a new series... By F.C. JUDD, A. Inst. E.

# EXPERIMENTS WITH SOUND & LIGHT & COLOUR

Currently much interest is being shown in the artistic exploitation of controlled lighting for decorative purposes.

Ever changing levels of light, and different hues, can be blended to create most pleasing and relaxing effects. When the visual display is directly controlled by a sound programme the effect is greatly enhanced. The two media are most satisfactory complements, one to the other. And it hardly needs emphasising that electronically composed music has an obvious and natural place here.

The subject is not new. Modern technology merely makes it more practical and extends the possibilities.

In this series, the author first provides a background by referring to some work carried out in recent years in this field. This first article also provides details of a simple basic colour light display. A more ambitious design involving the modification of a discarded television receiver will be given in the second and third articles. The series will conclude with a discussion about the programming of both displays from audio signals.

Precise " blueprint " details are not given—but there will be adequate information for those keen enough to start experimenting themselves in sound, light, and colour.

In music and audio and indeed in moving films, experiments have been made at one time or another with the co-ordination of sound, light and colour. A classic example in movie films was Walt Disney's *Fantasia*. Aside from films there have been applications such as coloured lighting controlled and synchronised by sound. Some experimenters have even tried to present sound in terms of colour, whereby each colour displayed as light on a screen represented a particular band of frequencies or specific sounds. The various combinations and methods are quite intriguing and perhaps attractive to experimenters who would like to try something different.

***This is the original c.r. colour pattern display as demonstrated at the 1962 Audio Festival in London***

The author's own particular interest in sound and colour came about as the result of research in the techniques of electronic music. Here the need for a visual element seemed obvious since most electronic music is of an abstract form. A search for information on such an unusual subject revealed that little had been written but that various methods had been used; for instance, at one exhibition in London a computer had been employed to analyse music and present its findings on a large screen in terms of colour illumination. Electronic organs have been used to control coloured lighting via the organ keys and coloured lighting has been combined with music as in *Son et Lumiere* programmes.

## CATHODE RAY DISPLAY

It seemed, however, that the cathode ray tube had been overlooked as a controllable means of displaying images of sound in abstract form. Multi-colour effects might also be produced by using colour tubes similar to those used in colour television receivers. These are of course expensive items, so the possibilities of a standard blue/white trace television c.r.t. combined with a colour "scanner" were investigated.

As a result, a complete display as shown in the photograph was devised and constructed by the writer and demonstrated at the London Audio Festival of 1962. The display featured a 10in × 8in screen and employed a standard 12in television c.r.t. and a colour scanner. The audio signals for producing the colour patterns were recorded on tape and synchronised with electronic music, also on tape. The programme could therefore be repeated as often as desired.

Such a display can be produced, as was the original version shown here, from an old television receiver with a 12 or 14in tube. The usual a.c./d.c. circuitry must be modified and all the normal r.f. and video sections removed. The experiment should in fact begin with no more than the c.r.t. and its e.h.t. supply. A separate power pack capable of delivering approximately 300V at 100mA is needed to cover all h.t. requirements. This should include a 6·3V heater winding suitable for about half a dozen 0·3A valves.

## LISSAJOUS PATTERNS

The basic function of the c.r.t is to display what are really complex Lissajous patterns derived from various audio frequency signals with different waveforms. Signals can also be taken from accompanying music as well. Auxiliary equipment therefore consists of audio signal generators with sine and square-wave outputs and a signal mixer. By tape recording the control signals, the editing techniques of magnetic tape can be applied, i.e. the pattern signals can be juxtaposed to a desired order.

The original experimental display consisted of the c.r.t. and e.h.t. supply together with X and Y deflection coil amplifiers and pulse generators. The colour scanner was made up from pieces of coloured (transparent) Cinemoid. A normal television tube produces a brilliant blue/white trace which when covered by Cinemoid transparency will change to whatever colour is being used. The scanner was made to rotate at about ten times per second whilst the c.r.t. grid was pulsed at around the same rate. Patterns displayed on the screen changed colour according to the rate of the scanner rotation and the frequency of the c.r.t. grid pulses. By varying the grid pulse rate as well as the repetition rate of the patterns themselves, quite beautiful and brilliant "psychedelic" effects can be produced.

Details and circuits for constructing a new and improved version of this c.r. display unit will be given in the next two articles. *This month's cover incorporates three colour photographs taken directly from the screen of this c.r. colour pattern display unit.*

For the reader eager to start experimenting in this field, we now give some practical details of a coloured light display using banks of small lamps. Less sophisticated than the c.r.t. device, this is relatively simple to construct, and is certainly very effective in operation.

## A COLOURED LIGHT DISPLAY

The idea of controlling coloured lights by audio signals is by no means new. Almost any audio power transistor can be made to pass enough collector current to light small flashlight bulbs connected in parallel or series-parallel in the collector circuit.

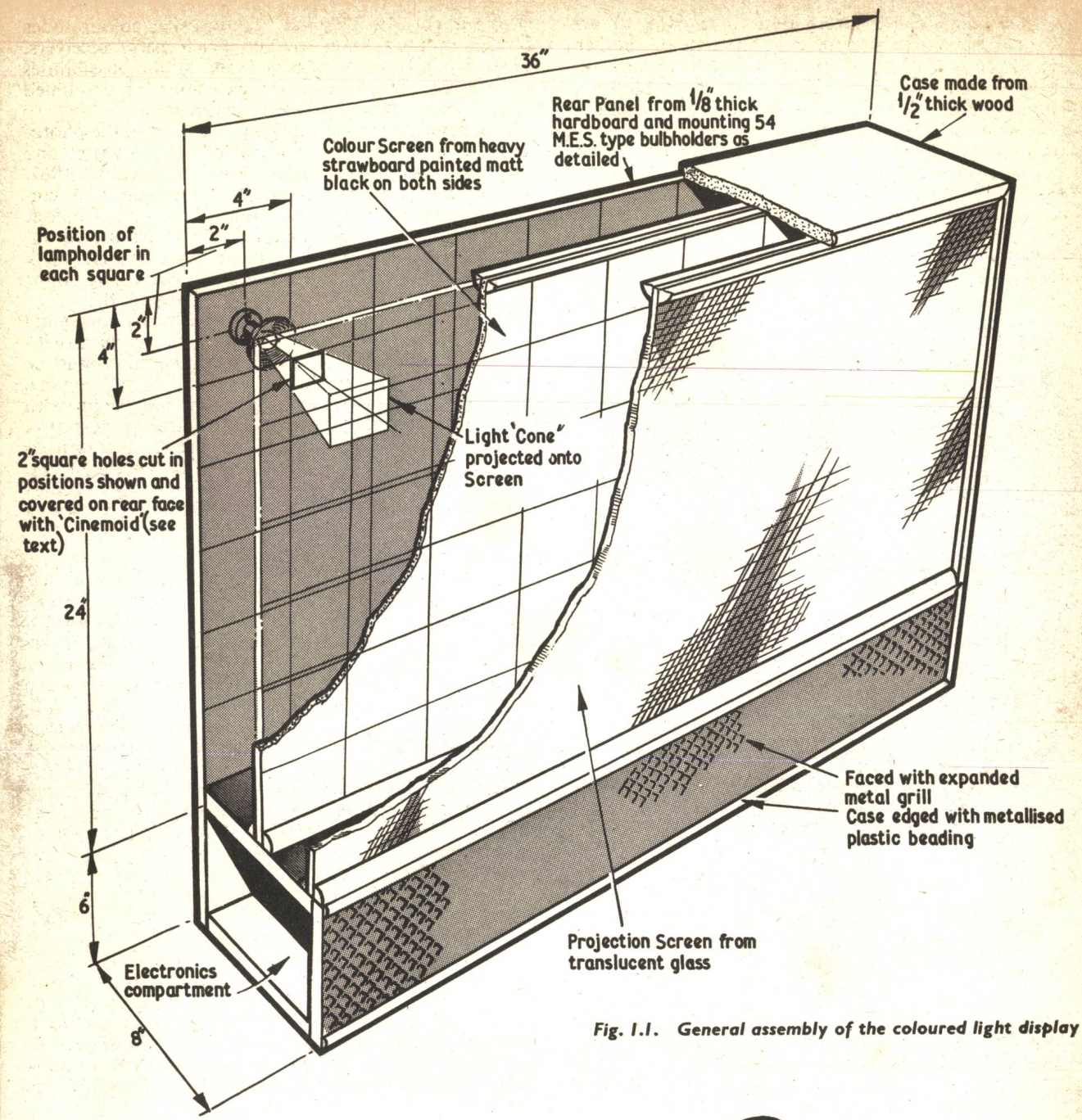



*Fig. 1.1. General assembly of the coloured light display*

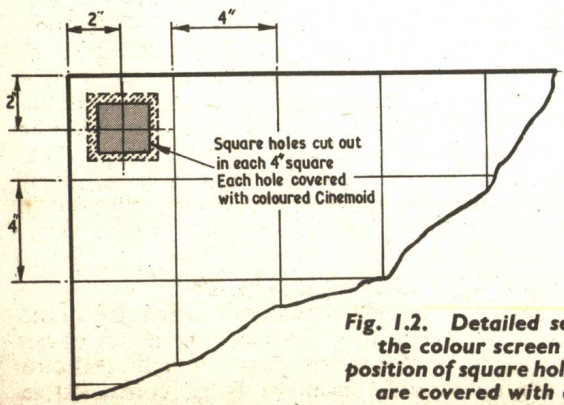



*Fig. 1.2. Detailed section of the colour screen showing position of square holes which are covered with coloured "Cinemoid"*

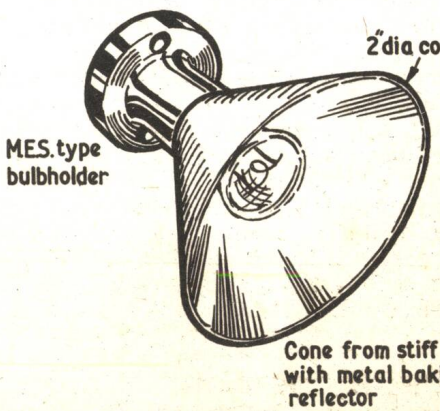



*Fig. 1.3. Lampholder and reflector*

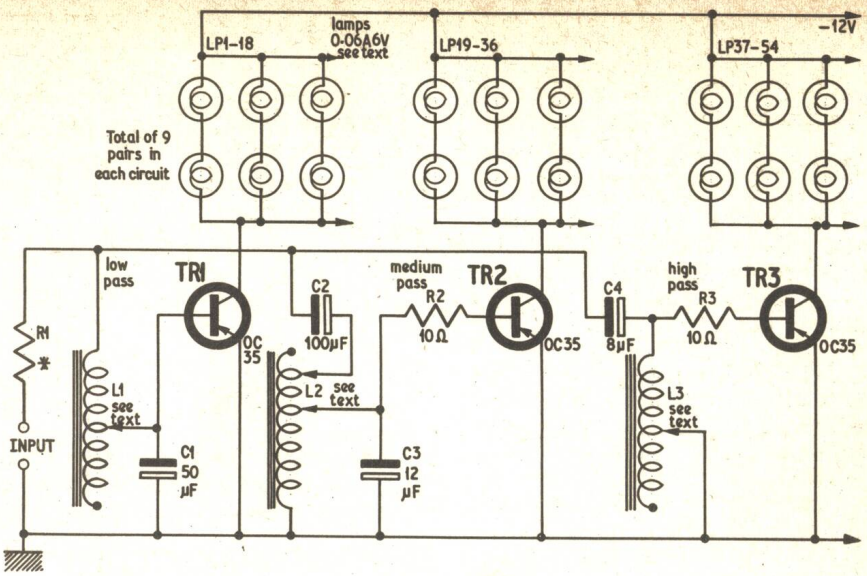
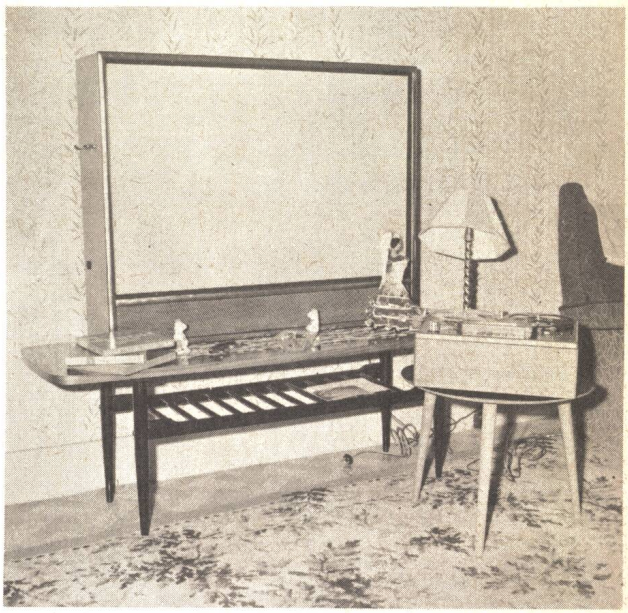



*Fig. 1.4. Filter amplifier circuit for the coloured light display. R1, nominally 10Ω, is selected to suit input source*

The basic principle is to drive the transistor from cut-off up to full collector current (no more) by applying signals at the base. As the collector current increases so also will the brilliance of the lamps. With a 12V supply and a maximum collector current of say 500 to 600mA, approximately eighteen 0·06A (6V) lamps in series–parallel in the collector circuit will light to full brilliance.

The display as shown in the photograph (right) has a screen 3ft × 2ft and fifty-four 6V 0·06A lamps are used to display colour blocks measuring approximately 4in × 4in on the frosted screen. Three transistor amplifiers with audio filters are employed to divide the audio frequency spectrum into bands covering approximately 50–100Hz, 200–1,000Hz, and 1,000–5,000Hz—and higher.

In a display of this kind, the original of which was demonstrated in London in 1963, the colours can be arranged in various ways, e.g. at random or geometrically. The effect was found to be more interesting when the colours and lamps were distributed at random. The display can be almost any size, i.e. smaller or larger than the one shown and described in this article. If a larger number of lamps are used the power transistors must of course be capable of passing the necessary current. Alternatively, more than three transistor amplifiers and filters could be used—together with extra lamps, accordingly.



*A colour display using small lamps. Constructional information is included in this article*

## DISPLAY SCREEN AND LAMPS

The recommended size of the display is 3ft wide, 2ft 6in high and 8in deep, see Fig. 1.1. This allows a front screen of translucent or frosted glass of 3ft × 2ft. The lower part of the case contains the 12V h.t. supply and transistor filter/amplifiers.

The 54 lamps are mounted on the back inside of the case as shown in Fig. 1.1. The colour screen is mounted approximately halfway between the lamps and the front glass screen so that squares of light approximately 4in square are projected onto the front screen. With three filter amplifiers 18 lamps per transistor can be used. This calls for audio power transistors such as the OC35 capable of passing a collector current of around 600mA. Each transistor must of course be mounted on a suitable heat sink.

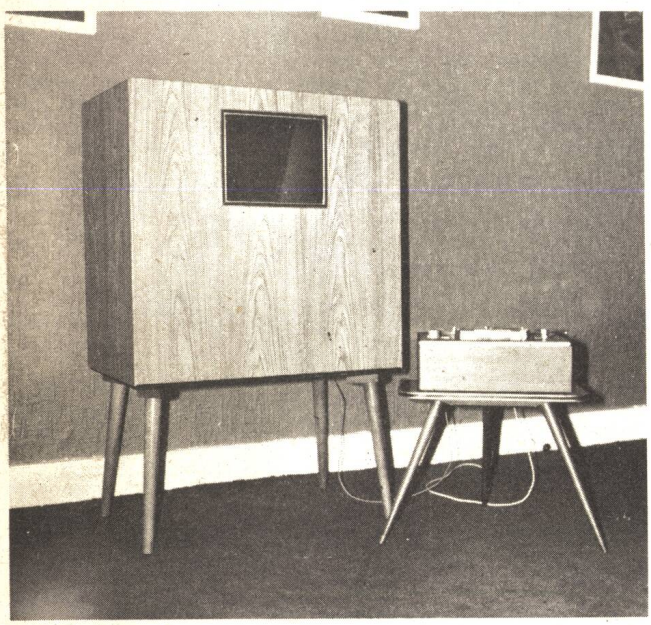
Every lamp is fitted with a small circular reflector to increase the brilliance and to focus the light forward. The reflectors are made from 2in squares of "food foil" pressed into shape by wrapping round a small rubber ball or similar spherical object. Make a hole in the centre (before pressing into shape) just large enough for the cap of the bulb to go through (see Fig. 1.3). The reflectors are fixed to the bases of the lamp holders with a spot of adhesive.

Those desirous of experimenting with a display of this nature are advised to carry out a few bench tests first of all with the transistors and lamps and the filter circuits. In this way adjustments to the circuits and the tuning of the filters with the help of an audio signal generator will facilitate final operation.

## THE FILTER AMPLIFIER

The filter amplifier of Fig. 1.4 consists of three sections —each controlling a group of lamps. Each transistor is normally cut off and collector current will flow only when signals are applied to the base via the requisite filter. The inductances for the filters have to be determined experimentally but in the original circuits Mullard type LA11 or Vinkor LA2002 pot cores each with a full winding of 30 s.w.g. enamelled wire were used. The windings were tapped every 50 to 60 turns so that each coil could be adjusted to the desired frequency cut-off in conjunction with the tuning capacitors.

The input signal required to drive the transistors into the fully conducting state can be taken directly from the low impedance output of the amplifier employed for the reproduction of music (extension speaker sockets of a radio or record player, etc.). It



***This photograph shows the new version c.r. colour pattern display based upon a discarded television receiver and which will be described in subsequent articles***

may be found that less audio power can be used if the base of each transistor is biased a little toward the negative h.t. rail, but not sufficiently to cause the lamps to light.

Instead of inductances consisting of wound pot cores as mentioned above and which are expensive, it should be possible to use the primary windings of small valve type audio output transformers. If these have tappings, so much the better. Each circuit can be checked with the aid of an audio signal generator and "tuned" experimentally for bandwidth by adjusting (a) tappings on the inductance or by using alternatives and (b) varying the value of the capacitors of the filter circuit.

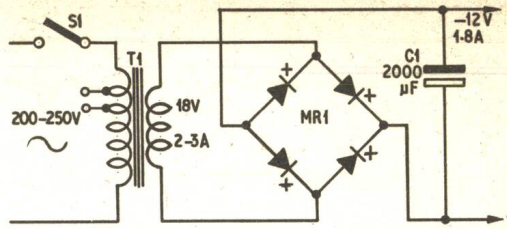



***Fig. 1.5. Power supply circuit for the colour display***

A circuit suitable for a power supply is given in Fig. 1.5. Smoothing other than that provided by the 2000$\mu$F capacitor C1 is not essential. There is ample room in the bottom section of the case for the filter amplifiers and the power supply. The power supply transformer T1 and the bridge rectifier MR1 together must be capable of supplying 12V at a peak d.c. current of 1·8A.

## DISTRIBUTION OF LAMPS AND COLOURS

The lamps are wired in series-parallel, 18 to each transistor circuit, as in Fig. 1.4. It has been found that random distribution over the backboard produces the best effect. Much the same applies to the colour screen, i.e. the colours are placed at random (see Fig. 1.1).

The final position of the colour screen relative to the lamps and the front screen is best found by experiment. The ultimate position is when squares of light approximately 4in square are projected on to the opaque front screen (see Fig. 1.1). The coloured "Cinemoid" from which pieces approximately 2½in × 2½in are cut is obtainable from Strand Electric and Engineering Company Limited, 250 Kennington Lane, London, S.E.11. Pieces 12in × 12in cost 2s 9d each and are known as "reference 61". Colours available include red, green, blue, yellow, orange, purple.

## COMPONENTS FOR THE DISPLAY

Most of the components used in this display are standard, i.e. resistors are ½ watt and the electrolytics are minimum 12V working. The transistors are Mullard OC35 or nearest equivalent. Pot cores are also available from Electroniques (S.T.C.) Limited, Edinburgh Way, Harlow, Essex, who can also supply all other components including a suitable transformer and rectifier for the power pack. The lamps are M.E.S. 6V 0·06A types.

## IN OPERATION

When connected to the loudspeaker output of a record player, radio or hi-fi system, the lamps will light at random but relative to the level of sounds and the frequencies. In consequence the colour blocks will actually appear to change position and at times several may even appear to move in one direction. The room lighting should be low since the power of the lamps is small.

There is no reason of course why such a system should not be developed so that higher power lamps could be employed, particularly as transistors capable of passing 5A to 10A at 24V are now available. The writer makes no claim for originality in the basic idea, but only for the display method and circuitry as described in this article.

**Next month: Details of a c.r. colour pattern display unit**