Fire Alarm

An expensive system that will detect a fire in any room, garage etc.

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Commercially available fire alarm systems are expensive and very few people (unfortunately) think the risk of fire in their house warrants such a large expenditure. There have been quite a few fire alarm projects in electronics magazines over the years, but nearly all depend on using expensive and hard to obtain gas sensors. The fire alarm described here, however, uses a simple, cheap, reliable and novel method of fire detection, is extremely versatile in that as many detectors as required can be added and will give enough warning to perhaps avoid another tragic disaster.

Fire Alarm

The fire alarm consists of two units: the master unit which sounds an alarm and displays where the fire is, and the detector units, one of which is mounted in each room. The master unit is intended to be mounted by the bedside in the main bedroom and to be switched on before a night's sleep. The unit has provision for six detector units, but this can be extended to any number if required. The unit supplies the power to the detectors, and when triggered sounds quite a loud warning device and illuminates an appropriates LED to show which detector has been triggered.

The detectors use a beam of infrared light supplied by an infrared LED to detect the presence of smoke particles. As the room fills with smoke, the intensity of the infrared (IR) beam reaching the IR detector transistor decreases, as the smoke particles scatter and absorb the IR light. This drop in intensity is detected and used to trigger the master unit.

When smoke is detected, a low signal is sent to the master unit; otherwise the signal is high. As the master unit expects to see a high voltage signal when in normal operation, any faults with the detectors and any breaks in the detector cables, which might be caused by fire burning through the cables, will be detected as the signal will go low and will trigger the alarm. This is an added safety feature which detects faults, as it is useless having a broken detector unit when you think it works perfectly.

Circuit Description — Master Unit

Power is obtained from transformer T1 (Fig. 1) through a fuse and is rectified and smoothed by D1, D2 and C1 to give a DC voltage of about 12V. This supplies IC1, the 555 timer, which is set to oscillate at about 1.5Hz. When TR1 is conducting, the signal from IC1 switches TR2 on and off which in turn switches the audible warning device (WD1) on and off. (If desired this warning device could be replaced by a relay which could drive a more elaborate alarm system — see Fig. 2.)

The signals from the detectors are fed to IC2, a CMOS hex inverter/buffer chip. The output voltage from this chip is the inverse of the input and is fed to the base of TR1 via R3 and diodes D11 to D16. A low voltage in produces a high voltage out which switches TR1 on and the alarm sounds.

The detector signals are also sent via R4 to R9 to a set of transistors (TR3 to TR8) which switch on LEDs D3 to D8 when the voltage to their bases goes low, hence showing which detector has been triggered. Resistor R16 and LED D9 are present to indicate when the unit is turned on.

Detector

The detector circuit is shown in Fig. 3.

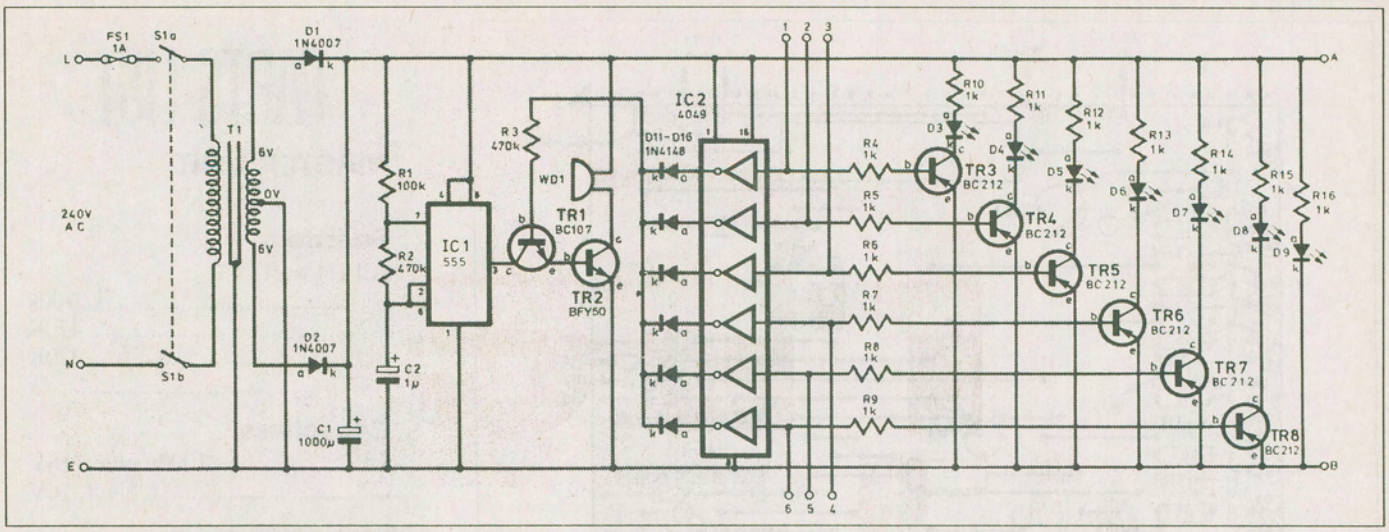

Fig. 1. Circuit of the Fire Alarm master unit.

About 50mA flows through the infrared LED D10 via R19 and R20 so that a high output of IR light is obtained. In the absence of smoke, this high intensity beam switches the IR transistor TR10 fully on so that the full supply voltage is dropped across R18 and the base of TR9 is at zero potential. Hence TR9 is not switched on, no current flows through R17 and there is no potential drop across it. The signal to the master unit is high.

When the intensity of the beam is reduced by the slightest amount, due to smoke particles, TR10 conducts less and so the base of TR9 sees a voltage. As the two transistors are directly coupled, this voltage switches TR9 fully on, the full supply voltage is dropped across R17 and the output signal is low.

Construction

The circuit board was made out of Veroboard, as this is the most available form of circuit board and allows the project to be made by less experienced builders who may not wish to purchase a ready-made PCB and who may be unfamiliar with PCB construction. As a result, however, there are quite a number of breaks in the tracks, and a large number of links are present so the layout shown in Fig. 4 will have to be very carefully followed.

A standard 3.75 inch X 5 inch Veroboard is cut to 29 holes and the off cut kept for the detector circuit board. Very carefully mark the breaks in the tracks and cut them with a razor knife or twist drill.

Start construction with the links, followed by the six stereo jack sockets. The resistors, capacitors and semiconductors

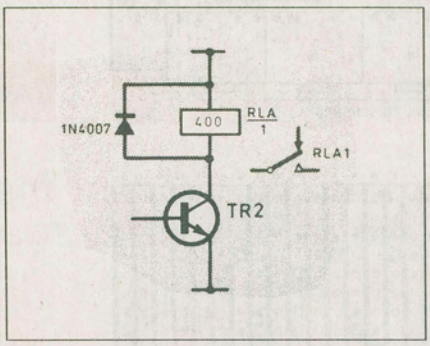

Fig. 2. Addition of a relay to drive other output devices.

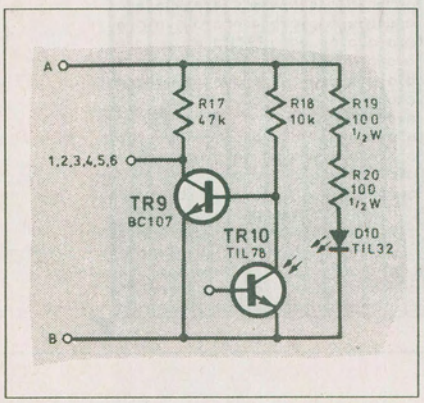

Fig. 3. Circuit of the alarm detector.

can then be soldered into place. Care must be taken with the orientation of polarized components (see Fig. 4). IC2 must be placed in a socket rather than directly soldered into the board (damage may occur due to the heat from the soldering iron, but IC2 is a CMOS device and none of the pins must be touched as this may cause damage to the chip due to static electricity).

Once the circuit board is complete, attention is now turned to the case construction and power connections. The case is a 152 X 82 X 50mm utility box, which accommodates the components snugly.

The transformer is mounted in the left hand corner using bolts and the fuse holder mounted at the back. The power cable enters the case through a grommet and a cable clamp should be included to prevent the power cable accidentally pulling out and weakening solder joints, which could be dangerous. Power wiring is shown in Fig. 5.

Six holes are drilled in the side of the case for the jack sockets and seven holes in the case lid should be drilled for the seven LEDs. The power switch S1 should be mounted in line with the power on LED (see Fig. 6). A hole will also have to be cut in the case lid for WD1 which should be fixed using epoxy resin.

After wiring up the circuit board, WD1, transformer, switch etc., (see Figs. 5 and 6) the circuit board can be mounted using bolts or the plastic spacers supplied with the case. All that remains is for the lid to be labelled with instant lettering.

Detector Unit

The few components which make up the detector unit are all mounted on a small piece of Veroboard left over from the main Veroboard. There is only one break to make and no links this time.

After construction of the circuit board has been completed (see Fig. 7) it is connected to the master unit via thin, 3-way power cable. The cable is attached to the circuit board as shown, fed through a grommet in the side of the case, and at-

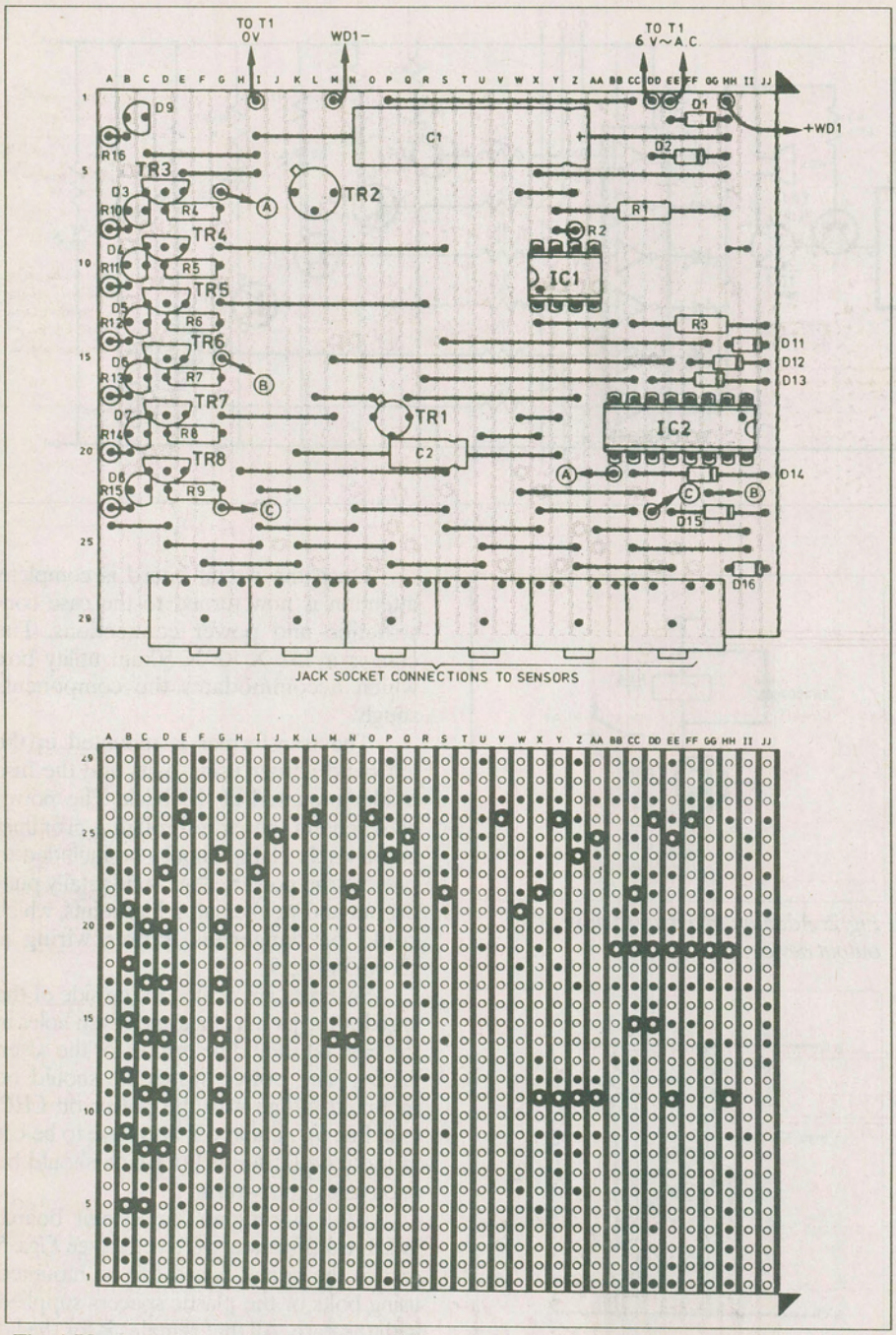

Fig. 4. Veroboard layout and wiring.

tached to a 3.5mm stereo jack plug, carefully noting which wire goes to which part of the plug (see Figs. 8 and 9).

Two holes should be drilled in the case lid so that the IR LED and transistor can poke through when the lid is placed on the case. The LED and transistor are then bent through 90 degrees so that they are facing each other, and are shielded from daylight, either by using a piece of pen case or rubber tubing. Particular attention should be made to shielding the transistor as external IR sources may interfere with the detector.

Plug the detector into the main unit and if the alarm is triggered, it means the LED and transistor are not correctly lined up with each other. If this happens, small movements of either the transistor or LED should be made until the alarm is silent.

Once alignment has been completed, the transistor and LED can be glued into place using epoxy resin. This also holds the

PARTS LIST

MASTER UNIT

Resistors

All 1/4 watt, 5%

R1 ..... 100k
R2 ..... 470K
R3 ..... 470K
R4-16 ..... 1k

Capacitors

C1 ..... 1000u elect. 16V
C2 ..... 1u elect. 16V

Semiconductors

D1,D2 ..... 1N4007
D3 to D9 ..... red LEDs
D11 to D16 ..... 1N4148
TR1 ..... 2N3904
TR2 ..... 2N2219, BFY50, etc.
TR3-8 ..... 2N3904, BC212, etc.
IC1 ..... 555 timer
IC2 ..... 4049 CMOS hex inverter

Miscellaneous

FS1 ..... 1A fuse and holder
S1 ..... DPDT toggle switch
T1 12V centre-tap 6VA transformer
WD1 audible warning device: 12V buzzer, piezo sounder, horn, etc.
16 pin DIP socket, Veroboard 3.75 inch by 5 inch, case – 152 X 82 X 50mm, 6 stereo jack sockets, cable clamp.

DETECTOR UNIT

(Items for one unit)

Resistors

R17 ..... 47k 1/4W
R18 ..... 10k 1/4W
R19 ..... 100 1/2W
R20 ..... 100 1/2W

Semiconductors

D10 ..... TIL32 IR LED
TR9 ..... 2N3904, BC107, etc
TR10 ..... TIL78

Miscellaneous

Case 72 X 47 X 25mm, Veroboard (see text); three-way power cable, 3.5mm stereo jack plug, grommet.

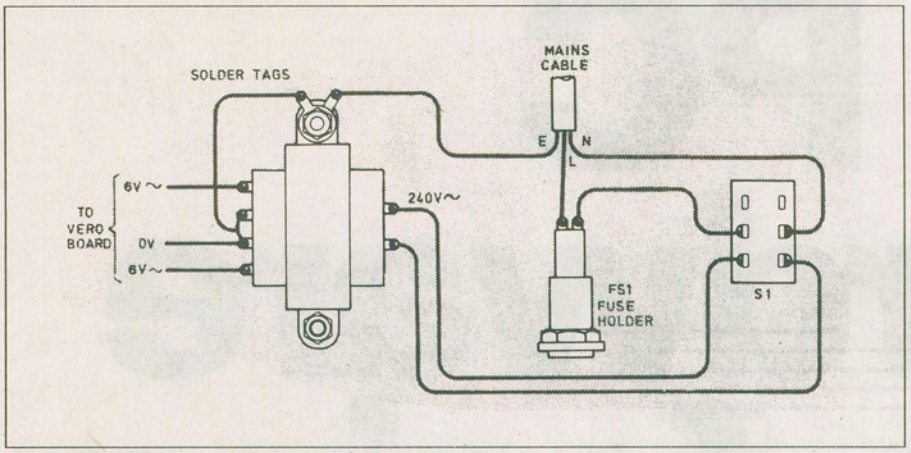

Fig. 5. Supply wiring.

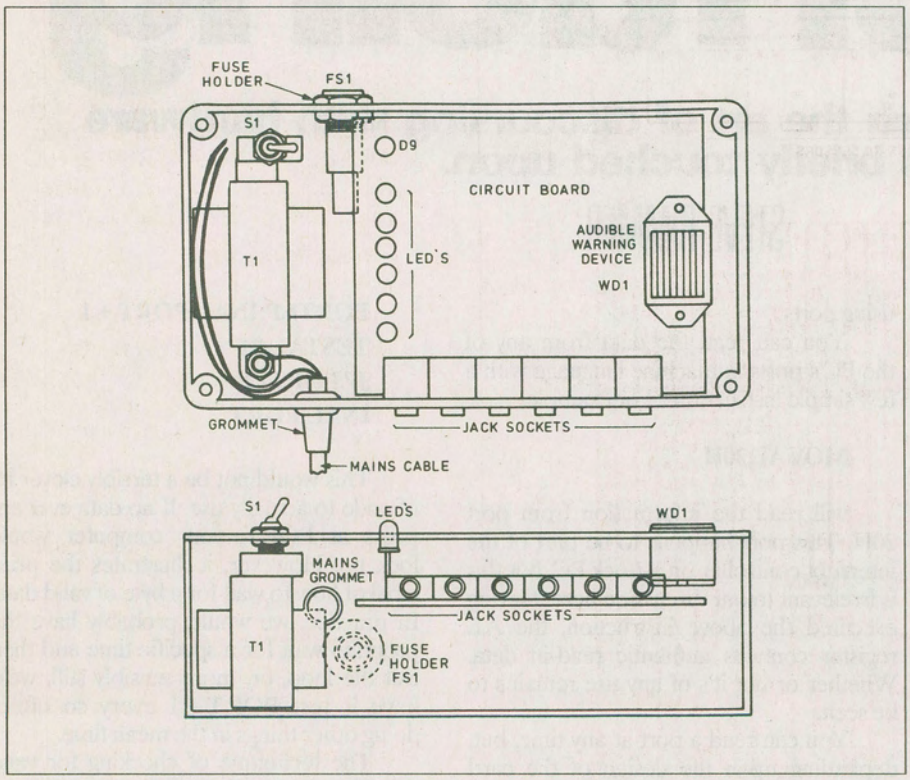

Fig. 6. Layout of the main components in the case.

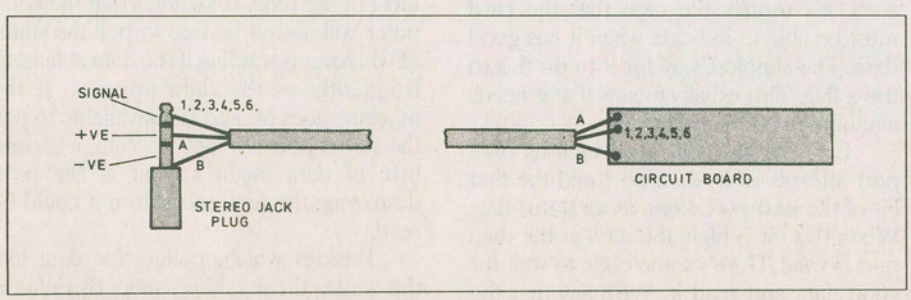

Fig. 9. Wiring of the detectors to the stereo plugs for connection to the master unit.

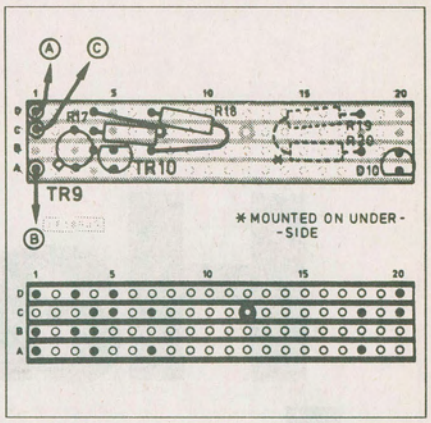

Fig. 7. Veroboard construction of the detector units. Note that point C goes to the jack plug tip.

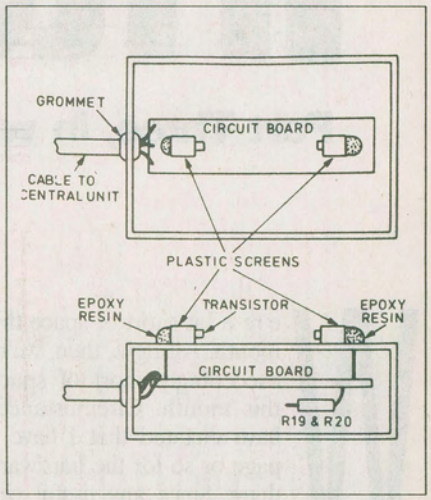

Fig. 8. Layout of the detectors.

circuit board in place. The detector is now complete.

Mounting and Testing

The detector units should be mounted high up on a room wall or on the ceiling as smoke tends to accumulate at the top of a room. Best positions are near potential fire hazards, e.g., near ash trays, electric heaters, above sofas, near electrical equipment etc., and detectors should be located as near to these as possible.

Testing is simply a case of cutting off the IR beam of each detector by placing a finger in the path of the beam, and checking to see if the corresponding LED lights. (You can also allow a little smoke from a cigarette to pass through the beam to check sensitivity.) If all is well, the project is now ready to protect your home from the dangers of fire. ■