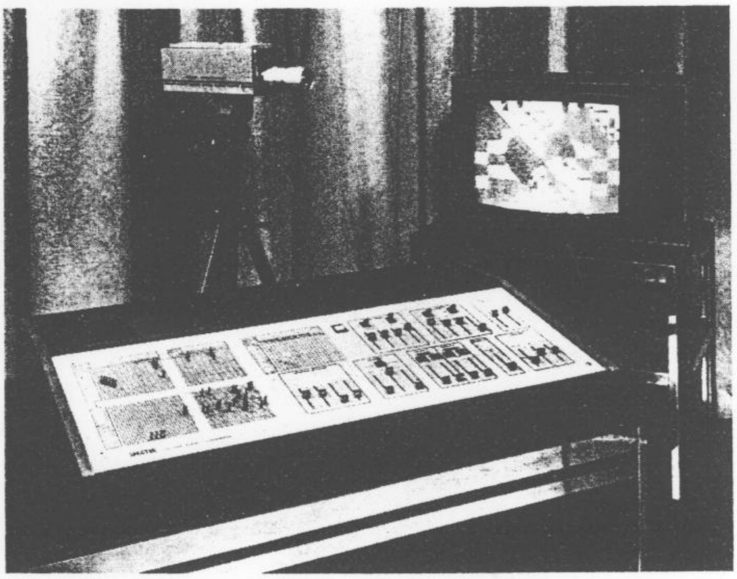
EMS SPECTRON COLOUR VIDEO SYNTHESIZER

ABRIDGED SPECIFICATION
Image sources: X and Y counters. Slow counter. Four shape generators. Video comparator (colouriser).
Image modifiers: Four overlay gates. Four invertors. Edge. Delay. Two flip-flops. Invert X. Invert Y.
Outputs: Two, each with four bits controlling luminance, three bits red bias, three bits blue bias. Colour swap. Output to analogue control matrix.
Voltage control sources: Two sine/square oscillators. Two random. Three audio inputs. Digital signal matrix (two sources). Four manual sliders. One external source.
Voltage control inputs: Two shape generators. One video input. One comparator level spacer input.
Price: £ 4500 (Spectron); £400 (modified Sony colour monitor).
Manufacturer: Electronic Music Studios (London) Ltd, 277 Putney Bridge Road, SW15 2PT.



THE DICTIONARY definition of synthesis runs more or less as follows: 'Combination, composition, putting together; building up of separate elements into a connected whole'. What, then, is a video synthesizer? Occupying little more space than the smallest writing desk, *Spectron* is capable of generating an extremely wide variety of motionless and moving multicolour images. It can also accept signals from an external monochrome television camera and colourise these in almost any way the operator chooses. If the camera is pointed at a screen carrying a *Spectron*-originated image, this image may be fed back into the system to produce extraordinarily complex patterns. Yet another facility is that of producing sound-controlled images which change in shape, colour and complexity according to the harmonic structure of perhaps a piece of music.

So who needs it? I need it, for one! This is the most fascinating tool that could ever be offered to the abstract artist whose imagination is better than his brushwork. More important, it is the ideal basis from which to commence a study of that relatively new art form: electronic painting. Fabric design, television special effects, perception studies, and 'the ultimate discotheque light show' are among the applications suggested by the manufacturer. I could add to 'perception studies' my own suggestion of "post-perception studies" since working with *Spectron* has greatly increased my hitherto limited ability to 'see' colour images with my eyes closed. This is no mere staring-at-the-sun afterglow, incidentally, but must result from using some minor region of the Kirk brain that is otherwise relatively dormant. Here, however, is what the eyes-open department made of *Spectron:*

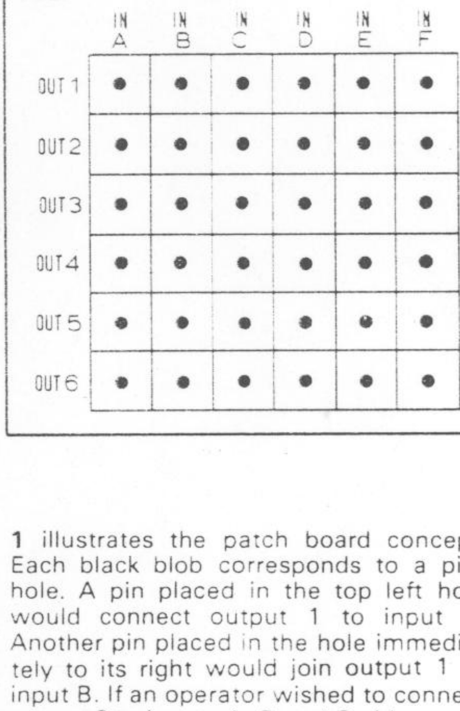
Video synthesizers have one major aspect in common with audio synthesizers. Both tools are at first acquaintance difficult to use. A novice at a synthesizer usually fares even worse than a beginner at the violin. Little tactile skill is needed to operate a synthesizer, though, and it requires only a few hours to become reasonably conversant with the workings of the instrument. This should be compared with the many hundreds of hours practice required to produce reasonable noises with a violin. Thus, I was not unduly distressed or surprised when my first efforts with *Spectron,* in the presence of its designer, produced nothing better than a third-rate pattern of pyjama stripes. Even generating a chess-board requires some little skill and that is only the barest beginning. So . . . patience, dedication, and the willingness to grapple with the unfamiliar jargon of flip-flops, inverters, overlays, comparators and colour swaps.

A second point of similarity between a video synthesizer and an audio synthesizer is that each is not so much a tool as a collection of inter-related tools – the electronic equivalent of a committee. A good audio synthesizer, for example, comprises all the individual bits and pieces that were previously needed in setting up an electronic music studio. Likewise, *Spectron* embodies in a single cabinet many separate items of equipment which might be found in the best equipped television effects studio. A synthesizer shows itself to best advantage when the problem arises of connecting together these different tools – eliminating (in this design at least) the practical problems of coupling one output simultaneously to ten or perhaps twenty different inputs.

Main advantage

The main advantage EMS synthesizers have over their competitors' designs is in the use of a pin matrix 'patch board'. This looks devilish at first sight but really is the embodiment of simplicity . . . provided the fag-ash and coffee-splash brigade are kept away. **Fig.**

FIG. 1



1 illustrates the patch board concept. Each black blob corresponds to a pinhole. A pin placed in the top left hole would connect output 1 to input A. Another pin placed in the hole immediately to its right would join output 1 to input B. If an operator wished to connect output 6 to inputs A, B and C, this would be accomplished by placing pins in the first three holes of the lowest row.

The foregoing patch board would be called a six by six or 6^2 matrix and – if every output were coupled to every input – would carry 36 pins. *Spectron* contains two such matrices, smallest being a 20 across by 16 down ANALOGUE CONTROL MATRIX. To the left of this is a much larger DIGITAL SIGNAL MATRIX with no less than 57 across, by 53 down. Regardless of size, the patching principle of these matrices is identical to that of our **fig. 1** specimen though the number of usable combination permutations is obviously much greater.

Fig. 2 shows the labelling down the left-hand edge of the digital signal matrix. The first few pinholes can also be seen though there is little point in pub-

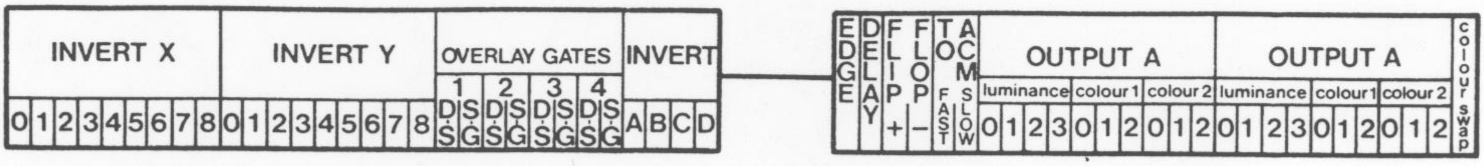


FIG. 3

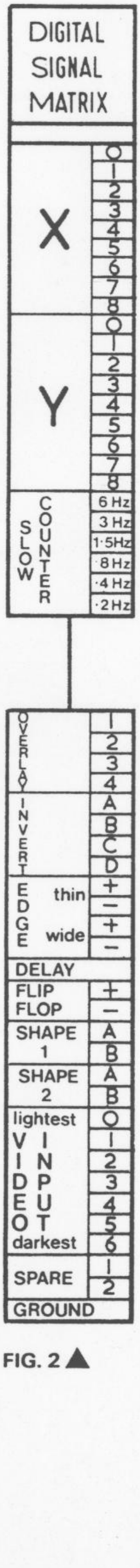


FIG. 2

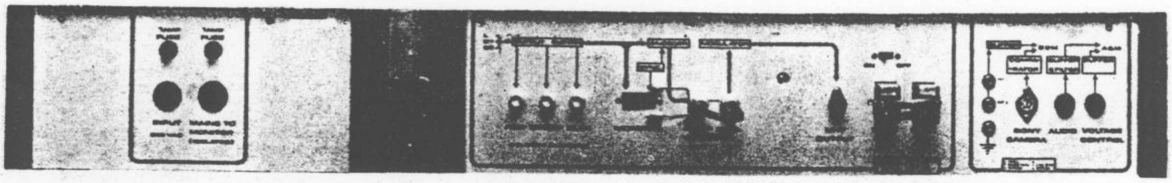


FIG. 4

FIG. 6

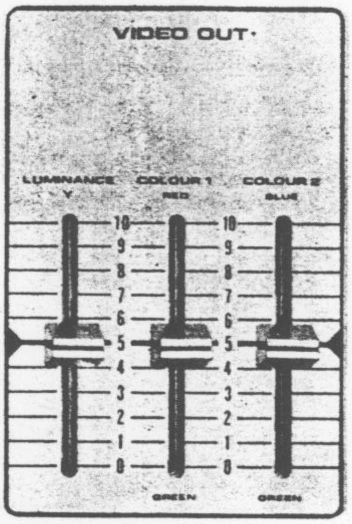
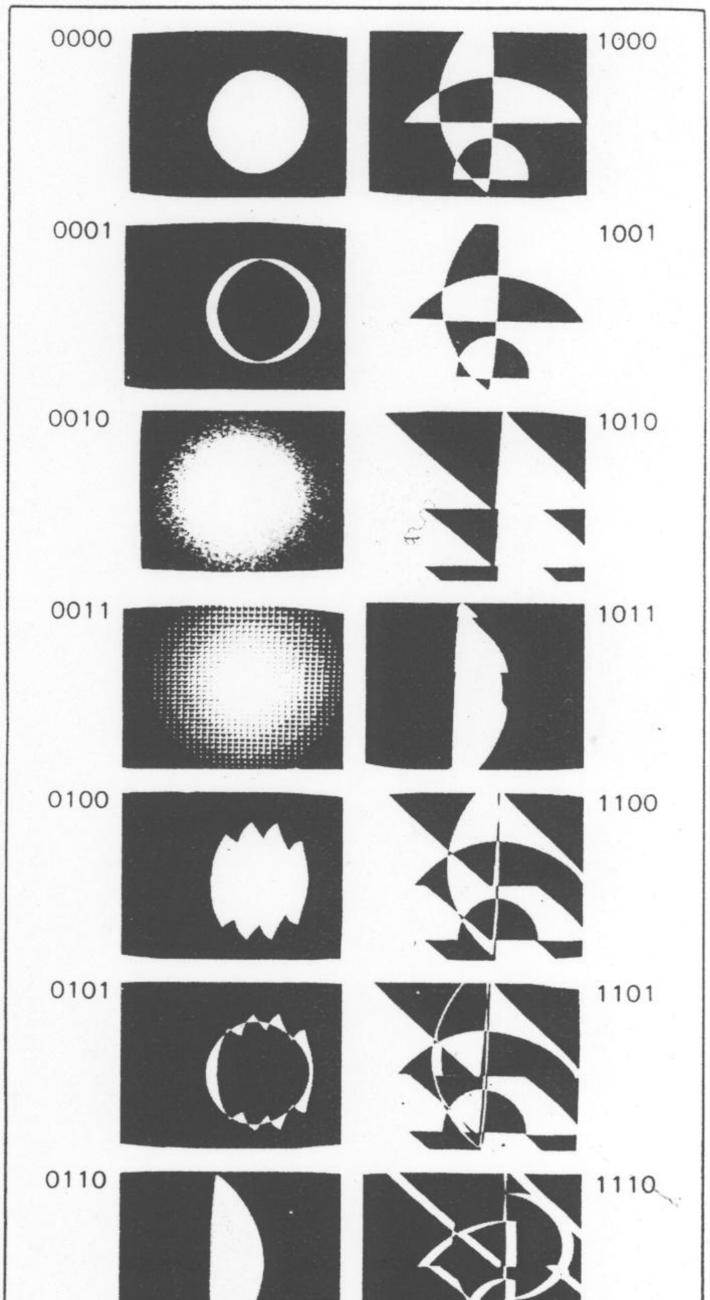


FIG.5



lishing an illustration of the entire pin area to this life-size scale. Remember that each label, no matter how obscurely worded, represents the output from one section or subsection of the synthesizer.

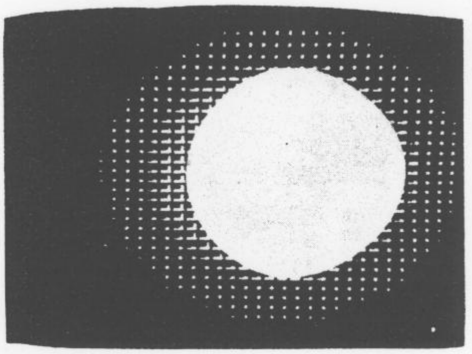
If we look now at **fig. 3**, we see the input labelling along the top edge of the digital signal matrix.

Now at last we start to see things. *Spectron* is plugged into a 240V 50Hz power supply and connection made from the video output panel (**fig. 4**) to a colour monitor, video projector, or household colour television receiver. **Fig. 5** shows the three output colour/brightness controls determining the initial relative luminance, red and blue balance. All colour television systems presently in use derive their entire spectrum from the three nominal primary colours.

With the three video output controls at their mid position, the monitor screen remains blank. When luminance is faded up, the screen becomes uniformly purple. This changes to red if the red fader is set to a higher position than the blue, and to blue if the blue fader is set higher than the red.

Before exploring *Spectron's* basic colour balance properties further, we need to programme some kind of image. This is made all the easier by the availability of sixteen 'built-in' shapes illustrated in **fig. 6**. There are in fact four shape sources: shape 1A and shape 1B being literally identical to each other but capable of independent selection. **Fig. 7** shows the effect of combining, for example, pattern 0000 (binary zero) from shape 1A with pattern 0011 (binary three) from shape 1B. The patterns available from shape 2A and 2B differed from the **fig. 6** series in only two ways, being slightly smaller and offset to the right. **Fig. 8** illustrates pattern 0000 from shape 1A combined with pattern 0011 from shape 2B. But things are getting too complicated too early. Back to our circle, screened by placing a

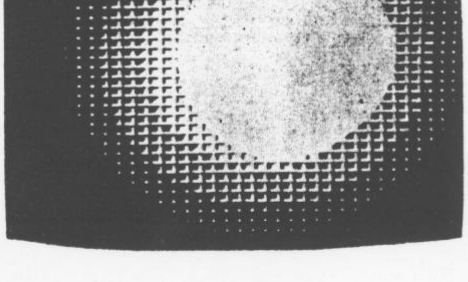
FIG. 7 ▼



pin into output row SHAPE 1A (**fig. 2** again) where it crosses the vertical input row labelled OUTPUT A, LUMINANCE 0 (**fig. 3**). This gives us a bright purple image on a nominally black background. Shifting the pin one hole to the right (to OUTPUT A, LUMINANCE 1) has the effect of lowering the brightness of the image without changing the colour. Shifting once more to the right (to pin row LUMINANCE 2), we find the purple image so dark that it can only be seen at all by raising the output luminance fader. Alternatively, we can leave a pin in input row LUMINANCE 0 and place a second pin in LUMINANCE 1, 2 or 3. The decreasing levels of purple are now added to the original (LUMINANCE 0) level, allowing reasonably fine choice of hue.

By now we are getting tired of purple. We can therefore explore other colours by placing pins (still on the SHAPE 1A output row) in the vertical input columns corresponding to COLOUR 1(A) and COLOUR 2(A). Some experience is required before one can plug up the basic colour one may be seeking, let alone the precise hue, and the logic of the system does eventually become clear. It is not surprising, for example, to find the combination of pins in inputs LUMINANCE 0, COLOUR ONE 0 and COLOUR TWO 0 (maximum brightness on all three primary colours) producing white. My expectations were thrown initially on discovering that a pin pushed into a COLOUR ONE input (labelled on the **fig. 5** output panel as

FIG. 8 ▼



'red') tended to send the image blue. When a pin in a COLOUR TWO row (nominally the blue channel) sent the image red, however, it became clear that the colour tones were subtracting.

Given that practically any imaginable colour can be obtained by deliberate or trial-and-error use of colour selection pins, the rest of the exercise becomes largely one of creating images. *Spectron* incorporates the means to produce a fairly wide choice of basic shapes, quite apart from the four groups of sixteen already mentioned. The real flexibility of the system comes in combining these optical building-bricks into complex multicoloured patterns. This synthesizer is equally suited to generating static 'electronic wallpaper' and continuously or sporadically moving images, being perhaps most exciting where driven from an external music source.

The topmost 16 output rows in the digital signal matrix, labelled X (one to eight) and Y (one to eight), are concerned with the generation of rectangular structures . . . chess-boards, tartans, individual horizontal or vertical lines, and so on. A pin in the topmost X row, routed to a viewable output, gives the single vertical split shown in **fig. 9.** A pin in X1 gives the double split of **fig. 10,** in X2 a fourfold split, and so on giving vertical stripes of progressively halved width down to the utmost invisible strips of X8.

FIG. 9 ▼

FIG. 10 ▼

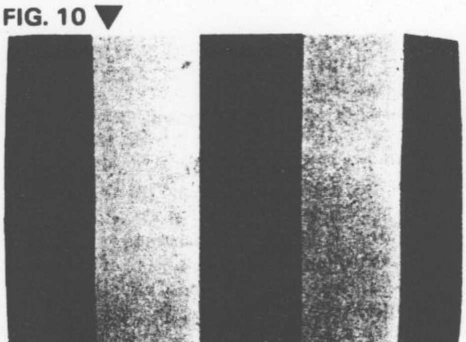
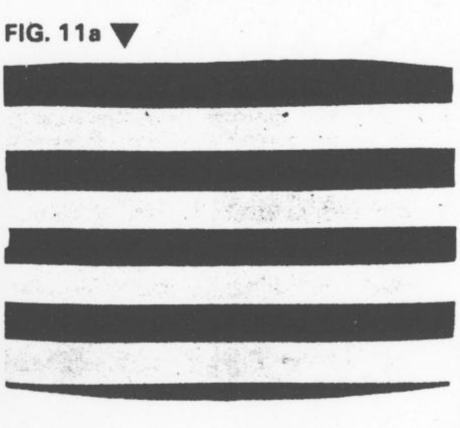


FIG. 11a ▼



Pins placed in the Y output rows have the same effect as in the corresponding X row only this time in a horizontal direction. **Fig. 11a** shows the effect of a pin in output row Y3 while **fig. 11b** illustrates the simultaneous insertion of a pin at X3. In **fig. 12**, one of the two pins has been shifted from an A LUMINANCE input to a B LUMINANCE input, causing a phase reversal of the digital bar pulses and hence a chess-board effect. As I write, I am patching these patterns in the LUMINANCE 0 rows and seeing each one in a tiresome 'Windolene' purple; it pays to be more imaginative!

If the foregoing has made heavy reading, the description now becomes more

FIG 11b ▼

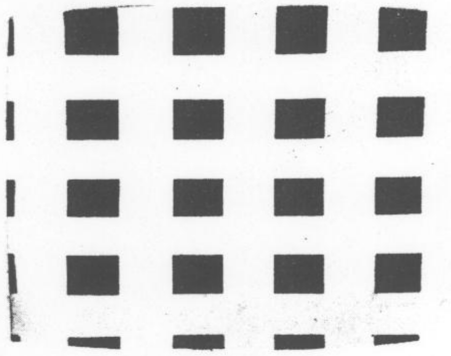
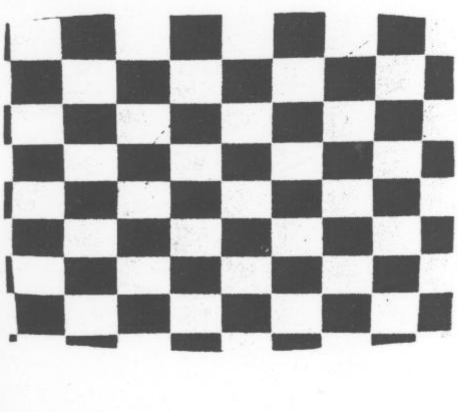


FIG. 12 ▼



straightforward. Below the X and Y outputs are six SLOW COUNTER outputs. These provide pulses at a rate of 6Hz, 3Hz, 1.5Hz, 0.8Hz, 0.4Hz and 0.2Hz. Patched straight to a luminance channel, they cause the screen to flash on and off at whichever frequency – or group of frequencies – has been selected. One of the more ingenious applications (I can say that as I didn't invent it) of the counter is in persuading the X/Y department tartans to move smoothly across the screen in a horizontal, vertical, or horizontal *and* vertical (diagonal) direction.

Referring back again to **fig. 2**, we find a fairly wide gap between the above-listed X, Y and COUNTER signal-source outputs and a second block of *processor* outputs. The processors normally only emit useful signals if they are first given something to process. We might, for

FIG. 13a

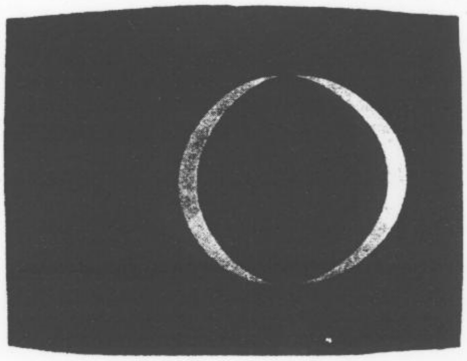


FIG. 13b

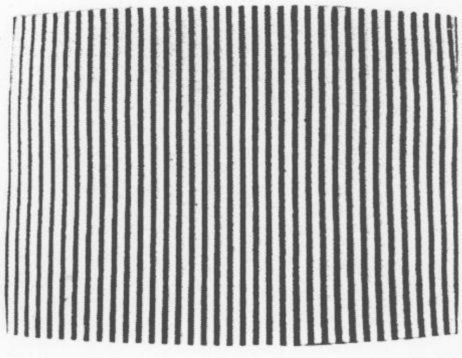


FIG. 13c

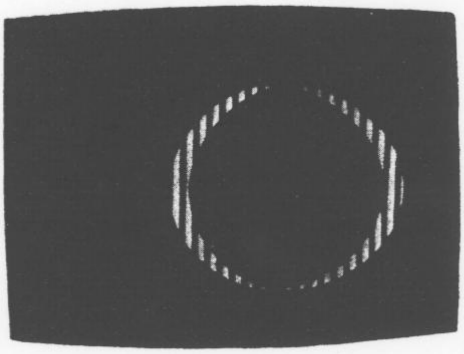


FIG. 13d

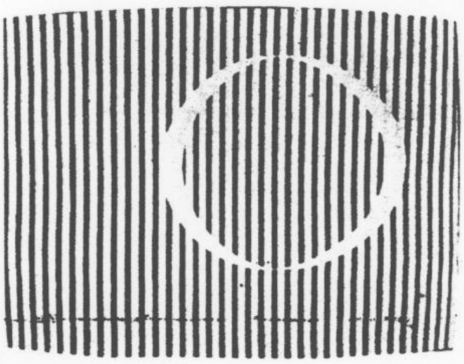
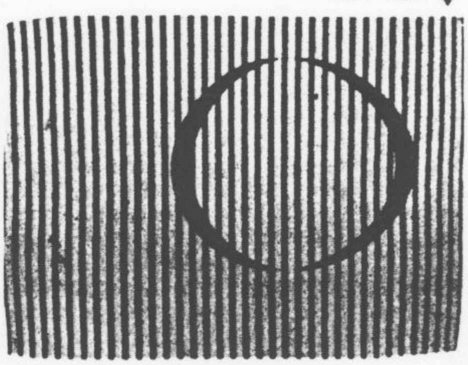


FIG. 13e



example, wish to add a thin edge to a series of vertical stripes. We therefore place a pin in, say, the X2 output row where it intersects with the OUTPUT A LUMINANCE 0 input. A second pin on the X2 output row is connected to the edge input – leftmost of the right-hand input group in **fig. 3**. We do not see an edge, of course, until another pin couples an EDGE output row to one or more appropriate luminance or luminance-and-chrominance vertical input rows. Using the colouring techniques described earlier, it is quite easy to patch the basic stripes in one colour and the edge in an entirely different colour. Similarly, inserting pins in the Y outputs can break up each column into brightly coloured or subtly contrasted colour divisions ... complete with matching edges.

Before considering the edge processor at greater length, it would be as well to examine the output processors in a more logical top-to-bottom order. Which brings us to the four OVERLAY output rows. These operate quite independently of each other and basically allow any four images to overlay any four backgrounds with as much or as little mutual interaction as the operator desires visible regions. Before planning any overlay, the operator should decide which image he wishes to retain as a 'foreground' and which he will discard into a 'background'. In **fig. 13**, shapes **a** and **b** have been patched together to form **c**. If image **a** is patched instead to an overlay SIGNAL input, and **b** to overlay DISABLE, the result is image **d**. Or we can swop over the SIGNAL and DISABLE patch to create image **e**.

If the reader at this stage is concerned by the simplicity of the illustrated shapes, he should remember that these are only the basic structures and facilities from which highly complex images can be assembled. Nor have we yet covered any suggestion of image movement.

Beneath the four OVERLAY output rows are outputs from four INVERT processors. if the image produced for **fig.13d** is patched to an INVERT input and the relevant INVERT output viewed, the result is **e**. All that was formerly dark here becomes light, and vice versa.

Moving to **fig. 14a**, we can now try routing this into the EDGE processor. Photo **b** shows the original image plus (wide right-hand) edge. Photo **c** shows the edge alone, the original image having been unpinned. Note the three-dimensional effect of this facility. Four types of edge are available: thin right, thin left, thick right and thick left. Right and left are indicated by the respective marks + and – on the **fig. 2** output row labelling.

One of the most useful processors on *Spectron* was the 1μs video delay line. While 1μs (one millionth of a second) may not seem long by everyday standards, it corresponds to a distance of about 6mm across a 35cm television screen width.

Now if I were writing the standard Book of Words for the *Spectron*, I would proceed glibly to describe the function of its FLIP FLOP processor. I must admit, however, that this gave me more headaches than any other aspect of the synthesizer. To some readers, Flip and Flop may sound like a couple of Viking warlords. To me they had vague connotations of two-state electronic switches

FIG. 14a

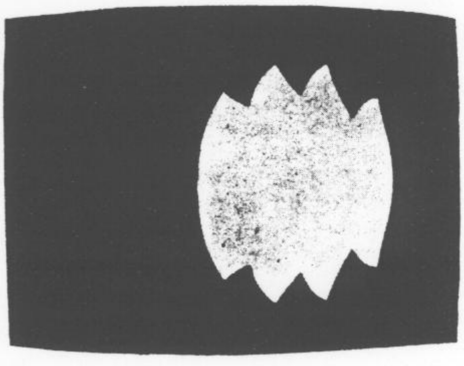


FIG. 14b

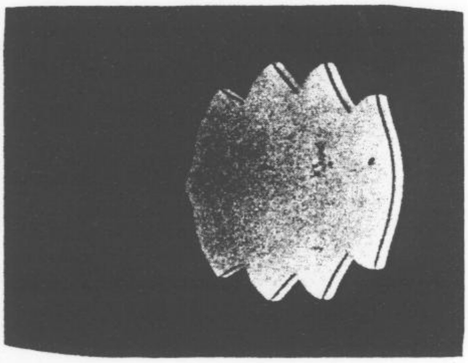


FIG. 14c

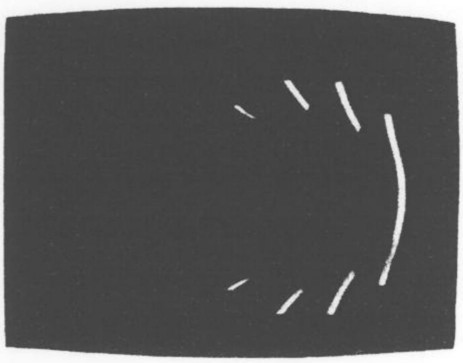


FIG. 15a

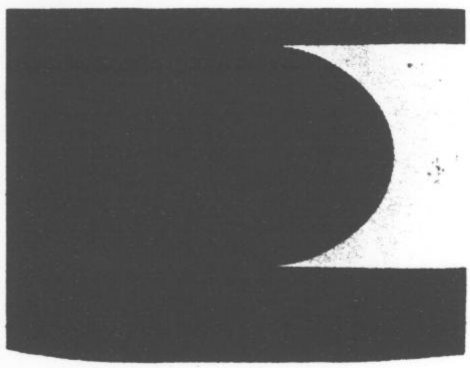


FIG. 15b

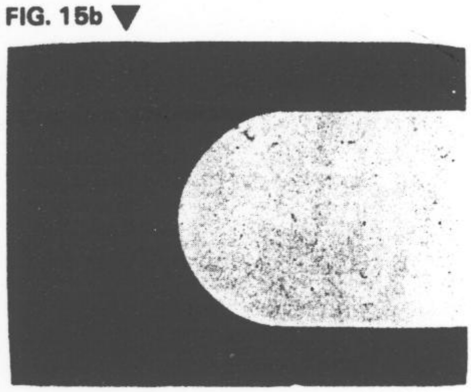


FIG. 16 ▼

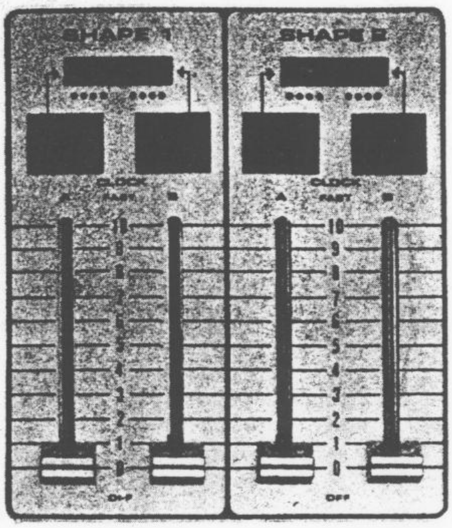
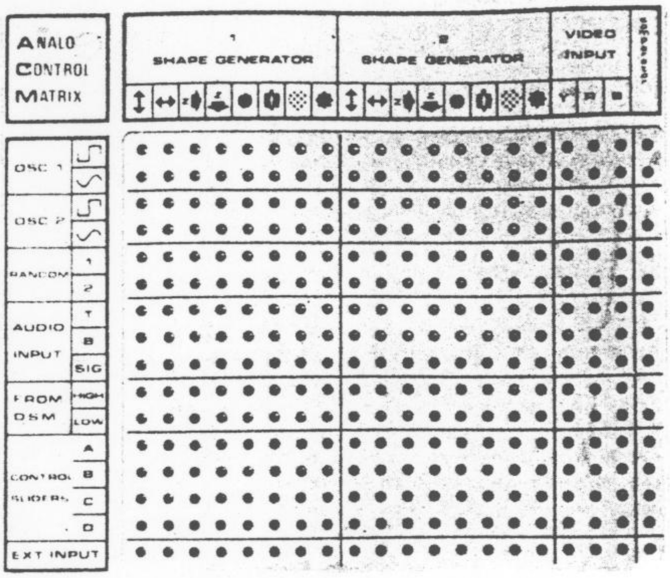


FIG. 17 ►



Below left:

Mixture of colour and shape effects applied to output from a Sony monochrome TV camera. Colour image, printed here in black and white.

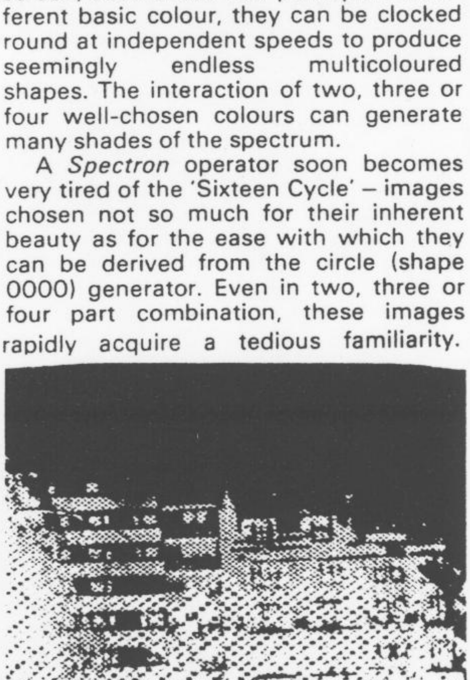
►

but that's as far as they went. The main effect of this processor is one of smearing, **fig. 15** being obtained by patching a circle into both FLIP and FLOP inputs and viewing the FLIP output (**a**) or FLOP output (**b**). Applied to more complex shapes, the effect of this processor was for me at least sometimes wildly unpredictable. Of all *Spectron's* facilities, this one requires the most experimentation before it can be used to full advantage.

Below the FLIP FLOP processor in our **fig. 2** row of outputs come four shape sources from any one of which we can derive the preprogrammed images in **fig. 6**.

The four shape sources (1A, 1B, 2A, 2B) are 'clocked' from the panel in **fig. 16**. Each of the four has its own sliding control, pushbutton and binary display. Pressing the appropriate button once switches a source on to its next image in the **fig. 6** sequence. This process can be automated by raising the sliding control; at low settings, the latter switches the images slowly through their full cyclic sequence while at high settings the switching occurs more rapidly. If all four shape sources are routed to the monitor screen, each of the four perhaps in a different basic colour, they can be clocked round at independent speeds to produce seemingly endless multicoloured shapes. The interaction of two, three or four well-chosen colours can generate many shades of the spectrum.

A *Spectron* operator soon becomes very tired of the 'Sixteen Cycle' – images chosen not so much for their inherent beauty as for the ease with which they can be derived from the circle (shape 0000) generator. Even in two, three or four part combination, these images rapidly acquire a tedious familiarity.



Their greatest artistic value comes when they are reshaped into more complex structures through the analogue control matrix (**fig. 17**). This can be programmed in the same way as the digital matrix and, being smaller than the latter, is shown life-size with its full complement of routing holes.

Looking from left to right along the **fig. 17** (horizontal) input labelling, we find a means of altering the vertical position of a shape (row ↕), and a similar means of horizontal shifting (row ↔). These influence all sixteen shapes on either Shape Generator One (left input group) or Shape Generator Two (right input group).

Analogue Matrix inputs and respectively modulate the vertical and horizontal components of the more complex mixed shapes in the 0000 to 1111 series. These controls were little used at first but soon rose from obscurity to become one of the most versatile features of the analogue matrix section. They permitted dramatic changes in the shape of, for example, the initially uninspiring saw-edge mixture in **fig. 6**.

Inputs , and ● each control the overall size of individual shapes in **fig. 6** – those shapes most resembling the pictorial labelling.

Video inputs Y, R, and B permit automatic control of each colour channel while the input labelled COMPARATOR effectively modulates the external camera sensitivity.

Looking now at the vertical row of outputs on the **fig. 17** analogue control matrix, we find two independent oscillators each offering a choice of squarewave, sinewave, or sine-plus-square.

The control panel of Oscillator One is identical to that provided for Oscillator Two. Three FREQUENCY controls are incorporated, these being (from left to right) coarse, fine and ultra-fine ('deviation'). To the right of these is an overall sine/square level fader. Of the two switches on each oscillator, one is a high/low frequency range selector and the other a synchronizer. When switched into circuit, the synchronizer causes the oscillator frequency to rise in steps related by integer ratios to TV line frequency (625 lines times 25 frames per second = 15,625Hz). The sync switch has two other settings: + running the oscillator slightly fast (if the deviation control is raised) while the – position correspondingly lowers the frequency.

Two sources of random signal are available for applications requiring a literally random control wave form. This unit is the electronic equivalent of a gaming die. The rate control determines the 'throwing speed' while the repeat switch, churns out the last sixteen 'die numbers' emitted prior to the instant of switch operation. In this case we have an electronic analogue of die numbers: voltage ramps. Once the output voltage equivalent to say a midway throw has been generated, it is held constant until the internal clock switches the output to another level. If this point seems difficult to comprehend, re-reading it a dozen times or so should clear the fog.

Continuing down the analogue matrix vertical output labelling in **fig. 17**, we come to a singularly valuable facility: the audio input. The concept of controlling visual images from sound in general, music in particular, has exercised many inventive minds over the years. Synchronized cartoon animation has always seemed to me an absurdly inefficient use of human labour though the common or garden discotheque lighting system is an aesthetically ridiculous alternative. In the latter, sound is split into bass, middle and treble, the intensity of each of these components being used to modulate the brightness of one or more coloured lights.

In *Spectron*, the sound-into-light techniques are an extension of the lissajous patterns derived by feeding bass the X and treble to the Y axes of an oscilloscope. Here, however, we have normal 625 line scan, full colour control, and all the support provided by the rest of the synthesizer. Audio signals entering *Spectron* can be used nominally as they arrive (matrix output row S1G) or filtered into separate treble (T) and bass (B).

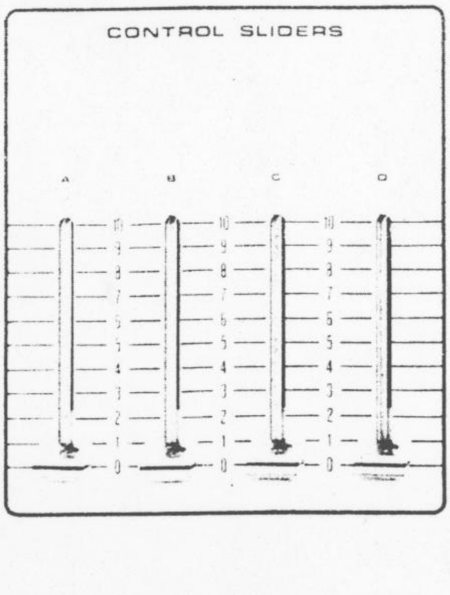
A fascinating group of patches were those coupling the three audio sources to control different shape functions. Image 0001 for example (**fig. 6b**) is very responsive to audio controlling its overall size (S1G to input ●) with bass and treble rows determining the luminance and blue channels . . . precise permutation depending on the type of music chosen. It matters little to *Spectron* whether the incoming sound is of acoustic origin (typically voice or orchestra), purely electronic (typically synthesized) or hybrid (typically 'pop'). This is an improvement on lissajous techniques where the complex harmonies of say a Monterverdi choral work can reduce an optical pattern into little more than a vague blur of fast-moving lines. It is possible only to hint at the vast number of shape-control permutations offered by the analogue control permutations offered by the analogue control matrix on the audio input rows alone. Whenever I thought I had explored to the end of the road, a new possibility would arise to stir up fresh experimentation.

Like the FLIP FLOP, one of the least used *Spectron* facilities in my early trial of the system was the ability to feed from the digital control matrix to the analogue matrix. Signals patched to the latter emerge on two rows beneath the audio signals output pin row. Separate matrix link channels are provided for high and low frequency digital signals. An example of a high frequency signal would be an output from the X8 vertical bar generator while the 0.2Hz slow counter provides one of the lowest frequency signals likely to travel between them provide an intriguing means of feedback in that the analogue matrix can be arranged to control a shape fed to the digital matrix which in turn cycles it back to the analogue department.

We have already noted that images generated by Shaper Two were offset slightly to the right of those produced in Shaper One, as well as being marginally smaller. Supposing we wished to centre them . . . perhaps even to make them identical in size? For these purposes, two or more sources of adjustable steady voltage are needed. These are available on analogue matrix output rows labelled CONTROL SLIDES A, B, C, D. Each output row is influenced by the **fig. 18** control slider of the same lettering. A pin joining slider output A to input ↔ thus gives manual control of a shape's lateral position. Thenceforth the shape may be non-manually modulated in the usual way from any other output row.

Which brings us back to the digital control matrix and a facility so far not touched. This is a seven-level colouriser and can produce colour images of a highly unusual nature from the output of an ordinary monochrome television camera. It follows, of course, that absolutely any monochrome image – photo print, newspaper cutting, movie film, video tape, line drawing, photostat or what-have-you – can be coloured much more quickly and flexibly than any chemical process permits; and at practically zero cost in terms of raw materials.

FIG. 18 ▼



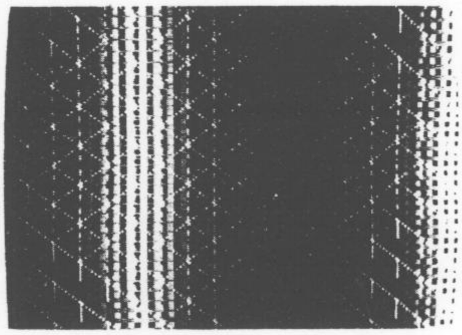
So how does it work and how does the operator maintain control over the colouring? Quite simply, the signal from the TV camera is divided into seven separate grey shades and each shade allocated an output row on the **fig. 2** digital matrix. Row 0 corresponds to the brightest image detected by the camera, row 6 to the darkest, and the intervening rows to the progressively darkening shades. So we point our camera at this column of text and find *Spectron* only registering on three of its seven input levels. Why? Because the camera is viewing only hard black (the print) and hard white (the background). These two can be coloured in any way we choose: white print on black, black print on white, green print on red, green on yellow, red on blue, cyan on olive; every conceivable colour permutation is attainable given patience or skill in combining the colour pin rows. The third level is an outline, giving additional control of border colouring.

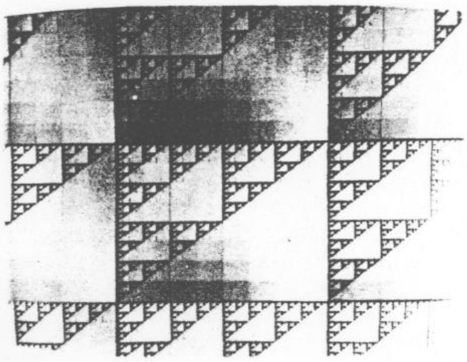
It proved quite easy to find images that react on all seven input shade levels, many of my own experiments involving re-colouring slide transparencies projected on a Singer *Caramate* rear-screen projector. Although the originals were in natural colour, the monochrome camera obviously eliminated the original hues and allowed me to reconstruct each slide in whatever colour configuration I choose. Purely as an exercise, I tried approximately to the original colouring and found this moderately successful – the limitations being largely in my own skill. Similar experiments with real live daffodils led to a lot of bother in imitating their numerous shades of yellow, let alone their green, and were aborted in favour of some magnificent alternatives. You can't really appreciate daffodils until you've seen them in full blue, pink, orange and black flower with brown and gold leaves on violet stems. Nor do you forget them when you tuck into bed; you close your eyes and they're still there!

It should be clear from the foregoing that *Spectron* has as many advantages to the graphic artist and magazine designer as it has in pure television. Graphic ideas – vague or specific – can be realised in a matter of minutes and alterations made almost instantaneously. In the video effects studio, it largely eliminates the need to use expensive colour TV cameras and cuts perhaps tenfold the time spent in patching one piece of equipment to another.

Did anything go wrong? Some slight trouble with an intermittent power supply, easily rectified if one were buying the system. And an occasional tendency to bend patch pins if one were hamfisted in pulling them out. Fortunately they bend straight again.

I did notice a fair whack of interference from the synthesizer, affecting a VHF FM radio within some 2m of the equipment. This also influenced 405 line TV reception but did not cause difficulties on 625.





▲

Two examples of fairly complex patterns produced by integrating generators and processors within Spectron.

As regards physical layout and construction, the design and assembly of this complex instrument is remarkably tidy. Both the horizontal wooden top and sloping metal front panel can be removed, giving complete access to the interior.

And there *Spectron* would appear to end. In fact that is only the start. Given a week or two it becomes reasonably easy to find your way around the two matrices and then things really start to happen . . . except to your reviewer who has then to send it back. I have not mentioned the dreamlike images *Spectron* can produce in conjunction with video feedback (pointing a camera at its own monitor display) or what can be done in merging camera images with internally-generated patterns. Nor have I touched on the injection of non-audio, non-video signals through the various auxiliary inputs. This is the stuff of artistic invention and, in these early days of video art, few pioneers are giving away their secrets.

David Kirk