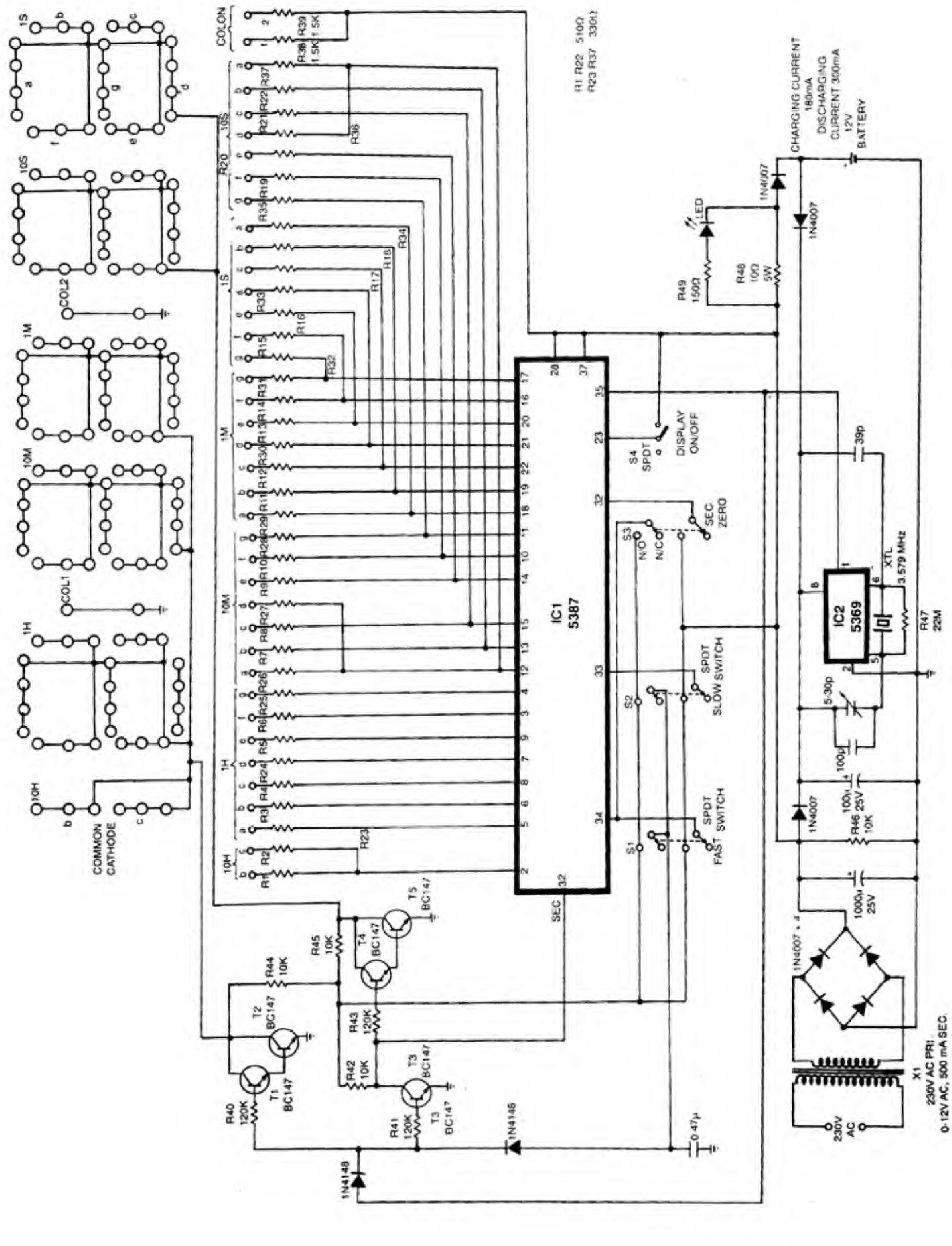
Seconds Display for Digital Clock

V. Ramparkash

Several circuit ideas have been published in EFY for a 6-digit digital clock. The circuit presented here uses the multiplexing technique to display seconds already counted in the 5387 clock IC.

It is well known that seconds can be displayed by IC 5387 by applying positive supply to pin 32. But during seconds display, the minutes display moves over to hours display. So, if we can provide a parallel display for seconds, and energise it only when seconds display is selected in the clock IC, and simultaneously blank minutes and hours displays, the seconds will be displayed in the extension display.

After some time, the positive voltage to seconds may be removed. The seconds display is blanked out and displays for hours and minutes are energised. The clock will now display hours and minutes. This process of alternately displaying hours and minutes/seconds is repeated at 60 Hz. At this rate, the displays will appear to be always on. The hours and minutes displays are grouped together and driven by darlington pair T1 and T2. Darlington pair T4 and T5 drives seconds display. Transistor T3 supplies positive voltage to seconds input of IC while seconds display is energised. if the battery used is the maintenance-free type it will keep the clock running as well as the display on, even in case of power failure. However, conventional connection to IC 5387 can also be used to disable display during power failure.

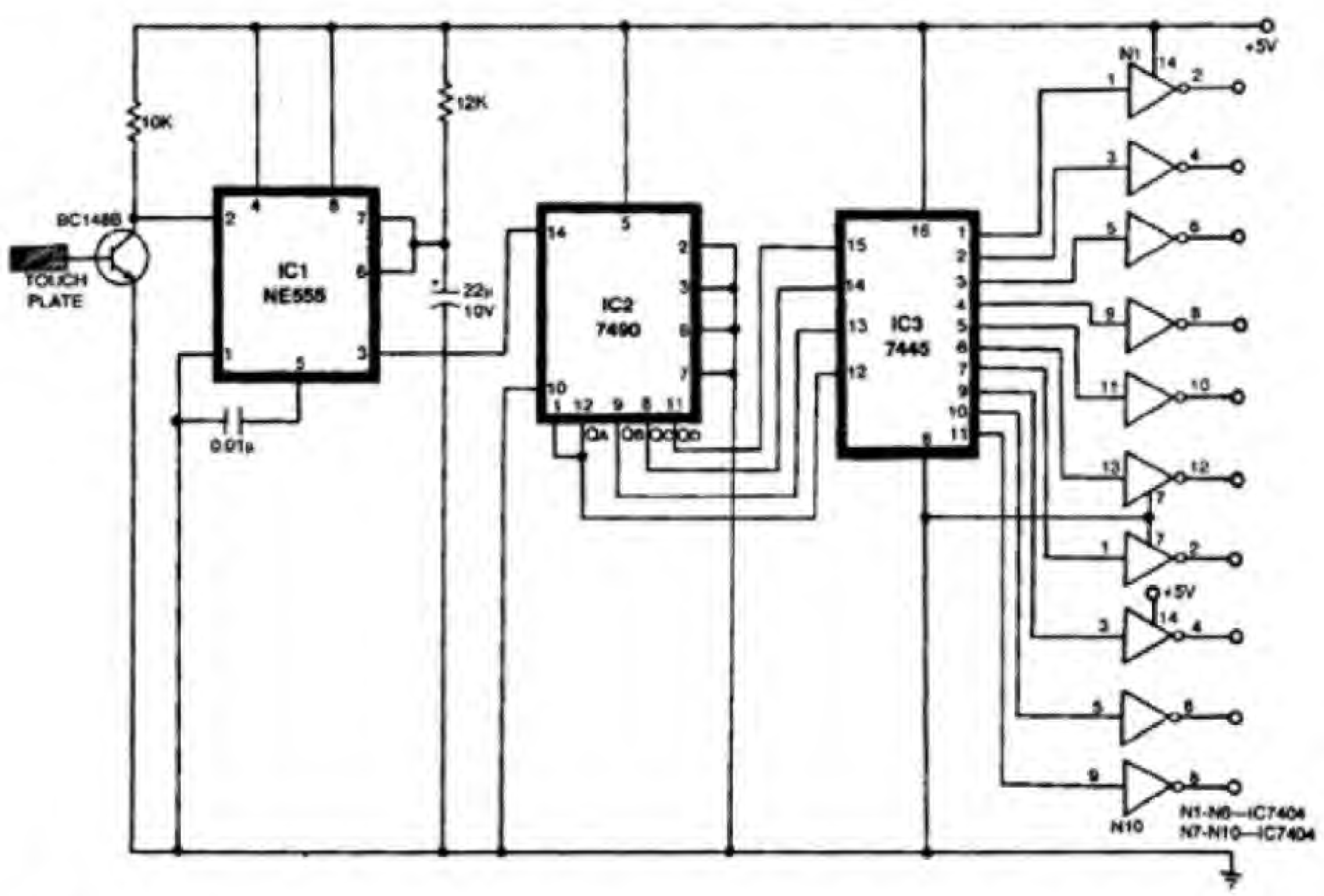

COMMON CATHODE
10H
1H
COL1
10M
1M
COL2
10S
1S
COLON
R1 R22 510Ω
R23 R37 330Ω
R38 1.5K
R39 1.5K
IC1 5387
SEC
S4 SPDT
DISPLAY ON/OFF
S3
SEC ZERO
S2
SPDT SLOW SWITCH
S1
SPDT FAST SWITCH
IC2 5369
XTL 3.579 MHz
R47 22M
39p
5-30p
100p
CHARGING CURRENT 180mA
DISCHARGING CURRENT 300mA
12V BATTERY
1N4007
LED
R49 150Ω
R48 10Ω 5W
100µ 25V
R46 10K
1000µ 25V
X1 230V AC PRI. 0-12V AC, 500 mA SEC.
230V AC
T1 BC147
T2 BC147
T3 BC147
T4 BC147
T5 BC147
R40 120K
R41 120K
R42 10K
R43 120K
R44 10K
R45 10K
1N4148
0.47µ

10-Channel Touch Switch

George V. Jr

The circuit described here allows the selection of a channel out of 10 channels by simply touching a touch plate. By lightly touching the touch plate (base of BC148), the transistor is driven into its on state. When the transistor is off, i.e. when the base of BC148 is not being touched, voltage at collector will be +5V. When the transistor is on, it will trigger IC 555 which is in monostable mode. This produces 200ms pulses at pin 3 of 555. These pulses are given as clock signal to IC 7490, connected as MOD 10 counter.

Initially, when the touch plate is touched, output QA of IC7490 will become high and QB, QC, QD will be low. These outputs are connnected to IC 7445 (decoder) characterised by inverted outputs, i.e. for the BCD input corresponding output is inverted. Hence, inverters are used (i.e. IC 7404) to get high output corresponding to each touch. This output can be used to drive relays via transistors or analogue switches.

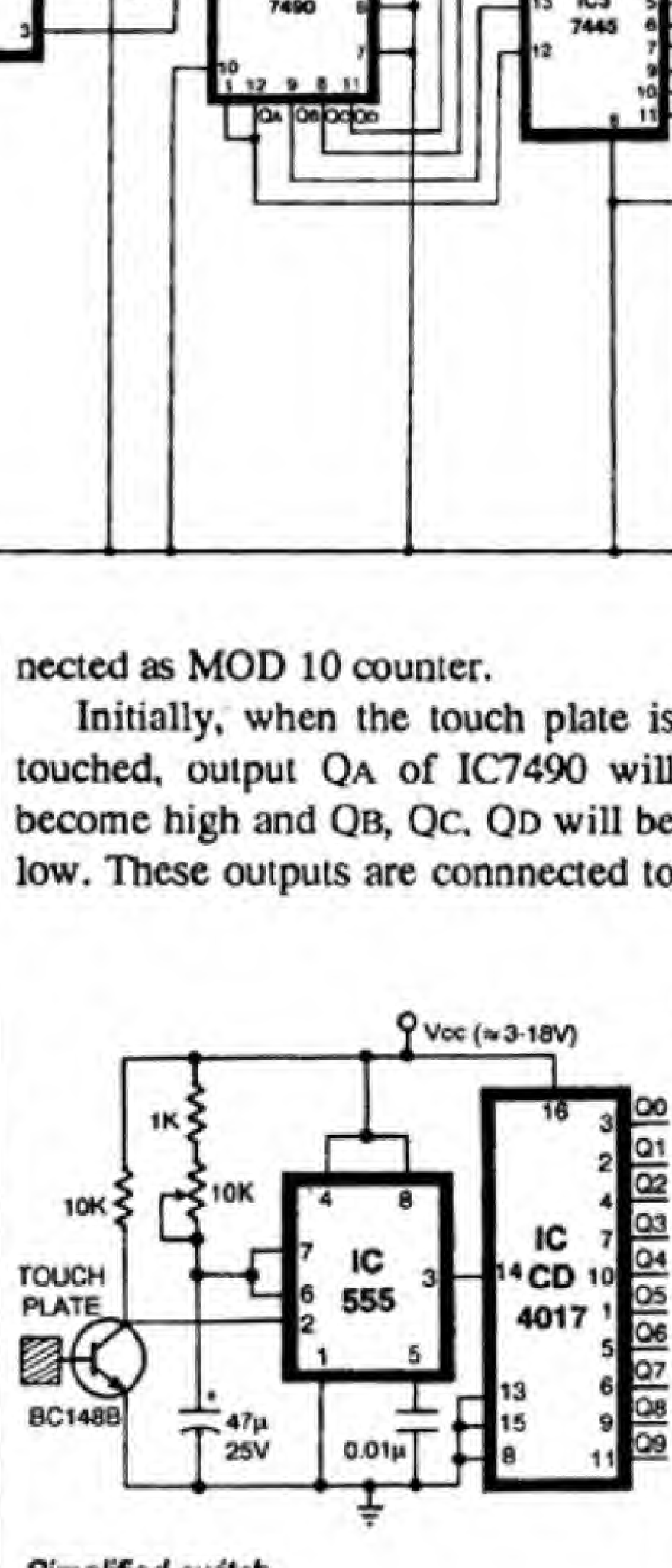


Readers' comments:

The circuit can be further simplified and made cheaper to build. I have designed the same circuit using just two ICs.

This circuit, costing Rs 25 approx., works properly from 3 to 18 volts. Use of CD4017 also eliminates the need for inverters at the output stage. Transistors can be used at the outputs of 4017 IC to drive relays etc.

AMIT KANDA
Aurangabad



Simplified switch.

The author, Mr George V. Jr, replies: Several letters have been received giving the same suggestion, which is absolutely correct. The reason why I did not use the 4017 was that I had access to TTLs only at that time. I am thankful to all these readers.

Auto Cut for Manual Stabilisers

Santosh K. Mahapatra

Many circuits have been published about the auto-cut arrangement in manual stabilisers. These circuits generally use transistors with zener diodes as the only sensing device. However, these circuits have two main drawbacks.

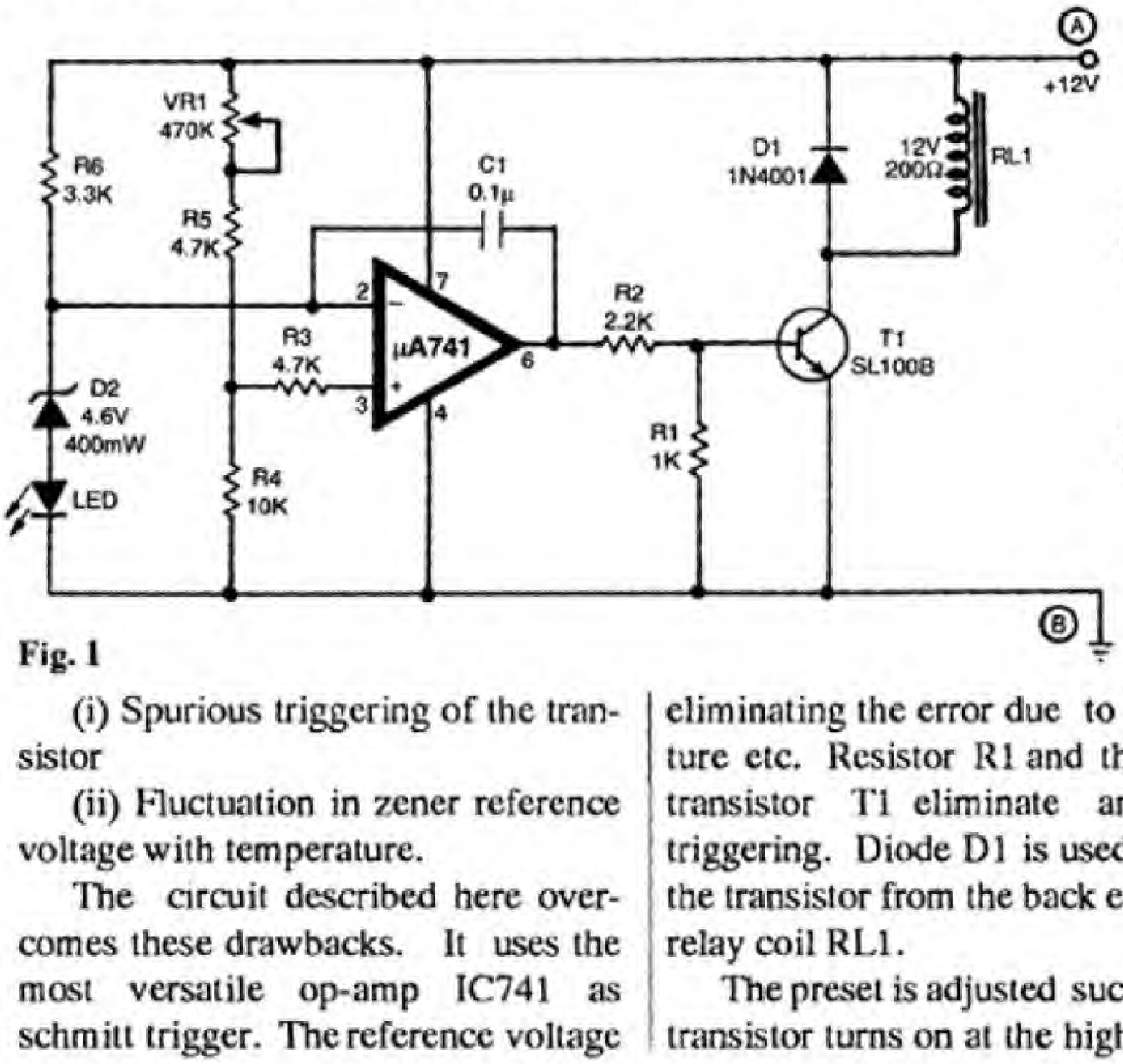


Fig. 1

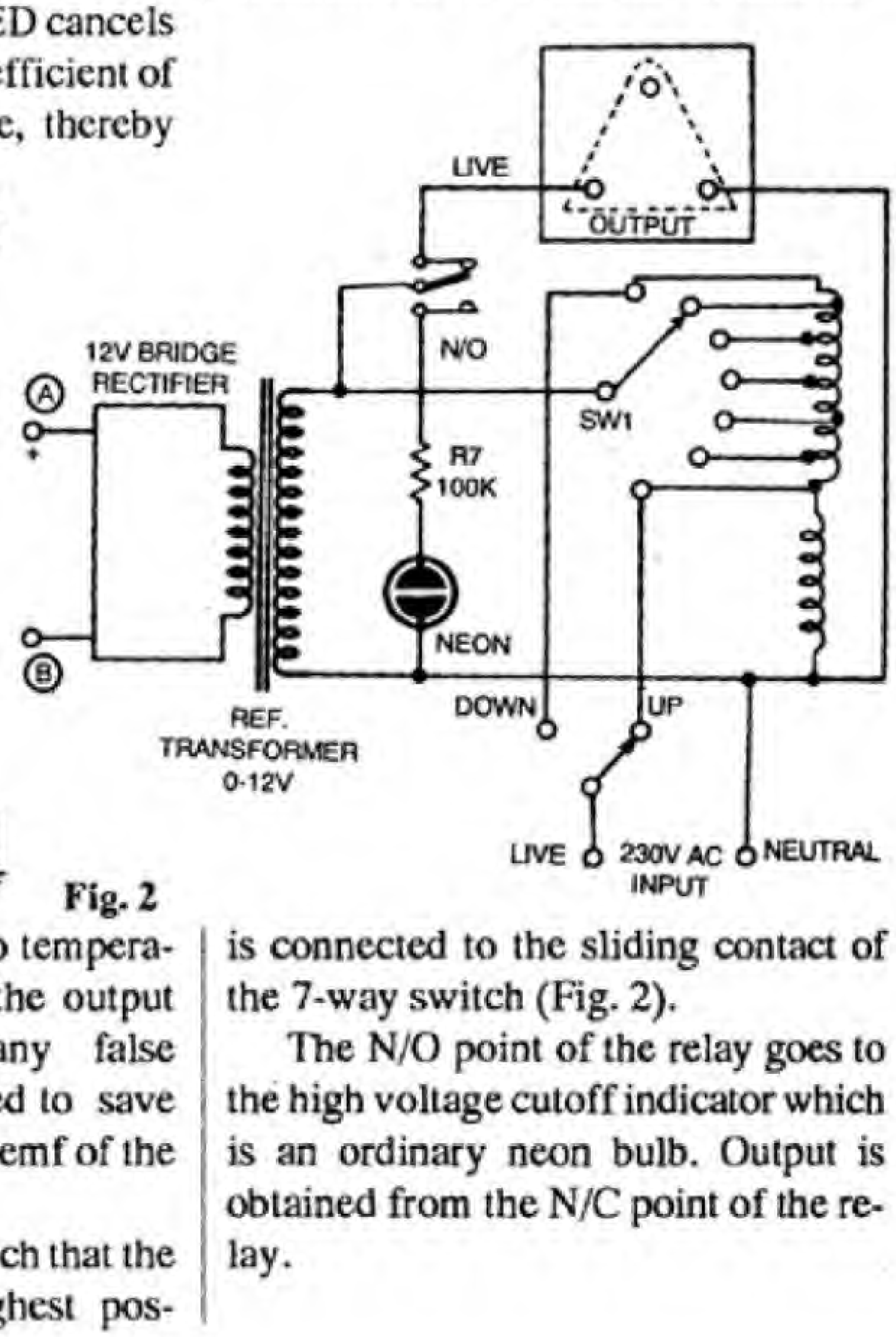


Fig. 2

(i) Spurious triggering of the transistor

(ii) Fluctuation in zener reference voltage with temperature.

The circuit described here overcomes these drawbacks. It uses the most versatile op-amp IC741 as schmitt trigger. The reference voltage is given by a combination of 4.6V, 400mW zener diode D1 and a 1.6V LED. The negative temperature coefficient of forward biased LED cancels the positive temperature coefficient of reverse biased zener diode, thereby eliminating the error due to temperature etc. Resistor R1 and the output transistor T1 eliminate any false triggering. Diode D1 is used to save the transistor from the back emf of the relay coil RL1.

The preset is adjusted such that the transistor turns on at the highest possible voltage on mains. Points A and B are connected to the reference transformer. The reference transformer is connected to the sliding contact of the 7-way switch (Fig. 2).

The N/O point of the relay goes to the high voltage cutoff indicator which is an ordinary neon bulb. Output is obtained from the N/C point of the relay.

Delay Starter

N. Devasaham and
S. Vasanthi

The systems using compressors such as airconditioners, refrigerators, freezers etc are to be cared for properly to avoid damage to the compressor due to fluctuations in the line voltage. After switch off, if it is switched on immediately, the compressor may fail. This is avoided by connecting it through DOL (direct on line) starter.

The DOL starter trips the supply as the power fails. When the power resumes, the starter has to be started manually. But the presence of an operator round the clock is not always possible. This problem is overcome by the delay

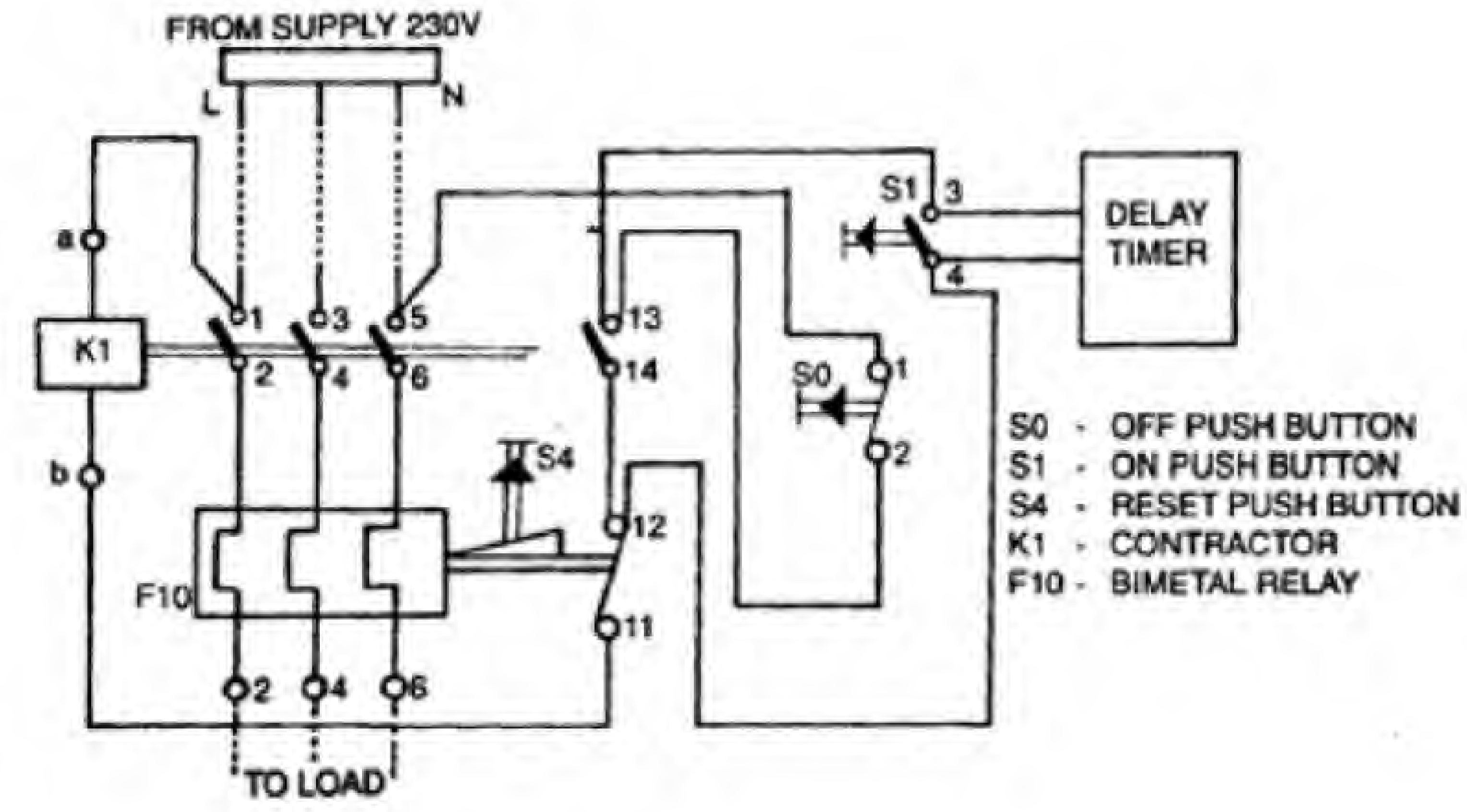


Fig. 1

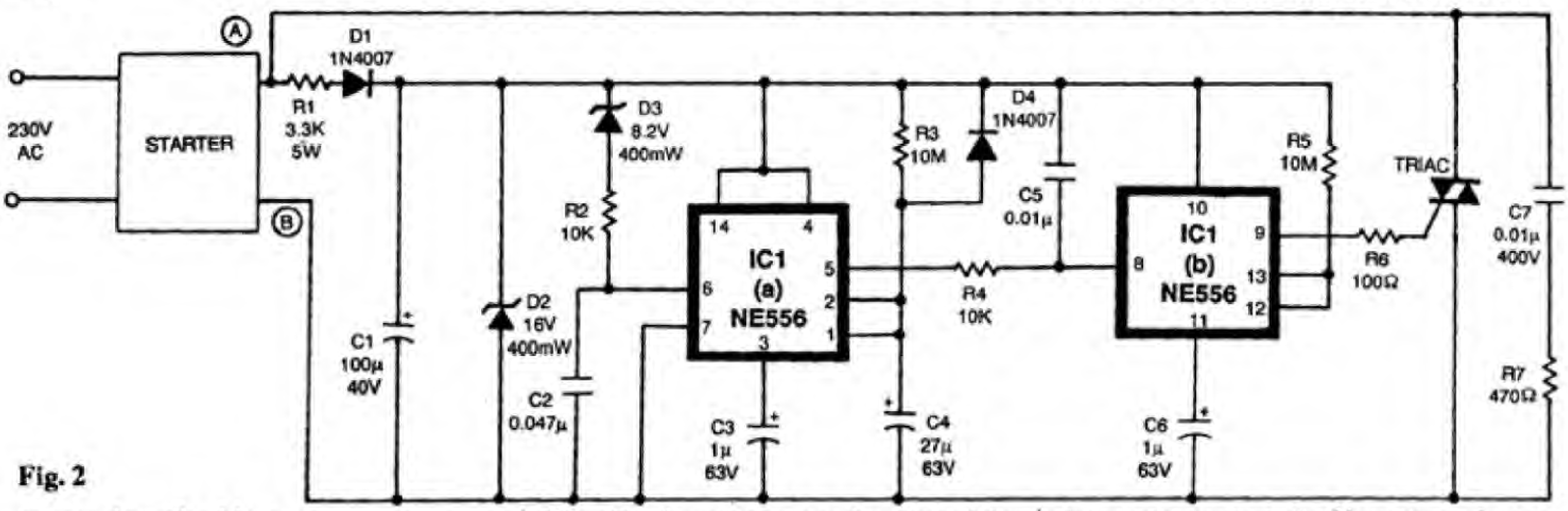


Fig. 2

starter described here.

Fig. 1 shows the wiring diagram and Fig. 2 the circuit diagram of the delay timer. The delay is set to approximately 4 minutes. The circuit is built around the dual timer IC 556 and a triac.

As shown in the wiring diagram (Fig. 2), the starter can be started by pressing the start switch S1. While it is not pressed, 230V AC is available across S1. This voltage initiates the delay timer and after the set delay, the triac which is across the start switch S1 is swithced on. 230V AC appears across the contactor coil K1 and the starter automatically starts.

230V AC is stepped down suitably by resistor R1, rectified and filtered using diode D1 and capacitor C1. The charging of capacitor C2 is delayed due to D3 and R2. Therefore the voltage across capacitor C2 is low. This low voltage triggers IC1a and the output of IC1a goes high. When the output becomes 8.2V, capacitor C2 starts charging. The output of IC1a stays high for a period determined by R3 and C4 and then it goes low. This low voltage triggers IC1b. The output of IC1b goes high and triggers the triac. This short circuits the start switch and the starter is started. Now there is no supply to the timer circuit as the voltage across the starter is 0V. The total delay is approximately 4 minutes. Diode D4 is provided for the immediate discharge of capacitor C4. Capacitor C7 and resistor R7 form the snubber network to protect the triac.

Door Alarm

K.A. Sakthidharan

Door alarms find applications where security measures get top priority. The alarm described here works in two modes:

(i) It produces a low beep sound when the door is opened and stops when the door is closed.

(ii) It produces a loud alarm when the door is pushed open. This alarm cannot be stopped by simply closing the door.

S3 is a normally closed leaf switch. A normally open leaf switch (usually seen with cassette mechanisms) can be easily converted into a normally closed one by bending one of its leaves against the other. S3 is placed on the door in such a way that it is closed when the door is open.

In mode (i) the audio alarm and SCR get positive supply only when S3 is closed. When it is open the SCR stops conducting (Fig. 1).

In mode (ii), switch S3 is used for firing the SCR. Once the SCR is triggered, it conducts continuously until the power supply is interrupted.

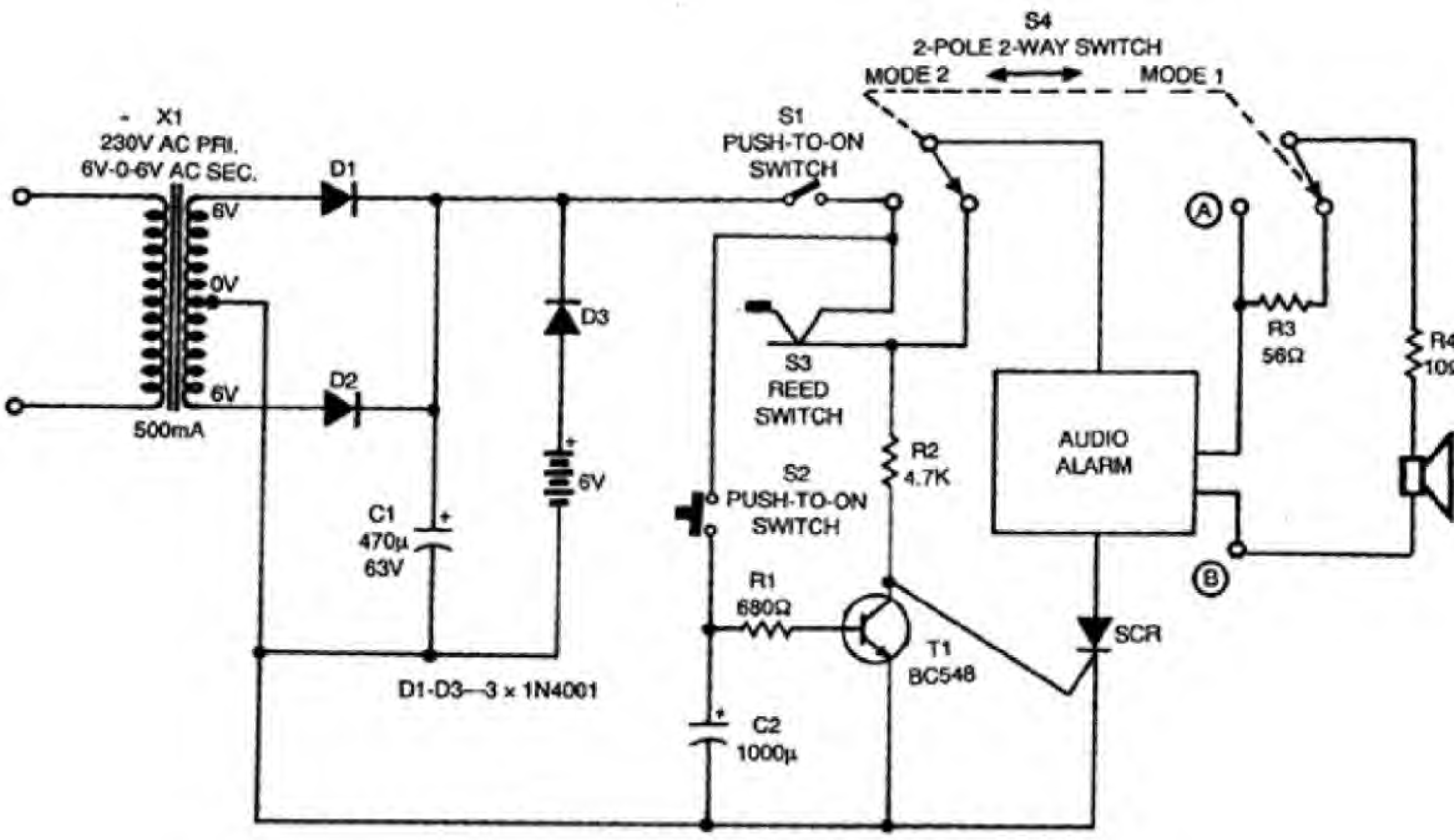


Fig. 1

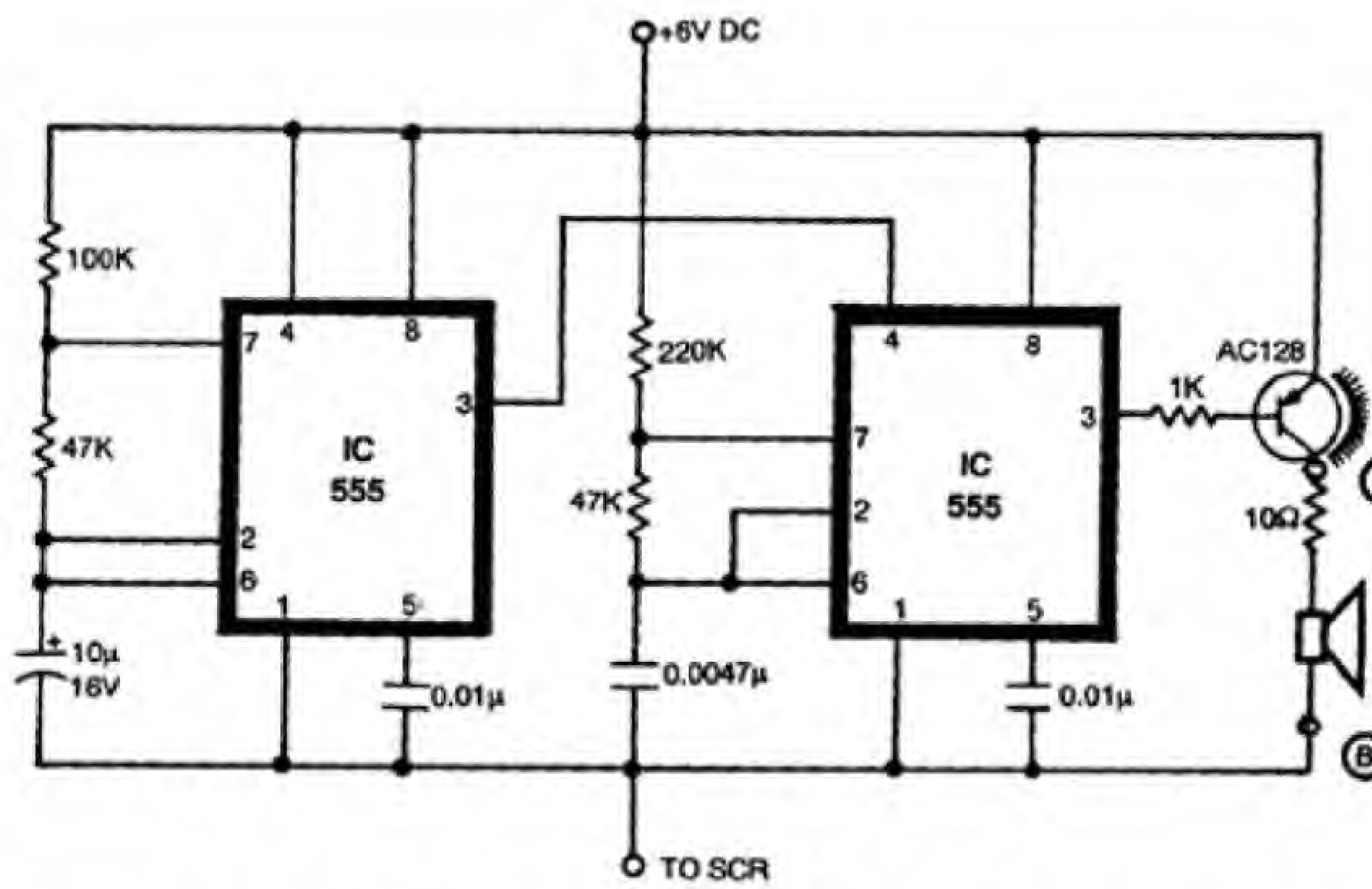


Fig. 2

Transistor T1, capacitor C2 and resistor R1 provide the delay in firing the SCR. When Switch S2 is pressed momentarily, C2 gets charged and the saturated transistor T1 holds the gate of SCR at ground potential for about 75 seconds giving enough time to close the door without energising the alarm.

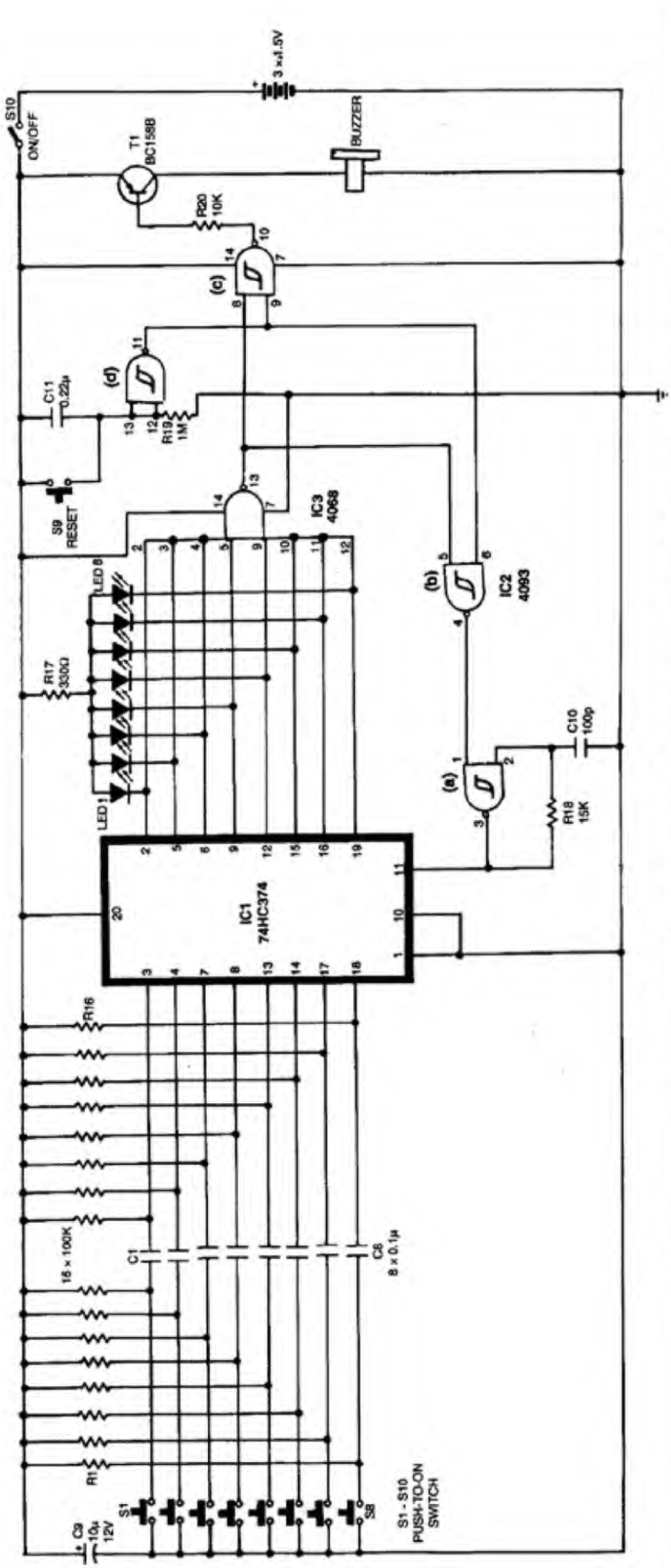
Switches S1 and S4 should be so placed that they cannot be found out easily. Automatic battery changeover is provided through diode D3, in case of mains failure.

The audio section shown in Fig. 2 is not critical. It may be replaced by any other circuit viz, siren, barking dog etc, or by a DC bell along with a reverse biased diode. The circuit operates at 6V. It can easily be adapted for 9V or 12V operation with minor modifications.

Simple 'JAM'

C. Sanjay

Here is a simple 'JAM' circuit that can accommodate upto eight participants. The circuit is battery operated and uses CMOS ICs only. It is very compact and portable. Immediately after power on, the output of IC2d



goes low. This enables IC2a operating as an oscillator. Logic 'one' is latched into all the eight latches of IC1 for about 200ms. Then the output of IC2d goes high. The oscillator thereafter is controlled by the output of IC3.

Now, the circuit is ready to accept a key. As all the outputs of IC1 are high, the output of IC3 remains low, enabling the oscillator built around IC2a. When any one of the keys S1 to S8 is pressed, corresponding input pin of IC1 becomes low. This 'low' input is latched into IC1 making the output of IC3 high. High output of IC3 disables the oscillator. The first zero that was latched stays at the output of IC1. The LEDs—LED1 to LED8—indicate the key that was pressed. At the same time transistor starts conducting and the buzzer is enabled. The buzzer will keep sounding until the circuit is reset.

Along with the reset switch if one of the keys S1 to S8 is pressed, small time constant of RC circuits at the input pins of IC1 ensures that all outputs of IC1 are at logic 'one' after the reset switch is released. The efficiency of the circuit depends on the clock frequency of the oscillator. With the present value of clock frequency, the probability of two keys being pressed within one clock period is too low. That is why only the first key will be recognised.

The circuit uses three 1.5V cells. As the circuit consumes only 20mA (when one LED and the buzzer are enabled) the batteries have longer life.

The LED Scanner

S. Manoharan

This is a device to illustrate scanning in TV or how the focus of our sight moves over the lines on a printed page while reading.

One hundred LEDs are arranged on a cardboard in 10x10 matrix form (Fig 1). The first LED at the top left corner glows first for nearly 0.1 second. Then the second LED in the top row glows. Thus, one by one all the 100 LEDs glow sequentially, moving from left to right and top to bottom covering the entire area of the board. After the last LED (i.e. 100th LED), the first LED again starts glowing. This process is repeated again and again. By adjusting the potentiometer we can so increase the speed of motion that all the LEDs appear to glow continuously.

On the LED board (Fig. 1) negative terminals of all the LEDs in each row are connected together and all the 10

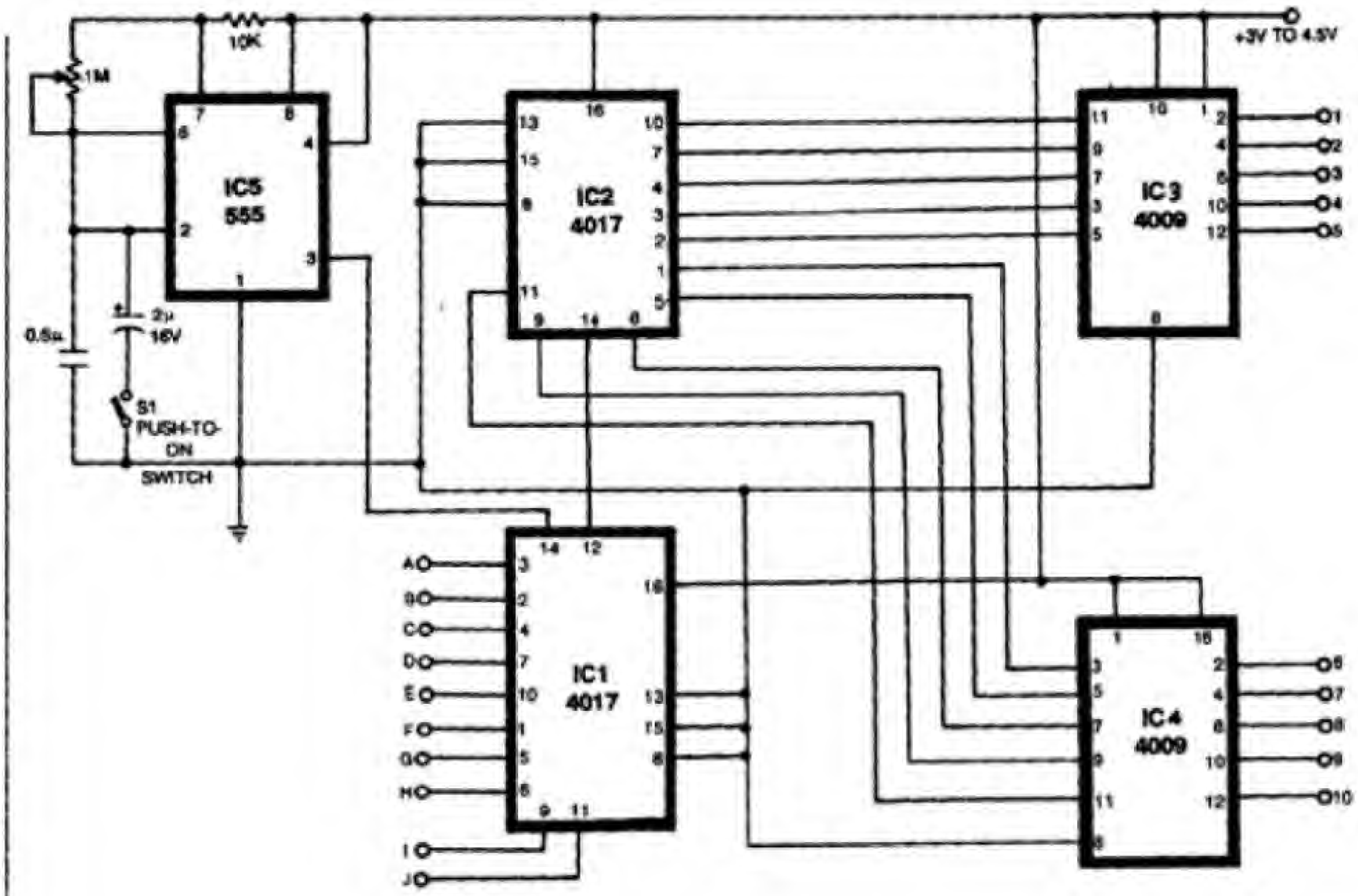


Fig. 1

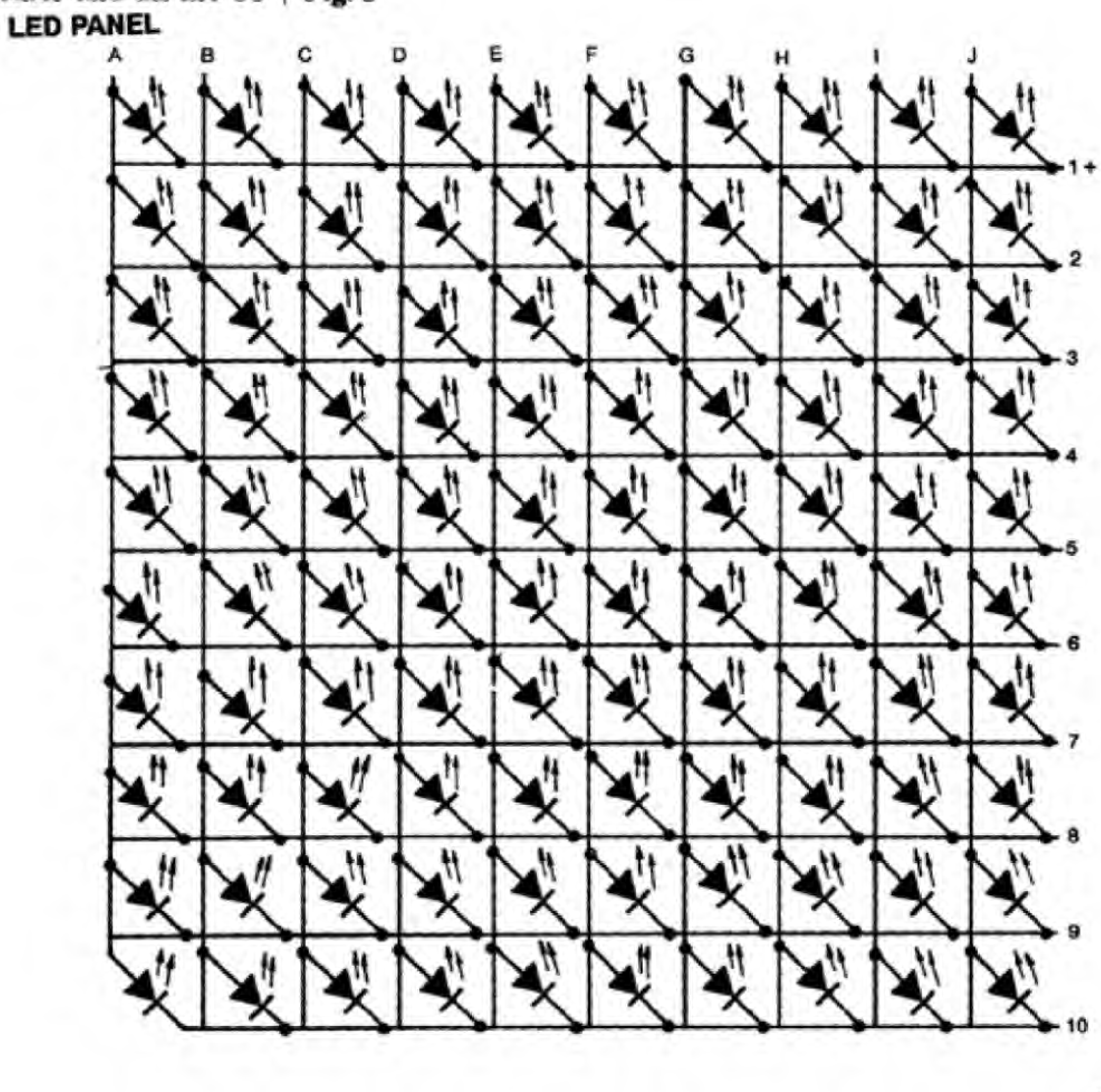


Fig. 2

leads (from 10 rows) are connected to the output pins of IC3 and IC4. In the same manner the positive terminals of all the LEDs in each vertical column are connected together and the leads (A to J) are connected to the output pins of IC1.

IC 555 is used as the pulse generator. Frequency of the pulse generated from IC 555 can be varied by the potentiometer. A capacitor of 2μ, 16V may be included in the circuit to increase the speed range still further. The output pulse from pin 3 of IC 555 acts as the clock for next two stages, viz, horizontal shifter and vertical shifter.

IC1 (CD4017), a decade counter is used as horizontal shifter. Pin 14 is the clock input. The output pulse appears at pins 3,2,4,7,10,1,5,6,9 and 11 of IC1 (CD4017) sequentially. The outcoming signals are directly given to the vertical columns of the LED board, i.e. pins 3,2,4......11 are connected to A to J respectively. IC1 divides the clock frequency by 10 and the output pulse appears at pin 12.

This output pulse from pin 12 of IC1 is given as clock pulse to pin 14 of IC2. IC2 is used as vertical shifter. The outputs at pins 3,2,4.....11 of IC2 are inverted by two hex inverters CD4009 and then fed to the LED board. Only one LED out of hundred LEDs gets the power of proper polarity and glows. The circuit works at 3V DC.

Vary the potentiometer and observe what happens. According to your imagination you can improve upon this and make it still more interesting.

Melody from IC Timer

Saravanan M. Mallesan

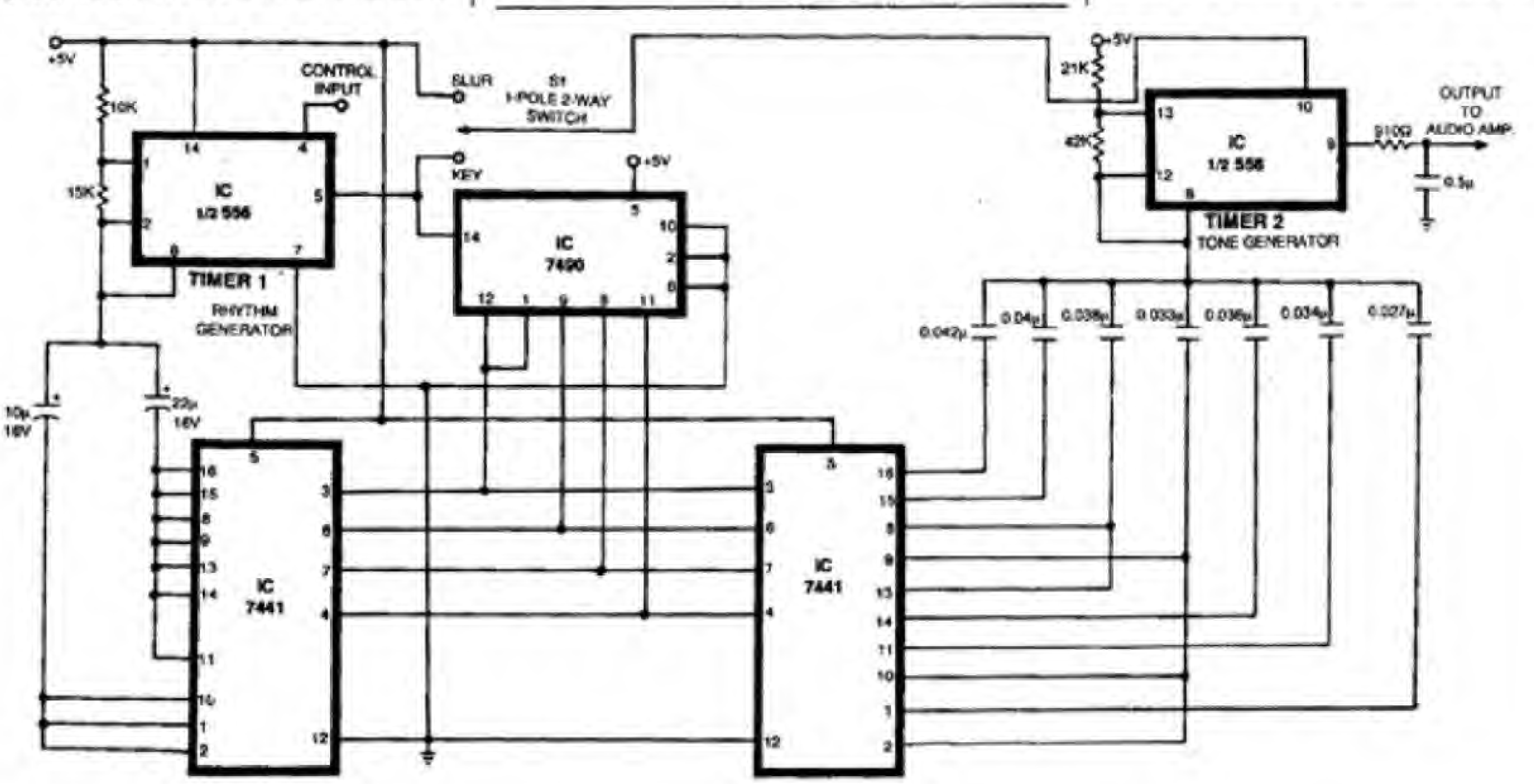
The IC 555 type timer has yet another application as a poor man's music synthesiser for playing signature tunes of simple songs. Two timers are needed; one generates the rhythm while the other produces the tone.

The circuit shown in the figure plays the first 10 notes of A pretty girl is like a melody . With the control input lead of timer returned to Vcc supply, the tune will be recycled automatically. But if a relay or flip flop is connected to this lead, the number of times the tune is to be repeated can be controlled. The position of the style switch S1 determines whether the tunes are played individually or blended.

When used along with a diode bridge that detects the presence or absence of ringing generator on the telephone line, the circuit can be programmed to play a distinct musical signature as a personalised telephone bell signal. Of course, many different combinations of resistors and capacitors can be used to obtain the desired music frequencies.

Tone generator frequencies for 'A pretty girl is like a melody'

Count	Capacitor (μF)	Frequency (Hz)
0	0.042	329
1	0.040	349
2	0.038	370
3	0.033	440
4	0.038	370
5	0.036	392
6	0.034	415
7	0.033	440
8	0.027	523
9	0.033	440

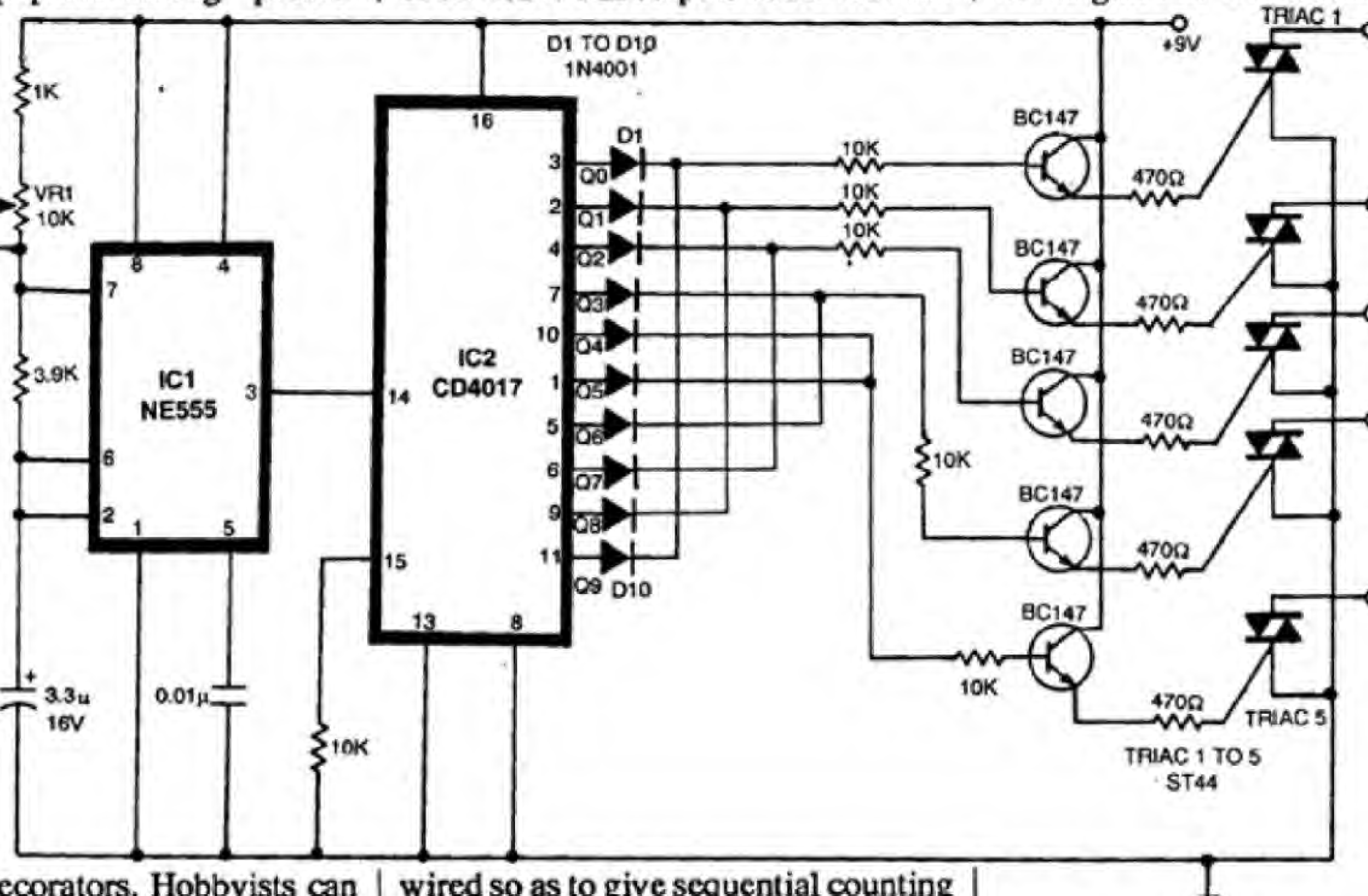


Disco Light Project

Pramod Kumar

Another interesting light effect circuit is presented here. It gives an effect like a pendulum. This kind of light effect is very popular among professional light decorators. Hobbyists can build this project on their own for domestic use.

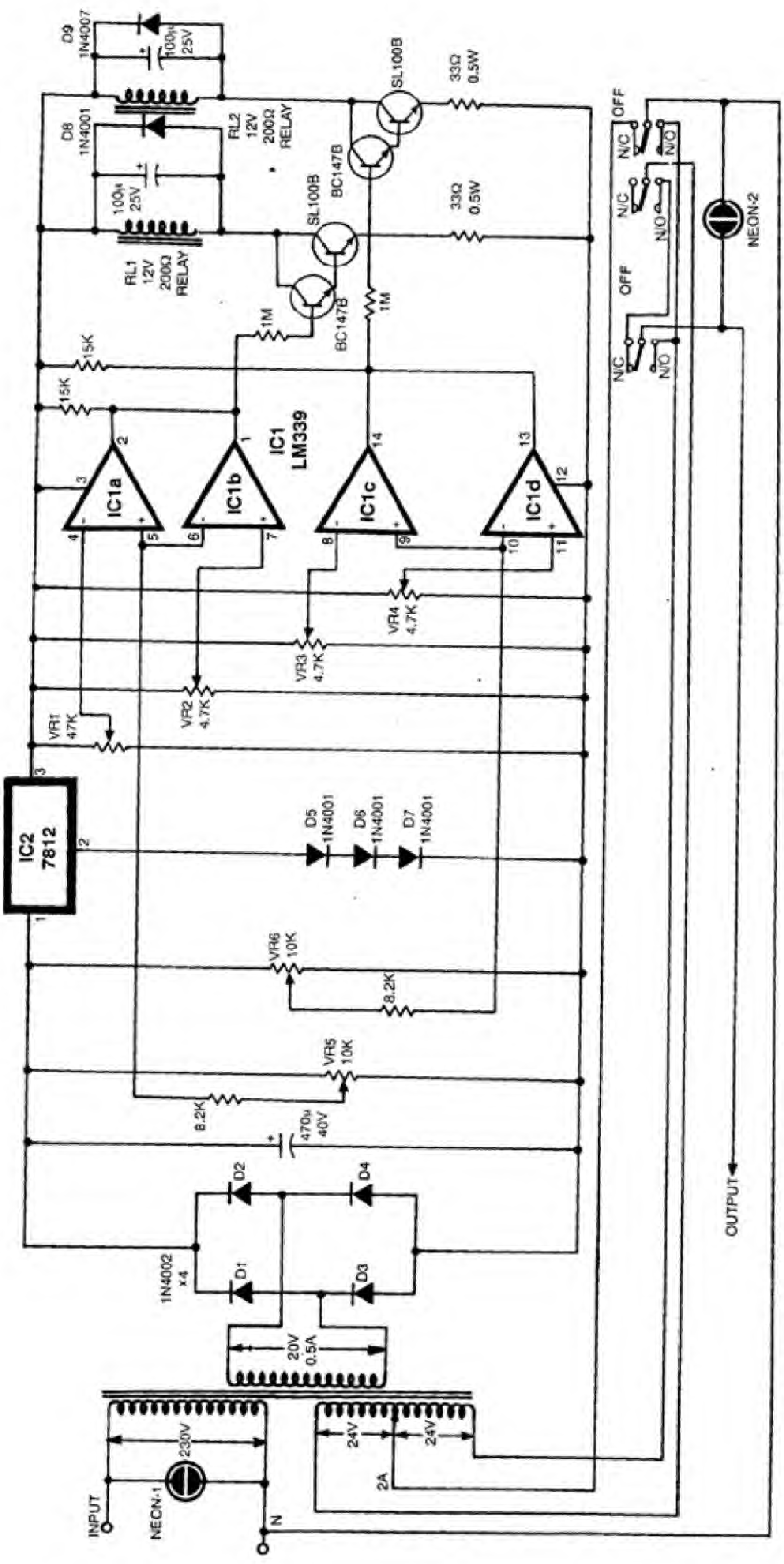
This circuit uses two ICs, IC 555 as timer and IC 4017 as decade counter. IC 555 works as a clock pulse generator. Clock pulse is provided to the input of IC 4017. All outputs of IC 4017 are wired so as to give sequential counting from Q0 to Q4 at first five clock pulses and then come back from Q4 to Q0 sequentially at next five clock pulses at its input. All five outputs are wired to the base of five transistors. The emitters of all five transistors are connected to the gates of five triacs. Triacs are used for switching. This project may be assembled at the cost of Rs 150.



IC Voltage Regulator

Ivan R. Miranda

Here is a circuit of a voltage regulator using IC LM339. It uses the principle of window comparators. Op-amps, IC1a and IC1b, form one window comparator while op-amps IC1c and IC1d form the second window comparator.



IC 7812 along with diodes D5, D6 and D7 provides 14 volts constant output. Pots VR5 and VR6 sense the change in line voltage and provide the feedback. Pots VR1, VR2, VR3 and VR4 are used to set the reference voltages. Set the pots VR1 and VR2 such that pins 4 and 7 of IC1 are at 2V and 4V respectively. Outputs of op-amps IC1a and IC1b and voltages at pins 5 and 6 are given in Table I.

Table I

Voltage at pins 5 and 6	Output of IC1a	Output of IC1b
> 2V < 4V	High	High
< 2V	Low	High
> 4V	High	Low

The relay is on only if outputs of both the comparators are high. All the pots are adjusted so that relay RL1 is off for voltage > 270V or < 200V and relay RL2 is off for voltage > 240V or < 160V.

To adjust the pots the following procedure should be followed.

Keep VR5 and VR6 in mid positions and connect a variac at the input. Keep the input voltage at 220 volts and vary pots VR1, VR2, VR3 and VR4 until both the relays are energised. Now keep the variac at 200 volts and adjust VR1 such that RL1 goes off. Now keep the variac at 160 volts and adjust VR3 such that RL2 also goes off.

Bring variac above 160 volts and see that relay RL2 becomes on. Increase variac further (200V) so that RL1 also turns on. Now bring variac to 240 volts and adjust VR4 such that RL2 goes off. Finally, keep it at 270V and adjust VR2 such that RL1 goes off.

Bring variac below 270 volts and check the operation of relays according to Table II.

Table II			
Relay RL1	Relay RL2	Output	Input voltage
ON	OFF (adjust VR4)	Buck	240V-270V
ON	ON	Normal	200V-240V
OFF (adjust VR1)	ON	Boost	160V-200V
OFF (adjust VR2)	OFF (Adjust VR3)	Cut-off	> 270V or < 160V

While doing these adjustments, VR5 and VR6 may be readjusted to suit the sequence of relay operation. Trimpot presets are recommended instead of normal presets.

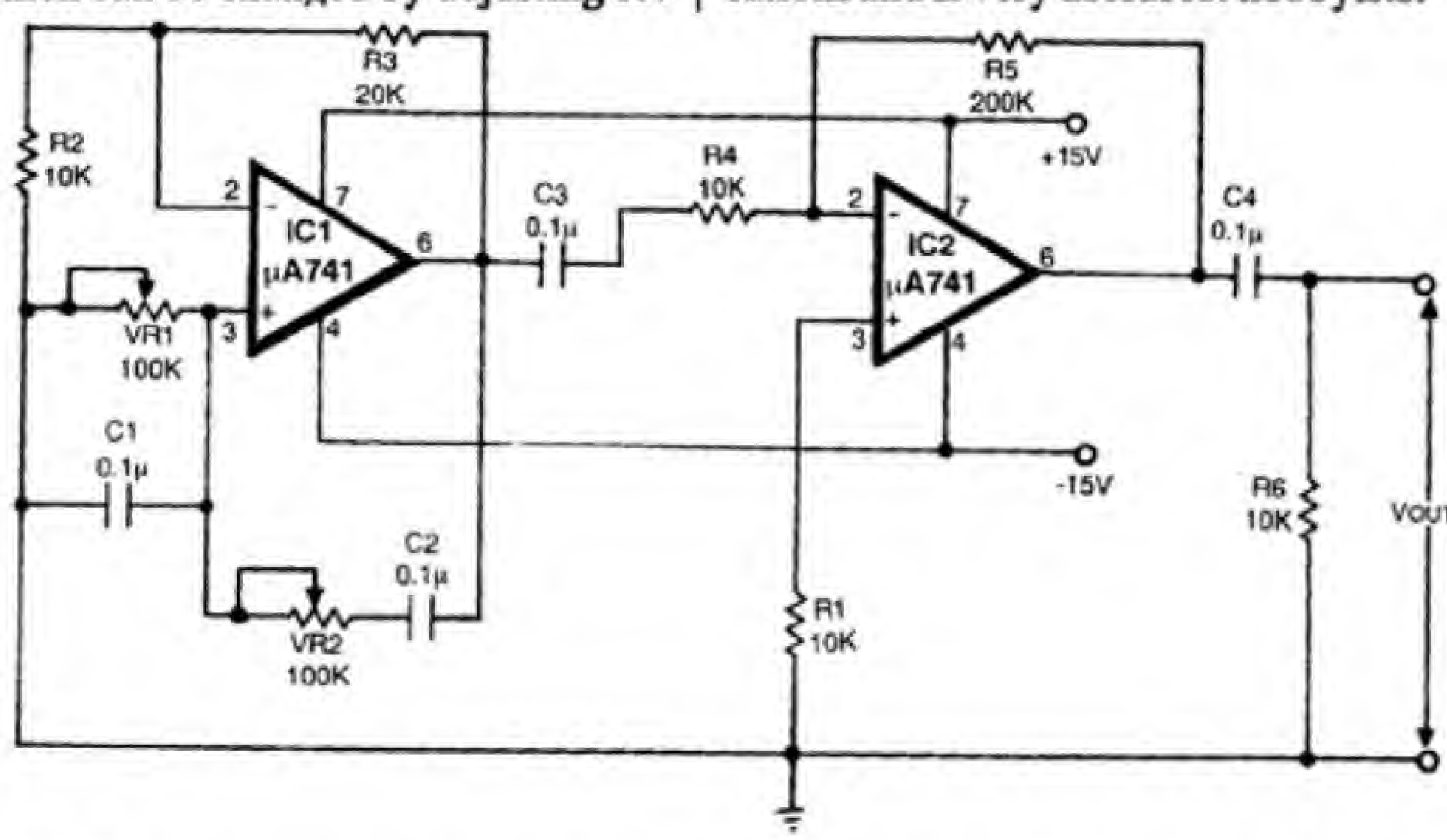
Audio-Frequency Oscillator

Y.R. Sowale

Here is a simple circuit for sinusoidal audio-frequency oscillator based on two μA741C ICs. Circuitry associated with the amplifier (IC1) is wein-bridge oscillator. Resonant frequeny of the circuit is

$$f_o = \frac{1}{2\Pi \times VR1 \times C1}$$

VR1 and VR2 must be ganged. For audio frequency range, C1 =0.1μF and VR1=100k pot. You can get the entire audio band by varying VR1. For sustained oscillations, it is necessary to keep R3 twice R2 in value. Hence the gain of the circuit becomes 1 + R3/R2 = 3. Required amplification is provided by the AC inverting amplifier (IC2). It multiplies the input signal by 20, i.e. we get inverted and amplified signal at the output. You can change the gain by varying R4 or R5. Bandwidth of this amplifier is about 47 kHz which can be changed by adjusting R4 or R5. Both op-amps require dual supply, +15V and -15V. The circuit can be used in inverters where 50Hz frequency is used. In that case R1 is changed to 31.8k.



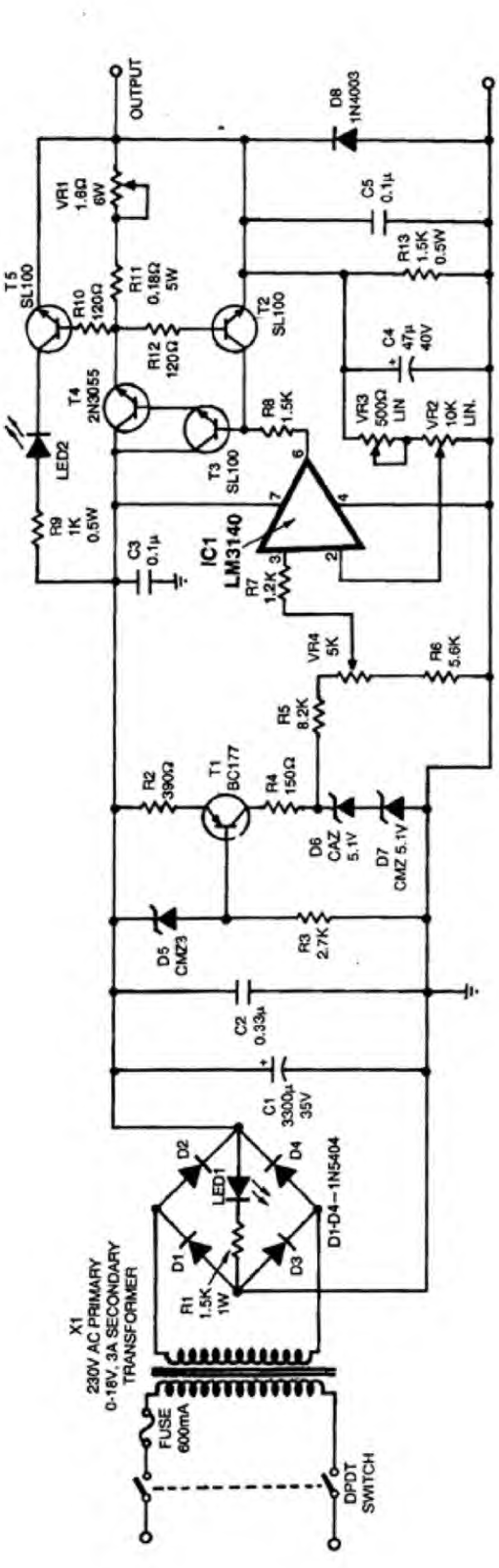
Thus, this circuit has a variety of applications and is very useful for hobbyists.

The AC amplifier using IC2 may be replaced by an integrating amplifier to get cosine output. This circuit can also be used for testing audio equipment.

Linear High Current Regulator

V. Brindavanan

The regulator given here utilises all the advantages of the operational amplifier LM3140. It has very high input impedance, high gain, high CMRR, low drift and high stability. The temperature compensated reference volt-



age is produced (about 10.2V) using low drift breakdown diodes and is fed to IC1. The circuit uses low-cost, high performance npn transistors which makes it suitable for high-current applications. The circuit is protected from overloads and short circuits which is indicated by an LED.

The circuit can deliver up to 3-amp load current continuously. The output voltage can be set in the range of 4V to 22V. Fine variation in the output voltage can also be done using VR3. The output current, ranging from 350mA to 3000mA, can be varied by VR1.

Any variation in the output voltage is sensed by LM3140 and compared with the reference voltage to produce error signal which in turn controls the output voltage. Thus, the output voltage is kept constant irrespective of the load connected across the output terminals.

The bridge rectifier (D1 to D4) feeds the rectified voltage to filter capacitors C1 and C2. Diodes D6 and D7 provide reference voltage of approximately 10.2V which is stepped down using the attenuator (R5, VR4 and R6) and fed to LM3140. The temperature coefficients of the diodes cancel each other.

Transistor T1 supplies a constant current to D6 and D7. Therefore, the current through R5, VR4 and R6 is also constant. The reference input to LM3140 is set by VR4. The output voltages can be varied continuously by VR2 (coarse adjustment) and VR3 (fine adjustment).

LM3140 drives the transistor darlington pair comprising T3 and T4 to increase the output current up to 3A. Whenever the output current exceeds the set value, transistor T2 limits the output current. Transistor T5 is also switched on along with T2 to indicate the overload and short circuit.

Capacitors C4 and C5 suppress the oscillations which are generated by the feedback. The capacitors C4 and C5 are discharged through R13, VR2 and VR3 whenever the output voltage decreases. Diode D8 bypasses the negative polarity voltages.

Readers' comment:

The circuit is superb, though I have a few doubts regarding this circuit:

(a) The output voltage ranges from 4V to 22V whereas the transformer rating is 0 to 18 volts, 3 amps! Can this transformer deliver the voltage required?

(b) What type of potentiometers are to be used for VR1 to VR4?

(c) VR4 sets the reference voltage for LM3140 IC. At what voltage is this potentiometer to be set? Or is it to be ganged with VR2?

(d) Diode D5's printed value was not clear. Is it CMZ-3 or CMZ-8?

(e) What is the procedure to reset if a short or overload occurs?

(f) Is heatsink to be used, as the circuit handles a high current of the order of 3 amps?

LAL BOOPATHY JI
Pathankot

The author, Mr V.Brindavanan, replies:

Since the input capacitors C1 and C2 charge up to 25.2 volts, which is the maximum value of the AC (Vmax), the output range as mentioned is obtained. However, the maximum current rating can't be expected above 18 volts (considering AC mains supply of 230V AC).

VR1 should be a 6W wirewound potentiometer, VR2 and VR3 should be 3W wirewound, and VR4 a carbon preset. VR4 can be adjusted to get the minimum voltage. To use VR4 as a front-panel control, a wirewound pot can be used.

VR4 should be set at approximately 3.8 volts with respect to ground. It need not be ganged to VR2.

D5 is only CMZ 3; D6 is CAZ 5.1V; D7 is CMZ 5.1V.

Once the load current exceeds the set value (set by VR1), transistors T2 and T5 are switched on to limit the load current. Whenever the overload is removed or short circuit is released the circuit returns to normal condition automatically.

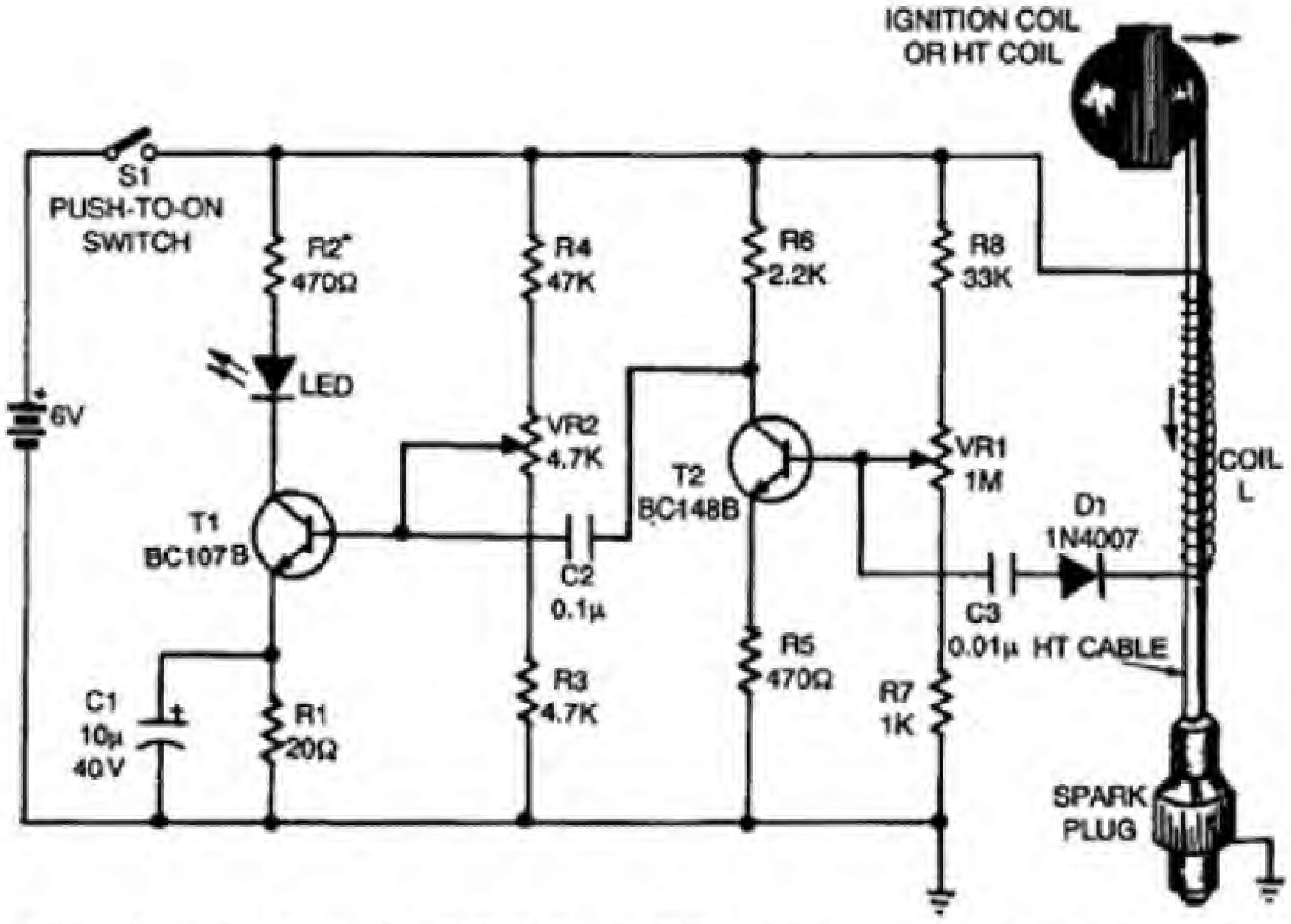
Yes, a higher wattage heatsink is to be used for T4 (2N3055), since power dissipated in the device exceeds 54 watts under the worst conditions.

Ignition Indicator

Deepak Chandran

The circuit persented here is a simple 2-stage amplifier using transistors BC107B and BC548B (or BC148B). Coil L consists of 100 to 200 turns of insulated copper wire (26 to 34 SWG). It is wound on the HT cable and connected in the circuit as shown in the figure. VR1 is used to vary the sensitivity of the amplifier and VR2 is used for controlling the brightness of the LED.

On installing the circuit in the vehicle, the supply is switched on and



VR2 is adjusted such that the LED starts glowing. Now the vehicle is started and VR1 is adjusted so that the LED starts flickering.

This circuit is very useful for detecting starting problems in automobiles.

When there is carbon deposit on the plug, the flickering on the LED is very dim.

If the LED is not flickering or the flickering is highly erratic then the problem is related to the timer or the contact breaker. If the HT coil is open, the LED will not glow. If the problem is related to the carburretor then the LED flickers normally.

For best results, the high tension or high voltage ignition coil should be exposed type and not shielded as found in Hero Honda.

The coil L should be placed near the HT coil and for the supply of 6V, a battery should be used.

Signal Injector cum Tracer

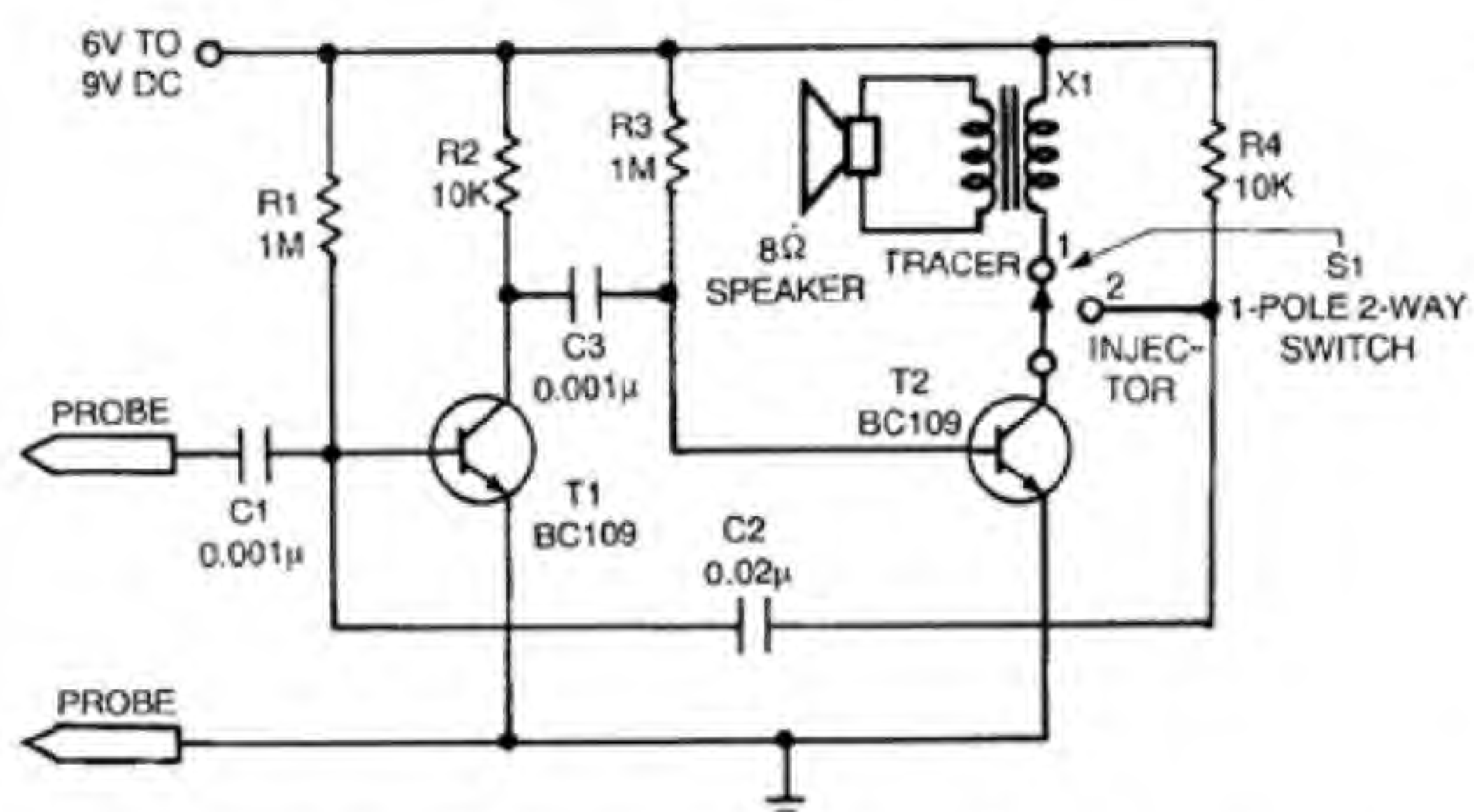
Shanavas.I

Here is a two-in-one test instrument incorporating a signal injector and a signal tracer.

If any audio equipment is not working, an audio signal can be injected at the volume control using this instrument. If audio signal appears at the speaker of the set, you can be fairly sure that there is no trouble in the audio output stage. Otherwise, the fault lies in the audio stage itself. Thus, by injecting the signal, the fault can be traced.

To check the RF stage, an audio signal can be injected in the RF stage. If the output appears at the speaker, the equipment is working properly, otherwise the fault lies in the RF stage. The circuit besides injecting signals at RF, IF and AF stages can also detect signals at these frequencies.

X1 is a 3V output transformer used in pocket transistor sets.



Musical AF/IF Checker

Mathews G. Kallattu

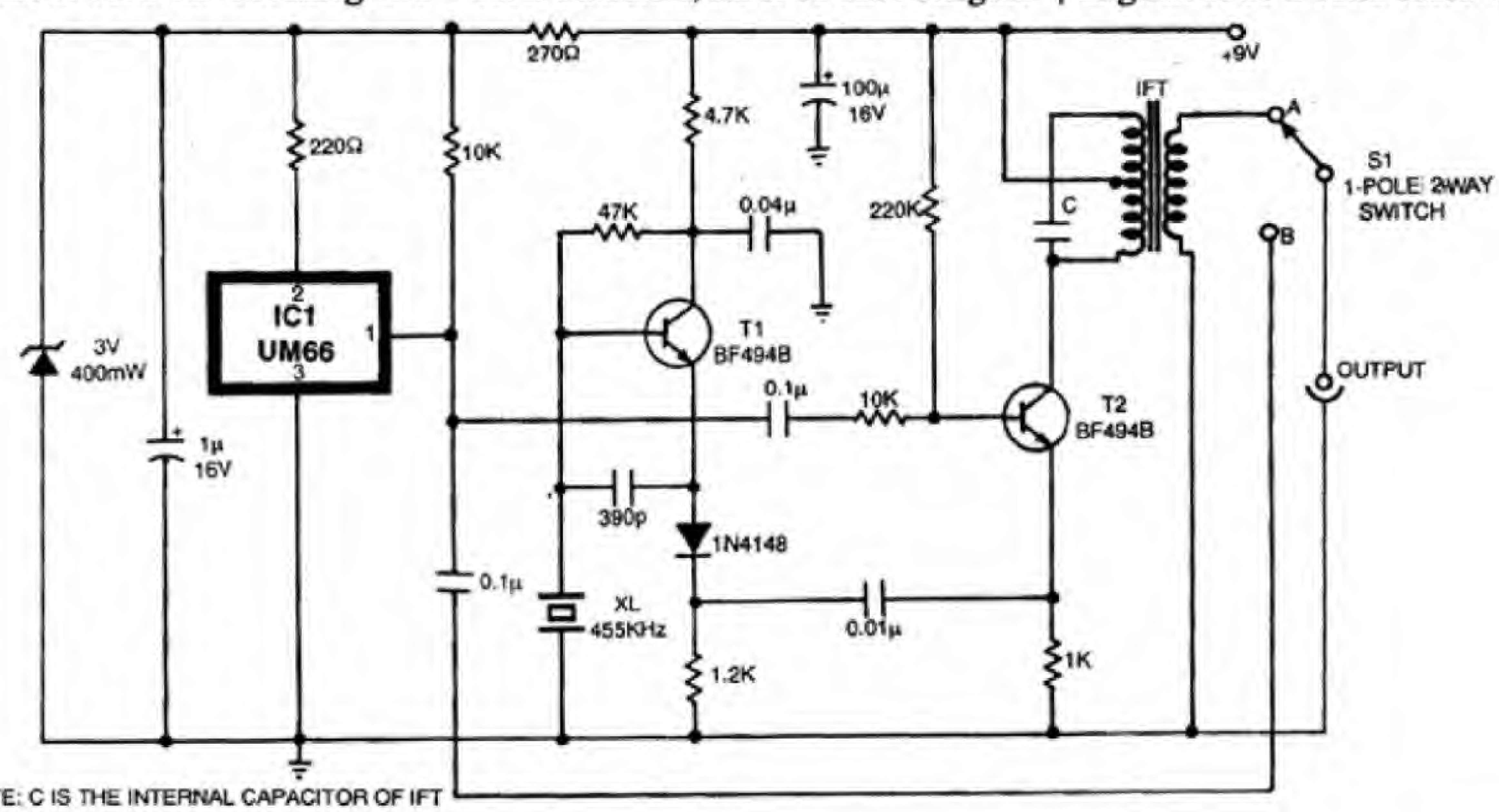
There are several signal generator circuits but few are reliable. Most of the circuits are designed for constant frequency. This circuit produces music instead of 10kHz oscillation. Music notes are modulated to 455kHz. This modulated signal is used for checking and alignment of IFTs at the time of servicing of audio equipment.

The main parts of the circuit are audio tone generator, RF oscillator and modulator. For audio tone generator the musical IC UM66 is used. This IC has 64-note ROM memory.

The oscillator section consists of low-noise crystal oscillator. The crystal of 455kHz is used for frequency control. There is no frequency drift in the circuit as no tuned circuit is being used. Therefore, the IFTs can be aligned correctly.

The output section of the circuit is the modulator which modulates the AF and RF signals. The modulated signal is taped from the output jack. The whole setup is enclosed in a small metal box. The output jack and switch S1 are fitted on the front panel of the box.

When switch S1 is in position A, we can get the modulated IF signal from the jack. When the switch is in position B, we get AF signal from the jack. For alignment of 2-band radio we can replace the crystal with another crystal producing frequencies of 550kHz, 1600kHz, 600kHz, 5MHz or 16MHz and replace the IFT with a small ferrite core transformer (or an IFT without the tuning capacitor can also be used).



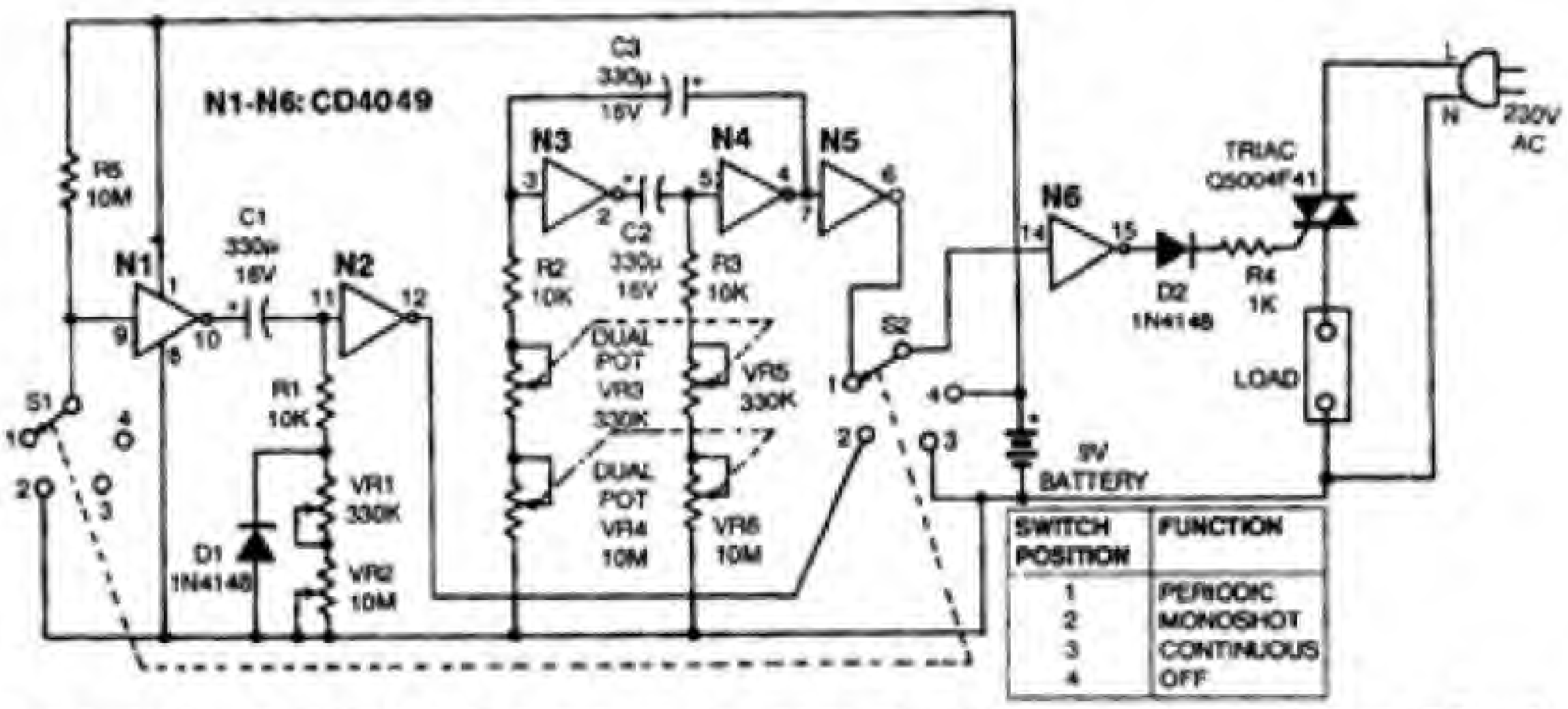
NOTE: C IS THE INTERNAL CAPACITOR OF IFT

Inverter-based 3-in-1 Timer

Kalpesh Dalwadi

A timer is almost impossible without IC 555 or counter ICs such as CD4029 or CD4060. The circuit presented here uses an inverter instead for doing the same job.

As shown in the circuit, gate N1 alongwith C1, R1, VR1 and VR2 forms a monostable multivibrator. When S1 and S2, which are ganged, are in position 2, input at gate N1 is held low and hence the output of gate N1 becomes high. This high output charges C1 via



series combination of R1, VR1 andVR2. At the same time output of gate N2, which is low, is given to gate N6 and the output of gate N6 becomes high.

The high output triggers the triac and the power is fed to the load. After a time period of $T = 0.7 \times C1 (R1 + VR1 + VR2)$, the output of gate N6 becomes low and the triac stops conducting. Thus this part of the circuit operates in monoshot mode.

When S1 and S2 are at position 1, the input of gate N6 is connected to the astable multivibrator built around gates N3 and N4.

Thus, the load is interrupted at regular intervals. Here VR3 is ganged with VR5, and VR4 is ganged with VR6 to generate a square wave. Duty cycle of the output can be varied by just removing the gang arrangement (because the charging and discharging time will be different). Here gates N2 and N5 are acting as buffers.

When S1 and S2 are in position 3, the input of gate N6 is grounded and so the output of N6 remains high as long as the switches are in this position. Hence, the triac remains on and the current flows continuously through the load.

Finally, when S1 and S2 are in position 4, the input of N6 is connected to Vcc as a result of which the output remains at logic 0. The triac does not conduct and thus there is no current in the load.

330k pots are calibrated for 0 to 60 seconds and 10M pots are calibrated for 0 to 30 minutes. Thus, one can obtain any desired timing from 0 to 30 minutes. Use of tantalum capacitors will surely enhance the accuracy of the circuit but at the same time the cost will also rise. Separate on/off switch is not required because stand-by mode consumption is only a few microamperes. In full load condition, the circuit consumes around 5 to 6 mA current ensuring a long life for the battery.

This kind of time switch can be used as a timer for washing machines, heaters and for process control involving short timing etc.

The circuit can be easily wired on a general-purpose PCB. It costs around Rs 50, without power supply.

All-in-one Circuit for Fridge

P.P. Chandrapal

Here is an all-in-one circuit for a fridge having features like time delay on, under/over voltage protection, automatic time basis defroster, timer circuit etc.

To switch the fridge on and off IC 555 timer is being used. At normal voltage, capacitor C1 is charged through resistor R4 and diode D3. If the supply fails and resumes immediately, IC 555 will not be switched on until C1 is discharged to 1/3 Vcc through R5. The delayed on time will depend on the values of R5 and C1.

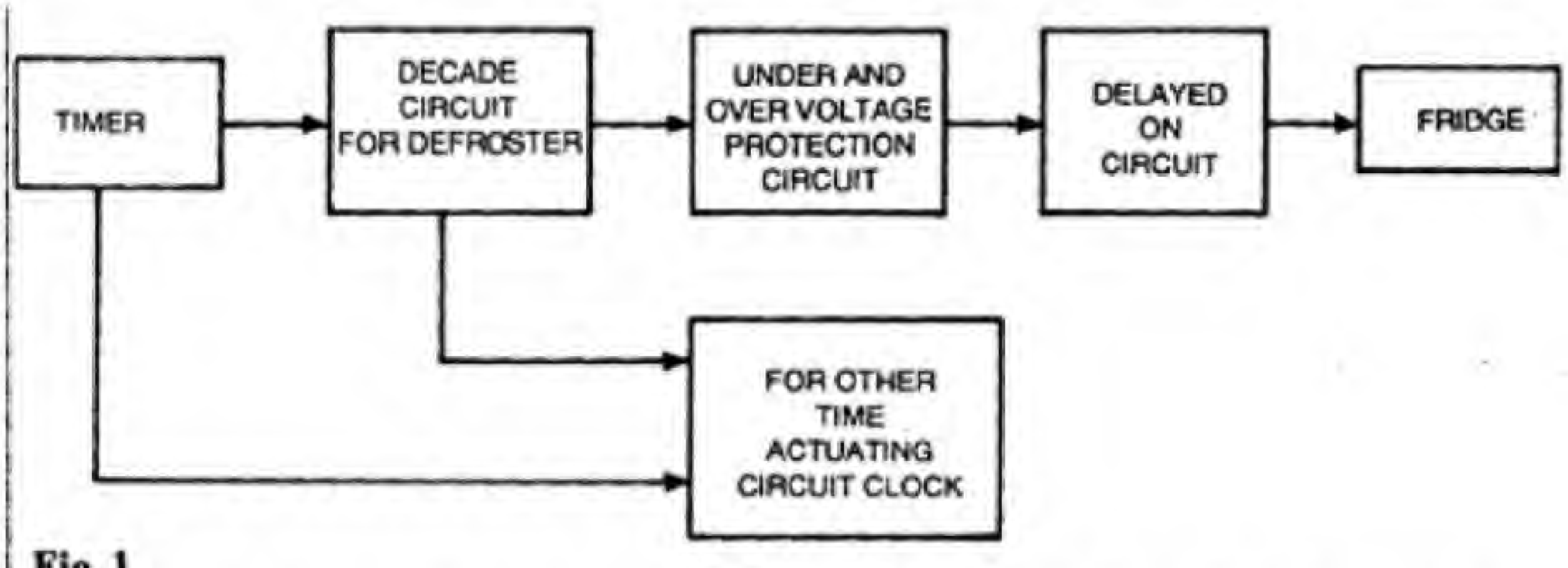


Fig. 1

When the input voltage is above or below normal, transistor T2 will be cut-off, making pins 6 and 2 of IC 555 high (above 2/3 Vcc). It results in low output at pin 3 of IC 555, which stops the fridge. At normal voltage, transistor T2

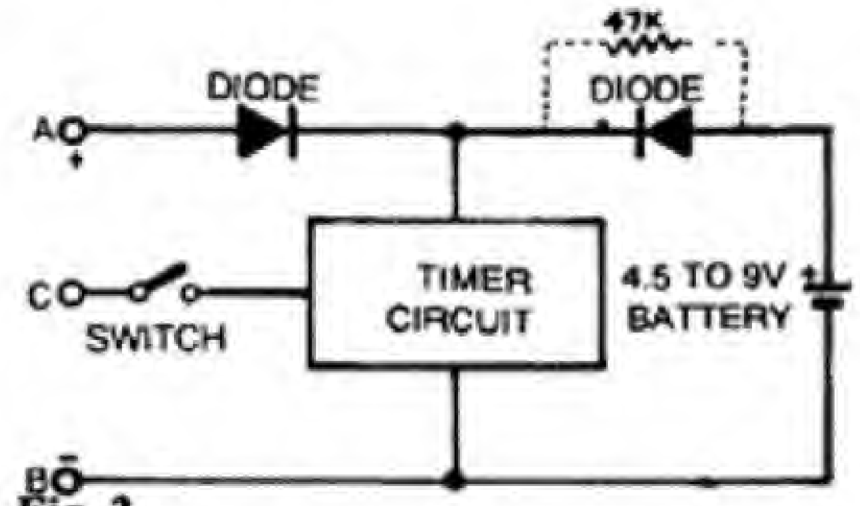


Fig. 2

will be conducting. Pin6 of IC555 will become loam but pin 2 will remain high because capacitor C1 is in charged condition due to the reverse biasing of diode D4. Now C1 starts discharging D1 and T1 start conducting. As diode D2 amd transistor T2 will not be conducting the fridge remains off.

The timer circuit is built around IC 4060 and IC4017. Time period of the output pulse available at pin 3 of IC 4060 depends on the values of C3 and VR3. It varies from 3 minutes to more than 2 hours. This clock output is fed at pin 14 of IC4017. At each clock pulse, IC4017 starts counting and high output appears at the output pins. The outputs cient high.

The defrost condition is indicated by LED2. Each clock output of IC 4060 is indicated by LED1 through transistor T3. Base of T3 (point D) can be con-nected to pin 6 or 5 of IC2 for lower time output indication. The end of preset time (high pulse at pin 11) is indicated by LED4.

When the same output appears at pin 13 of IC 4017 it stops counting the clock pulse till the reset switch is pressed.

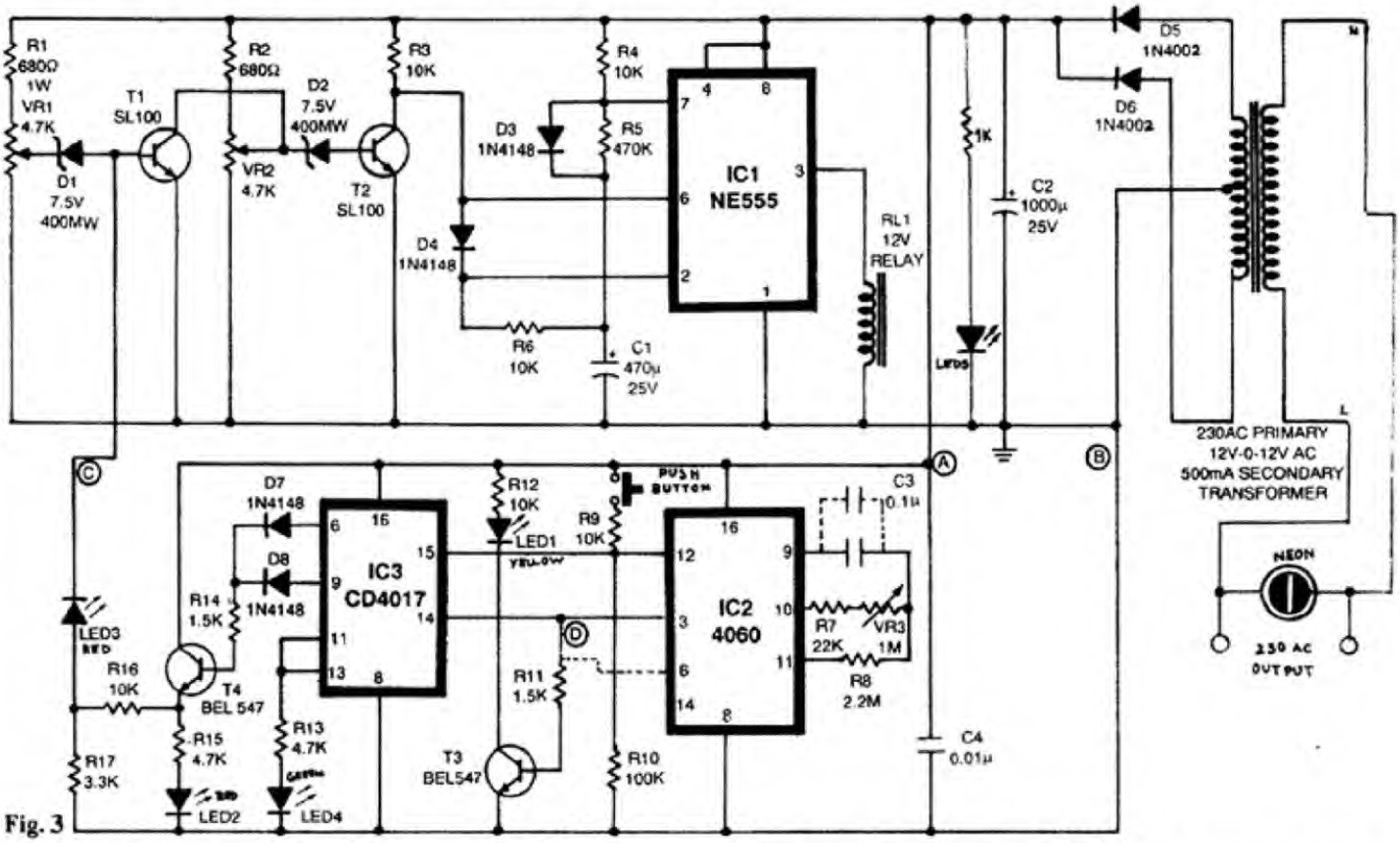


Fig. 3

through R5. When the voltage across C1 become less than 1/3 VCC, pin 3 of IC555 will go high and will switch on the fridge.

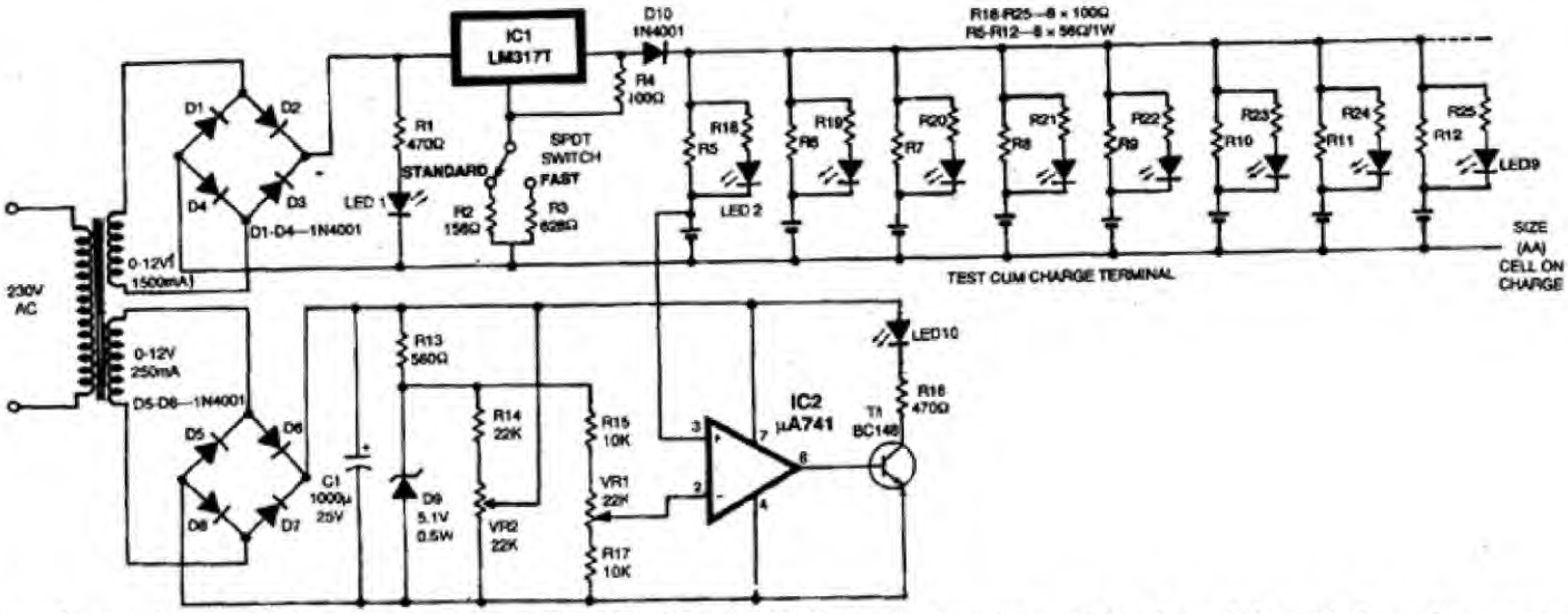
At low voltage, diode D2 and transistor T2 are cut-off and pins 6 and 1 of IC555 are high. The fridge is switched off during this period. At high voltage Q7 at pin 6, and Q8 at pin 9 are connected to the base of T4 through diodes D7 and D8 to double the defrost time. Similarly, other outputs can be used for setting different time periods. R16, R17 and LED3 are wired to avoid the false stopping. Fridge is switched off when the voltage at the emitter of T4 is sufficient high.

Back-up power supply can be provided to the timer circuit to maintain timer cycles during power failure as shown in Fig. 2.

By using different output (Q0 to Q9, not shown) of IC 4017 or IC 4060, the timer can be utilised for purposes such as delayed and precise switching.

Ni-Cd Cell Charger

This Ni-Cd cell charger can charge up to eight cells at a time and has facilities of standard and fast charging and full-charge indicator. The auto shut-off chargers are unsuccessful in India due to frequent interruptions in



the main supply.

The transformer has two separate windings of 0-12V on the secondary side—the first being for the charging circuit and the second for the monitoring circuit. IC LM317T variable voltage regulator is the heart of the circuit which selects between the standard and the quick charging modes. Diode D10 blocks the reverse flow of current during mains off while R5 to R12 limit the current. Comparator IC2 μA741 compares the reference voltage with the monitoring voltage. When these are equal LED2 starts glowing, indicating full-charge condition. The monitoring circuit monitors only one cell at a time. A multi-way switch can be used to monitor the other cells.

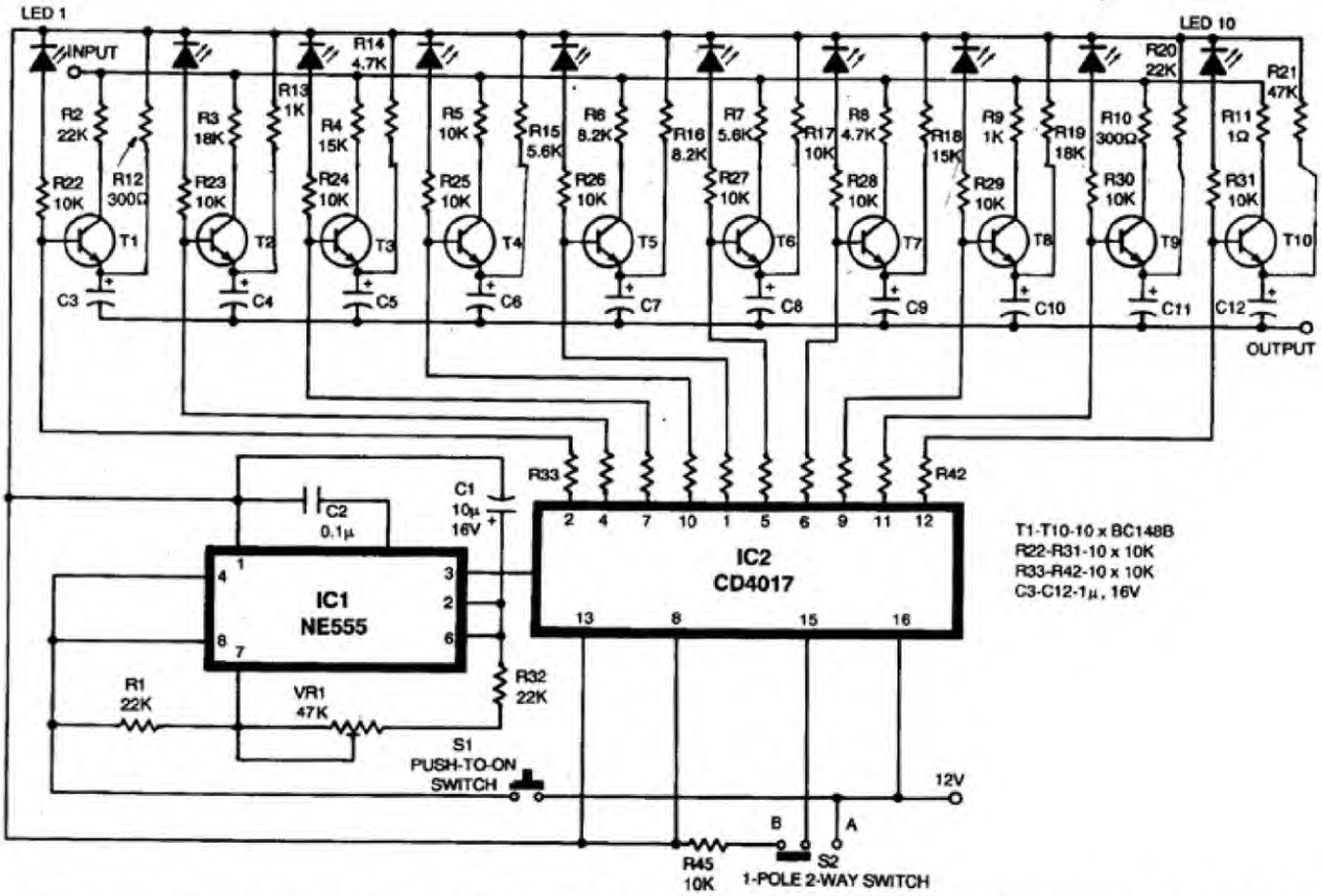
This circuit can be used for charging more than eight cells by using a transformer and semiconductors of higher current capacity. IC LM317T should be used with a suitable heatsink. For the adjustment of VR2, adjust VR1 to read 3V and then connect a fully charged Ni-Cd cell in the test cum charge terminal. Adjust VR2 till LED10 just starts glowing.

❑

Digital Volume Controller

Umesh Kumar Pushkarna

The circuit shown here is based on the switching action of transistors. Volume of a stereo deck can be controlled with the help of a potentiometer which changes the resistance between the output of the preamplifier and input



of the amplifier. This can be done with the help of decade counter IC 4017 and some transistors.

The input is applied at collectors and the output is taken from emitters of the transistors. Depending upon the output of IC 4017, the corresponding transistor gets saturated. Output from the emitters is taken through a coupling capacitor to block the DC components. When pin 4 of IC 4017 goes high, the corresponding transistor (T2) gets saturated and the input signal is directly fed to the output through the collector resistance.

To start with, press switch S1. The timer IC (IC 555) will start generating pulses at equal interval of time which are fed to IC2. Depending on the output of IC 4017 the transistor is selected. When desired volume is reached, release the switch.

To reset the counter, switch S2 is brought to position A.

The time period of the output pulses can be set, using the formula

T_d= 0.693 (R1 + 2VR1 + 2R32) C1 seconds.

The circuit costs around Rs 60.

Phase Sequence Change Indicator

Biju M.J.O.

In electric motors, phase sequence in 3-phase configuration is very important. Change in phase sequence may cause trouble in machines. Here is a circuit which indicates the change in phase sequence by a beeper or an LED.

Transistors T1,T2 and T3 are used to square the 3-phase waveforms. The resistor value should be such that the transistor gets fully saturated when the base voltage becomes 10V. During negative cycle, the diode at the base keeps the reverse voltage below 0.6V.

It is assumed that if the phase sequence is correct, the red-phase lags the yellow-phase by 120° and the green-phase lags the red-phase by 120°. Any change from this sequence produces a beeping sound.

Transistor T4 is not only used for phase inversion but also to decrement the slope of the rising and falling edge (i.e. to decrement the rise time of the square wave). Output of this transistor is fed to the clock input of the flip-flop (IC 7476). Thus, during every cycle the phase sequence is checked.

For the clock, squared waveform of the yellow-phase is used. Other phases are inverted during squaring operation (Fig.2). So at the falling edge, transistor T3 is cut-off and T2 is in saturation. Collector of T2 is connected to the input J of IC1a and K of IC1b. So at the clock edge we get low at both the inputs. Collector of T3 is connected to K input of IC1a and J of IC1b resulting in high output at the clock pulse. At the rising edge of the clock we get J low and K high for IC1a. So it gets reset and gives high at Q. Similarly, when the J and K inputs of IC1b are high the flip-flop is set. The Q output of IC1a and Q output of IC1b are O Red and fed at the base of T5 in order to switch on

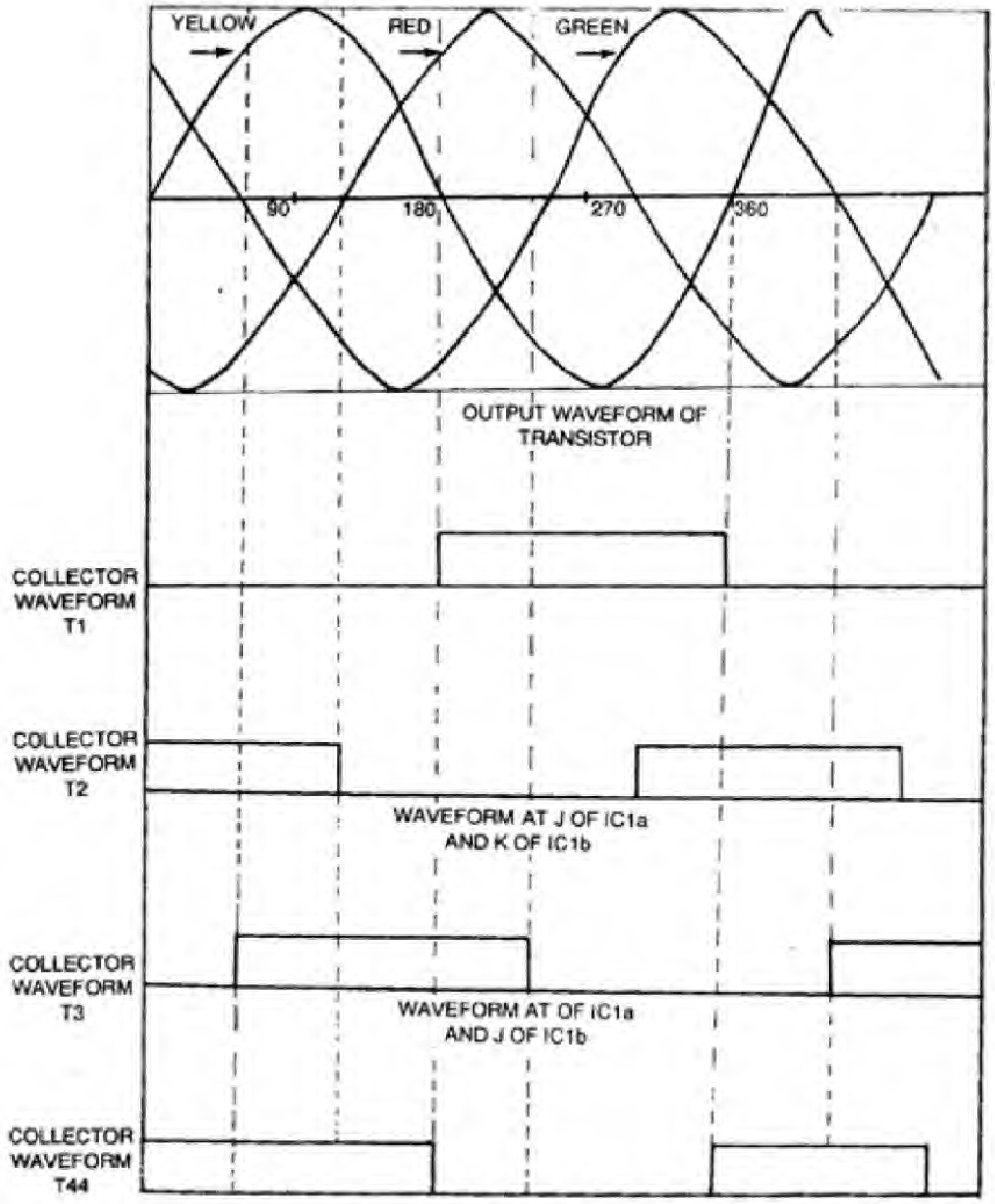


Fig. 1

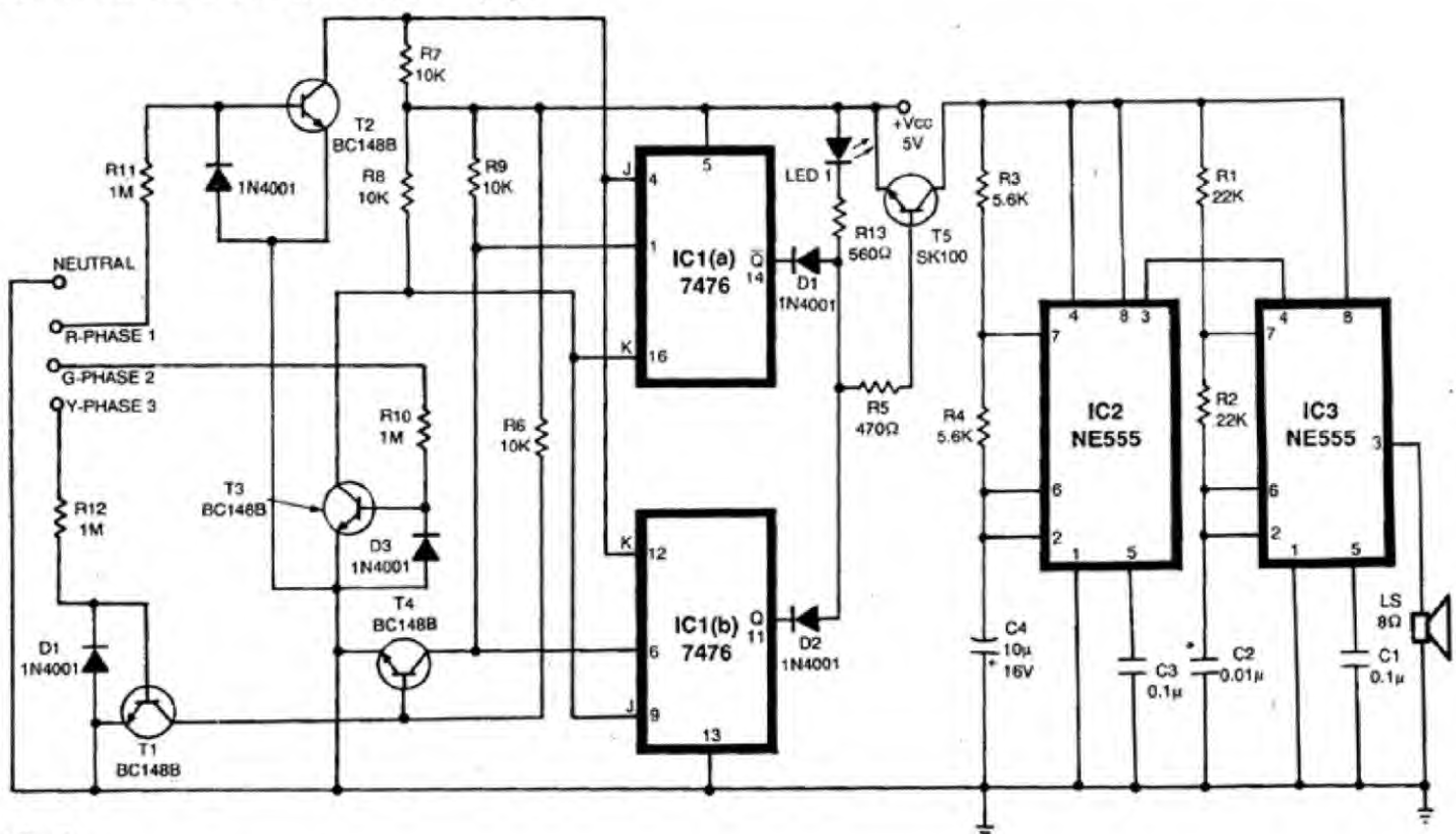


Fig. 2

the alarm. In place of the alarm, an LED can also be used as an indicator. As long as the phase sequence is correct, both Q of IC1a and Q of IC1b are high and the transistor SK100 remains in off state.

Whenever the phase sequence changes, both the outputs become low and turn on transistor T5.

The beeper circuit comprises of a low frequency oscillator and a high frequency oscillator. The low frequency oscillator, which oscillates at 10 Hz, makes the high frequency oscillator enable and disable. The high frequency oscillator produces 3kHz output and a beeping sound in the speaker.

If a relay driven circuit is used, the system can be turned off when the phase change occurs.

Readers' comment:

Please clarify the following in phase sequence change indicator circuit:

1. Neutral point has been used in the circuit whereas in most cases the neutral point for motors is not used. Does this circuit work without neutral?

2. What indication is given on phase failure?

3. The input voltage to this circuit isn't given anywhere in the description. What is the allowable input voltage variation?

PRODUCTION ENGINEER
Waves Electronics Pvt Ltd
Kizhakkambalam

The author, Mr Biju Mon J.O., replies:

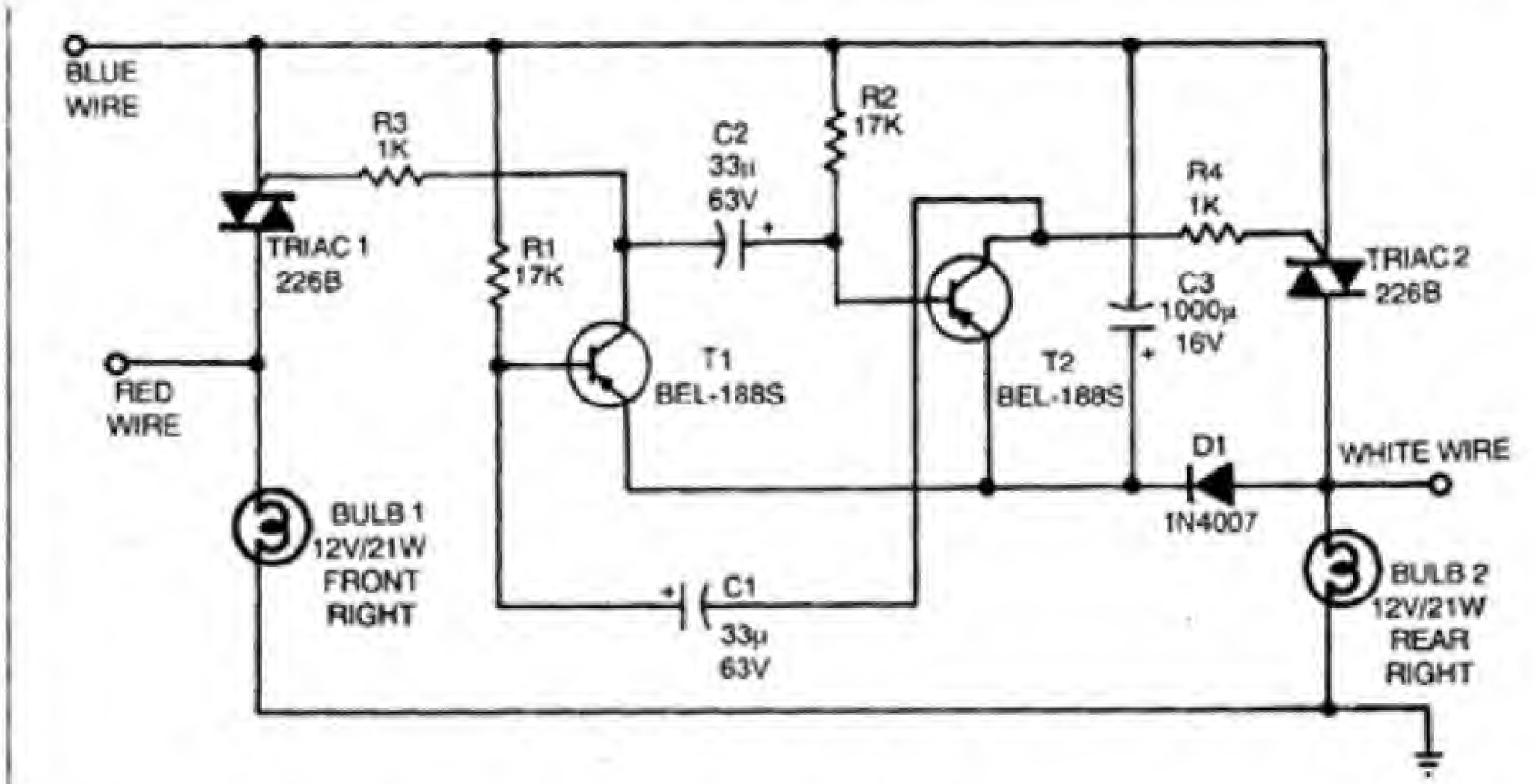
The circuit uses neutral as the reference line for waveform generation.

There is no provision in the circuit for indicating a phase failure.

Supply voltage to the circuit is 5 volts, and pahse checking inputs are connected directly to phase through a voltage divider.

LML Vespa Flasher

R.K. Gupta



Replacement of burnt LML vespa flasher costs around Rs 150. The flasher can be replaced with the help of the circuit shown here. It costs around Rs 70.

The circuit consists of a multivibrator built around transistors T1 and T2. The time period of the output pulse can be varied by changing the values of R1, R2, C1, and C2. The values shown in the circuit are chosen to match the flasher with the flashers available in the market. Gates of triacs are connected to the collectors of T1 and T2 through 1k resistors.

When transistor T1 starts conducting, triac 1 is triggered and bulb1 starts glowing. This activates the buzzer. When T2 starts conducting, triac 2 is triggered, thereby illuminating bulb 2. Thus, the flashing of the bulbs (bulb1 and bulb2) takes place alternately and the buzzer also sounds in unison with the frequency of flashing of the bulbs. In addition, the pilot lamp indicating the flashing of bulbs also glows.

For convenience, connections of the flasher, indicating the colour of wires to be connected, are shown. The circuit works properly at 12V AC only. Only front right and rear right bulbs are shown in the circuit for simplicity.

Dual Trace Generator

Umasankar V.

A single beam CRO can be used for simultaneous display of two signals using this simple circuit. The circuit uses one NE555 and two µA741 ICs, besides some passive components. The diode (OA79) is used to get 50 per cent duty cycle.

IC 555 is connected in astable mode and acts as a self-switching analogue switch between the two signals to be displayed on the CRO. The output of IC 555 is given to the CRO. In order to display the two waveforms at different positions, a DC shift is given to one of the waveforms.

Output of IC2 switches between two voltage levels (Vcc and GND) at pins 8 and 1. The frequency of switching is decided by the external RC network. The output frequency of IC 555 is independent of the supply voltage and remains constant over the entire operating range of voltage, i.e. from 3V to 18V. Therefore, if two independent time varying signals are fed at pins 1 and 8, the output of IC2 will switch between the voltage levels at two pins with constant frequency. The signals should be within the operating range and of correct polarity.

One of the signals to be displayed is given sufficient positive DC shift and fed at Vcc terminal. The other signal is fed at the ground terminal (pin 1) of IC 555 through a buffer. The output of IC 555 automatically switches between

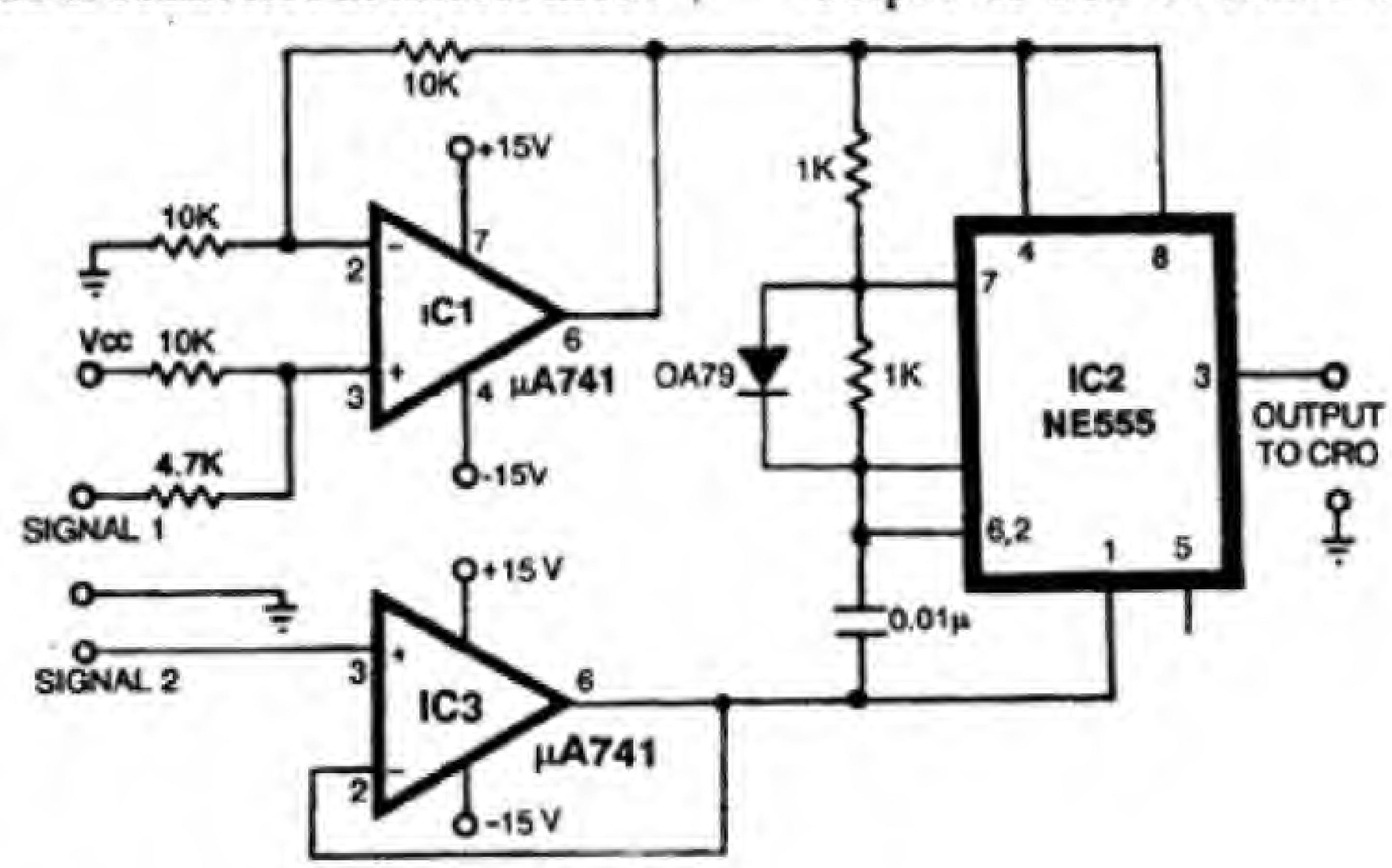


Fig. 1

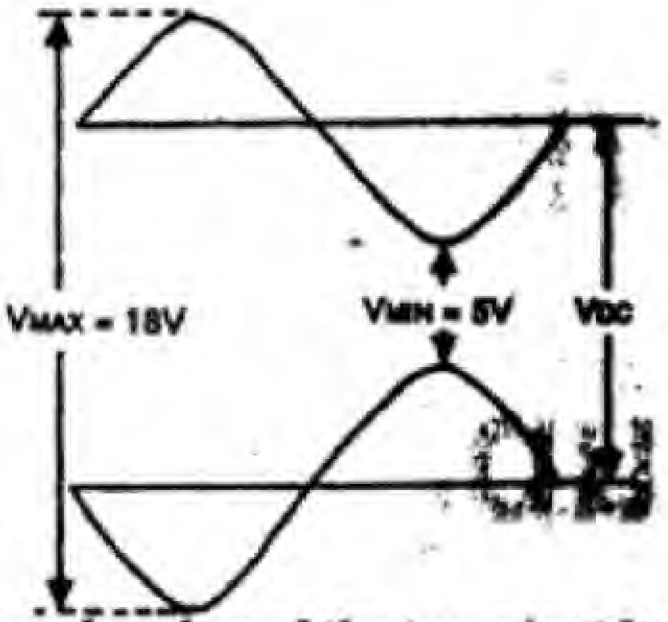


Fig. 2

these two levels and the two signals displayed on the CRO with the given DC shift between them. The tracing between these levels is not visible because the switching frequency is very high compared to the frequency of input signals.

Each 741 is connected as a unity-gain adder in the non-inverting mode, to give the required DC shift to one of the waveforms. When there is no signal, two beams will be displayed on the CRO.

Since it is a measuring instrument, the circuit will not load the source, i.e. minimum current will be drawn from the source.

The DC shift should be sufficient for worst conditions of input signals, i.e. when signal 2 is at its positive peak and signal 1 is at negative peak, the potential difference between these terminals should not be less than 5V. When signal 1 is at positive peak and signal 2 at negative peak, the potential difference should not exceed 18V (Fig. 2).

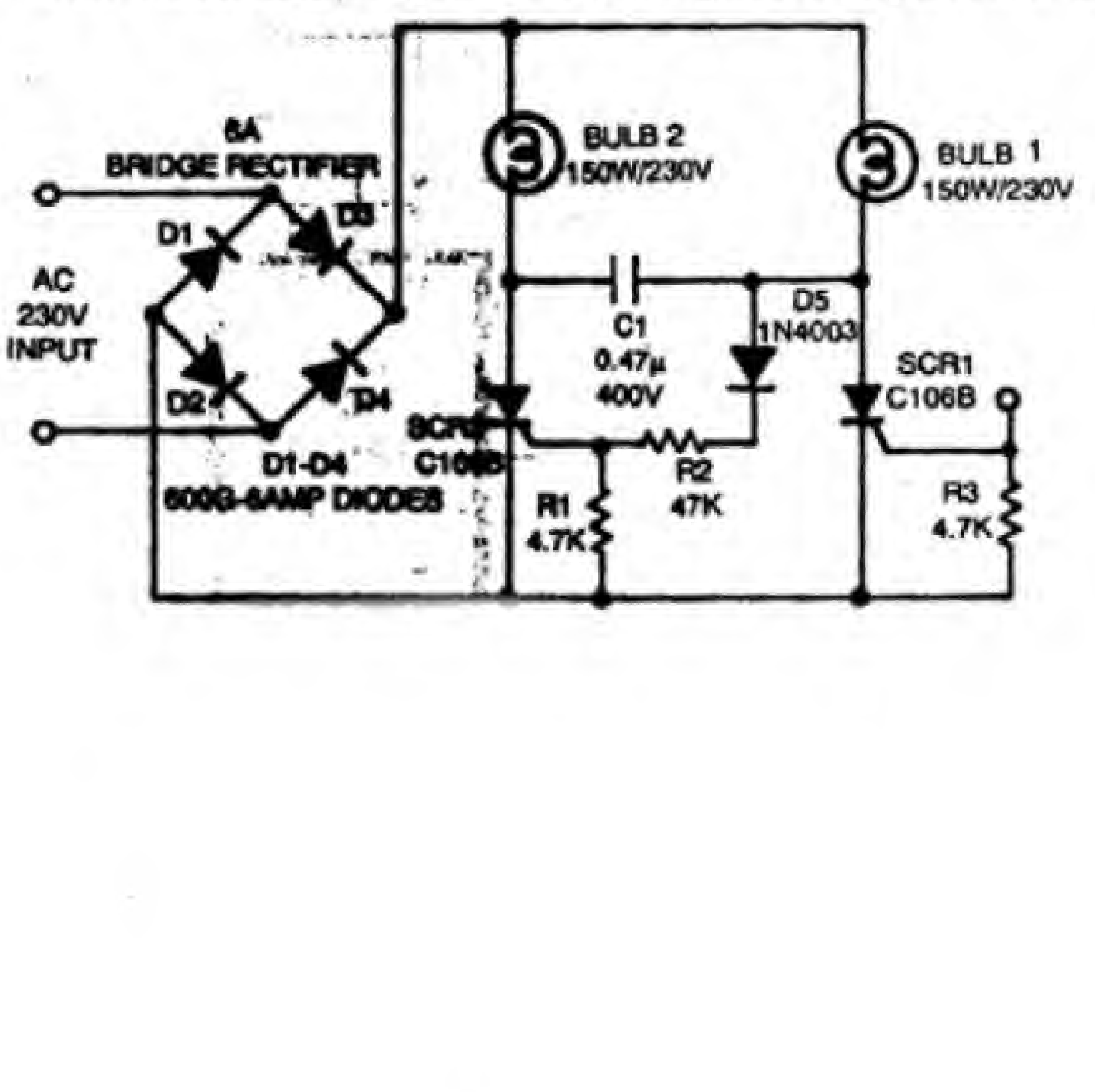
The capacitor of 0.01 µF, normally connected between pins 1 and 5, is not connected to avoid unwanted modulation of the displayed waveforms. For large waveforms, the input signals must be attenuated before feeding the circuit.

One disadvantage of the circuit is that the signals cannot be overlapped on the CRO for comparison.

Complementary Lighting Control

Saravanan M. Mallesan

This circuit is very useful for stage lighting, light shows, or even home movies. It decreases the light intensity of one lamp while simultaneously increasing the light of the other. The usual design for such a control unit uses dual potentiometers, two fader circuits, and is quite complicated. But the circuit presented here can perform this function with lesser number of components and the two loads track each other accurately without any adjustment.



The gate of SCR1 is driven from a standard phase-control circuit, based on an UJT or a diac. To use this circuit with lamps rated at more than 150 watts, the value of capacitor C1, in microfarads, is given by the relation

$$C1 = (1.5 \times T_{off} \times I)/E$$

where Toff is the turn-off time of the SCR in microseconds, I is the maximum load-current, and E is the voltage at maximum load current.

Readers' comment:

Can I use 100W, 230V bulb instead of 150W, 230V in this circuit. Please suggest an equivalent of SCR C106B as it is not available.

D. DEEPAK
Hoskote

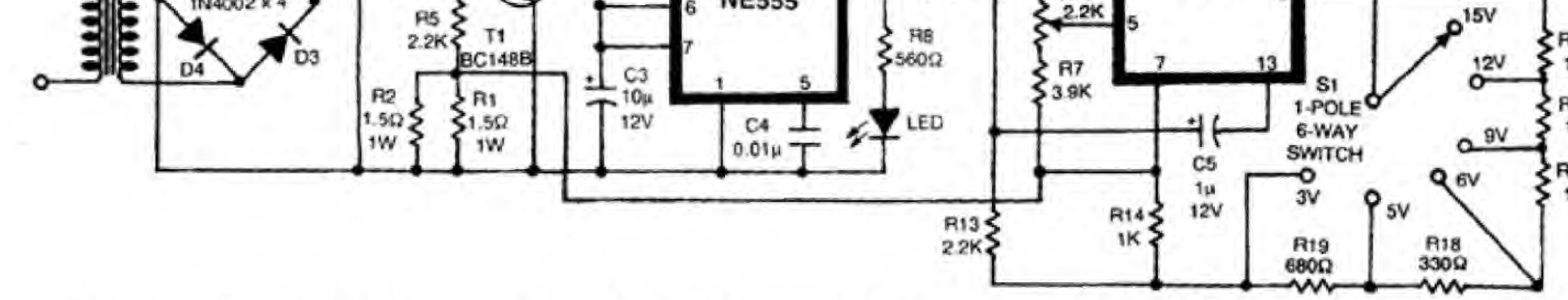
The author, Mr Saravanan M. Mallesan, replies:

The published circuit can be readily used with 100W, 230V bulbs. In fact, it is obvious that the circuit can be used with bulbs rating anywhere up to 150W. It requires modification only beyond 150W. Regarding the equivalent for SCR C106B, an SCR SN104 can be used instead.

Short-Proof Power Supply

R. Shankar

This is a completely short-proof power supply which gives 3V, 5V, 6V, 9V, 12V and 15V output voltages and a maximum output current of 700 mA. The unique feature of this circuit is that the power dissipated is reduced to a negligible level during short-circuit or overload conditions. In conventional power supplies, the maximum rated current continuously flows through the load under overload conditions. This may damage the power supply and the load.



The circuit shown here 'plays cool' under overload conditions. Whenever the output current exceeds 800 mA, the circuit is turned off and after a second, it is turned on automatically. If the overload condition persists, the circuit is turned off again and the cycle is repeated until the overload is removed.

Since the pass transistor is cut-off most of the time, the power dissipated during overload condition is negligible, thereby protecting the power transistor and the load. The LED starts glowing during overload condition.

The heart of the circuit is LM723 voltage regulator. A reference voltage of 7.15V appears at the IC's pin 6. This is tapped and given to the non-inverting input (pin 5) through R6, R7 and VR1. The output voltages can be selected by switch S1.

Under normal conditions, pin 3 of IC1 is low. However, during overload condition, the voltage across R1 and R2 exceeds 0.6V and transistor T1 starts conducting. This makes pin 2 of IC1 negative and triggers the monostable multivibrator. Thus, the output of IC1 becomes high. The voltage at inverting input (pin 4) of IC2 becomes more than the voltage at non-inverting input and the output voltage is brought down to zero. However, after a second, pin 3 of IC1 again goes low. If the short-circuit persists, the cycle is repeated.

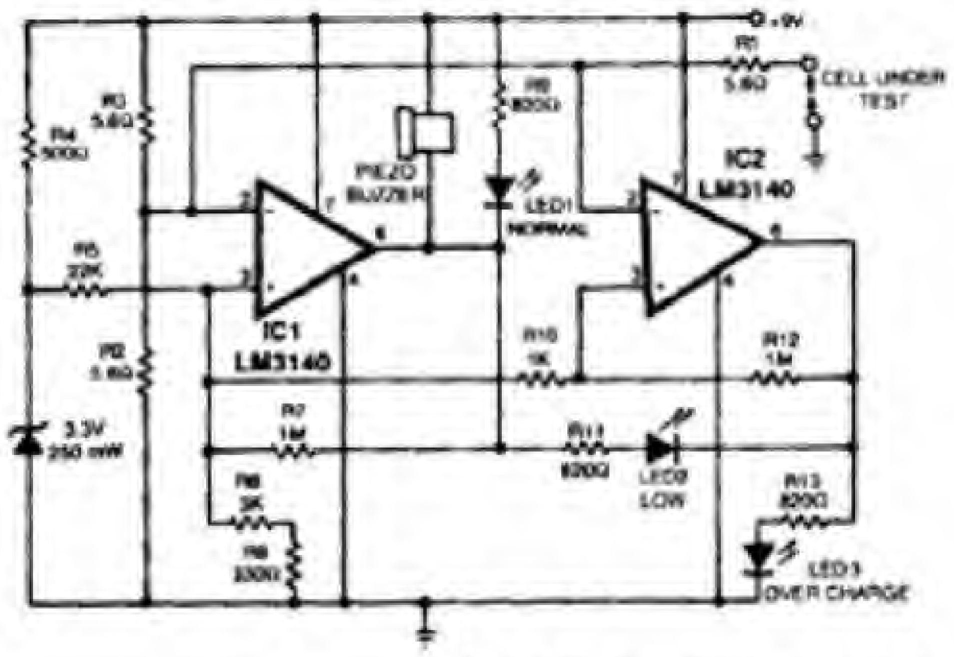
C2 and R5 delay the switching of transistor T1. Narrow spikes of duration less than 10 ms are passed through the circuit and are limited to 1.8A by R10, R11 and R12. Regulated 6.6V is supplied to IC1 through transistor T2. T3 and T4 are the pass transistors and must be mounted on suitable heatsinks.

For calibration, set switch S1 at 5V position and adjust VR1 to get 5V at the output. Now change the position of switch S1 and check the output voltage. Similarly, calibrate for all positions of the switch. Now short-circuit the output. The LED should start glowing (to indicate overload) if the circuit is correctly assembled.

Universal Cell Evaluator

Amrit Bir Tiwana

The circuit shown here allows instant testing of dry cells of any size. This portable unit operates on a 9V battery. R3 and R2 form the potential divider and the input is applied across it. The sensor stages, built around two op-amps, compare this voltage and the output is indicated by the LEDs.



LED1 shows that the battery is fully charged. An alarm is also provided as an indication. LED2 shows that the battery is not usable and the voltage level is below normal. LED3 glows to warn the user that the battery is overcharged and may damage the equipment.

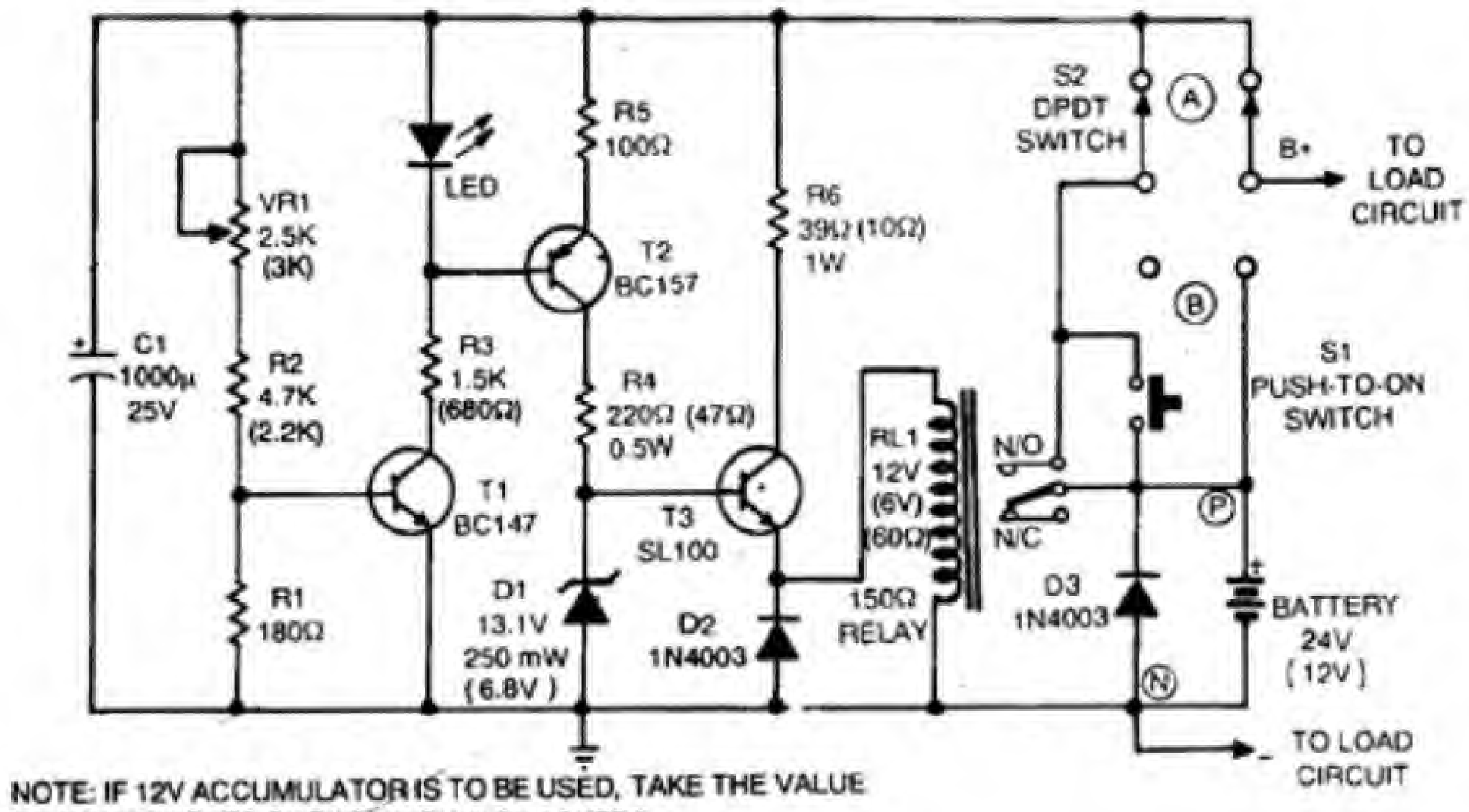
The circuit uses two LM3140 ICs as comparators. Values of R3 and R2 are shown for 'D' sized cells. In case some other type of battery is to be tested, R3 and R2 may be substituted by another one of suitable value, or a variable resistor. A 9V dry flat battery is used as power supply for the circuit. As the current consumption of the circuit is very low, the battery has a very long life. ❑

Overdrain Protector for Lead-Acid Accumulators

V. Brindavanan

The storage batteries like lead-acid accumulators should not be discharged below a certain voltage specified by the manufacturer, e.g. a 24V lead-acid battery should not be discharged below 18V. If drained below 18V, hard insoluble lead sulphate is formed on the plates of the accumulator. This increases the internal resistance, thereby reducing the load voltage and efficiency.

To overcome such problems, the circuit shown here is very useful. The protection is provided by disconnecting the load circuit automatically at preset voltage level. This circuit draws approximately 100mA current from the battery. Therefore, for high capacity accumulators, this circuit is very use-



NOTE: IF 12V ACCUMULATOR IS TO BE USED, TAKE THE VALUE OF COMPONENTS SHOWN WITHIN BRACKETS.

ful. For low capacity batteries, the indicating circuit is suitable which drains less than 8mA current. In place of the relay, an LED is connected for indication of overdrain. Since the LED does not need any driver, the current consumption is reduced. The load circuit is disconnected from the battery manually. The battery is recharged for further use.

The circuit is switched on by switch S1. The relay connects the accumulator to the load circuit. The LED indicates that the battery is connected to the load. Zener diode D1 provides the reference voltage for the emitter follower transistor T3. Transistor T3 drives the relay and maintains approximately 12V for the relay coil. Resistor R5 limits the voltage at the base of T3, thereby eliminating the necessity of higher wattage transistor or higher wattage heatsink for T3. One-watt heatsink is sufficient for T3. Diodes D2 and D3 provide protection against voltage transients. Capacitor C1 filters out any spikes produced due to the reactive load connected to the accumulator. In case the protector is not needed, the load can be directly connected to the accumulator (keeping S2 in position B).

Whenever the terminal voltage of the accumulator falls below a certain preset level, transistor T1 is cut-off and the relay disconnects the load circuit. The circuit ensures complete cut-off from the battery. That is why there is no indication for the off state.

The circuit must be calibrated before regular use. The following sequence of procedure should be followed for calibration. For a 24V accumulator, take any DC variable power supply of 0 - 30V range (15V-25V range is also sufficient) and set the desired voltage ranging from 16V to 23V (or 9V to 12V for 12V accumulator). At this voltage, the circuit disconnects the load from the accumulator, thus protecting the accumulator from overdrain.

Replace the battery with the variable power supply. Observe the polarities while connecting the power supply. Point P is positive and N is negative as shown in the figure. Adjust preset VR1 to get null/zero position. Keep switch S2 in position A. Press switch S1 for a moment and release it. By pressing S1 the relay will be switched on automatically. If not, check VR1. If VR1 is correct, check the whole circuit again.

Now switch on the relay and adjust preset VR1 till the relay is switched off. For exact setting of VR1, trial and error method can be used. This position of VR1 should not be disturbed. With this the calibration is over and the circuit is ready to be used.

Clap Switch

Narpat Singh Rana

The circuit presented here consists of silicon transistors. The circuit can be divided into three parts.

1. Audio trigger stage
2. Bistable multivibrator stage
3. Relay operation stage

In audio trigger stage, with the sound of a clap the condenser microphone (34LOD) triggers transistor T1. This gives positive pulse to the bistable multivibrator based on transistors T2 and T3. With the first positive pulse transistor T2 starts conducting and T3 remains off. With the second positive pulse the state of the bistable multivibrator changes, i.e. transistor T3 starts conducting and T2 turns off.

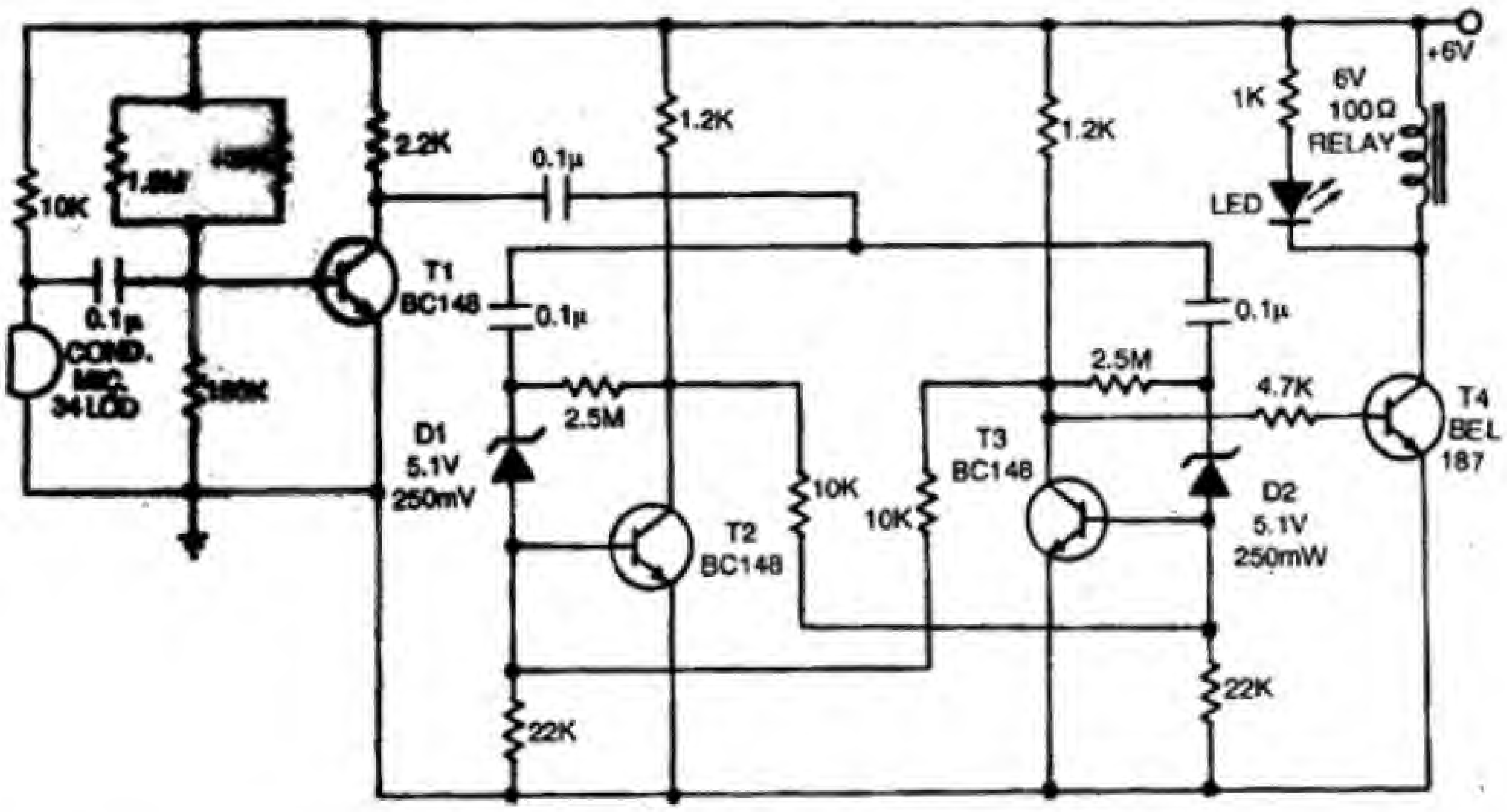
This is basically a single input, negative edge triggered bistable multivibrator. Due to parameter mismatch let at the very instant T2 conduct more than T3, after some nano seconds, the stable state will be T2 on and T3 off. When the mic. gets the clap sound or the sound of a whistle, a negative going pulse appears at the common input of the bistable. It retards T2, as a result T3 is put in conduction and T2 in off state.

In the third stage, a realy driver transistor BEL187 is used. For visual indication an LED is used in parallel with the relay.

This clap switch can be used for a portable radio. The radio is set at a particular frequency. With the first clap the radio will be turned on and with the second it will turn off.

The quiescent current of the circuit in off state is of the order of a few milliampers.

The clap switch should be inside the radio and care should be taken to insu-



late it from rest of the components of the radio receiver. The condenser microphone should be mounted outside the radio receiver. Keep it away from the speaker or it will be triggered by its own feedback sound. For better performance use with battery is recommended; AC adaptor should not be used.

Readers' comments:

I have assembled the circuit but it worked properly only after the 6V supply was increased to 9V and the collector and emitter of transistor T4 (BEL187) were interchanged. Please clarify why this was so.

Further, when power was supplied from a highly regulated AC adaptor, the clap switch showed unstability at the time of switching on/off of tubelights, fans etc.

The author has suggested that the circuit may be housed inside the cabinet of a pocket transistor but certain frequencies of sound keep triggering the switch. Please clarify.

AMEET HINGORANI
Secunderabad

❑ The circuit for the clap switch is not a new one. I made the same circuit three years ago with a PCB and components obtained from Gala Electronics, Bombay. Now that circuit has become very popular.

PRADEEP G.
Alappuzha

❑ The LED in the clap switch circuit gives out very little light. To use the circuit for a night lamp, can I replace the 1k resistor and the LED with a 6V bulb?

H.N. NAVEEN
Mysore

The author, Mr Narpat Singh Rana, replies:

Use of AC adaptor is not recommended for the clap switch if malfunction is to be avoided. But it can be used with 4.5V portable transistor sets by following the procedure given below:

1. Connect the transistor set at the relay points and power the circuit from the set's 4.5V battery.

2. The switch may be fitted within the cabinet of the set using insulation or cello tape.

3. The condenser mic. should be fitted outside the cabinet.

4. Volume should be kept at such a level that only loud sounds can trigger the circuit.

As regards Mr Pradeep's comments, the world is vast and every man has got the right to think freely. It is quite possible that more than one person can hit upon the same idea. However, I have designed the switch after a long experimentation.

We cannot connect a 6V bulb in place of the LED to obtain more light. The 1k resistor may however be replaced with a 100-ohm resistor to get some more light from the LED itself.