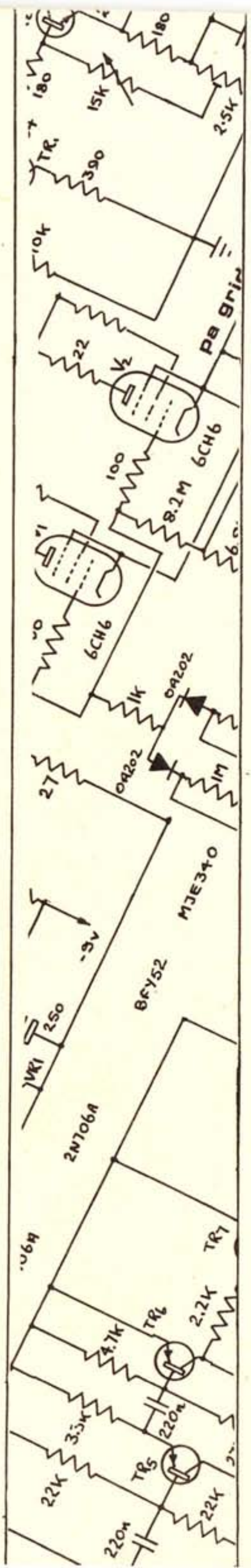


AMATEUR TELEVISION

A CQ-TV PUBLICATION

FORWARD by the President of B.A.T.C.

The title of this booklet is "Amateur Television". But what is an amateur? The boundary between amateur and professional is an ill-defined area. We welcome in our ranks the professional who has been stimulated to become an operational amateur by the work that he is doing, and we know of many amateurs who have become professional as a result of their hobby. All technologies have their amateurs, but radio communication is our best-known example, with massive contributions towards progress of the science from men with an amateur approach to their work.

Radio was conceived by the mathematician Maxwell, as a theoretical possibility. The physicist Hertz, demonstrated that radio actually worked but, some years later, an Italian named Marconi (described by someone as "a gifted amateur") launched radio as a viable means of communications.

Many amateurs followed the work of Marconi, andtook up radio as a fascinating hobby. By the outbreak of the 1st World War in 1914, several hundred amateurs were available in this country to put their specialised knowledge at the disposal of the Government; they were now professionals! The discovery, by the amateur, of long-range communication using the h.f. band, is now historic. In the 1920's, another "gifted amateur" appeared on the scene, - John Logie Baird.

Baird, like Marconi, gathered together a number of ideas, added many of his own and, for the first time ever, showed how a visual scene could be transmitted over a radio system. Many older members of the Club will never forget their first glimpse of a picture when, on their home-constructed motor-dirven scanners, they received the BBC broadcasts of Bairds 30 line transmissions on the medium wave band.

Radio as a hobby, has branched into many specialised areas and, in 1949, the British Amateur Television Club was formed to encourage a collective interest in amateur television. The Club has now decided to produce this booklet in order to collect together information required by the radio amateur, who is seeking to expand his hobby interest with television.

Modern television has come a long way from Baird but, although techniques have become much more sophisticated, the development of integrated circuits has, in many respects, simplified circuit construction. Amateur television is a challenging hobby. Colour, digital techniques, band-saving and many other things all offer considerable scope for interesting experimentation.

It is with considerable pleasure that I write this Foreword, with the sincere hope that the booklet will encourage many more radio amateurs to enter the field of television. If the booklet stimulates the readers enthusiasm for a very forward-looking branch of our radio hobby, it will serve its purpose.

Bob Roberts G6NR

Bob G6NR

chapter 1
BACKGROUND

By Don Reid

These notes are intended to give the reader an outline of the history of the British Amateur Television Club, and to act as an introduction to this new booklet of Amateur Television techniques and circuits. Anyone who wishes to learn more about the early days of B.A.T.C. is recommended to see the articles listed at the end of this section.

Over the years, so many people have given their services freely and energetically to the B.A.T.C. that I have decided to omit all references to individuals, with one exception.

The Club was founded in April 1949 by Michael Barlow, then G3CVO, who contacted a few like-minded enthusiasts, and started circulating a newsletter. He issued 25 copies of the first number of the Club journal, "C Q - T V", in October 1949. The circulation rose to about 55 when C Q - T V 3 was published in January 1950, and voluntary donations could no longer support the cost of duplication and postage. A subscription of 4/6d per annum had to be levied, and this became 5/- per annum by December 1952.

To appreciate the difficulties of the early days, one must remember that there was a great scarcity of information which would help an amateur to create his own television pictures. There was no vidicon camera tube, and transistors, integrated circuits and videotape recording were unheard of!!

However, there were Government surplus components available quite cheaply, and the 931A photomultiplier and 5FP7 CRT formed the basis of a flying spot scanner. In C Q - T V 16, March 1953, it was announced that reject staticons were to become available to Club members at £25 each. By October 1953, there were three photicon cameras, seven CPS emitron cameras and seventeen 5527 iconoscope cameras owned by Club members, and twenty-two staticons were on order.

In Spring 1956, the predecessor to this booklet, "An Introduction to Amateur Television Transmission" by M. Barlow was published at 3/6d. This booklet has exactly the same aim - to present information and circuits not readily obtained elsewhere, to assist a beginner to amateur television.

The B.A.T.C. has never owned or rented any premises, or employed any paid officers. All work on behalf of the Club has been, and is, undertaken as a voluntary spare-time activity. This includes writing and publishing articles in C Q - T V. Most of the income derived from subscriptions is spent on C Q - T V, with an ever-increasing proportion being needed to cover the cost of postage.

From the earliest days, the word "British" in our title has been rather a misnomer, as the Club is always pleased to welcome members from any part of the world. In C Q - T V 14, for example, we find correspondence from Canada, Finland, France, New Zealand, the Netherlands, South Africa, and U.S.A. At the time of writing, the B.A.T.C. membership of approximately 1000 includes many from Australia, Canada, France, Germany, Netherlands, New Zealand and U.S.A. in particular, as well as smaller numbers of members living in many other countries abroad.

The Club is affiliated to the Radio Society of Great Britain, and also maintains contact with similar amateur television bodies in other countries. 15 delegates from B.A.T.C. attended the first International Amateur TV Conference in Armentieres in Spring 1969, a highly successful event.

To help establish and maintain personal links amongst members, the Club organised the first national B.A.T.C. Amateur Television Convention in 1951, and since then, it has organised similar Conventions at intervals of approximately two years. These are usually one day events, with the notable exception of "CAT-70", the Conference on Amateur Television which was held at Churchill College, Cambridge, to mark the Club's 21st Anniversary in 1970. This extended over a long weekend, from Friday to Sunday.

Inevitably the cost of membership has increased over the years - from 4/6d initially, to 5/- in 1953, to 10/- in 1956, to £1 in 1971, and to £2 per annum from January 1976.

As far as I am aware, the Club has only published a membership list on one occasion - in 1966, issued with C Q - T V 59. To produce such lists demands someone with enough spare time to compile the information from Club records, as well as the Club providing the money to pay for the cost of printing. Inevitably, membership lists lose their value as members move house. However, members can generally be furnished with the names and addresses of others in their locality.

After exhibiting at the R.S.G.B. Show in November 1952, it was appreciated that the Club should recommend some technical standards to facilitate the interconnection of television equipment built by different members. Such standards relate to the plugs and sockets used, and the voltage amplitudes and impedances of the sync pulse and video signals.

In three issues of C Q - T V during 1971, a battle raged between a "Modern Amateur" and an "Active Amateur" on the relative merits of 625 and 405 line standards. However, by 1976, 625 lines has won the day - so that domestic TV sets can be pressed into service as monitors, and surplus 625 line professional TV equipment can be readily adapted for amateur use. Members in the U.S.A. and Canada naturally tend to operate on the 525 line standard, for the same reason.

It is worth emphasising at this point that anyone who is working on his own closed circuit system is perfectly free to experiment with any television system which interests him - for example, spiral scanning, or a field sequential colour system, or very high definition systems. The question of working to agreed standards only arises when amateur vision signals are being transmitted or received, or when an experimenter is exhibiting his equipment in collaboration with others.

Over the years, C Q - T V has carried many informative and helpful articles. Picking out a few as examples: C Q - T V 39 in Spring 1959 carried the first B.A.T.C. article on micro-wave links. No. 40 in Summer 1959 contained the first B.A.T.C. article on slow scan television, which was subsequently demonstrated at the Radio Hobbies Exhibition during November 25th-28th 1959.

C Q - T V 47 proved a popular issue; it contained full details on the construction of a 7 valve vidicon camera, and an article on the construction of a valve sync pulse generator for 405 lines. The earliest issue to contain transistor circuitry was No. 49 in 1962. The 1962 Convention was the first one at which amateur built transistor vidicon cameras were demonstrated.

The first article in a popular series entitled "Circuit Notebook" appeared in C Q - T V 68, November 1969, and has continued as a regular feature ever since. Another long-running and informative series on Integrated Circuits commenced in C Q - T V 71, August 1970.

Among the services offered by the Club to members is the ability to buy sub-standard (spotty) camera tubes at a reduced price, through the kind co-operation of camera tube manufacturers. Camera tube scan and focus coils, test cards and reporting charts can also be bought by members at reasonable costs.

Though I have not made more than a passing reference to some aspects of amateur television activity (for example, colour television and slow scan television), I hope that the reader has gained some understanding of the history of the B.A.T.C. and the services it can offer. But what of the future?

With the present rate of inflation, it is easy to predict that the subscription is likely to cost more than £2 per annum in ten years time!

Turning to the technical aspects, it is evident that there will be an increasing use of integrated circuits, as the cost of using these devices is likely to become much less than the cost of using discrete components. The amateur has a big advantage over his professional colleague- he can experiment with any circuit or idea which interests him, for as long as he likes. The amateur has no labour costs to pay, and for this reason, I consider that the amateur will continue to have the opportunity to discover and test new techniques which commercial companies would find too expensive to investigate.

At present slow scan television has an enthusiastic following; no doubt there will be increasing interest in fast-to-slow, and slow-to-fast scan conversion circuits.

Amateur colour television should become more widespread. We have had stereo sound for some years - how about more work on stereoscopic colour television?

On the transmission side, no doubt increasing use will be made of the microwave band.

There could well be a change to digital rather than analogue methods of video signal processing,especially when solid state camera"tubes" become available cheaply.

It is evident that the future holds many fascinating and exciting opportunities for the television amateur, whether his interests lie in transmission or closed circuit, black and white or colour, slow or fast scan, low definition or high definition. Almost inevitably, new devices will be invented in the next decade - remember that the description "transistorised vidicon camera" would have been quite meaningless when the B.A.T.C. was founded!

References to the History of the B.A.T.C.

1. Progress in Amateur Television.
   M. Barlow: Wireless World, September 1952.pp. 371-373
2. Amateur Television Progress
   M. Barlow: Wireless World, December 1953,pp.589-592
3. Amateur Television Progress in Colour Transmission.
   M. Barlow: Wireless World, November 1956, pp.548-549
4. The Present Position of Amateur Television
   C. Grant Dixon: Journal of the Television Society. October/December 1958 pp.409-496

chapter 2

AERIALS AND RECEPTION

By Cyril Chivers

For successful amateur television reception there are several basic requirements. First, we must realise that we are likely to get strong signals from amateur television stations only if they are very close; distant stations will be much weaker.

With a station some 10-15 miles away putting out the best signal he can, you are only likely to get some 50-100 micro-volts in the amateur bands. A signal of 1-3 milli-volts is required to produce a signal of commercial standards. What can be done at the receiving end to produce the best possible picture?

1. A Good Aerial

Not always the aerial with the most rods. My work involves me in the erection of television aerials for the trade, and in my experience I have yet to see any aerial with dozens of elements produce a picture better than can be obtained with a 10 element, well-designed aerial fitted in the best possible position. Most people fail to realise that the more rods you have, the more critical the aerial becomes and where you started with a match of 75 ohms, you end up with an aerial with an impedance of 5-10 ohms causing considerable mismatch and loss of power in the tuner.

2. Aerial Position

By moving an aerial just a small distance either up or down or left or right, a considerable improvement can be made, Sometimes a gain of some 10 times can be made.

Before fitting any amateur television aerial, get the amateur station to put out a caption with the highest power he can acheive. Then fit about 5 yards of cable to your 10 element aerial and connect a field strength meter or your receiver to the end. Wander round your site. Perhaps one side of the building produces a much stronger signal than the other. Generally more height produces more signal, but not always. Sometimes you have a 100 micro-volt at 50 feet from ground level, and 80 micro-volt at 35 feet above ground. What we have gained in signal strength in height, we have now lost in cable loss.

3. Cable Loss

Cable loss is more serious than most people would expect.at 436 m/cs. An aerial produces from an amateur station say, 100 micro-volts with 2 yards of cable fitted. We now extend the cable to 20 yards to reach the shack only to find we have only 30 micro-volt on the end. Cable quality does count, but not as you would expect. If you have 20 yards of super, high grade co-ax cable, the loss would be about the same as 15 yards of low loss cable.

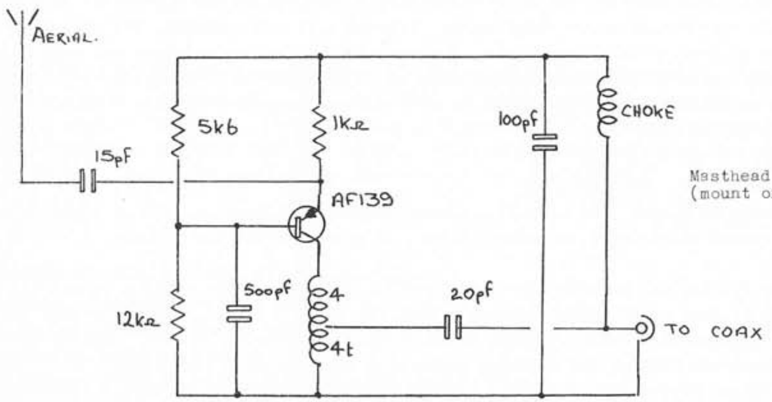
Next we have a signal, and we have found the best spot. It is about 30 yards from the shack. How can we get it back? This brings us on to mast head amplifiers.

If you have low water pressure, you install a pump to help water along the pipe. If you have a weak signal you install a mast head amplifier to pump the signal down the co-ax. A well designed, single stage amplifier will produce at 436 m/cs. at the end of 35 yards of co-ax as much signal as is recieved at the aerial itself. No seperate power lead is required to power the amplifier, and the inner of the co-ax can be used by means of simple chokes. If it is required to run the cable over a longer length a step-down converter is used and the signal frequency is converted to IF(36-39)m/cs. or to band 1 (45-70)m/cs., and the received converter to receive this frequency, or a varicap tuner could be tuned from the shack up to 200 yards away without any serious loss of picture.

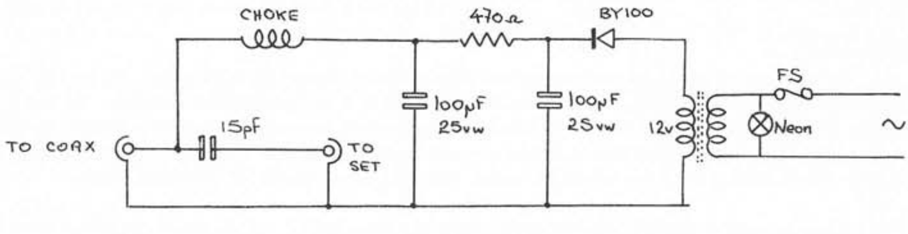
4. <u>A Good Receiver</u>

Most people fit small condensers in parallel on a standard UHF tuner to bring the frequency to 436 m/cs. A much better way is to cut the lecher lines near the small condenser with a junior hack-saw blade and insert a ½" dia. circle of 16swg copper wire between the line and the condenser. Be careful not to heat the condenser too much or the vanes will drop in the tuner. Make sure all circles are the same and that soldered joints are O.K. Realign and you will find your tuner works on 190-460 m/cs. A larger coil would cover the 144 m/cs band. How interesting F.M. on 144 m/cs works perfectly.

A further improvement can be made by using the aerial tuner circuit as an extra amplifier by fitting an extra UHF transistor. With these mods quite a good picture can be obtained with a 100 micro-volt signal.



Masthead Pre-amplifier
(mount on aerial)



Pre-amplifier power supply
(mount adjacent to receiver)

Recently A.C. Bevington G6AFV/T and John Wood G6AHT/T worked out how to modify a varicap tuner for amateur use. Mullard ELC1043s have been used for some time for 70cm TV work as they require no modification to their tuning range, but the more recent low-noise version known as the ELC1043/05 will not tune down to a low enough frequency. Only simple changes are necessary to overcome this problem.

Remove the bottom cover and locate the four ceramic leadless capacitors protruding through the printed circuit board (Fig.1). Take two pieces of thin covered wire 1½ inches long and solder one to each side of the oscillator capacitor as shown. Repeat with the mixer capacitor. Set the tuner voltage at pin 3 to around +0.5v and twist together the wires across the capacitors a little at a time until an amateur signal is tuned in. This will give you a tuning range which overlaps the phone end of the 70cm band. Use as little extra capacity as possible since too much capacity on the oscillator could stop it. Lay the twisted pairs against the PC board and replace the cover.

Remove the top cover and, whilst a station is being received, adjust the right-hand link coupling in the mixture compartment (marked X) for maximum output; this changes the oscillator injection level to the mixer and should be carried out using a plastic trimming tool. Finally, adjust the coupling lines in the two RF tuned circuits and the input coupling to the mixer for maximum signal. For those with a noise generator the tuner should be aligned for best signal-to-noise ratio.

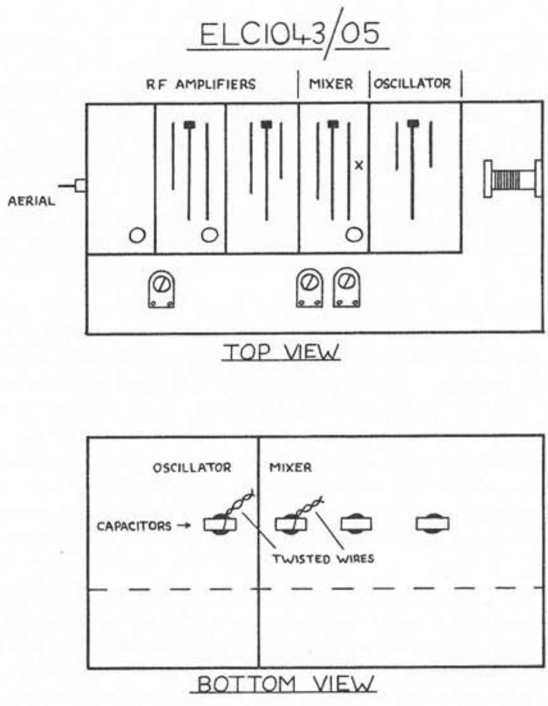


FIG 1

G6AHT/T

The ELC1043 and /05 tuners are wired up in the usual way and the information details are shown in Fig. 2.

On the standard ELC 1043 you will need approximately +0.6v on the tuning supply input (pin 3) to tune 70cm. Initially adjust the IK preset supplying the agc voltage (pin 1) to around +2.5 to +3 volts. When a 70cm signal has been located this 'pot' is peaked for maximum signal. The IF output coil should be peaked with your TV receiver set to channel 1 VHF or connected directly into the IF. A further increase in gain can be obtained by removing three turns from the IF output coil and re-peaking, this should not be done however if you are feeding directly into the IF.

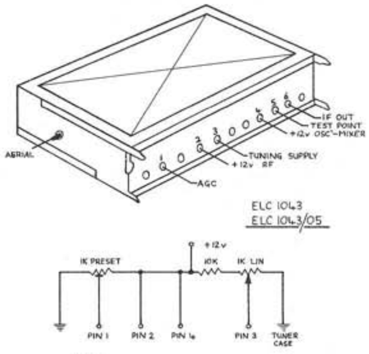


FIG 2

A regulated power supply is essential since any voltage fluctuations will alter the tuning.

chapter 3

TRANSMITTING

By J.J. Rose M.R.T.S. G6STO/T

To the average amateur there are usually three main problems to be overcome to enable him to transmit television on the 70 cm band.

(a) To build a transmitter with an output on that band or raise the frequency from 2 meters into the 70 cm band: assuming that the band is not already in use for sound transmission.

(b) To arrange the power amplifier stage such that it can be modulated with a television signal.

(c) To build a suitable modulator.

POWER AMPLIFIERS

These will be dealt with first in order that when the whole transmitter is considered the precautions in the P.A. will be understood.

First examine the requirements of a P.A. For N.B.F.M. operation the P.A. will not be modulated at all and will be required only to give a constant output over a very narrow range of frequencies; in the order of 6 KHz. Very high Q tuned circuits may therefore be used with the advantages of high amplifier efficiency and reasonable suppression to the F.M. sidebands which stretch, in diminishing amplitudes, to infinity in both directions. Also, the P.A. may be run in class C mode for higher efficiency as there will be no modulation distortion occuring. For amplitude modulation much the same conditions apply if the actual power amplifier is being modulated, with the exception that with high level modulation care must be exercised to ensure that the peaks do not exceed the rating of the device (valve or transistor) being used in the amplifier. Naturally, if the modulation is being applied at a previous stage then the P.A. must be run in a linear condition which, for any reasonable sort of efficiency, dictates the use of class B or class AB2. In all cases the power supply decoupling must be adequate to bypass all the audio and R.F. frequencies present in the P.A. along with sufficient screening to prevent radiation and positive feedback leading to instability.

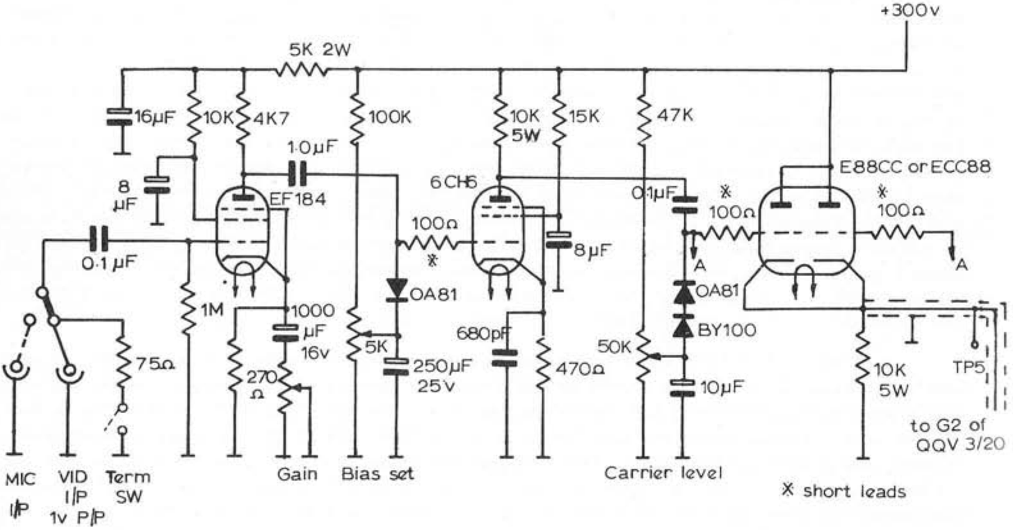
A television transmitter power amplifier is amplitude modulated and all that has been said about class of operation, screening and decoupling applies to it. However, where the sound P.A.'s were decoupled as both R.F. and audio amplifiers the T.V. P.A. must additionally be decoupled as a video amplifier and this can be a little difficult if it is not appreciated what it must cope with to achieve this. Video frequencies range from D.C. to sometimes, as much as 4.5 MHz and it will be realised that much effort must be made to prevent these higher frequencies from appearing where they are not wanted either by inadequate screening or by being carried along the supply lines. The low frequencies create an equally tricky problem as the reactance of even very large capacitors is quite high at just a few Hz and such signals impressed on the DC supply lines can lead to severe instability and multiple decoupling of a T.V. P.A. becomes virtually mandatory.

The P.A. tank circuit must not be of the high Q variety for what must by now be the obvious reason that it must cope with a bandwidth of twice the highest modulating frequency; or about 9 MHz. This is not too difficult to arrange as tuned parallel lines or striplines can generally have their Q drastically reduced by overcoupling the output loop so if the coupling is made variable the P.A. can be used for narrow band high efficiency sound or wide band lower efficiency television signals. On this subject, it is interesting to note that many amateurs restrict the bandwidth of their video signals to about 2 MHz and use a higher Q tank circuit.

This is not as detrimental as it may at first, seem, as the average domestic television set rarely produces detail corresponding to a higher frequency than this. Such an arrangement permits the use of coaxial tank circuits with valves of the 4X150A, 4CX250B family, but if in the future the transmission of colour signals is envisaged then the lower Q wide band P.A. must be used.

MODULATION

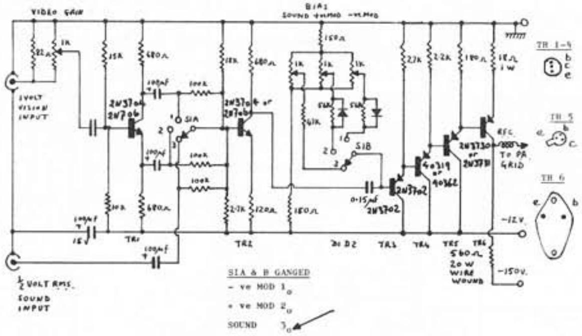
The methods normally associated with ways of amplitude modulating a transmitter high-level plate and screen, screen, series gate, grid and cathode, may all be employed with varying degrees of difficulty. Transformers cannot, of course, be emplyed for coupling video signals and if high-level modulation is required a series device must be used in the anode of the P.A. The task of building such a unit, particularly for a high-power transmitter, with its isolated but decoupled power supplies and screening would be formidable and is not normally encountered in either professional or amateur transmitters. Cathode modualtion is reasonably efficient and is often used in low power transmitters where the cathode current is low enough to allow the use of a transistor with the consequent short leads and ease of screening but for larger transmitters problems arise in not having the cathode very securely bonded to chassis. A problem at 145 MHz let alone at 435 MHz. Screen grid modulation is quite popular and a typical circuit is shown in Fig. 1. This appeared as part of a transmitter constructional article by G6AHR/T in C Q - T V No. 87.



Such a modulator will have control of the D.C. level of the P.A. screen and will therefore control the nominal power output of the transmitter. It will be seen that for a standard 1 volt peak to peak input with the whites positive and the sync pulses negative the output of the modulator will be inverted and hence the transmitter would give a "negative-going" output which is correct for a 625 line picture.

To set up a modulator it is essential to have some form of R.F. probe and detector with which to view the waveform as it is in the aerial cable. This is because the characteristic of a valve grid is not a straight line and the modulator must be set to give the correct ratio of 30% sync pulses and 70% picture in the aerial. The modulator in Fig. 1 is very simple and absolutely corrected waveforms cannot be obtained although with care the results can be very acceptable. The carrier level is set, with no input to the modulator, such that the transmitter radiates about 70% of its maximum carrier output. A signal is applied and the gain advanced until the transmitter is fully modulated, adjusting the carrier level so as not to overdissipate the P.A. valve and the bias level for best picture/sync ratio. It is beneficial to reduce the amount by which the curves of the ends of the screen characteristic are used and consequently reduce the level of sync-tip "crushing" and peak-white "crushing" which would otherwise occur. As with any video modulator, it should be meticulously screened and placed as close to the P.A. as practical.

The most common method of modulation is control grid and a very simple and effective modulator for this is shown in Fig. 2. This is taken from an article in C Q - T V No. 60 by G6OUO/T and G6RSA/T where it was used to modulate a 4X150A but it is equally suitable for use with a QQV03-20A or QQV06-40A.



All the components except the output transistor are mounted on a suitable piece of veroboard or P.C. board and housed in screening, such as a die-cast box. The last two transistors require heat sinks; the driver transistor using a normal push-on type. The heat sink for the output transistor, which is a TO3 type, is a little bit special. The problem is the comparably huge capacity to earth of the average TO3 heat-sink arrangement which would tend to decouple the HF component of the modulating signal. The trick is to mount the transistor directly i.e. without mica insulator, onto a two or three square inch piece of aluminium and to mount this a ¼" or so above the chassis on insulated pillars. As the heat sink is small it will require blowing but if the P.A. is of the 4X150A/4CX250B type there is little hardship in directing a whisp of air from the main cooling fan. With other types of P.A. valve a fan would have to be provided but it is good policy to cool a P.A. valve in any case as it will lengthen its useful life. This modulator has, in common with the previously described screen grid modulator, no provision for correcting the crushing of the signal which occurs due to the characteristic of the valve grid and so cleaner results can be obtained by keeping the modulation level a little below maximum.

Where it is required to run the modulation level as close to 100% as possible the signal applied to the modulator must be equalised, or pre-distorted, to correct to the distortion caused by the P.A. The circuits used to achieve this are known as "sync-stretch" and "white-stretch" circuits and in principle are quite simple whether valves or transistors are used. Both circuits can be identical if they are placed in successive inverting stages as the same action is required of both i.e. at a particular point on the modulator characteristic, corresponding to the curve on the transmitter P.A. grid characteristic, it is required to increase the gain to compensate for that curve. This necessity will be more easily understood from Fig. 3 which shows power output as a function of grid voltage for a P.A. valve. It will be seen that at the bottom of the characteristic, between lines A and B, the change in grid volts needed to

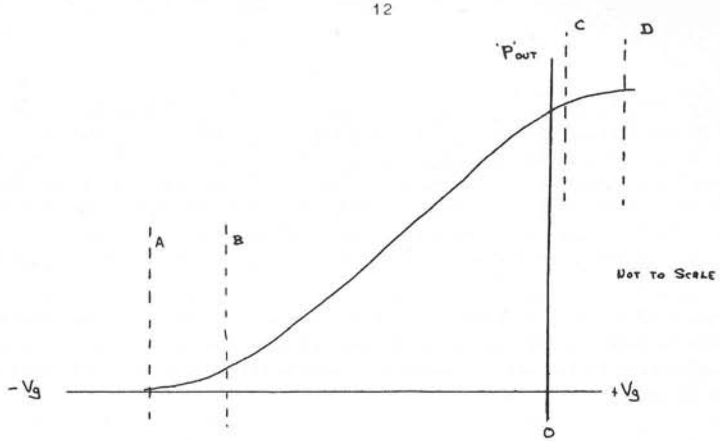


FIG 3

effect a given change in output power is far greater than that needed in the centre, linear, part part between B and C. The same applies to the upper part of the characteristic between lines C and D.

A very simple and effective circuit by G6KOK/T for sync and white stretching in a single stage was published in C Q - T V No. 36 and could easily be transposed to an equivalent transistor circuit. This is shown in Fig. 4.

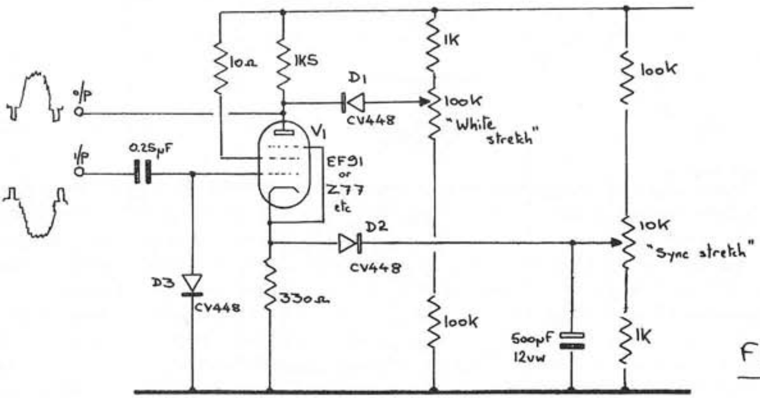


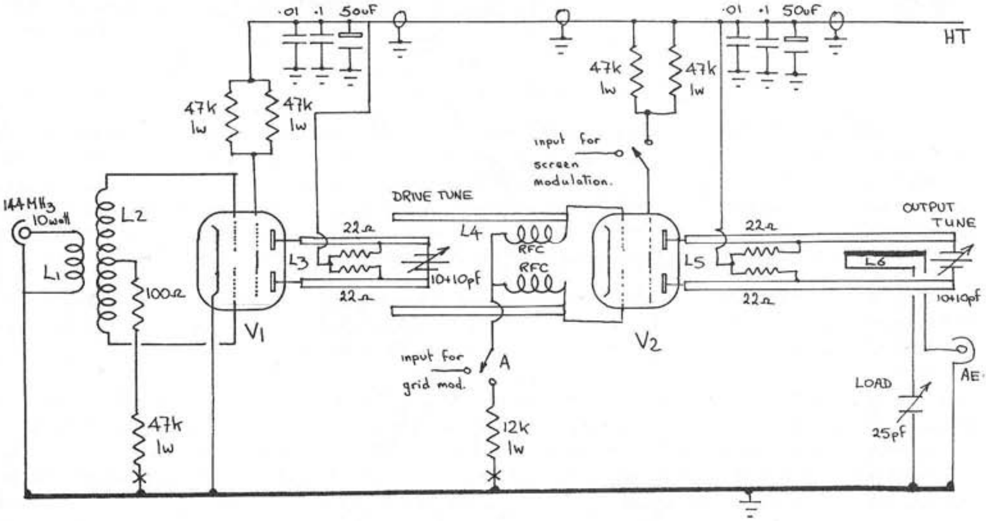
FIG 4

In this circuit the negative-going input signal is D.C. restored to earth potential at the sync tips and at this time the valve is turned on. The cathode is positive with respect to earth and so D2 is turned on. The cathode bias resistance is therefore 330 ohms in parallel with the diode (about 250 ohms); about 140 ohms. As the input signal goes negative and the cathode current falls a point, set by the sync stretch control, will be reached when D2 turns off and the cathode resistance will increase to 330 ohms. At this point the stage gain will fall to 0.6 of its previous value. Throughout this period the anode load has comprised of IK5 in parallel with about IK3 i.e. about 800 ohms, due to D1 conducting. As the anode current falls a point set by the white stretch control is reached where D1 turns off and the anode load increases tc IK5, giving an increase in gain of 1.9 times. As it stands, the circuit could be used as the second, unity gain, stage of a modulator but if it is desired to use it as a first stage of either a modulator or a separate equalising unit where positive-going signals are to be applied, diode D3 should be reversed and the labelling of the contrls is reversed.

Using such a circuit as this in the video modulator with a wide-band P.A. circuit will allow very high quality pictures to be transmitted.

TRANSMITTERS

Where a 2 meter transmitter is already in use it is a fairly straightforward matter to build a tripler stage to follow it in order to radiate a 70cm signal. However, it is not recommended that an attempt be made to modulate the tripler for, although it can be done, full modulation is impossible unless a certain amount of modulation is applied to the stage driving it. Additionally, considerable problems of instabililty can occur as well as very poor efficiency. A much better plan is to build a two-stage tripler with the second stage as a straight amplifier on 70 cm. Such a tripler/amplifier is shown in Fig. 5. It will be seen that the amplifier



COIL DATA

L1	2 turns 20 swg $\frac{1}{2}$" dia. inside L2	V1	QQV03 - 20A
L2	4 turns 16 swg $\frac{1}{2}$" dia. $\frac{1}{2}$" long.	V2	QQV03 - 20A with 300v HT
L3	copper strips $\frac{1}{2}$" wide $3\frac{1}{2}$" long, spaced $\frac{3}{4}$"		QQV06 - 40A with 500v HT
L4	copper strips $\frac{1}{2}$" wide $2\frac{7}{8}$" long, spaced $\frac{1}{2}$"		
L5	copper strips $\frac{1}{2}$" wide $3\frac{7}{8}$" long, spaced $\frac{3}{4}$"		
L6	14 swg loop $\frac{1}{2}$" wide $1\frac{1}{4}$" long inside L5.	RFC	12 turns 22 swg 0.3125" dia.

section may be either a QQV03-20A or a QQV06-40A. If the QQV03-20A is used with a 2 meter drive of 10 watts or more the unit will give an R.F. output of about 20 watts C.W. or at sync tips when TV modulated. It can be supplied with a single HT line but very great care should be taken to decouple it wherever possible and better still; also used screened wire with the braiding earthed frequently. With a QQV06-40A in the final the HT to its anodes only can be raised to about 500 volts when the R.F. output will be about 40 watts C.W. or at sync tips. Figs. 6a and 6b show the basic layout of the unit. V1 is mounted through a hole in the chassis and V2 is mounted horizontal with its socket behind a metal partition in the $3\frac{1}{2}$" square screening box. With the valves so enclosed it is wise to cool them and a blower can be fixed to the back runner of the chassis. A group of holes should be drilled in the chassis below V2 and a bottom fitted to the chassis so that the air will pass around V1 and be blown over V2. The screening box should have a well-fitting lid with groups of holes drilled above both valves and should of course, be screwed on.

FIGURE 6A

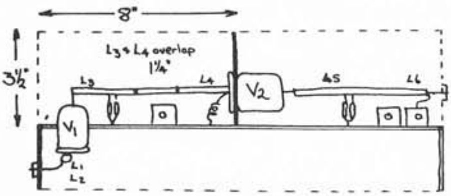
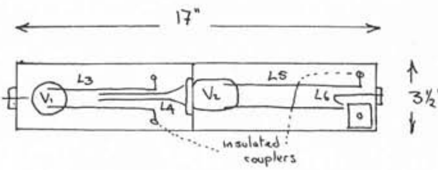


FIGURE 6B



With the heaters switched on and 2 meter drive applied the spacing of L2 should be adjusted for maximum V1 grid current which should be about 3mA. H.T. should then be applied to V1 and it's anode tuning capacitor adjusted for maximum grid current in V2. Adjust the position of L4 lines with respect to L3 lines until at least 4mA of grid current can be obtained in V2. A load should now be applied to the output; a 50W headlamp bulb will do, and HT applied to the final. The output tuning and loading should then be adjusted for maximum lamp brightness.

If the final grid RFC's have been mounted between the valve base pins and a single feedthrough insulator (not a capacitor) in the chassis it would be easy to mount the output transistor of the modulator in Fig. 2 close to this and the remainder of the modulator in a die-cast box on the outside of the chassis as close as possible to it. If a meter is included in the final anode supply it should be 150mA FSD and the output tune adjusted for greatest dip whilst the output load is adjusted for highest peak. Any meters fitted should not be mounted through the screened box but should be fitted to a false panel mounted on brackets in front of the unit. The spindles of the tuning capacitors must not be earthed to this and they are lengthened inside the screened box with shafts joined to them with insulated couplers.

If a suitable driver is not available Fig. 7 shows a suitable unit. This is from a constructional article in C Q - T V No. 87 by G6AHR/T.

To set up the driver HT is applied first to the oscillator only and L1 adjusted to 24 MHz, adding a few pF across the coil if required. This should give 0.5 to 1 mA at TP1 when HT is applied to V2 and L2 adjusted to 72 MHz. HT is next applied to V3 and L2 "tweaked" to give 1.25 to 1.5mA at TP2. L3 and L4 are tuned to 144 MHz. When HT is applied to the QQV03-10 output stage TP3 should give a reading of 3 to 4 mA when L3 and L4 are finally adjusted. L5 and L6 can be tuned for maximum brightness in a lamp load which will give an approximate setting for feeding the tripler/amplifier. These two adjustments can be finally corrected when connected to the tripler/amplifier, in conjunction with L2 in that unit for maximum tripler current.

The arrangement described so far would allow very satisfactory pictures to be transmitted and fulfill the statutory requirements of transmitting the station call sign by telephony on the vision frequency. However, if it is desired to transmit simultaneous sound and vision a second transmitter will be required, with an output 6 MHz higher in frequency, and a means of combining the two outputs into one aerial. Unfortunately , the 70cm band is not quite wide enough to allow the whole of both signals to be radiated but this does not matter if careful filtering is used to remove most of the lower sideband of the vision signal which is redundant in any case. Broadcast stations only radiate just over 1 MHz of the lower sideband and this is known as "vestigial sideband". A very simple combining filter unit was described in C Q - T V No. 72 and is shown in Fig. 8.

This is constructed from the body of a UHF TV tuner which had half wave lines. It is stripped of all but the trimmers and new lines fitted of 1.4 mm diameter silvered copper. All holes except the spindle holes, through which the input coaxes are joined, are soldered up and a SO239 socket fitted where shown.

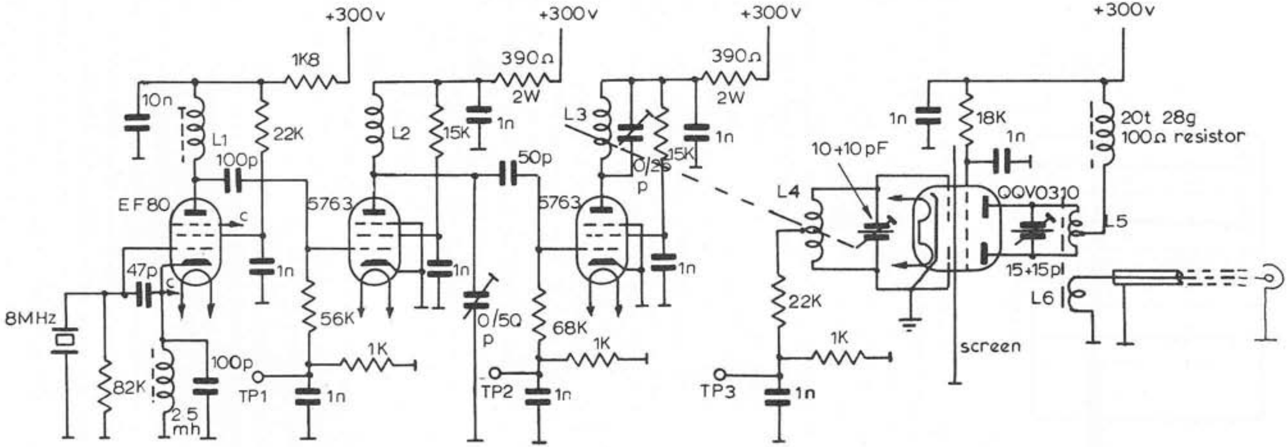


FIGURE 7

COIL DATA

L1	20 turns 24 swg ¼" former with slug	L4	2 turns + 2 turns 18 swg 5/16" I.D.
L2	6 turns 18 swg 5/16" I.D.	L5	2 turns + 2 turns 16 swg ⅜" I.D.
L3	2 turns 16 swg ⅜" I.D.	L6	2 turns 18 swg ⅜" I.D.

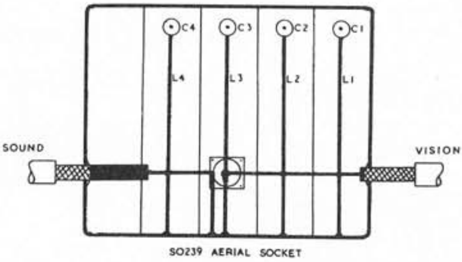


FIGURE 8

To adjust the unit the sound carrier is applied and C4 adjusted for maximum output to the aerial as shown on a field strength meter, SWR bridge, output probe, etc. Next the vision carrier only is applied and C1, C2 and C3 adjusted for maximum output. The vision circuit capacitors C1, C2 and C3 are then slightly reduced in capacity such that a modulated carrier is sharply attenuated at frequencies more than 1 MHz lower than the vision carrier frequency.

There are numerous other ways of achieving simultaneous sound and vision; all requiring some form of filtering. It is possible to mix a 6 MHz F.M. sound carrier with the video signal at the P.A. grid but aerial filtering is still required as the output is still double sideband vision and would have a sound carrier at 6 MHz above and below the vision. A very popular and effective method is to generate a signal at TV I.F. (about 39 MHz) and amplitude modulated it with vision before adding a 6 MHz FM sound carrier. All the filtering required can then be done at around 39 MHz with relative ease and the result hetrodyned up to 70cm. Unfortunately, all subsequent stages must then be linear as they are handling a modulated signal. This is a small price to pay to be able to filter easily and do most of the job with transistors as a big P.A. can soon put the power loss right. Another system uses a similar vision I.F. arrangement but generates the FM sound at TV I.F. (about 33 MHz) to mix with the vision. This has two great advantages, (a) it can easily be set up by feeding the mixed signals into a TV set I.F. strip, (b) a TV receiver I.F. strip can be used to make an A.F.C. loop for the sound oscillator. The main disadvantage of this system is that in order to get the correct sound above vision at 70cm the mixing must be done with an injection signal above 70cm (about, say, 474 MHz-39 MHz=435 MHz) and this makes the mixer difficult to set up.

PROBES

As previously stated, some form of monitoring the aerial signal is essential in order to correct for modulation non-linearity in the P.A. and a very suitable circuit by G6OUO/T appeared in C Q - T V No. 56. This is shown in Fig. 9.

The principle virtue of the unit lies in its construction. It is built in a $5\frac{3}{8}$" x $2\frac{3}{8}$" die cast box with a coax socket on each end and the centre connection of the sockets is cut down to 3/16" long. The two sockets are joined together with a piece of super-aeraxial coax and as the length is almost $\frac{1}{4}$ wavelength the mismatch at the sockets tends to cancel. The remaining components are mounted on stand-offs and the feedthrough capacitors with the meter and battery external. C1 is a piece of 22g wire pushed up one of the holes in the super-aeraxial cable. The video output must always be terminated in 75 ohms and with this condition satisfied and no R.F. applied the potentiometer is set to give a meter reading of 1.5 mA. For transmitters of less than 50 watts input R1 is omitted and C1 withdrawn from the coax before switching on the transmitter. With RF applied C1 is inserted until the meter reads 15 mA at full transmitter input. For higher power transmitters C1 is connected into the coax for $\frac{1}{8}$" and R1 adjusted to give the required meter reading. R1 will be between 100 ohms and 10Kohms and for a 150 watt transmitter, is typically 220ohms. The meter will give an indication of relative power and the video output is taken to an oscilloscope where it will be terminated in 75 ohms or, if desired, be bridged to a video monitor so that the aerial picutre may be viewed. Fig. 10 shows a typical arrangement.

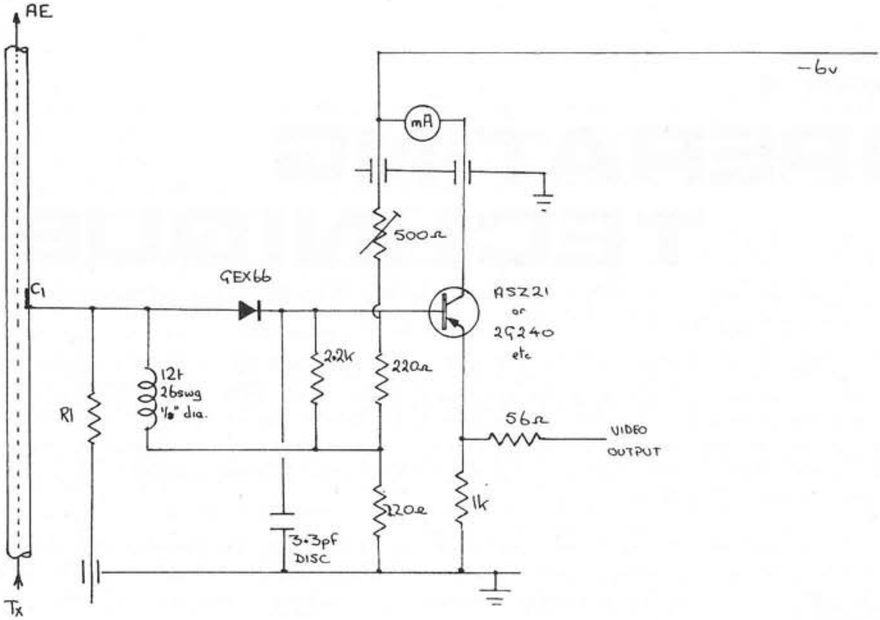
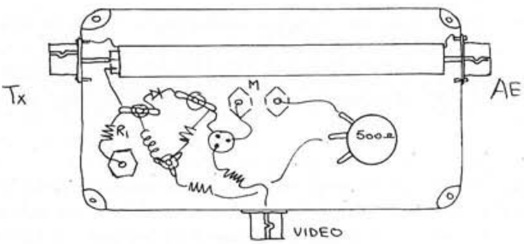
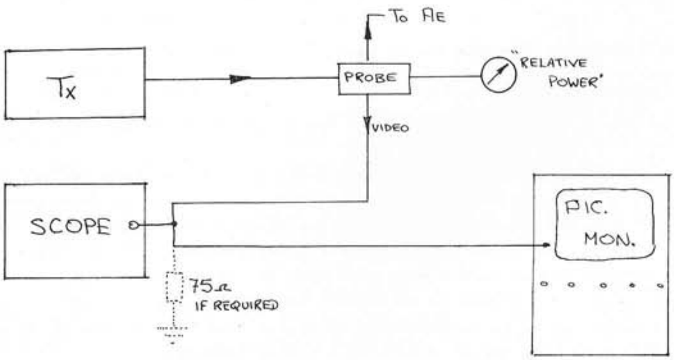

AE
-6v
mA
500Ω
GEX66
C_1
ASZ21
or
2G240
etc
2.2k
220Ω
12t
26swg
1/8" dia.
R1
56Ω
VIDEO
OUTPUT
220Ω
1k
3.3pf
DISC
Tx

FIGURE 10


Tx
AE
M
R_1
500Ω
VIDEO


To AE
Tx
PROBE
"RELATIVE
POWER"
VIDEO
SCOPE
PIC.
MON.
75Ω
IF REQUIRED

chapter 4

OPERATING TECHNIQUES

by J. Wood G6AHT/T

Amateur television can be found mainly on the 70cm band, but an increasing number of stations are also equipping for 23 cms.

One of the reasons for this is that increasing pressure is being put on the TV portion of 70cms. and parts of it are being nibbled away for one purpose or another. Consequently, at present there is really only space for one tv channel; this is not as bad as it sounds since it is seldom that two stations wishing to transmit at the same time are close enough to cause mutual interference. 23cms. however has plenty of space available and incidently will be the band used by any TV repeaters.

Perhaps the majority of stations these days use the 625 line standard with negative modulation (peak sync); however, there are a lot of stations using 405 lines with positive modulation (peak white). As far as possible you should be prepared to take any combination of these standards.

Most TV'ers use their TV transmitters for sound as well, this is usually on the TV frequency and can be either amplitude or frequency modulated. A good strength sound signal usually indicates that a picture can at least be locked in; as a rule of thumb an S9 signal is required to produce a good picture.

It is the exception rather than the rule for video contacts to be established as a result of calling CQ in the TV portion of the band. It is more usual to call CQ either in the phone end or on one of the 2 meter TV calling frequencies (144.75 MHz or 144.23 MHz). Also announcing yourself as looking for TV stations on your local repeater very often reveals a surprising amount of interest.

Where possible it is preferable to make regular skeds with stations in your area, these may be weekly, fortnightly or whatever. The advantages are that you are certain of regular contacts, which is desirable for checking out equipment and keeping your interest alive. Also, others in your area may be stimulated by the fact that regular pictures are on the air and they may well feel it worth while setting up with at least a receiver.

If you don't know any ATV stations in your area a look in the callbook should produce someone who is active.

A few words may be in order to illustrate the procedure for a typical TV QSO.

Assuming you have made a sked with another station you normally establish contact first on phone, usually on the vision frequency to be used. If however you have never worked the other station on TV and are not sure whether you can make it then perhaps your initial contact should start on 2 meters and later QSY to your vision frequency. It is often a good idea to transmit a few minutes of vision before your sked time to let the other station know you are there and, also to give him a chance to accurately align his beam. The aerials used on UHF usually have a narrow beamwidth so it is important to ensure your beam alignment is optimum; the best way is to swing your beam whilst observing a vision picture.

Now a golden rule; whenever you finish a contact you should announce your callsign phonetically and state that you are tuning the band for any further calls. Many a new QSO is missed by assuming there will be no one else listening, and closing down without checking the band. From time to time the B.A.T.C. organise contests, advance notice of these and details of the rules appear in the 'C Q - T V' magazine.

Contests are very useful indeed for everyone and should be supported fully. Even if you don't want to enter you can be certain there are many stations on and can usually get contacts with stations who are perhaps not too active but like to support the contests. It is also interesting to contact stations more distant than usual. It is often very surprising just how weak a signal can be before the picture is lost. When sending video under these weak signal conditions ensure that your captions have high contrast levels, keep the letters large and bold so that they may be picked out of the white noise on the receiver screen.

On the subject of captions try to make them interesting, it is very boring to receive several minutes of test card and call sign. Even routine information captions such as ATV, CQ and "tuning 70" etc. can be brightened up by inserting a cartoon character somewhere on the card. Alternatively, superimpose the lettering over a pretty picture. This sort of thing is far more interesting to the receiving station.

All your caption cards should be the same size, usually the same as the standard test cards, that is approximately 12" x 10", even though usually called "twelve by nines".

Don't just prop up your caption precariously, it is well worth while making a small frame out of metal or wood and mounting it on a wooden board. There should be room for two caption cards to be inserted into the holder at any one time. This means that while a caption is being displayed the next card can be slid into the holder behind it and, when ready, the top caption card is slid quickly out.

Many people seem to have difficulty in producing caption cards. Most say "but I can't draw"; that's O.K., you don't necessarily have to, how about cutting out your picture or cartoon character from a magazine or calender and pasting it onto a piece of light card. The lettering can be put on using Letraset, but this can be expensive. You can buy sheets of stencils in art shops, these are good but after drawing out your letter fill in the parts that hold the pieces of stencil together, otherwise your caption will look like a packing case (that's a good idea for another caption!). Alternatively you can draw your own characters with nothing more elaborate than a ruler, a pair of compasses and a pen and pencil. Fig. 1 shows how letters may be measured out and filled in with a pen or small sable brush and drawing ink. It is well worth while keeping an eye on the broadcast TV stations for caption ideas. Some of the regional identification slides are very adaptable to amateur purposes.

How about a rotating caption? Use a plain card with a large circle cut out of the centre, behind this is a disc which is mounted onto a centre shaft, this disc being driven be a small electric motor. If you paint a spiral or a star on the disc the result can be rather effective and having a moving caption is certainly an improvement on the fixed card.

A second camera is a great asset, you can set one up permanently on your caption holder which leaves the second one free to dolly around the shack.

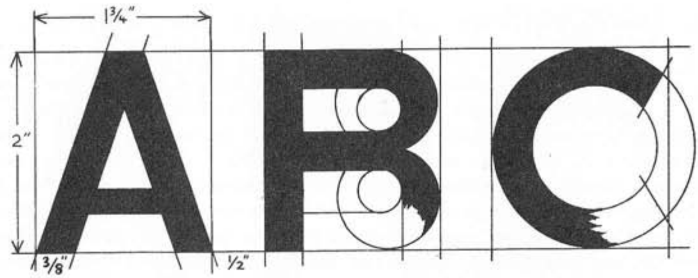
Don't forget the electronic video generator, a chequer board pattern for instance is much easier to pick out of a very noisy screen than a caption from a camera. Both vertical and horizontal bars and a staircase (grey scale) generator are particularly useful for setting up equipment.

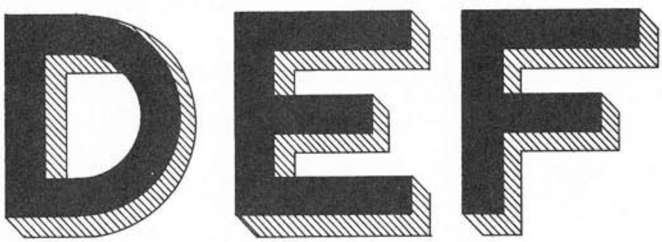
Fading and wiping between two scenes is a very effective way indeed for changing pictures and really adds that touch of professionalism to your transmissions. Designs for all of these function generators have appeared in the C Q - T V magazine and back issues are available for those who are interested. In short, you should aim to present the most interesting and entertaining programme possible.

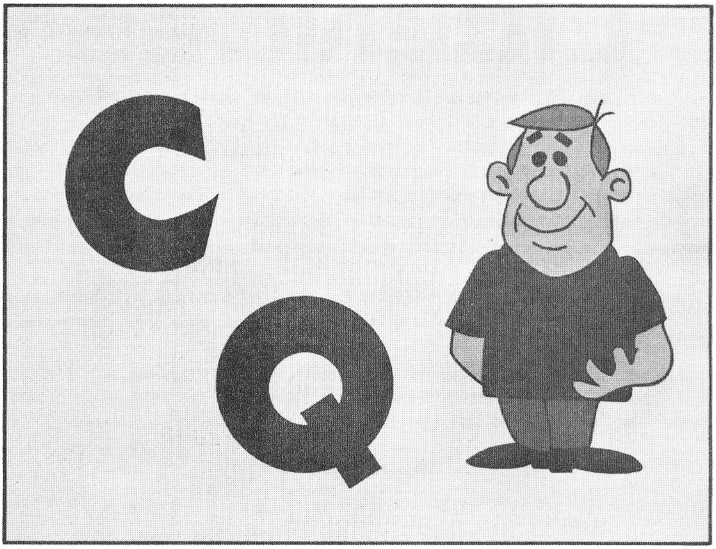
When an opening occures try to make as much of it as you can. The object is to make your presence known. You can do this in several ways. If you can't transmit vision then call "CQ TV" in the phone end of 70 cms or on either of the 2 meter calling frequencies; don't be put off if no one comes back straight away, just keep calling in all directions, also keep a close eye on 70 cms. for video.

The transmitting stations can and should call CQ as above but in addition, and most important, should transmit a few minutes of a LARGE CQ caption and announce in both vision and sound where you are tuning. One of the main reasons for putting on video is because there are always TV receiving stations looking in and even if you don't make a two-way vision contact the chances are fairly good that someone will see your pictures and hopefully will send you a report. Do remember to make your captions bold, as in all probability the received signals, even under lift conditions, will have noise on them, and you do want to have the best chance of being identified.

Keeping an eye on the "TV on the air" column in the C Q - T V magazine will guide you to the most likely areas of activity in your vicinity.



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G6AHT-T

chapter 5

LICENCES

by Malcolm Sparrow G6KQJ/T G3KQJ

A Licence is not required for Amateur Television experiments conducted on a closed circuit basis, but before the Amateur Television enthusiast may transmit amateur television in the United Kingdom, one must first obtain, or already posess, an Amateur Licence A or B.

The Government department responsible for the administration and licencing of Amateur Radio stations in the United Kingdom is the Home Office, and the address to which enquiries and applications should be sent is:

The Home Office
Radio Regulatory Department
Radio Regulatory Division
Licensing Branch (Amateur)
Waterloo Bridge House
Waterloo Road
London
SE1 8UA

The two most popular types of Amateur Licence which the Home Office will issue, subject to the appropriate requirements being met, are "The Amateur Licence A" and "The Amateur Licence B", the "A" licence being the full licence, whilst the "B" licence is for VHF operation only. Both of these amateur licences are for sound, and for both Fast Scan and Slow Scan Amateur Television transmissions. Full details of these licences can be obtained by writing to the Home Office and requesting a copy of their pamphlet entitled "How to become a Radio Amateur". In order to qualify for one of these licences you must

a) be over fourteen years of age
b) be a British subject
c) have passed the Radio Amateur Examination
d) have passed the Post Office Morse Test (only if applying for an "A" licence)
e) have paid the licence fee (currently £5.50 per annum)

As the Post Office Morse Test Pass Slip is only valid for a period of one year from the date of issue, the applicant is recommended to first study for and take the Radio Amateur Examination; once this qualification has been obtained, then proceed with the Post Office Morse Test. If the applicant wishes to restrict his operations to the VHF bands, then it is not necessary to obtain the morse qualification. Fast Scan (high definition television) amateur transmission are permitted on the 432 MHz band and higher frequency amateur allocations, whilst Slow Scan Amateur Television is permitted on the 3.5, 7, 14, 21, 28 and 144 MHz amateur bands.

Details of where to obtain tuition for the Radio Amateur Examination and the Post Office Morse Test can usually be obtained by asking the Secretary of the local Amateur Radio Society or Club in your area. Courses are often held at Evening Schools held at the local Technical College or Polytechnic.

With either type of licence, one of the essential requirements is that the transmitting amateur must be able to measure the frequency of his transmissions, and preferably the second and third harmonics also. This can be acheived in the case of a crystal controlled transmitter with an absorbtion wavemeter, but in the case of a Variable Frequency Oscillator controlled transmitter, then the licencee will be expected to have a more accurate means of frequency checking, such as a Grid Dip Oscillator, or a Heterodyne Frequency Meter.

The Amateur Licence A and B application Form, paragraph 6, states as follows:-

"I undertake to maintain at the station, frequency checking equipment of sufficient accuracy to ensure that transmissions are within the frequency bands allocated for amateur use, and equipment to enable me to confirm that harmonic and spurious emissions are suppressed. I understand that out of band working, whether intentional or not, will be regarded as a serious misdemeanour and could result in the withdrawal of the licence."

and the applicant has to sign to this effect when making his application for a licence.

The Home Office pamphlet "How to become a Radio Amateur" contains in Appendix F, some notes as a guide to Home Office requirements with regard to frequency and harmonic content measurement.

Note: the current (1977) issue of Appendix B of "How to become a Radio Amateur" should have "footnote 10" against the frequency band 3.5 - 3.8 MHz. This was omitted in error.

Once the Amateur Licence A has been obtained, the amateur is not required to retake the Post Office Morse Test provided that the licence is renewed on a continuous basis.

Slow Scan Amateur Television Specification

Number of lines per picture	128 ∓ 8 lines	256 ∓ 16 lines
Aspect ratio	1 : 1	1 : 1
Horizontal frequency	$16\frac{2}{3}$ ∓ 1 Hz	$8\frac{1}{3}$ ∓ $\frac{1}{2}$ Hz
Vertical frequency	7.68 seconds	30.72 seconds
limits	6.79 - 8.68 seconds	27.16 - 34.72 seconds
Horizontal sync pulse duration	5 milliseconds	5 milliseconds
Vertical sync pulse duration	30 milliseconds	30 milliseconds
FM Subcarrier		
Sync bottom	1200 Hz	1200 Hz
Black level	1500 Hz	15oo Hz
Peak white	2300 Hz	2300 Hz

The general accepted frequencies on which Slow Scan Amateur Television transmissions can be found are 3.845 MHz, 7.040 MHz, 12.230 MHz, 21.340 MHz, 28.680 Mhz and 144.230 MHz.

Frequency-Checking Equipment in Amateur Stations

The Home Office receives many enquiries seeking amplification of the clause in Amateur licences which requires a licencee to have in his station "Equipment for frequency measurement capable of verifying that the sending apparatus comprised in the station is operating with emissions within the authorised bands". Although the Home Office must continue to assess the suitability of the frequency- measuring equipment offered by individuals in licence applications, the following notes may be helpful as a guide to Home Office requirements.

1. A Licencee is required:-

   (a) to be able to verify that his transmissions are within the authorised frequency band, (i.e. that no appreciable energy is radiated outside the band).

   (b) to use a satisfactory method of frequency control.

   (c) to ensure that his transmissions do not contain unwanted frequencies (i.e. harmonics and spurious frequencies).

2. When his station is inspected by officers authorised by the Sectreary of State, the licencee will be expected to demonstrate that he can conform with the requirements (a) to (c) above.

3. As a general rule, a station requires a crystal reference source to comply with 1(a) and (b) above so that:
(a) with a crystal-controlled transmitter an absorption device of suitable frequency range and accuracy is necessary to check that the desired harmonic of the crystal frequency is selected.
(b) with a transmitter that is not crystal-controlled a wavemeter based on a crystal oscillator is necessary.

Within these outline requirements the Licencee is free to decide how he will meet the licence regulations. The Home Office cannot of course, endorse or recommend particular makes or types of equipment, and assesses the suitability of what the licencee proposes to use from the details he gives in his licence application.

4. The following comments may provide useful guidance:
(a) Frequency measuring equipment should be of sufficient accuracy to verify that emissions are within the authorised frequency bands. For example, operation in the centre of the 21.0 - 21.45 MHz band would require frequency measurement to an accuracy of ± 1.0% to ensure that emissions were within band, whereas operation within, say, 10 KHz of band edge would require measurement to an accuracy of ± 0.05%. When determining the proximity of an emission to band-edge, the bandspread due to modulation, on the appropriate side of the carrier, needs to be added to the frequency tolerance of the carrier.

(b) Heterodyne wavemeters and crystal calibrators. When used in conjunction with a general coverage receiver, a 100 KHz crystal is usually adequate for checking frequencies up to 4MHz. For higher frequencies the spacing between 100 KHz marker points is too small for accuracy, and a crystal of 500 KHz, or preferably 1MHz, should be used in addition. If the receiver covers only the Amateur frequency bands the bandspread scale will usually allow a 100 KHz crystal to be used with sufficient accuracy throughout the h.f. bands.

(c) Absorption wavemeters and similar devices. The scale length and accuracy should be suitable for measurements of the required accuracy to be made, and the frequency coverage should extend up to the second, and preferably the third, harmonic of the radiated frequency so that the presence of unwanted frequencies may be detected. For v.h.f. and u.h.f. transmitters, probably the best technique is to measure the frequency of the fundamental oscillator as accurately as possible and to use an absorption device to confirm that the wanted harmonic has been selected. When a v.h.f. or u.h.f. converter is used in conjunction with an h.f. receiver and the calibration of the main receiver can be checked with sufficient accuracy, this will provide a means of frequency measurement but it is also advisable to use an absorption wavemeter to check the measurement and to confirm that no unwanted radiations are present.

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HOME OFFICE

WIRELESS TELEGRAPHY ACT, 1949

AMATEUR LICENCE A

Date of Issue .... Fee on Issue £5.50.

Renewable .... in each year Fee on renewal £5.50.

Call sign ....

1. (1) *Licence* ....

of ....

(hereinafter called "the Licensee") is hereby licensed, subject to the terms, provisions and limitations herein contained:

(a) to establish in the United Kingdom an amateur sending and receiving station for wireless telegraphy (hereinafter called "the Station"):

(i) At the above address

(hereinafter called "the main address") or

(ii) At any premises (hereinafter called "the temporary premises") or any location (hereinafter called "the temporary location") for separate periods none of which shall exceed four consecutive weeks; or

(iii) At any premises (hereinafter called "the alternative premises") provided that at least 7 days before the Station is established at the alternative premises notice in writing of the postal address of the alternative premises is given to the General Manager of the Post Office Telephone Area in which the alternative premises are situate or in the case of the Channel Islands to the Director of the Telecommunications Board of the appropriate Bailiwick. The said General Manager or Director shall also be notified in writing when the Station is no longer established at the alternative premises; or

(iv) in any vehicle or vessel but not on the sea or within any estuary, dock or harbour;

(v) as a pedestrian;

(b) to use the Station for the purpose of sending to, and receiving from, other licensed amateur stations as part of the self-training of the Licensee in communication by wireless telegraphy;

(i) Messages in plain language which are remarks about matters of a personal nature in which the Licensee, or the person with whom he is in communication, has been directly concerned;

(ii) Facsimile Signals;

(iii) Radio Teleprinter Signals;

(iv) Visual Images;

(v) Signals (not being in secret code or cypher) which form part of, or relate to, the transmission of such messages, signals or images.

(c) to use the Station, as part of the self-training of the Licensee in communication by wireless telegraphy, during disaster relief operations conducted by the British Red Cross Society, the St John Ambulance Brigade, the Emergency County Planning Officer, or any police force in the United Kingdom, or during any exercise relating to such operations, for the purpose of sending to other licensed amateur stations such messages as the Licensee may be requested by the said Society, Brigade, County Planning Officer or police force to send, and of receiving from any other licensed amateur station such messages as the person licensed to use such other licensed amateur station may be requested by the said Society, Brigade, County Planning Officer, or such police force to send;

(d) to use the Station for the purpose of receiving transmissions in the Standard Frequency Service.

(2) Limitations. The foregoing Licence to establish and use the Station is subject to the following limitations:

(a) The Station shall not be established or used in an aircraft or a public transport vehicle.

(b) The Station shall be used only with emissions which are of the classes specified in the Schedule hereto and are within the frequency bands specified in the Schedule hereto in relation to those respective classes of emission, and with a power not exceeding that specified in the Schedule hereto in relation to the class of emission and frequency band in use at the time.

(c) The Station shall be operated only (i) by the Licensee personally, or (ii) in the presence of and under the direct supervision of the Licensee, by any other person who holds a current wireless telegraphy licence issued by the Secretary of State to use another amateur station or who holds an Amateur Radio Certificate issued by the Secretary of State.

(d) Messages other than initial calls shall not be broadcast to amateur stations in general, but shall be sent only to (i) amateur stations with which communication is established separately and singly, or (ii) groups of particular amateur stations provided that communication is first established separately and singly with each station in any such group.

(e) When the Station is used for the purpose of sending messages by the type of transmission known as Radio Teleprinter (RTTY) it shall be used only with International Telegraph Code No. 2(5 – Unit Start–Stop) and with speeds of transmission of 45.5 or 50 bauds.

(f) No message which is grossly offensive or of an indecent or obscene character shall be sent.

2. International Requirement. The Licensee shall observe and comply with the relevant provisions of the Telecommunication Convention.

3. Frequency Control and Measurement.

(1) A satisfactory method of frequency stabilisation shall be employed in the sending apparatus comprised in the Station.

(2) Equipment shall be provided capable of verifying that the sending apparatus comprised in the Station is operating with emissions within the authorised frequency bands.

4. Non-Interference.

(1) The apparatus comprised in the Station shall be so designed, constructed, maintained and used that the use of the Station does not cause any undue interference with any wireless telegraphy.

(2) When telegraphy (as distinct from telephony) is being used, arrangements shall be made to ensure that the risk of interference due to key clicks being caused to other wireless telegraphy is eliminated. At all times, every precaution shall be taken to avoid over-modulation, and to keep the radiated energy within the narrowest possible frequency bands having regard to the class of emission in use. In particular, the radiation of harmonics and other spurious emissions shall be suppressed to such a level that they cause no undue interference with any wireless telegraphy. To ensure that the requirements of this subclause are met, tests shall be made from time to time and details of those tests shall be recorded in the Log as required in clause 6 hereof.

5. Operators and access to Apparatus. The Licensee shall not permit or suffer any unauthorised person to operate the Station or to have access to the apparatus comprised therein. The Licensee shall ensure that persons operating the Station shall observe the terms, provisions and limitations of this Licence at all times.

6. Log.

(1) An indelible record shall be kept in one book (not loose-leaf) (in this Licence called "the Log") showing the following:

(Fixed Station)

(a) Date

(b) Time of commencement of period of operation of the Station.

(c) Call signs of the stations from which messages addressed to the Station are received or to which messages are sent, times of establishing and ending communication with each such station, frequency band(s) and class or classes of emission in each case (including the tests referred to in clause 4(2) above; and CQ calls).

(d) Time of closing down the Station.

(e) The address of the temporary premises or the alternative premises or particulars of the temporary location when the Station is established other than as provided in clause 1(1)(a)(i) hereof.

(f) No gaps shall be left between entries and all entries shall be made at the time of sending and receiving.

(Mobile Station or as a Pedestrian)

(g) Entries made in respect of calls made when operating from a vehicle or vessel, or as a pedestrian should be made as soon as practicable after the end of a journey and must consist of date, geographical area of operation, frequency band(s) used and time of commencement and end of journey. A separate log book may be maintained for mobile or pedestrian use.

(2) If the Station is at any time operated by a person other than the Licensee (see clause 1(2)(c)(ii) hereof) the Licensee shall ensure that the Log is signed by that person with his full name, and that the call sign of the station which he is licensed to use, or (if there is no such station) the number of his Amateur Radio Certificate, is shown in the Log.

(3) All times shall be stated in GMT.

7. Receiver. The Station shall be equipped for the reception of messages sent on the frequency or frequencies, and by means of the class or classes or emission, which are in current use at the Station for the purpose of sending.

8. Recorded messages.

(1) Messages addressed to the Station from any licensed amateur station with which the Licensee is in communication may be recorded and retransmitted in accordance with this Licence, provided that the retransmission is intended for reception by the originating station only, and that the call sign of that station is not included in the retransmission.

(2) Modulation is prohibited by means of recordings of any kind other than special recordings of sinusoidal tone or tones within the audio frequency spectrum which may be either constant or steadily changing in frequency.

(3) Gramophone or tape recordings of the type intended for entertainment purposes may not be transmitted for any purpose.

9. Call Sign and notification of location

(1) Whenever the Station is used the call sign mentioned on the first page of this Licence shall be transmitted: provided that when the Station is used:

(a) at an address other than the main address the Licensee shall, in order to indicate the country or place of use, vary the prefix letter to the call sign by using the prefix letter(s) appropriate to that country or place, being G for England, GM for Scotland, GW for Wales, GI for Northern Ireland, GJ for Jersey, GU for Guernsey and GD for the Isle of Man;

(b) at the temporary premises the suffix "/A" shall be added to the call sign;

(c) at the temporary location or as a pedestrian the suffix "/P" shall be added to the call sign;

(d) in or on a vehicle or vessel the suffix "/M" shall be added to the call sign;

(2) The call sign, which may be sent either by morse telegraphy at a speed not greater than 20 words per minute or by telephony, shall be sent for identification purposes at the beginning and at the end of each period of sending, and whenever the frequency is changed. When the period of use exceeds 15 minutes the call sign shall be repeated (in the same manner) at the commencement of each succeeding period of 15 minutes.

(3) When telephony is used, the letters of the call sign may be confirmed by the pronouncement of well-known words of which the initial letters are the same as those in the call sign; but words used in this manner shall not be of a facetious or objectionable character.

(4) When the Station is used at the temporary premises or location, the address of the temporary premises or location shall be sent at the beginning and end of the establishment of communication with each separate amateur station, or at intervals of 15 minutes, whichever is the more frequent.

(5) When sending high definition television signals, the call sign sent for identification purposes must be adjusted to the centre of the video channel.

10. Inspection. The Station, this Licence and the Log shall be available for inspection at all reasonable times by a person acting under the authority of the Secretary of State.

11. Station to close down. The Station shall be closed down at any time on the demand of a person acting under the authority of the Secretary of State.

12. Period of Licence, Renewal, Revocation and Variation. This Licence shall continue in force for one year from the date of issue, and thereafter so long as the Licensee pays to the Secretary of State in advance in each year on or before the anniversary of the date of issue the renewal fee prescribed by or under the regulations for the time being in force under section 2(1) of the Wireless Telegraphy Act, 1949; Provided that the Secretary of State may at any time after the date of issue (i) revoke this Licence or vary the terms, provisions or limitations thereof by a notice in writing served on the Licensee, or by a general notice published in the London, Edinburgh and Belfast Gazettes, or in a newspaper published in London, a newspaper published in Edinburgh and a newspaper published in Belfast addressed to all holders of Amateur Licences A, (ii) revoke this Licence by a general notice published by being broadcast by the British Broadcasting Corporation addressed to all holders of Amateur Licences A. Any notice given under this clause may take effect either forthwith or on such subsequent date as may be specified in the notice.

13. This Licence is not transferable.

14. Return of Licence. This Licence shall be returned to the Secretary of State when it has expired or been revoked.

15. Previous Licences Revoked. Any licence, however described, which the Secretary of State has previously granted to the Licensee in respect of the Station is hereby revoked.

16. Interpretation.

(1) In this Licence:-

(a) The expressions –

(i) "the Secretary of State" shall mean the Secretary of State for the Home Department;

(ii) "messages" and "signals" shall include visual images sent by television and facsmile transmission;

(iii) "remarks about matters of a personal nature" shall not include messages about business affairs;

(iv) "Standard Frequency Service" shall have the same meaning as in the Radio Regulations and Additional Radio Regulations in force under the International Telecommunication Convention signed at Malaga–Torremolinos on the 25th day of October 1973, where it is defined as "A radio-communication service for scientific, technical and other purposes, providing the transmission of specific frequencies of stated high precision, intended for general reception".

(v) "the Telecommunication Convention" shall mean the International Telecommunication Convention signed at Malaga–Torremolinos on the 25th day of October 1973, and the Radio Regulations and Additional Radio Regulations in force thereunder and includes any Convention and Regulations which may from time to time be in force in substitution for or in amendment of the said Convention or the said Regulations;

(vi) "the United Kingdom" shall mean the United Kingdom of Great Britain and Northern Ireland, the Isle of Man and the Channel Islands.

(b) References to the operation of the Station shall include references to the speaking into the microphone comprised in the Station;

(c) References to a certificate issued or granted by the Secretary of State shall include references to a certificate issued or granted by the Postmaster General or Minister of Posts and Telecommunications.

(d) Except where the context otherwise requires other words and expressions shall have the same meaning as they have in the Wireless Telegraphy Act 1949 or in the Regulations made under Part 1 thereof.

(2) Section 19(5) of the Wireless Telegraphy Act 1949, shall apply for the purposes of this Licence as it applies for the purpose of the Act.

(3) Nothing in this Licence shall be deemed to authorise the use of the Station for business, advertisement or propaganda purposes or (except as provided by clause 1(1)(c) hereof) for the sending or receiving of news or messages of or on behalf of, or for the benefit or information of any social, political, religious or commercial organisation, or anyone other than the Licensee or the person with whom he is in communication.

for the SECRETARY OF STATE FOR THE HOME DEPARTMENT

THE SCHEDULE

FOOTNOTE NO.	FREQUENCY BANDS (in MHz) (See A overleaf)	CLASSES OF EMISSION (See B overleaf)	POWER: MAXIMUM DC INPUT POWER (See C and D overleaf)	POWER: RADIO FREQUENCY OUTPUT PEAK ENVELOPE POWER FOR A3A and A3J EMISSIONS ONLY (See D overleaf)
1 and 5	1.8 – 2	A1, A2, A3, A3A, A3H, A3J, F1, F2 and F3	10 watts	$26^2/_3$ watts
2	3.5 – 3.8		150 watts	400 watts
10 and 12	7 – 7.10 14 – 14.35 21 – 21.45 28 – 29.7			
1 and 3	70.025 – 70.7		50 watts	$133^1/_3$ watts
4, 10 and 12	144 – 145		150 watts	400 watts
10 and 12	145 – 146			
1, 7 & 8	430 – 432	A1, A2, A3, F1, F2 and F3	–	–
1 and 11	432 – 440	A1, A2, A3, A3A, A3H, A3J, F1, F2 and F3	150 watts	400 watts
1	1,215 – 1,225			
1 and 11	1,225 – 1,290			
1	1,290 – 1,325			
1 and 11	2,300 – 2,450			
1	3,400 – 3,475			
1 and 11	5,650 – 5,850			
1 and 11	10,000 – 10,500			
9 and 11	24,000 – 24,050			
1, 9 and 11	24,050 – 24,250			
1 and 6 1 and 6 1 and 6	2,350 – 2,400 5,700 – 5,800 10,050 – 10,450	P1D, P2D, P2E, P3D and P3E	25 watts mean power and 2.5 kilowatts peak power	–

FOOTNOTES:-

1. This band is allocated to stations in the amateur service on a secondary basis on condition that they shall not cause interference to other services.
2. This band is shared with other services.
3. This band is available to amateurs *until further notice* provided that use by the Licensee of *any* frequency in the band shall cease immediately on the demand of a Government official.
4. The following spot aeronautical frequencies must be avoided *whenever* this band is used:- 144.0, 144.54. MHz.
5. The type of transmission known as Radio Teleprinter (RTTY) may not be used in this band.
6. Use by the Licensee of *any* frequency in this band shall be only with the prior written consent of the Secretary of State.
7. This band is not available for use within the area bounded by 53°N 02E, 55°N 02E, 55°N 03W and 53°N 03W.
8. In this band the power must not exceed 10 watts erp (effective radiated power).
9. Use by the licensee of *any* frequency in this band shall only be with prior written consent of the Secretary of State and such consent shall indicate the power which may be used, taking into consideration the characteristics of the licensee's station.
10. Slow Scan Television may be used in this band.
11. High Definition Television (A5, F5) may be used in this band.
12. Facsimile transmission (A4, F4) may be used in this band.
13. Data transmission may be used within the frequency bands 144–145 MHz and above provided (a) the Station callsign is announced in morse or telephony at least once every 15 minutes and (b) emission is contained within the bandwidth normally used for telephony.

A. Artificial satellites may not be used by stations in the amateur service except in the bands 7-7.10 MHz, 14-14.25 MHz, 21-21.45 MHz, 28-29.7 MHz, 144-146 MHz, 435-438 MHz, 24,000-24,050 MHz.

B. The symbols used to designate the classes of emission have the meanings assigned to them in the Telecommunication Convention. They are:-

Amplitude Modulation

A1 Telegraphy by on-off keying without the use of a modulating audio frequency.

A2 Telegraphy by on-off keying of an amplitude-modulating audio frequency or frequencies, or by on-off keying of the modulated emission.

A3 Telephony, double sideband.

A3A Telephony, single sideband, reduced carrier.

A3H Telephony, single sideband, full carrier.

A3J Telephony, single sideband, suppressed carrier.

Frequency (or phase) Modulation

F1 Telegraphy by frequency shift keying without the use of modulating audio frequency, one of the two frequencies being emitted at any instant.

F2 Telegraphy by on-off keying of a frequency modulating audio frequency or on-off keying of a frequency modulated emission.

F3 Telephony.

Pulse Modulation

P1D Telephony by on-off keying of a pulsed carrier without the use of a modulating audio frequency.

P2D Telegraphy by on-off keying of a modulating audio frequency or frequencies or by on-off keying of a modulated pulsed carrier – the audio frequency or frequencies modulating the amplitude of the pulses.

P2E Telegraphy by on-off keying of a modulating audio frequency or frequencies or by on-off keying of a modulated pulsed carrier – the audio frequency or frequencies modulating the width (or duration) of the pulses.

P3D Telephony, amplitude modulated pulses.

P3E Telephony, width (or duration) modulated pulses.

C. DC input power is the total direct current power input to (i) the anode circuit of the valve(s) or (ii) any other device energising the aerial.

D. As an alternative, for A3A and A3J single sideband types of emission, the power shall be determined by the peak envelope power (P.E.P.) under linear operation. The radio frequency output peak envelope power under linear operation shall be limited to 2.667 times the DC input power appropriate to the frequency band concerned. This column gives the maximum power determined by this method which may be used.

E. Double Sideband Suppressed Carrier emissions are permitted within the terms of this licence.

NOTES

(a) The Secretary of State should be notified promptly of any change in the correspondence address of the Licensee. Except as provided in (b) below, correspondence should be sent to the Home Office, Radio Regulatory Department, Radio Regulatory Division, Waterloo Bridge House, Waterloo Road, LONDON, SE1 8UA.

(b) Remittances and correspondence about payments to the Secretary of State required under this Licence should be sent to The Cashier, Accounts Branch, Tolworth Tower, Ewell Road, Surbiton, Surrey KT6 7DS. It is unnecessary to send the Licence when making remittances.

(c) Clause 4(1) of the Licence requires that the apparatus comprised in the Station shall be so designed, constructed, maintained and used that the use of the Station does not cause any undue interference with any wireless telegraphy. In order to prevent interference due to close coupling of aerials, the aerial to be used for the Station should be sited as far as possible from any existing television or other receiving aerials in the vicinity. This is particularly important if it is proposed to instal an indoor transmitting aerial, eg in the loft, where interference may be conducted through the electricity supply wiring. In some circumstances it might not be possible to use an indoor aerial.

(d) If the Station is situated within half a mile of the boundary of any aerodrome, the height of the aerial or any mast supporting it must not exceed 50 feet above the ground level. An aerial which crosses above or is liable to fall or to be blown on to any overhead power wire (including electric lighting and tramway wires) or power apparatus must be guarded to the reasonable satisfaction of the owner of the power wire or power apparatus concerned.

(e) Demands for closing down (see clause 11) can be expected to be received in connection with national emergencies or when interference is being caused to a Government wireless station or other important services. An oral demand by a person acting under the authority of the Secretary of State to close down the Station will be confirmed in writing.

(f) Under Section 1 of the Wireless Telegraphy Act, 1949, it is an offence to use any station or apparatus for wireless telegraphy except under and in accordance with a licence granted by the Secretary of State. Breach of this provision may result in this Licence being revoked and the offender being prosecuted.

(g) If any message, the receipt of which is not authorised by this Licence, is received by means of the Station, neither the Licensee nor any person operating the Station should make known the contents of any such message, its origin or destination, its existence or the fact of its receipt to any person except a duly authorised officer of Her Majesty's Government, a person acting under the authority of the Secretary of State, or a competent legal tribunal, and should not retain any copy or make any use of any such message, or allow it to be reproduced in writing, copied or made use of. It is an offence under section 5 of the Wireless Telegraphy Act, 1949, deliberately to receive messages the receipt of which is unauthorised or (except in the special circumstances mentioned in that section of the Act) to disclose any information as to the contents, sender or addressee of any such message.

(h) It is an offence under Section 5 of the Wireless Telegraphy Act, 1949, to send by wireless telegraphy certain misleading messages.

(i) This Licence does not authorise the Licensee to do any act which is an infringement of any copyright which may exist in the matter sent or received.

(j) This Licence does not absolve the Licensee from obtaining any necessary consent before entering on private or public property with any apparatus.

(k) The Secretary of State regards himself as free to publish the Licensee's name and address at his discretion unless within one month of the date of issue of this Licence the Licensee specifically asks that this should not be done.

(l) The expression "wireless telegraphy" used in this Licence has the meaning assigned to it in the Wireless Telegraphy Act, 1949, and includes radiotelephony.

(m) With reference to clause 9(3) of this Licence it is recommended that for uniformity the phonetic alphabet contained in Appendix 16 of the Radio Regulations, Geneva, 1976, reproduced below should be used when the letters of the call sign are transmitted phonetically.

A.	Alfa	J.	Juliett	S.	Sierra
B.	Bravo	K.	Kilo	T.	Tango
C.	Charlie	L.	Lima	U.	Uniform
D.	Delta	M.	Mike	V.	Victor
E.	Echo	N.	November	W.	Whiskey
F.	Foxtrot	O.	Oscar	X.	X-Ray
G.	Golf	P.	Papa	Y.	Yankee
H.	Hotel	Q.	Quebec	Z.	Zulu
I.	India	R.	Romeo		

FREQUENCY–CHECKING EQUIPMENT IN AMATEUR STATIONS

The Home Office receives many enquiries seeking advice on suitable apparatus for frequency measurement for use in amateur stations. Particular makes and types of equipment cannot be endorsed or recommended, but the following notes should act as a guide to Home Office requirements.

1. A licensee must:-

(a) be able to verify that his transmissions are within the authorized frequency band, (i.e. that no appreciable energy is radiated outside the band).

(b) use a satisfactory method of frequency control.

(c) ensure that his transmissions do not contain unwanted frequencies (i.e. harmonics and spurious frequencies).

2. When his station is inspected by officers authorised by the Secretary of State, the licensee will be expected to demonstrate that he can conform with the requirements (a) to (c) above.

3. As a general rule, a station requires a crystal reference source to comply with 1(a) and (b) above so that:-

(a) with a crystal-controlled transmitter an absorption device of suitable frequency range and accuracy is necessary to check that the desired harmonic of the crystal frequency is selected.

(b) with a transmitter that is not crystal-controlled a wavemeter based on a crystal oscillator is necessary.

Within these outline requirements the licensee is free to decide how he will meet the licence regulations.

4. The following comments may provide useful guidance:

(a) **Frequency measuring equipment** should be of sufficient accuracy to verify that emissions are within the authorised frequency bands. For example, operation in the centre of the 21.0 – 21.45 MHz. band would require frequency measurement to an accuracy of ± 1.0% to ensure that emissions were within band, whereas operation within, say, 10 kHz. of band edge would require measurement to an accuracy of ± 0.05%. When determining the proximity of an emission to band-edge, the bandspread due to modulation, on the appropriate side of the carrier, needs to be added to the frequency tolerance of the carrier.

(b) **Heterodyne wavemeters and crystal calibrators.** When used in conjunction with a general coverage receiver, a 100 kHz. crystal is usually adequate for checking frequencies up to 4 MHz. For higher frequencies the spacing between 100 kHz. marker points is too small for accuracy, and a crystal of 500 kHz. or preferably 1 MHz. should be used in addition. If the receiver covers only the Amateur frequency bands the bandspread scale will usually allow a 100 kHz. crystal to be used with sufficient accuracy throughout the the h.f. bands.

(c) **Absorption wavemeters and similar devices.** The scale length and accuracy should be suitable for measurements of the required accuracy to be made, and the frequency coverage must extend up to the second, and preferably the third, harmonic of the radiated frequency so that the presence of unwanted frequencies may be detected. For v.h.f. and u.h.f. transmitters, probably the best technique is to measure the frequency of the fundamental oscillator as accurately as possible and to use an absorption device to confirm that the wanted harmonic has been selected. When a v.h.f. or u.h.f. converter is used in conjunction with an h.f. receiver and the calibration of the main receiver can be checked with sufficient accuracy, this will provide a means of frequency measurement but it is also advisable to use an absorption wavemeter to check the measurement and to confirm that no unwanted radiations are present.

Produced in England by Her Majesty's Stationery Office, Reprographic Centre, Basildon

RLn Ho. 389 9/76 TP

From OB's in Singapore and Studios in Jamaica to Cameras in London

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chapter 6

PICTURE SOURCES

by J. LAWRENCE GW6JGA/T

INTRODUCTION

There are two units which are essential to any television system, the picture source and the monitor or receiver. The monitor or receiver will almost invariably contain a cathode ray tube to display the television picture, but the picture can originate from a number of different types of video source, for example:-

1. Camera
2. Flying spot scanner
3. Monoscope
4. Pattern generator
5. Alpha-numeric generator
6. Video recorder

All the video sources, with the possible exception of No. 6 have a common requirement in that they need synchronising signals from the station Sync Pulse Generator(S.P.G.). This is to ensure that all the picture will be correctly synchronised with the blanking and sync signals when these are added later.

SIMPLE EQUIPMENT

Before examining some of these signal sources in more detail, let us look at the main requirements in Amateur TV equipment for the beginner.

The equipment should be easy and quick to build, operate successfully and should allow for expansion as the need arises.

The most elementary system for producing a TV picture is the Flying spot scanner. This is suitable for generating captions etc. and with suitable optical arrangements can be used to scan 35mm (2x2) slides. The basic arrangement is shown in Fig. 1.

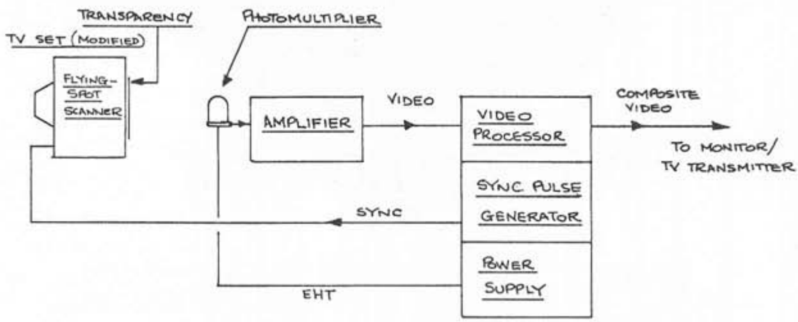


FIG. 1. SIMPLE TV SYSTEM

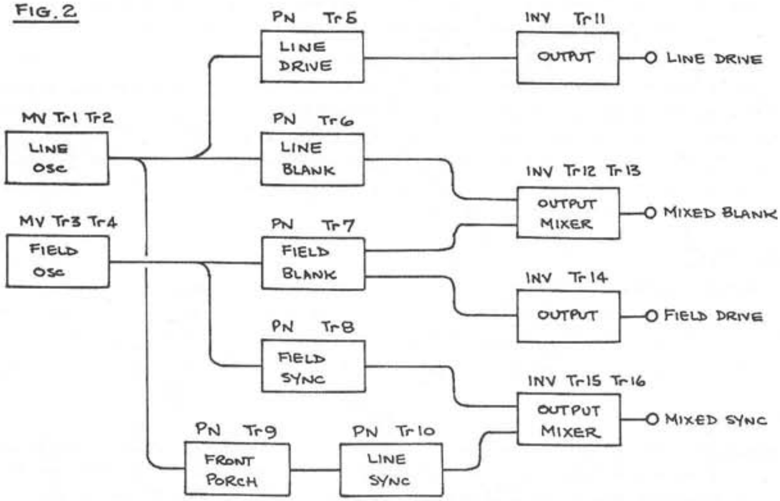
SYNC PULSE GENERATOR

The S.P.G. is the heart of any tv system. This unit provides pulses, to lock the time-bases of the flying spot scanner, or other video source, and mixed blanking and synchronising pulses which are combined with the video signal in the processing unit to provide a composite (video + sync) video signal.

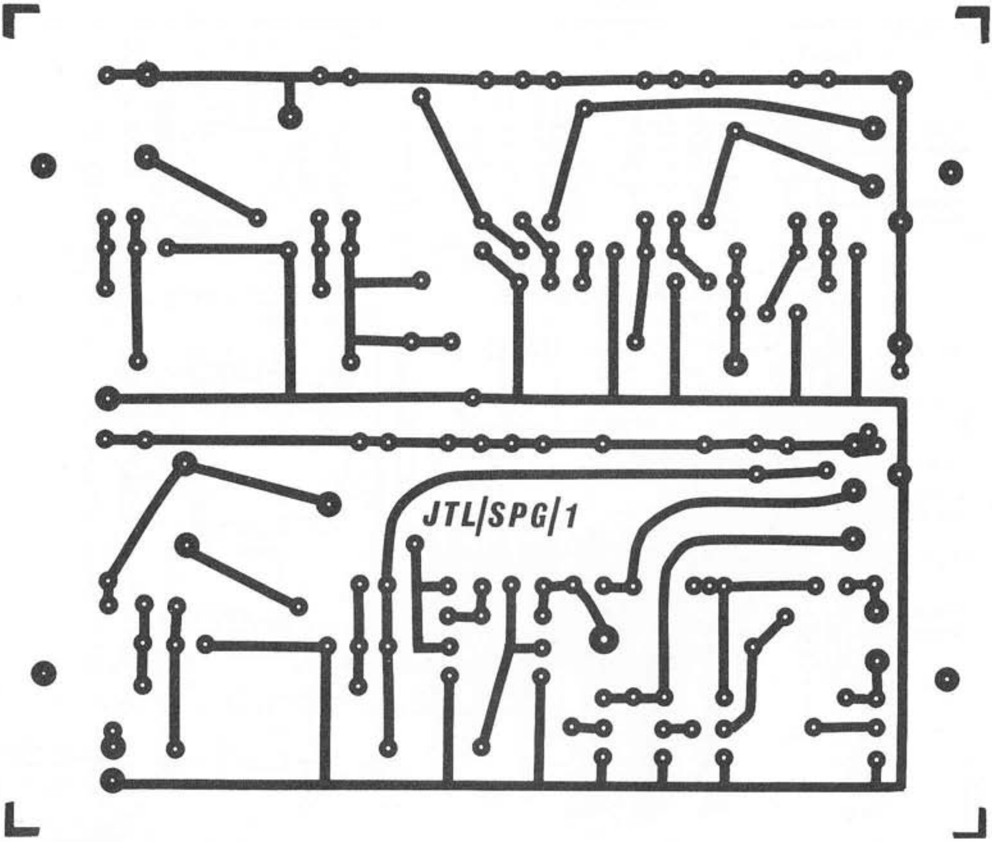
The experimenter who is just starting with amateur tv may feel that a full scale S.P.G.

SIMPLE 405/625 LINE SYNC PULSE GENERATOR GW6JGA/T

FIG. 2



MV - MULTIVIBRATOR. PN - PULSE NARROWER. INV - INVERTOR.



to U.K. standards is rather more than he wants to tackle. This simple S.P.G. whilst not conforming to the full waveform specification, is simple to build and get working, and will provide a satisfactory source of pulses for driving the usual range of amateur tv equipment.

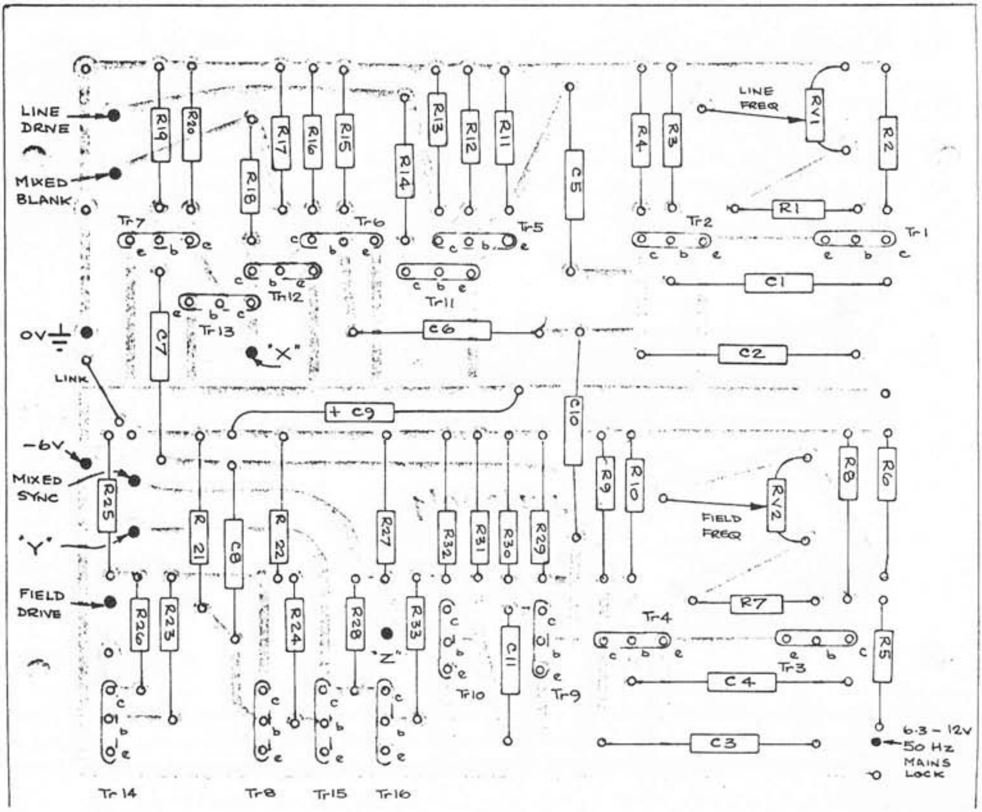
The S.P.G. generates Mixed Syncs, Mixed Blanking, Line Drive and Field Drive, all at 2 volts p-p into 75 ohms. If the line and field drives are not required, these circuits may be omitted. The line frequency, sync, blanking, and drives may be set for 405 or 625 line standards by selecting the appropriate value of capacitors in the timing circuits. The field oscillator may be free running, or if desired, locked to the mains frequency. High level outputs of line sync, mixed blanking and mixed syncs are available for driving a Video Processing Unit, to be sited adjacent to the S.P.G. This unit is described later.

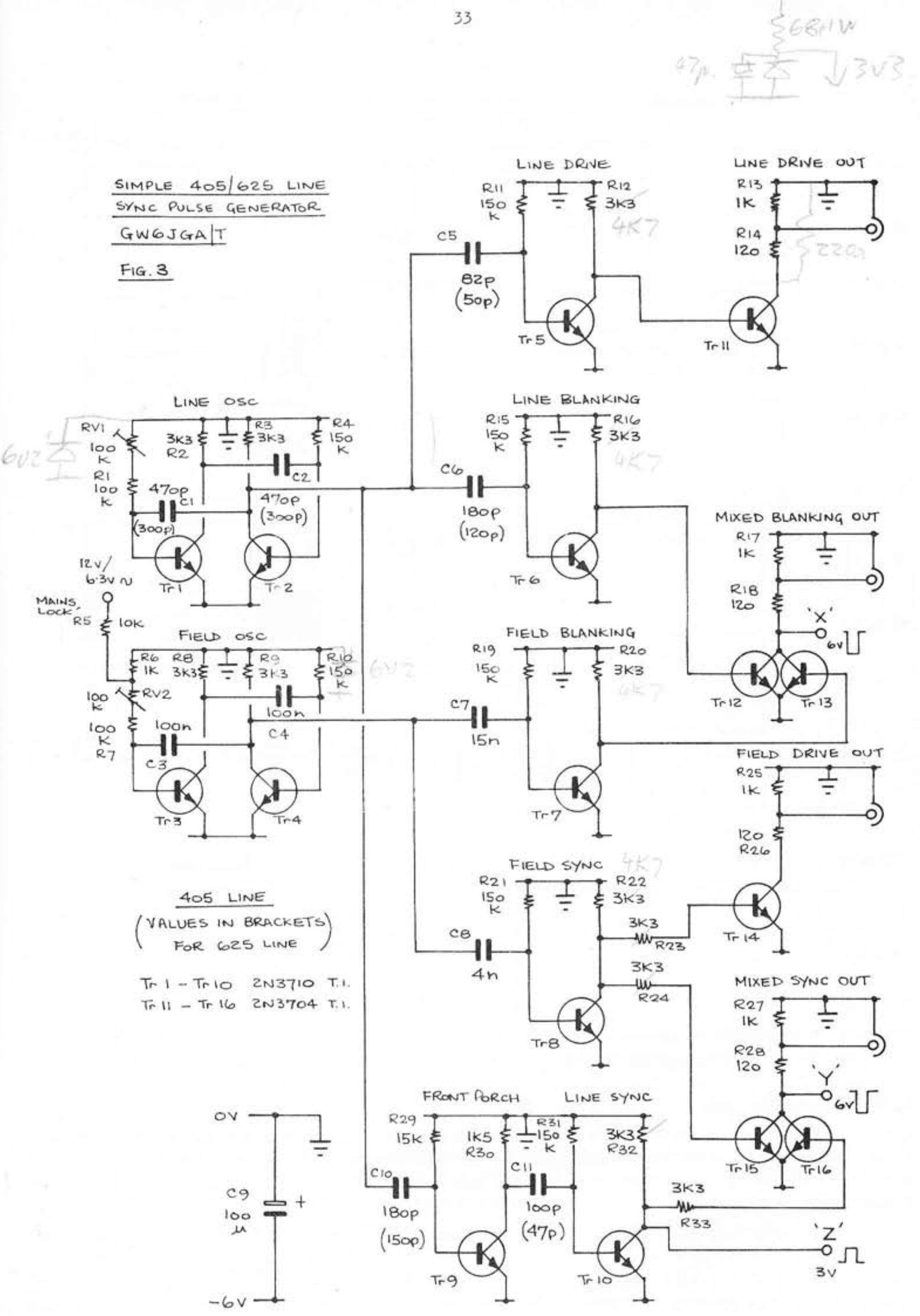
CIRCUIT ARRANGEMENTS

A block diagram of the S.P.G. is shown in Fig. 2. The complete circuit is made up of three basic types of circuit, a multivibrator, a pulse narrower and an invertor output stage. The complete circuit is shown in Fig. 3, and the associated waveforms for all parts of the circuit are shown in Fig. 4.

SETTING UP

Assuming there are no faults, the line and field frequency controls may be set by feeding mixed syncs from the S.P.G. into a video monitor, which has previously been set to operate correctly on a broadcast transmission. The controls, RV1, RV2, should be set so that a locked raster is obtained. The 6.3/12 volt mains-lock supply should be temporarily disconnected whilst this is being done. Any faults may be located using an oscilloscope and comparing the observed waveforms with those in Fig. 4.





SIMPLE 405/625 LINE SYNC PULSE GENERATOR

GW6JGA/T

FIG. 3

405 LINE

(VALUES IN BRACKETS FOR 625 LINE)

Tr 1 – Tr 10 2N3710 T.I.

Tr 11 – Tr 16 2N3704 T.I.

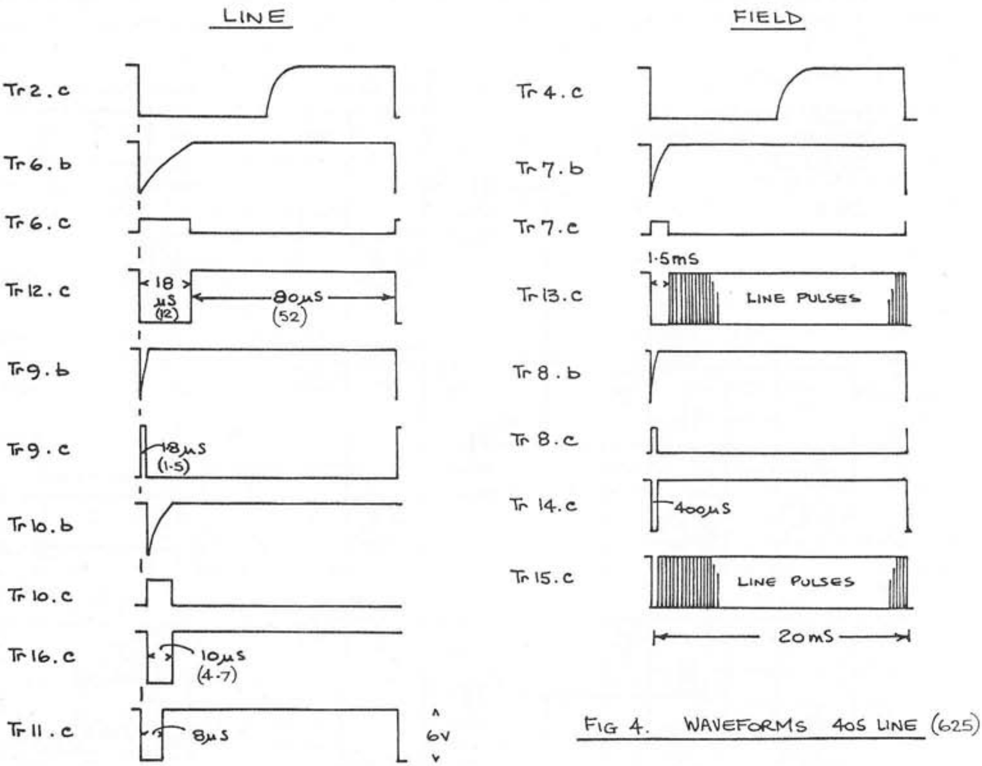


FIG 4. WAVEFORMS 405 LINE (625)

Performance	405 lines	625 lines
Line frequency	10,125 Hz	15,625 Hz
Line blanking	18 uS	12 uS
Front porch	1.8 uS	1.5 uS
Line Sync	10 uS	4.7 uS
Field blanking	1.5 mS	1.5 mS
Field sync	400 uS	400 uS

Accuracy is dependant on component tolerances.
The Video Processing Unit connects to X, Y and Z.

VIDEO PROCESSING UNIT

This video processing unit (V.P.U.) is intended to work with the S.P.G. described above. It is usual for the video signal generated by the video source (Flying spot scanner etc) to consist of a positive-going voltage signal, with suppression of the video during the line and field blanking periods.

To make this signal into a composite video signal, suitable for feeding to a monitor or vision transmitter it is necessary for it to be processed. This entails inserting blanking and sync signals of the correct timing, duration and amplitude relative to the video component. The controls in the processing unit enable the relative amplitudes of the various signals to be adjusted to give the correct proportions to the composite video signal. A block diagram showing the various parts of the circuit is shown in Fig. 5, and the complete circuit is shown in Fig. 6.

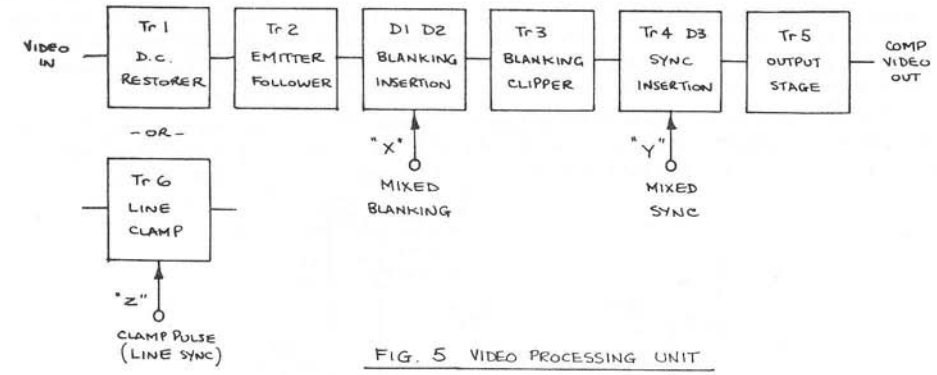


FIG. 5 VIDEO PROCESSING UNIT

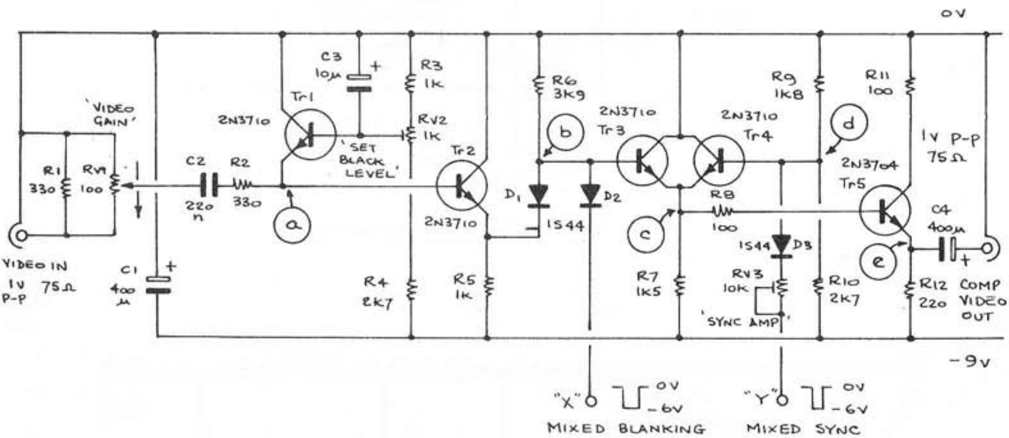


FIG. 6. VIDEO PROCESSING UNIT

CIRCUIT OPERATION

Input video signals across RV1 are a.c. couple via C2 to the emitter of Tr1. Tr1 emitter conducts on the negative-going excursions of the video signal, thus restoring the d.c. component. The d.c. level is set by RV2. The d.c. restored signal is passed to the emitter follower stage, Tr2, which has a high input and a low output impedance. Mixed blanking is inserted by D1 and D2. During the time the mixed blanking input is at 0 volts, D2 is non-conducting and the video signal from the emitter of Tr2 passes through D1 to the base of Tr3. When the mixed blanking input is at -6 volts, (during the blanking period) the current through R6 switches from D1 to D2 and D1 becomes non-conducting, thus blanking off the video signal to Tr3. Leaving Tr3 for a moment, the base of Tr4 is taken to a reference voltage, (nominally - 3.4v) provided by the potentail divider R9,R10.

Negative-going mixed sync is superimposed on this reference voltage and can be adjusted in amplitude by RV3.

Returning to Tr3, the video signal with large blanking pulses is fed to the base, and when this video signal is more positive than the reference voltage, Tr3 conducts and blanked video is present at the emitters of Tr3, Tr4. When the blanking makes the video signal more negative than the reference voltage, Tr3 cuts off and Tr4 turns on, providing mixed sync at the emitters of Tr3, Tr4. This composite video signal is fed to Tr5, the emitter follower output stage which provides a composite video output of 1 volt p-p into 75 ohms.

The d.c. restorer is quite satisfactory for fairly 'clean' input signals, but for input signals containing a large proportion of mains hum or low frequency 'tilt' a line clamp may provide better results. The circuit for a suitable line clamp is shown in Fig. 7.

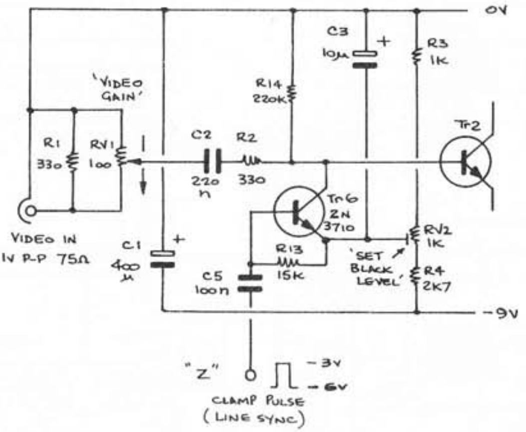
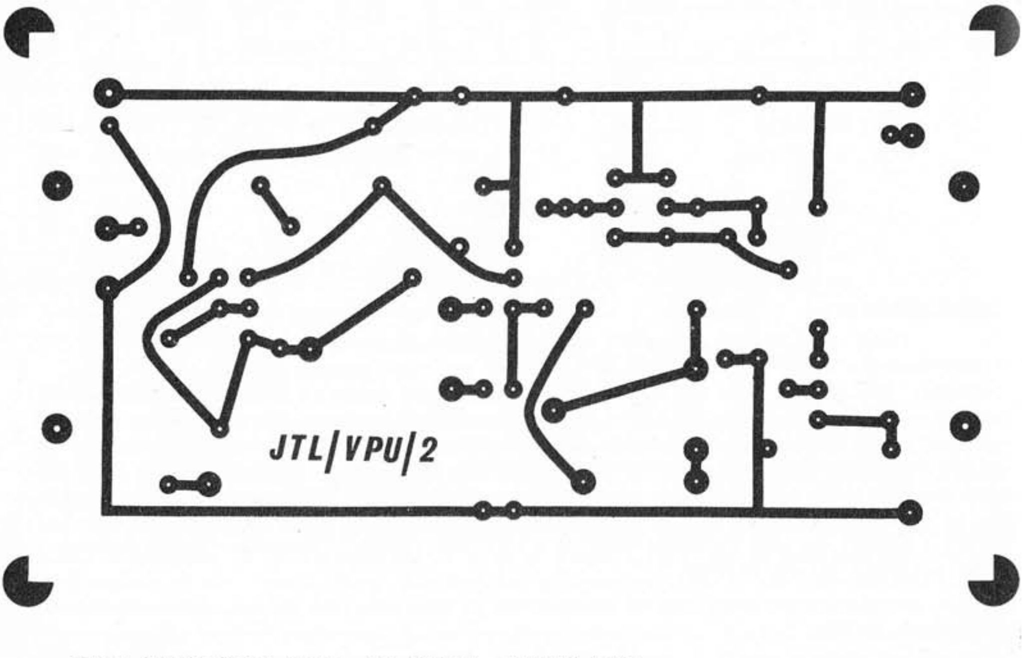


FIG.7 VIDEO PROCESSING UNIT, INPUT LINE CLAMP



VIDEO PROCESSING UNIT P.C. BOARD COPPER SIDE

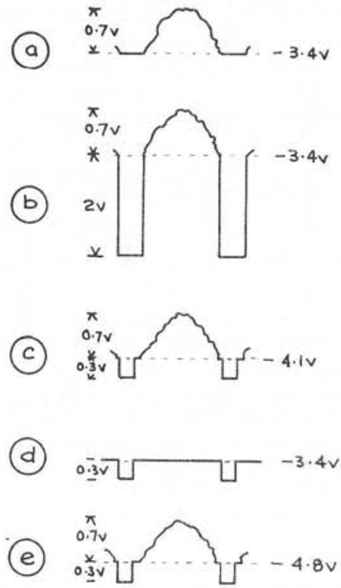
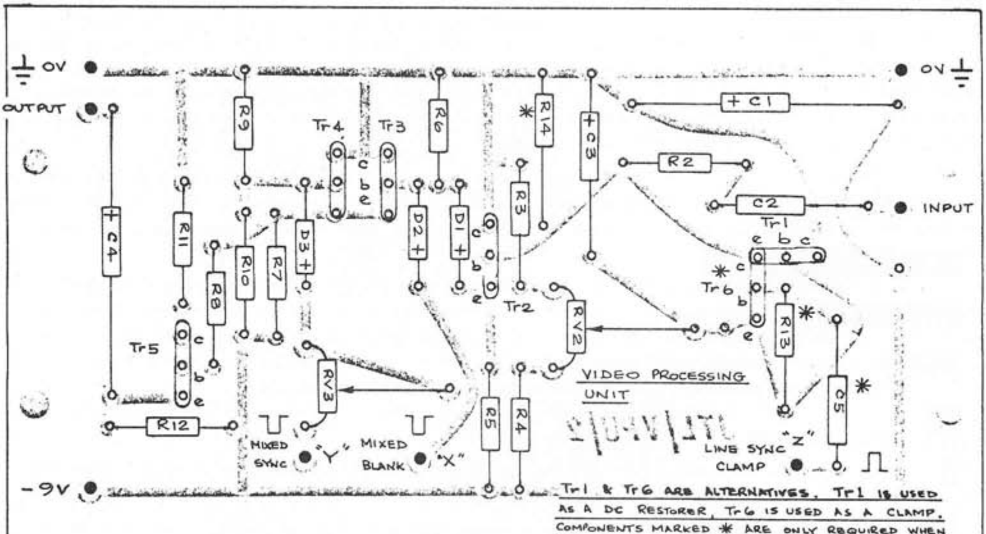


FIG. 8



VIDEO PROCESSING UNIT P.C. BOARD. COMPONENT SIDE

LINE CLAMP OPERATION

Input signals across RV1 are a.c. coupled via C2 to the collector of Tr6 and the base of Tr2. Tr6 is non-conducting during the picture period but is turned hard on for a short time during the blanking period. This effectively clamps the voltage at Tr6 collector and Tr2 base to the potential set by RV2. As this is done at the start of each line, it removes any unwanted low frequency tilt in the video signal. Positive-going pulses, required at the base of Tr6, are a.c. coupled by C5 and provided by the S.P.G. from point 'Z'. The pulses are in fact positive-going line sync pulses of about 3 volts p-p. R14 provides a small current which approximately compensates for the base current of Tr2. The points 'X','Y' and 'Z' should be connected directly to these points on the S.P.G. using short leads. It is essential that the 0 volt line is common to both units.

SETTING UP

Connect a 75 ohm termination to the output socket and connect an oscilloscope across this termination. Set the 'Video Gain' to minimum and the 'Set Black Level' to the negative end of its rotation. Adjust RV3 for a mixed sync pulse amplitude of 0.3 volts p-p. Adjust RV2, the 'Set Black Level' so that the blanking pulse is just visible, giving a 'pedestal' of about 10% of the sync amplitude. Feed in a suitable video signal to the video input, (if a line clamp is in use, the video signal must be blanked at line frequency) and adjust RV1, the 'Video Gain' control, to give a total output signal of 1 volt p-p. Waveforms at various parts of the circuit are shown in Fig. 8.

FLYING SPOT SCANNER

The Flying Spot Scanner (F.S.S.) system consists of a scanning unit containing a cathode ray tube and a photomultiplier tube and amplifier as shown in Fig. 1. A video monitor would make a suitable scanner but a modified TV set can also be used. Here the mains supply to the receiver is taken from an isolation transformer, to allow a direct connection to the chassis, and the sync signals are taken through a suitable coupling capacitor to the base or grid of the video output stage. This enables the time bases to be locked to the sync signals from the S.P.G.

To generate a picture, a caption or picture is drawn on cellophane (similar to that used on an overhead projector) and fixed to the face of the scanner picture tube, and the photomultiplier tube views the raster through the transparency. The varying brightness of the scanning spot, seen by the photomultiplier tube, as it passes behind the caption, produces a varying current which, when amplified, becomes the video signal.

The photomultiplier tube contains a light sensitive photo-cathode and a multi-stage electron multiplier giving a very high overall amplification. This amplification can be readily controlled by varying the applied EHT voltage. A suitable type of tube is the American 931A (Mazda 27M1).

A normal TV picture tube, when used in the scanner, will give acceptable results for Amateur purposes, although special (and usually very expensive) F.S.S. cathode ray tubes are available for professional use. The main problem being the long 'afterglow' from the picture tube phosphors which causes some smearing of the picture. Afterglow correction is normally built into the F.S.S. head amplifier and this is adjusted for optimum results.

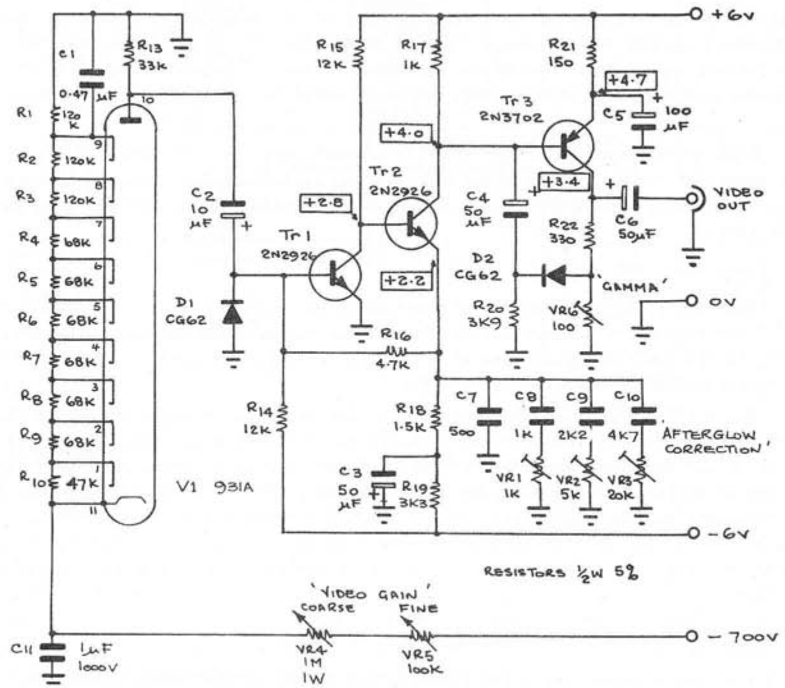
F.S.S. HEAD AMPLIFIER

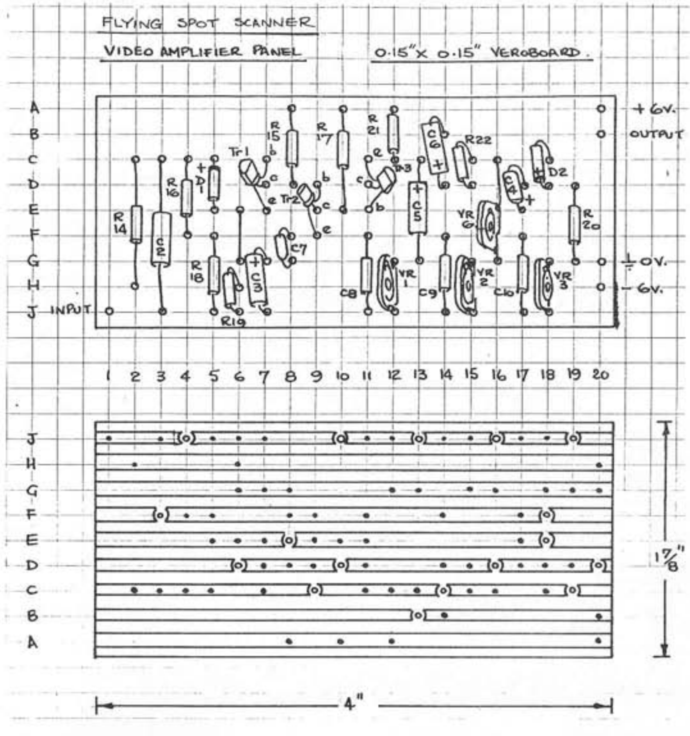
This F.S.S. head amplifier provides afterglow correction and simple gamma correction with the minimum of components. The circuit is shown in Fig. 9.

The photomultiplier tube provides a video signal current of about 100uA p-p. This signal is a.c. coupled to the input of the current amplifier Tr1 and Tr2. The low frequency current gain of Tr1 and Tr2 is about X3. At high frequencies the gain increases due to C7 and the afterglow correction circuits associated with VR1, VR2 and VR3, which shunt the feedback resistor R18. Details of adjustment are given later.

Amplified current signals at the collector of Tr2 are directly coupled to the base of

Fig 9. FLYING SPOT SCANNER VIDEO AMPLIFIER.





Tr3. The normal current gain of this stage depends of the beta of Tr3 (60-300). Negative shunt **current feedback** is fed to the base of Tr3 via D2 and C4. The amount of signal fed back is deter**mined by the setting** of VR6. Due to the curvature of the V/I characteristics of D2, a simple **form of gamma** correction is provided and can be adjusted for best results as seen on the viewing **monitor.**

When operating normally the complete circuit provides 1 voltp-p video into 75 ohms for **an input** signal of 100uA p-p. No video gain control is built into the video head amplifier it**self**, but the overall sensitivity may be adjusted by varying VR4 and VR5 and thus the EHT supply to the PM tube.

SETTING UP

Make a setting up transparency chart as shown in Fi.g 9., the longest black bar being about ¼ of the picture width, and fix to the scanner screen. The overall gain should be set by adjustment of VR4 and VR5, to give about 1 volt p-p output signal with VR1, VR2 and VR3 at maximum resistance and VR6 at minimum resistance.

Allow about 15 minutes for the F.S.S. tube to settle down before commencing other adjustments. When viewing the test chart on the monitor, VR1 should be adjusted for the best definition of the smallest block, VR2 for the best definition of the next higher blocks and VR3 for minimum streaking at the end of the longest blocks. The value of C7 was chosen empirically and its value may be changed between 100pF - 500pF for best detail. When scanning a photograph, VR6 should be adjusted for best grey scale when viewing on the monitor. The 'video gain' VR4, VR5 should be increased as necessary. For all adjustments, the output must be terminated in a 75 ohm resistor.

POWER SUPPLY

A suitable power supply for powering all the units described is shown in Fig. 10. The zener diodes are 2 watt types and other makes of at least 1 watt rating would be suitable. The EHT supply for the photomultiplier tube is lethal and due care should be taken, particularly in ensuring that the earth return for the EHT remains connected at all times.

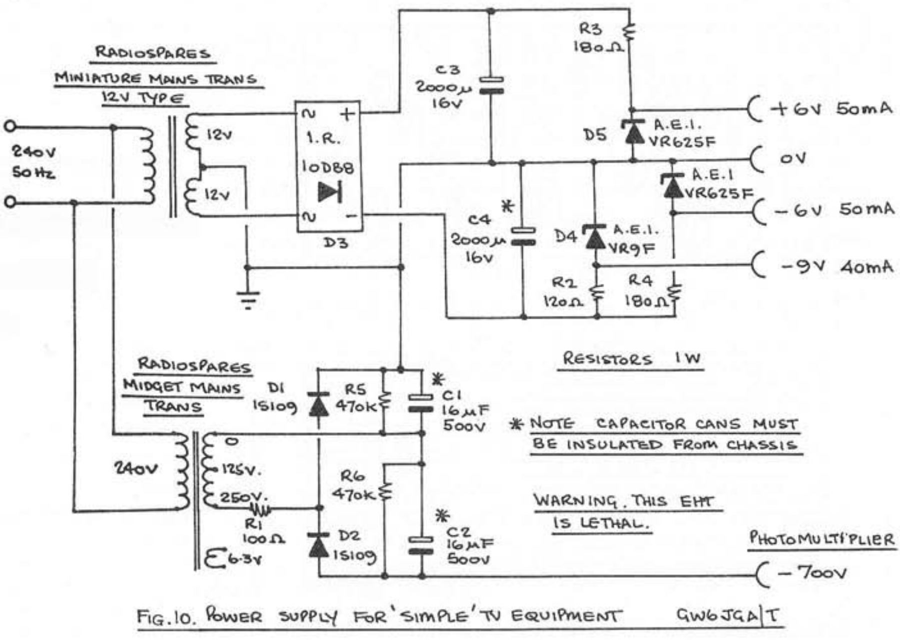


FIG.10. POWER SUPPLY FOR 'SIMPLE' TV EQUIPMENT GW6JGA/T

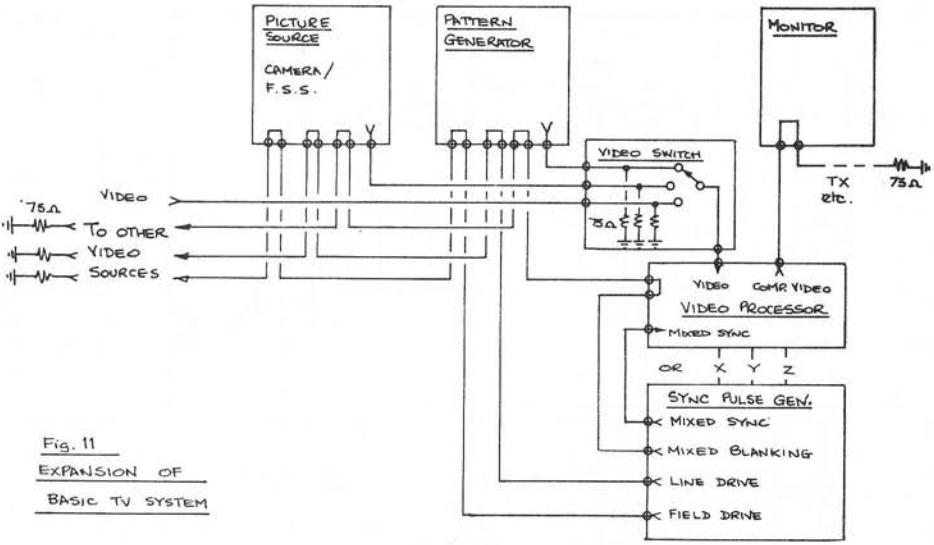


Fig. 11
EXPANSION OF
BASIC TV SYSTEM

ADDITIONAL VIDEO SOURCES

After starting with the basic Amateur TV system, the next move is to add an alternative video source, such as one of those listed previously. The problem of connecting this into the system is solved by 'looping through' as shown in Fig. 11.

All the cables are 75 ohm coaxial and after looping through as many units as required, a 75 ohm terminating resistor is connected to the 1st coax socket to terminate the coaxial cable in its correct impedance. For convenience the terminating resistor may be built into the equipment and is switched in when required. In each unit a buffer amplifier, with high input impedance picks off the signal without mismatching the coaxial line. A simple emitter follower stage is quite adequate for this. The usual pulse signal amplitude is 2 volts p-p when the cable is terminated. Video and composite video signals are usually 1 volt p-p, again with the cable terminated in 75 ohms.

PATTERN GENERATOR

The pattern generator can provide an inexpensive and consistant video source. Different patterns will enable particular tests to be made on the equipment, in addition to providing a standby signal whilst other sources are being adjusted or worked on.

CRUCIFORM GENERATOR

This Cruciform Generator, by T. Brown, G6AGM/T, provides an adjustable 'cross' pattern which is easily identifiable under difficult transmission conditions. It is also very useful for showing up L.F. distortion, 'tilt' etc. The circuit uses TTL 74121 monostables and is shown in Fig. 12.

GREY SCALE STAIRCASE GENERATOR

This Grey Scale Generator provides a staircase waveform at line frequency and is principally used for checking amplitude linearity of, for example, a transmitter vision modulator. The circuit is shown in Fig. 13.

The circuit consists of a gated oscillator using a dual Schmitt-trigger 7413 and a decade counter 7490. The counter is reset to zero on the trailing edge of the line blanking and the gated oscillator runs until a count of 8, when the binary outputs are at logic 1 causing the clock

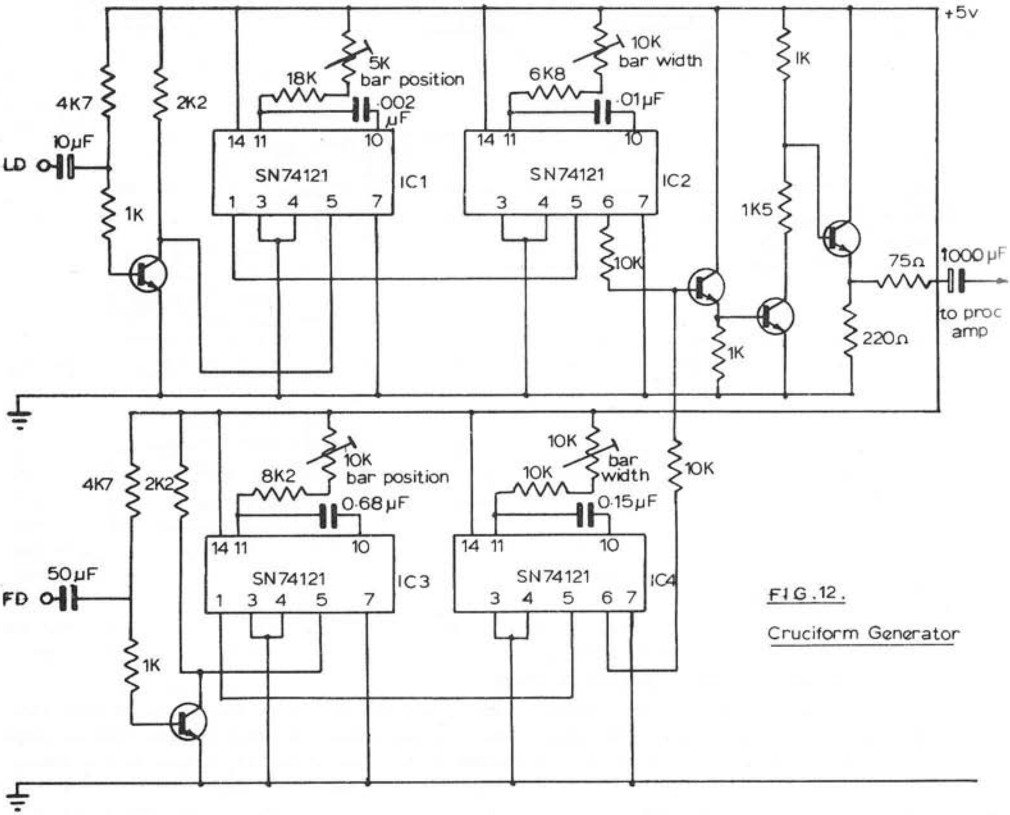


FIG.12.

Cruciform Generator

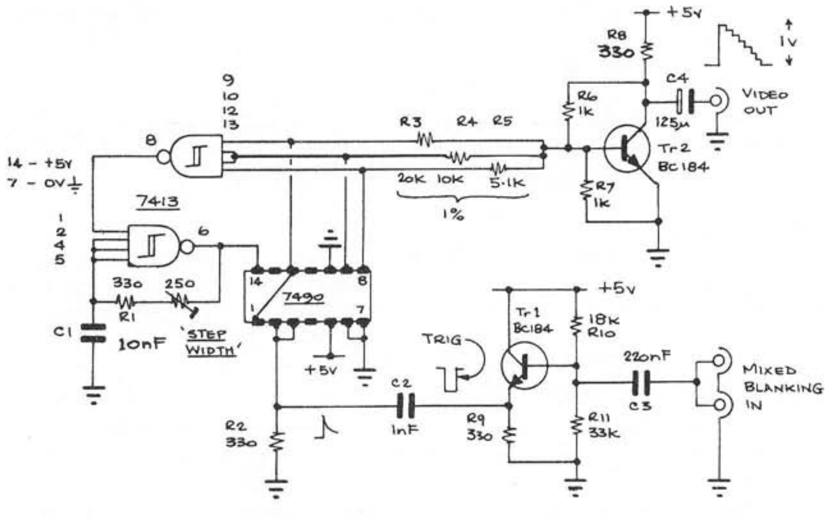


FIG13 VIDEO STAIRCASE GENERATOR

GW6JGA/T

to stop. The binary outputs are weighed by R3, R4 and R5 and summed in Tr2, giving a staircase output at the collector.

TELEVISION CAMERA

The Television Camera is by far the most useful video source as it can provide live pictures around the Station, including close-ups, and can be used with various Test Cards for qualitative tests and station identification. There are a number of TV cameras in Amateur use employing an Image Orthicon camera tube, but by far the most popular is the type which uses a 1 inch Vidicon tube. This type of tube is capable of producing very acceptable pictures.

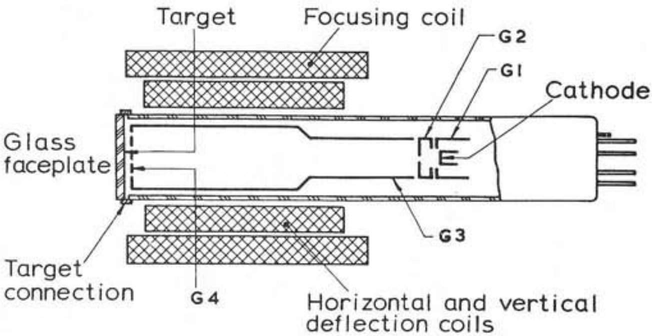
A number of commercially made Vidicon cameras are available from time to time on the second-hand market, a popular example being the Pye Lynx.

For the amateur who wishes to build his own, several articles have been published on this subject and printed circuit boards are available for some of these designs. A certain amount of mechanical construction work is required but the usual range of home workshop tools are sufficient to carry out this work successully.

Commercial Vidicon cameras usually have the camera tube in a fixed position relative to the lens and focussing range of about 1 metre to infinity. For Amateur TV purposes it is useful to be able to focus to closer distances and some means of moving the Vidicon relative to the lens is very desirable as this will permit focussing down to a few centimetres. If you decide to build your own camera, the extra effort in building a sliding arrangement for moving the Vidicon and its scan coil assembly, is well worth while.

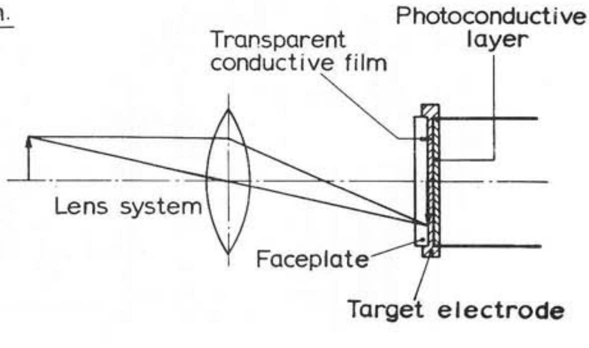
THE VIDICON CAMERA TUBE

The Vidicon Camera Tube has a flat window at one end on which is a transparent conduct-



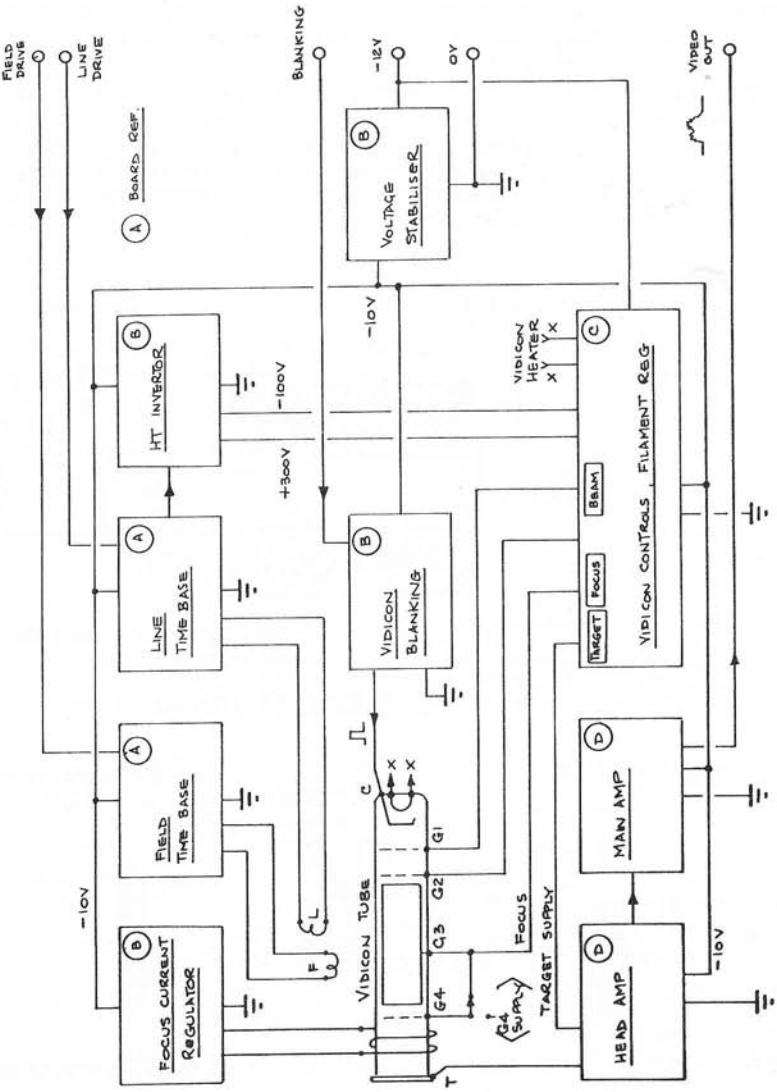
A mounted vidicon

The target section.



ive coating which acts as a signal plate. The target, which consists of a photoconductive layer, deposited on the signal plate, is scanned by a fine beam of electrons generated by a simple electron gun. The modulator, G1, controls the beam current, the limiter, G2, accellerates the electrons and allows a narrow beam to enter the wall anode, G3, which controls the electrical focus in conjunction with the magnetic field provided by the focus coil. A mesh, G4, mounted across the end of the wall anode provides a strong decelerating field in front of the target. The beam of electrons stabilises the surface of the target at cathode potential. Thus by applying a positive potential to the signal plate via a signal resistor, apotential difference is set up across the target. Where light falls on the target a more conductive path is established, a current flows across the target and the potential of the illuminated area rises towards the signal potential. When the beam scans the target surface it restores the elements in turn to cathode potential and produces a varying signal current in the signal resistance which constitutes the video signal.

FIG.15.



VIDICON CAMERA BLOCK DIAGRAM

Magnetic deflection of the beam is provided by sets of coils driven by the scanning circuits.

A diagram of the Vidicon tube is shown in Fig. 14.

VIDICON CAMERA

The Vidicon Camera to be described is one which has been built and operates satisfactorily. The circuits are partly modified commercial designs and partly original and the whole circuit is included as an example of circuitry used in a Vidicon camera for Amateur TV purposes, rather than a fullt detailed constructional article. It is not a 'Close Circuit' type of camera and does not provide composite video or a modulated RF output.

The block diagram of the camera is shown in Fig. 15. The camera requires Line Drive, Field Drive and Mixed Blanking signals and provides non-composite video for feeding to a video processing unit.

The Focus Current Regulator stabilises the current to the focus coil to prevent variations of current due to any change of coil resistance with temperature. Fig. 16.

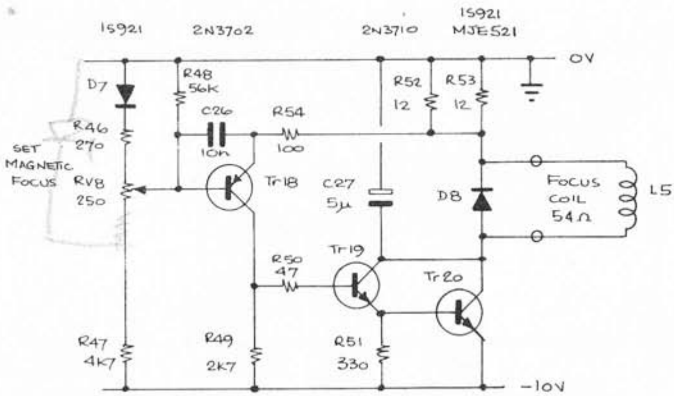


FIG.16. FOCUS CURRENT REGULATOR

The Line and Field Time Bases provide the necessary scanning currents for the deflection coils and are synchronised by the Line Drive and Field Drive signals originating in the Station SPG. Figs. 17 and 18.

Blanking for the Vidicon tube is provided by a blanking amplifier driven by the Mixed Blanking, again from the station SPG. Fig. 19.

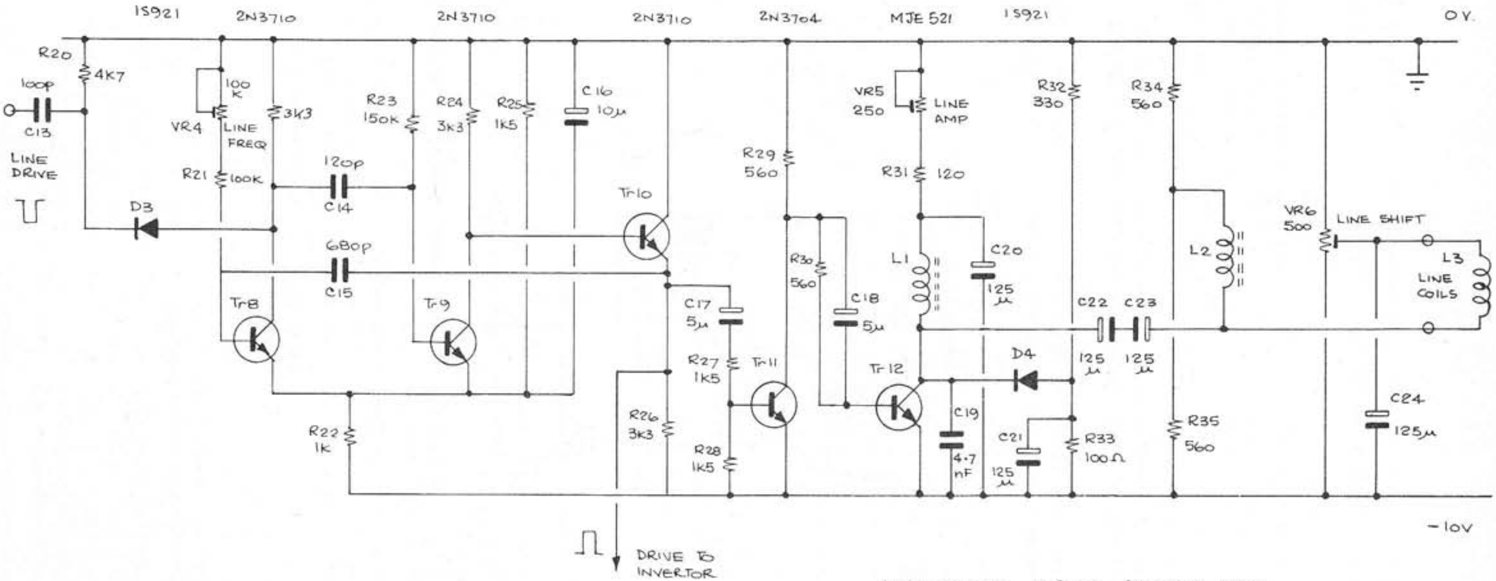
The Head Amplifier and Main Amplifier are combined in one circuit and provide an amplifier having the necessary low noise, high gain and wide bandwidth for amplifying the small video signal currents, from the Vidicon tube up to the nominal 1 volt p-p level. Fig. 20.

The Vidicon Controls consist of appropriate potentiometers and decoupling circuits for setting the operating potentials of the tube. Heater voltage stabilisation is also incorporated. Fig. 21.

The HT Inverter employs a ringing transformer, with voltage rectifying and multiplying circuits which provide a +300 volt and a -100 volt supply for the Vidicon tube. Fig. 22.

The Voltage Stabiliser provides a -10 volt supply for powering all the sections of the camera. Fig. 22. The stabiliser will accept inputs from -10.5 volts to-13.5 volts and will operate satisfactorily from a car battery or a conventional mains transformer, bridge rectifier and capacitor smoothed supply. The transformer used has a secondary of 12.6 volts at 1.8 amp rating, with a 10,000uF capacitor for smoothing.

The Vidicon camera described above is designed to use an Integral Mesh Vidicon tube.



LINE CHOKES L1 & L2 FX2238 ASSY.

FILL FORMER WITH 30 SWG ENAM. CU

FIG. 17. LINE SCAN

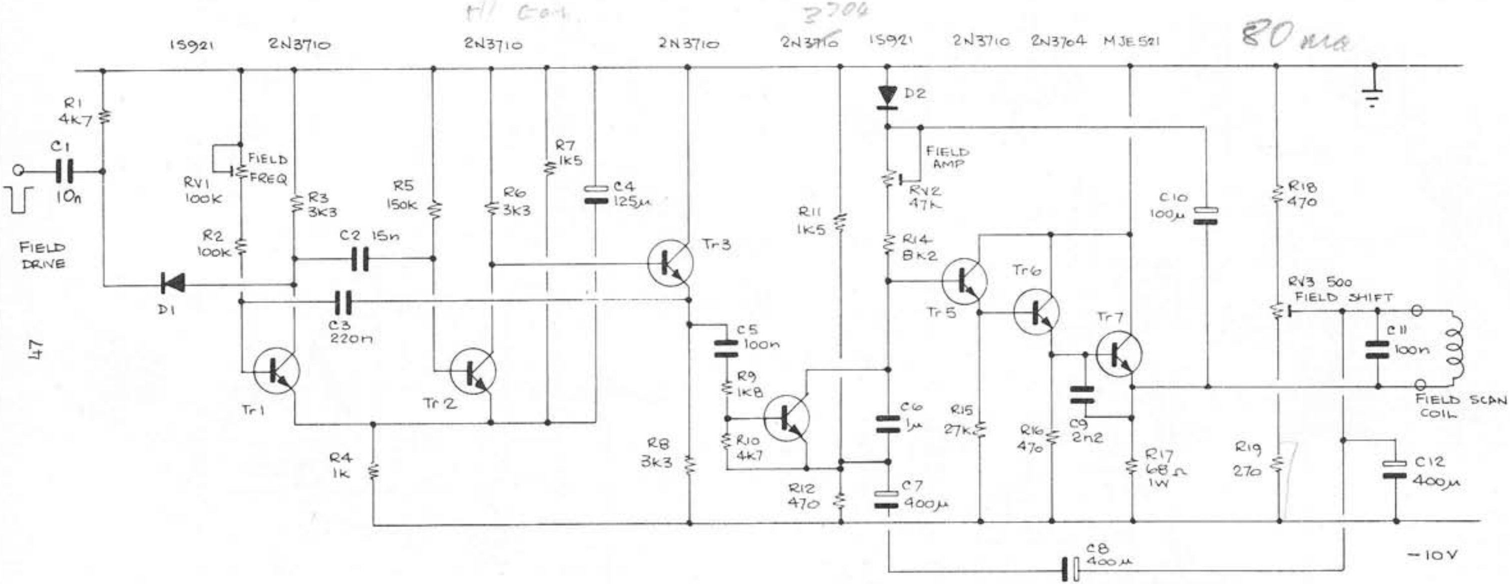


FIG.18. FIELD SCAN

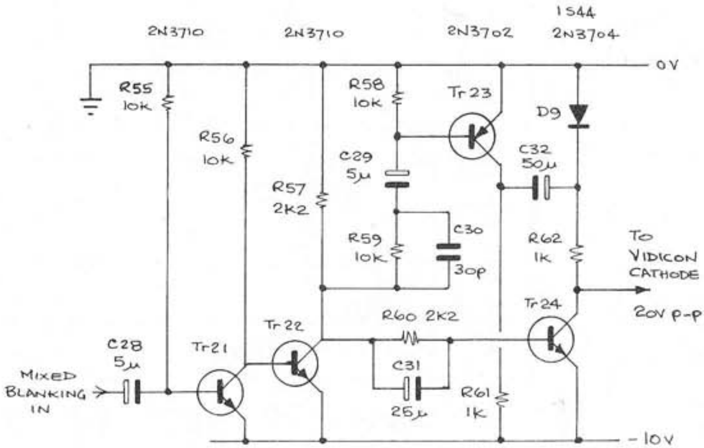


FIG.19. VIDICON BLANKING

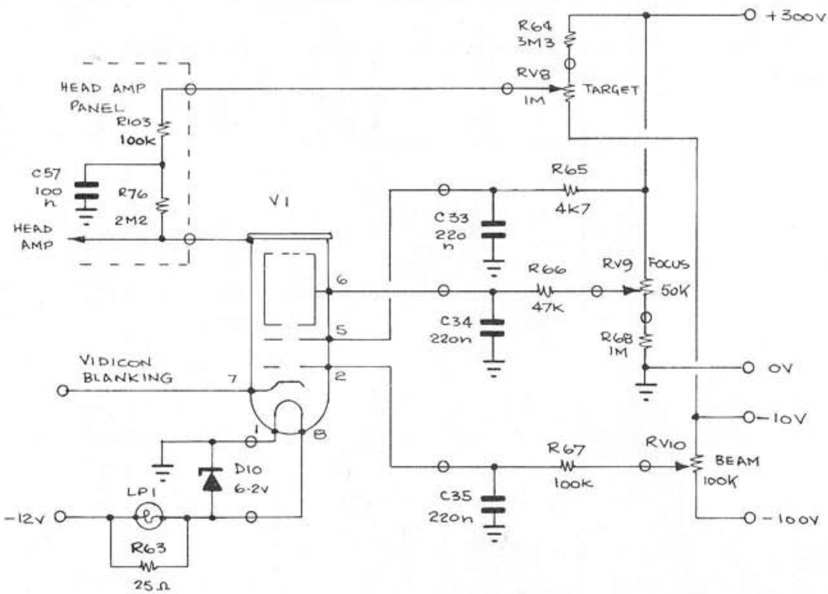


FIG.21. VIDICON SUPPLIES

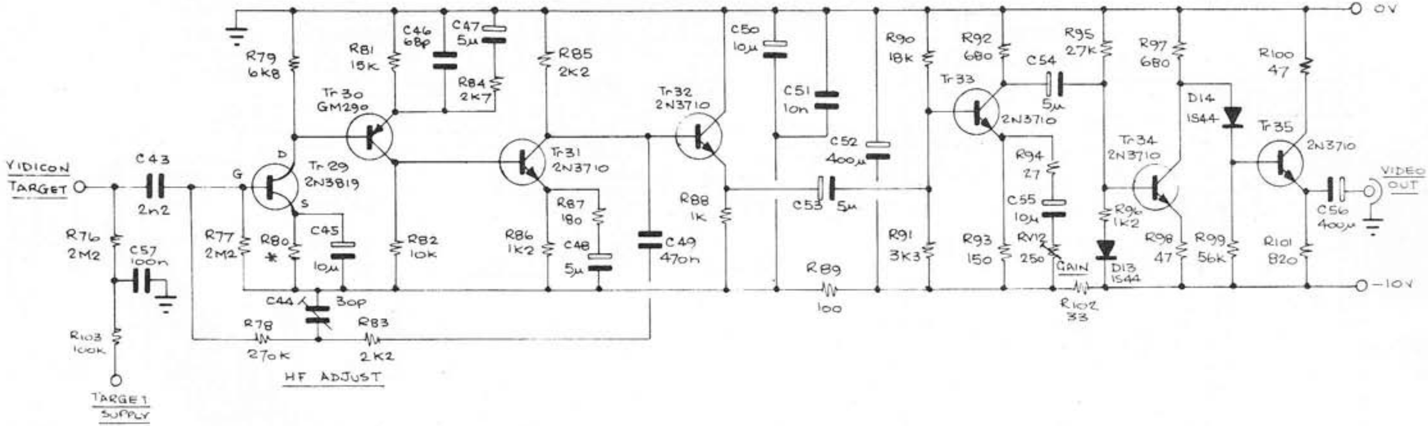
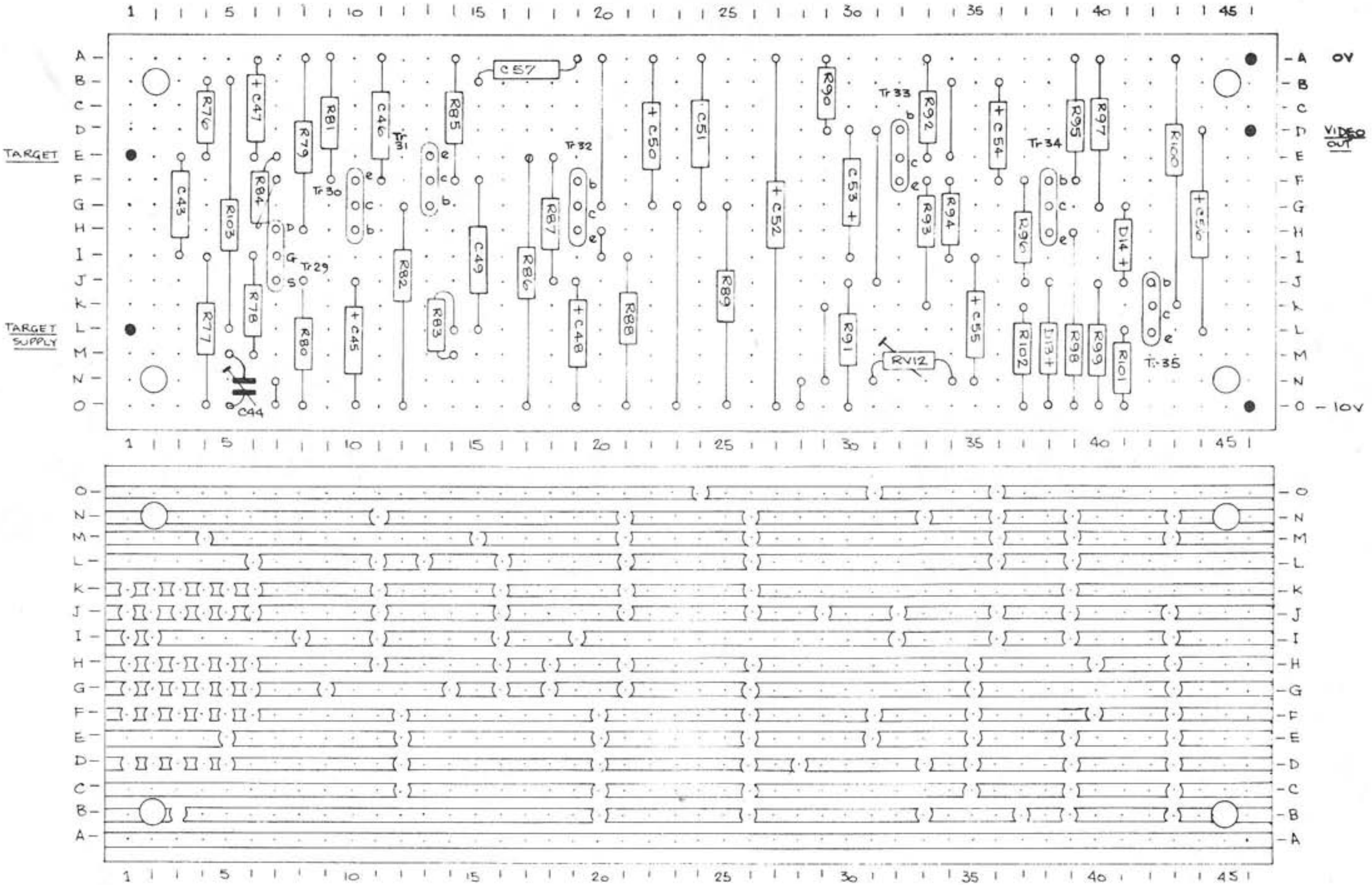


FIG 20. HEAD AMPLIFIER



HEAD AMPLIFIER VEROBOARD LAYOUT 0·15" × 0·15" MATRIX

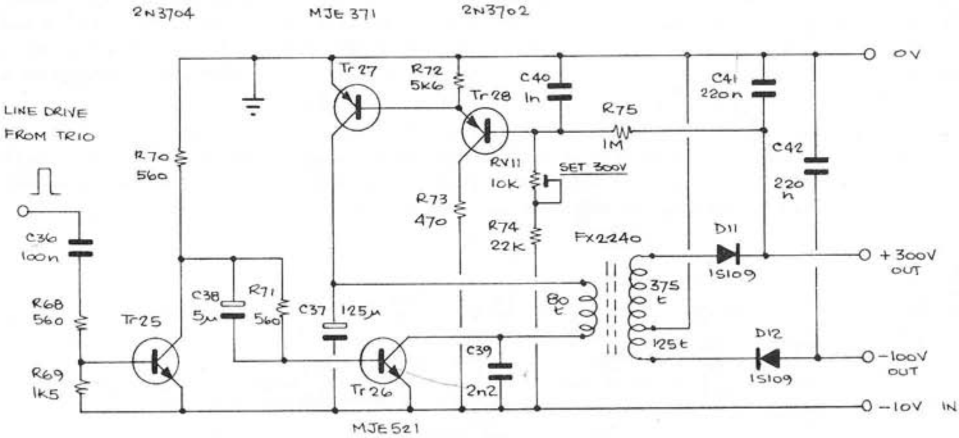


FIG. 22. H.T. INVERTOR

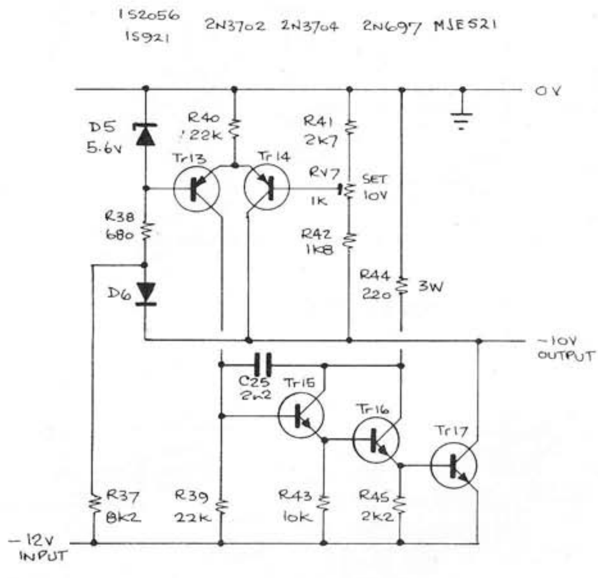


FIG. 23. VOLTAGE STABILISER

If a separate Mesh type of tube is to be used then the Mesh, G4, should be connected to the Wall Anode, G3, and the tube used as though it was an Integral Mesh Type.

VIDEO MIXER AND PROCESSING UNIT

This unit consists of a two input (A-B) mixing unit containing two buffer amplifiers, fader potentiometers and a summing amplifier, followed by a Video Processing Unit. Figs. 24 and 25. The VPU has the same processing circuits as the simple VPU, described previously, but to make this unit conform to standard levels of pulse input signals, extra stages have been added to generate a clamping pulse and to amplify the blanking and sync signals.

Although the two inputs are shown connected to two sets of coax sockets, the mixer would normally be connected to two rows of push-button switches enabling any two of a number of inputs to be selected and mixed. The construction of a suitable 'quadrant' type fader is described in C Q - T V No. 79. A suitable power supply is shown in Fig. 26.

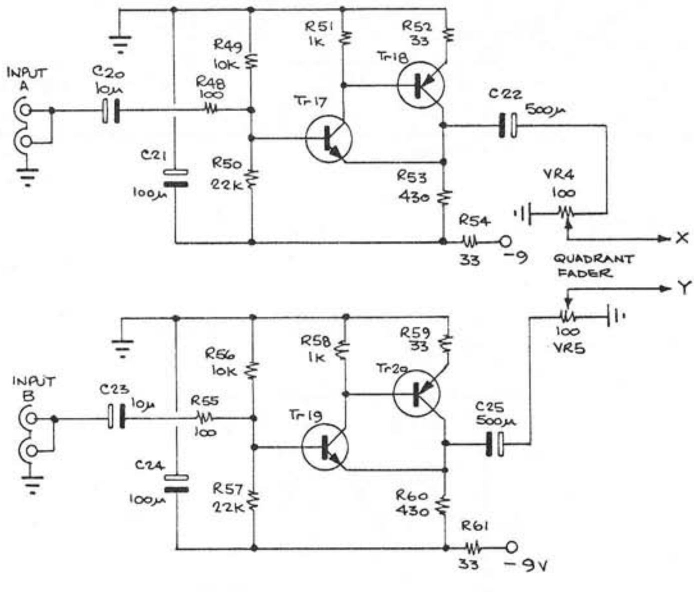


FIG.24. VIDEO MIXER

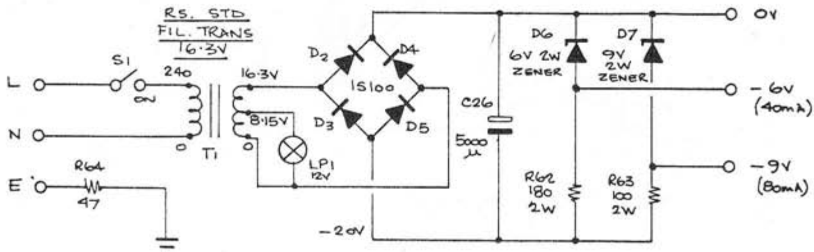


FIG. 26. POWER SUPPLY

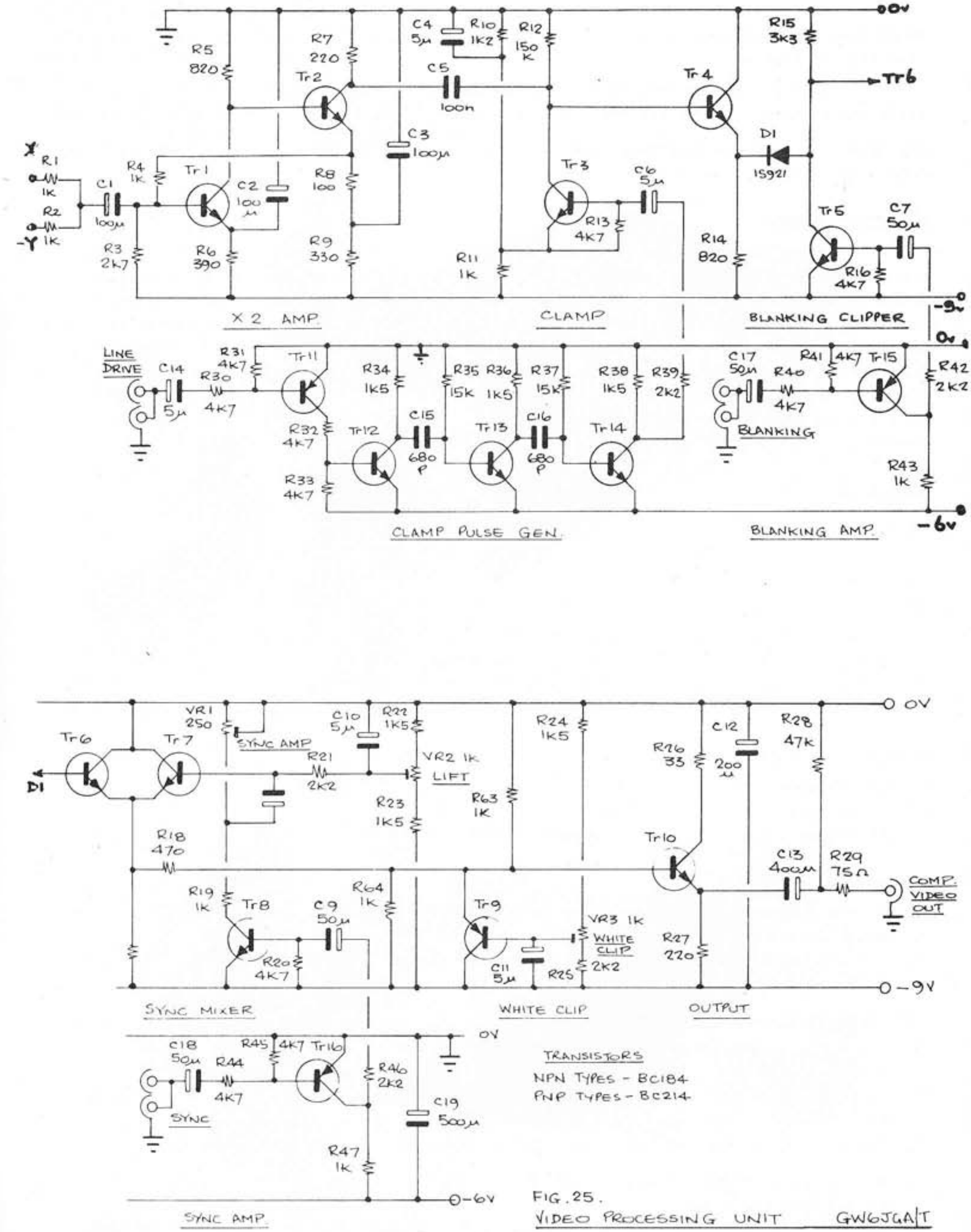


FIG. 25.
VIDEO PROCESSING UNIT GW6JGA/T

ALPHA-NUMERIC CHARACTER GENERATOR

One version of this type of video source uses a number of digital integrated circuits to provide the necessary 'scanning' of a diode matrix which is hard-wired for the particular Call Sign of caption.

In the most sophisticated character generators the information to be displayed is keyed in, using a Teletype keyboard, and stored in a digital memory. This is scanned electronically and in conjunction with a character generator I.C. the information is read out in serial form to produce the video signal.

MONOSCOPE CAMERA

The Monoscope Camera is a device for producing television signal of a test chart. The camera utilises a Monoscope tube which has the required test chart printed on a target in a material of different secondary emission properties, from the target base. When this is scanned by an electron beam a signal is developed due to this difference in secondary emission properties. The Monoscope tube is of conventional cathode ray tube shape and the target is mounted inside the tube in the position of the normal screen. The tube is magnetically scanned and the output signal is amplified to standard video level. The most likely source of supply for a Monoscope tube is from surplus or second-hand equipment and the test chart is likely to have the original owners name in the pattern.

REFERENCES

General

1. I.B.A. Technical Review No. 1 & 2. Independent Broadcasting Authority
2. A Simple Amateur Television Station. I. Waters CAT 70 Booklet B.A.T.C.

Flying Spot Scanners

1. Afterglow Correction Techniques. P. Blakeborough. C Q - T V No. 69
2. A Flying Spot Slide Scanner M.H. Cox C Q - T V No. 50 p.13
3. A F.S.S. Telecine System for 16mm G6RJO/T C Q - T V No. 50 p.19
4. Flying Spot Scanner. Calculatio of Optics, Transparency scanning C Q - T V No. 30 p.5.

Pattern Generators

1. Step Wedge and Grille Generator. J. Lawrence. C Q - T V No. 72 p.11.
2. A Cruciform Generator. T. Brown C Q - T V No. 85 p.15.
3. TV Pattern Generator. K. Wolk. VHF Communications Aug. 73 p.177. Nov. 73 p.250.

Character Generators

1. An I.C. Character Generator. D. Lawton. C Q - T V No. 74 p.3.
2. An I.C. Character Generator. M. Allard. C Q - T V No. 78 p. 16.
3. A Character Generator for ATV. WA4JNA. Specialised Communication Techniques ARRL p. 35.
4. TV Typewriter. Don Lancaster. Radio-Electronics (Gernsback Publications U.S.A.).

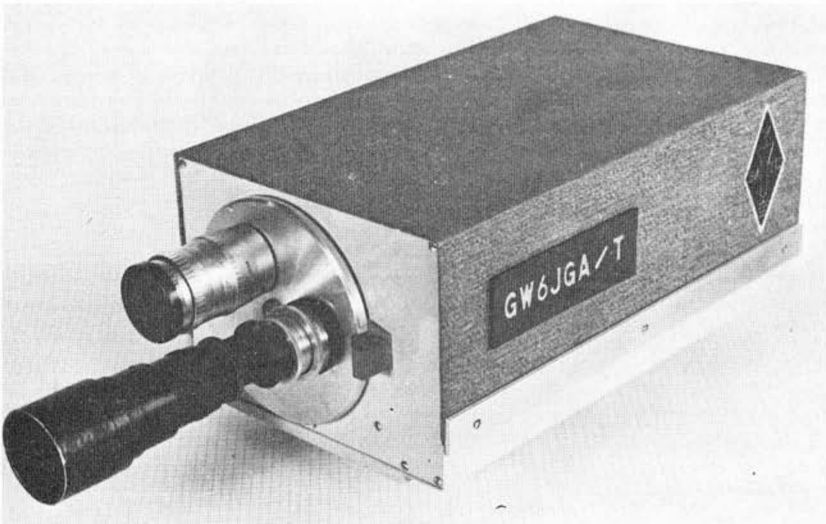
Vidicon Tubes and Cameras

1. Television Camera Tubes with Photoconductive Targets.
   W.P. Longhurst and A.J. Woolgar. English Electric Valve Co.
2. Some Aspects of Vidicon Performance. H.G. Lubszynski, Dr. Ing. S. Taylor & J. Wardley.
   E.M.I. Electronics Ltd.
3. E.M.I. London Symposium 1964, Camera Tubes. A.C. Dawe. E.M.I. Electronics Ltd.
4. FETs as Input Stages for Camera Tube Amplifiers. Mullard Bulletin. Nov.1969.
   & C Q - T V No. 71 p.5.
5. A Camera Tube Head Amplifier. P. Rainger. R.T.S. Journal Vol. 11. No. 10 1967 p. 230.
6. Mullard Closed Circuit TV Camera Kit. Crofton Electronics Ltd.

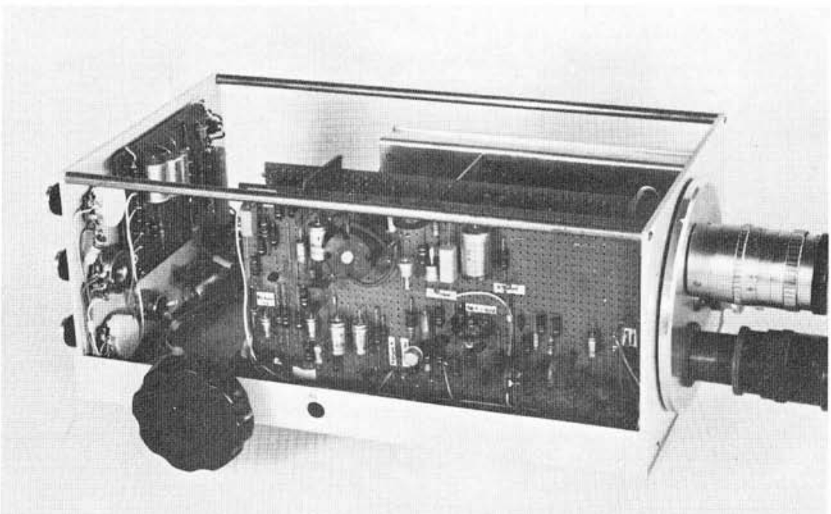
7. Practical Electronics CCTV Camera. A.V. Flatman & G.D. Bishop.
   Practical Electronics Sept. 74 p.766. Oct. 74 p. 879. Nov. 74 p. 986. Dec. 74 p. 1056.

<u>Monoscope Generator</u>

1. A Simple Monoscope Unit. M.H. Cox. C Q - T V No.30 p.4.
2. A Monoscope Camera. Jeremy Royle. C Q - T V No.34 p.6.
3. Graham Hill's Monoscope. C Q - T V No. 44. p.5.



A general view of the Vidicon Camera.



Side view of Vidicon Camera showing regulator and EHT board.

chapter 7
MONITORS

By Brian Summers G6AJU/T

The television camera is only half the story of the C.C.T.V. or Radio Frequency Television link. The other half, and of equal importance, is the picture monitor. Monitors come in all shapes and sizes and two distinct types, i.e. monochrome or colour. All monitors are similar in principle and have a number of common features and components. Referring to Fig. 1 which is a block diagram for a monochrome monitor, the video signal input of standard level (.7v video .3v sync) is connected to SK1 and the 75 ohms termination resistor is switched into circuit by SW1, if the monitor is on the end of the input cable. Alternatively , the video signal may be looped of SK2 and taken to another monitor and subsequent termination. Occasionally the need may arise for the monitor to operate on non-composite video signals (i.e. no sync pulses) in which case SW2 should be set to external sync and synchronising pulses fed to SK3 which may or may not be terminated as required. The block diagram is very similar to an ordinary television set and indeed conversion of one will be described later. Most of the controls are self-explanatory, i.e. line hold height etc. The brightness control should be adjusted to display a dim raster with the contrast set to minimum; then advance the contrast for correct grey scale. Video and sync connectors in older equipment are usually SO239 sockets and BNC in more recent equipment. In home-brew equipment the Club standard recommends Belling Lee TV type sockets.

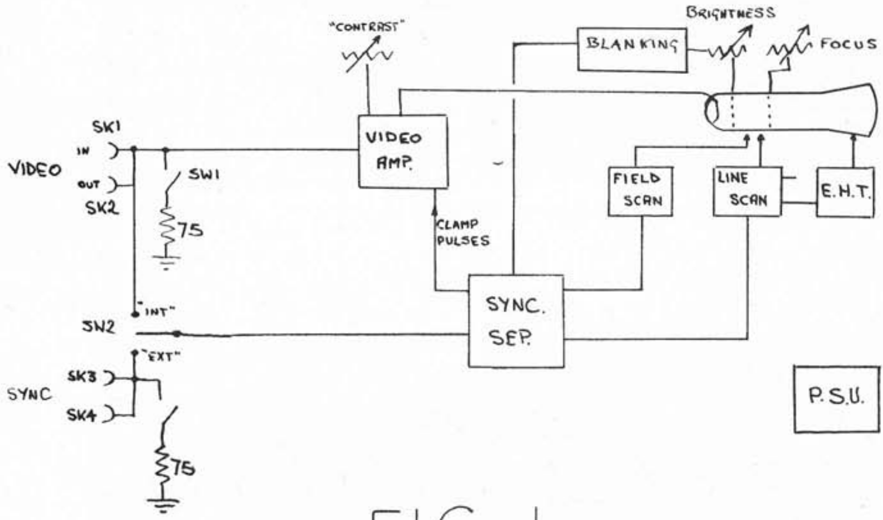


FIG 1

Precision monitors are used for critical examination and produce an excellent picture and often feature all major controls accessible from the front panel. Controls for varying the scan amplitudes are provided to enable the picture edges to be observed. Regulated EHT is applied to the CRT to prevent picture blooming and de-focussing on peak-white. The video amplifier will have a clamp circuit to fix the black level. Industrial monitors are basic in their design and are frequently built to a price! Often being no more than a "monitorised" television set in a metal case. Colour monitors are more complex and expensive than their monochrome brothers, because of the extra video amplifiers, scanning and EHT requirements. The shadowmask tube reigns supreme in colour monitors but is not without competition notably from Sony's Trinitron Tube. Referring to Fig. 2 the reader will see that the block diagram is quite similar to the monochrome one in principle. Description of the method of working of the shadowmask tube can be found elsewhere. The line scan and EHT supply are extra powerful and caution should be employed when working on a colour monitor especially if a shunt EHT regulator valve is used, as these give off lots of nice (?) X-rays. Space is sometimes provided for a plug-in decoder for PAL or NTSC. Input connections are red, green, blue and sync, or if a de-coder is fitted an en-coded signal input socket.

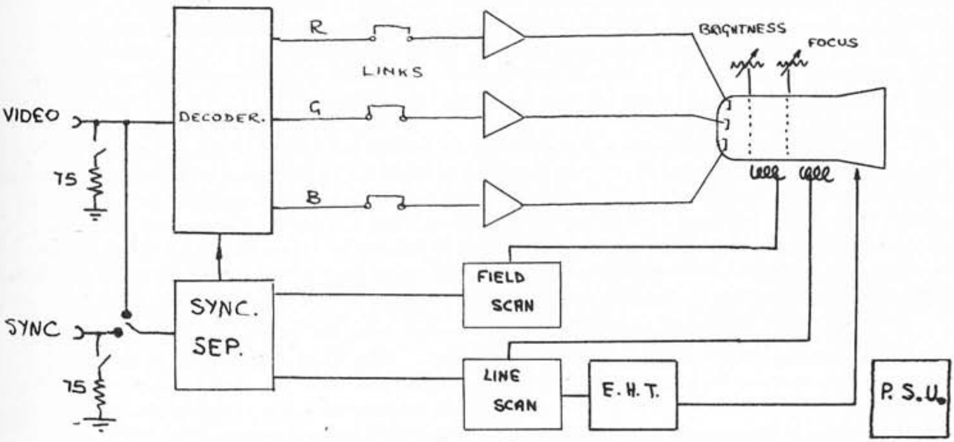


FIG 2

As an amateur the financial situation will usually decide what sort of monitor is acquired. Monitors often appear on the surplus market and enquiries made to surplus electronic dealers will often produce an ex-broadcast company or industrial monitor. Colour monitors are, at the time of writing, hard to obtain second-hand at a reasonable cost. The other alternatives open to the amateur are:

1. build it
2. modify a TV set
3. buy a new one

Modification of a domestic tv receiver must take into account the power supply as most TV's feature the live chassis technique. This MUST be isolated by the use of a double-wound transformer so that the chassis can be connected to the supply earth. See Fig. 3.

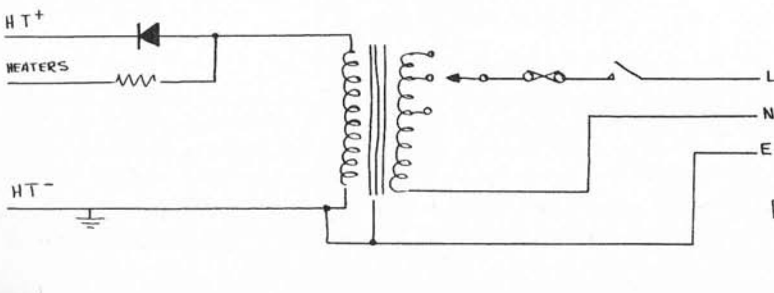


FIG 3

WARNING IT IS DANGEROUS TO USE A TV AS A MONITOR WITHOUT A MEANS OF ISOLATING THE CHASSIS FROM THE PUBLIC ELECTRICITY SUPPLY. The transformer selected must be a double wound one; an auto transformer is not a safe one as no isolation is provided. The rating of the transformer will be dictated by the power requirements of the set. See makers panel for the wattage required for secondary rating. Usually about half to one and a half amps are required. Sometimes an old HT transformer can be found with a 250v winding of sufficient current. Transformer economies can be made by removal of the tuner and IF stages, reducing the HT current requirements and heater total voltage enabling the heater chain to be fed from a tap on the mains transformer secondary with appropriate adjustment of the dropper resistor. Siting the transformer will require some experimentation to find the position of least picture disturbance by the magnetic field from the transformer. The best position is behind the electron gun in the tube neck, though not always possible due to the cabinet shape. Try rotating the transformer as the intensity of the magnetic field is not uniform about the transformer.

Moving onto the video input stage, which is needed to raise the signal from 1v to 3 or 4v for the video output valve, if the receiver section is to be kept a switch will be needed to select the video input or the receiver. The video signal is positive-going i.e. peak white equals maximum signal voltage. According to whether the CRT is grid or cathode fed with the video signal and the number of stages of amplification (polarity reversal with each stage) an extra stage may be required to invert the signal polarity. Input arragements can be as described earlier in Fig. 1.

As the sync separator normally takes its signal from the video amplifier it is not always possible to provide easily a separate sync input. Fig. 4 is a simple one stage input circuit. VR1 is the contrast control and should be accessible when the monitor is in use. The circuit may be constructed on a piece of veroboard and mounted near the video output valve. Fig. 5 shows a typical valve output stage and Fig. 6 a typical transistor output stage.

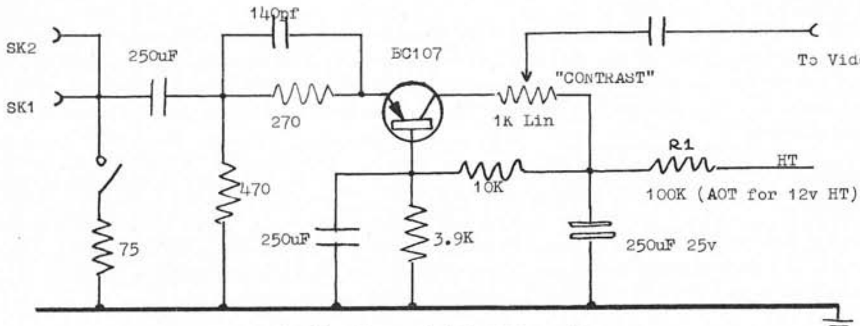


FIGURE 4

Fig. 7 details the complete video input stage, with input protection circuit and HF compensation trimmer. Adjust R1 to give 14 to 15 volts HT on the supply rail. A positive voltage may be available in the TV from the IF strip if it is transistorised and this could be used for the video pre-amplifier.

Fig. 8 shows a complete monitor circuit which was published in C Q - T V No. 76. Martin G6AEM/T, the author, says in his article that it is very easy to construct and the cost is quite reasonable.

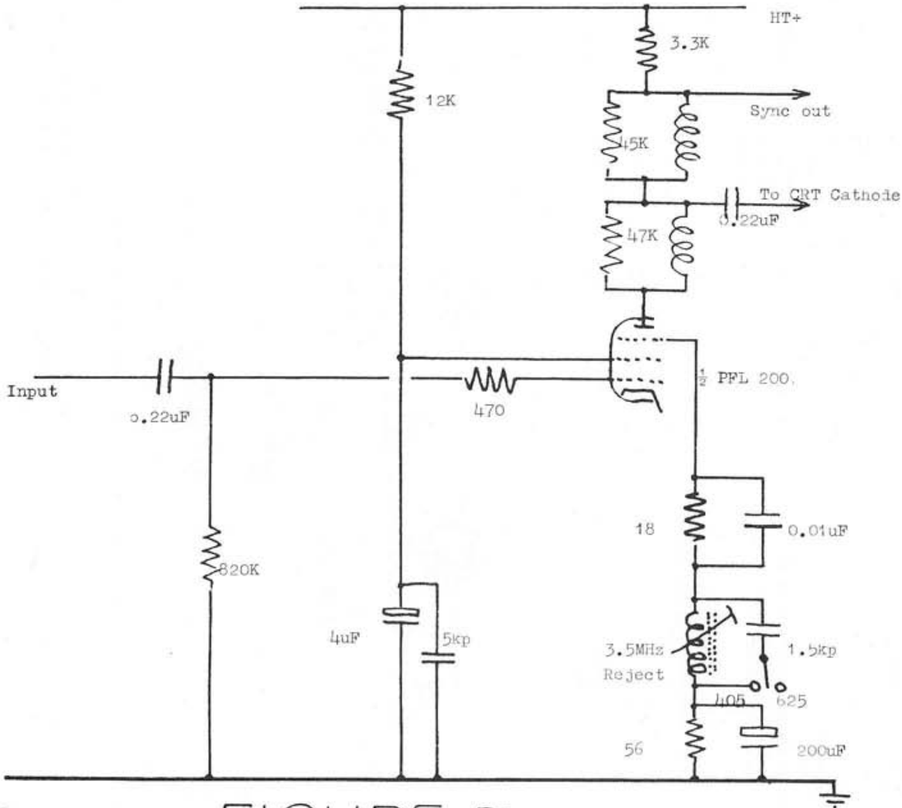


FIGURE 5

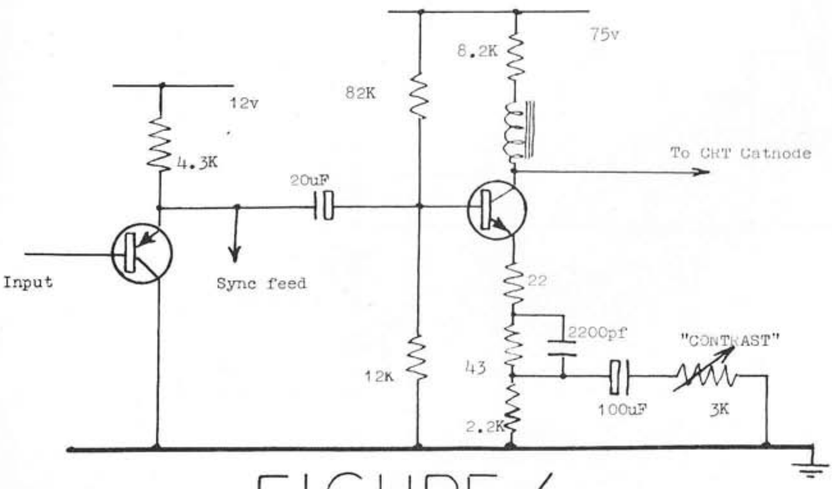
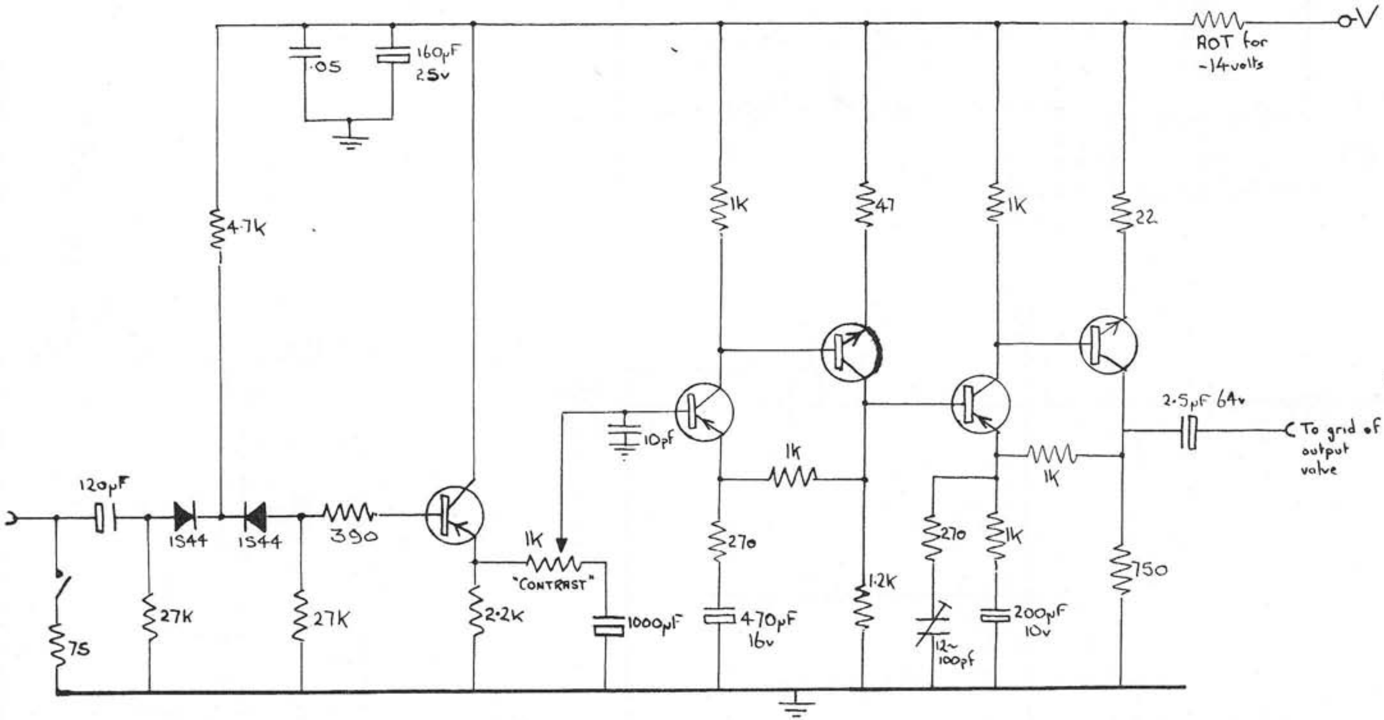


FIGURE 6



PNP transistors are BC107 or similar
NPN transistors are BC177 or similar

FIG 7

Fig. 9 is an explanatory diagram for a black level clamp circuit often used in video amplifiers to stabilise the black level. From this figure it will be seen that two diodes in conjunction with the resistors R7,8 and 9 form a bridge across one diagonal of which is the base circuit of VT2, and across the other the push pull source of clamp pulses. During the application of these pulses in the polarity shown, a circulating current flows in the bridge network in an anticlockwise direction charging the capacitors C4 and 5. At the conclusion of the clamp pulses these charges start to decay through R7, 8 and 9. The time constant is long compared with the line period and only a small loss of charge occurs. Thus, except during the clamp pulse period both diodes are cut off and the base to earth impedance is high. During the clamp pulse period both diodes will conduct. Assuming R8 to be at the centre of its travel, the base of VT2 will take the potential at the opposite end of the diagonal, i.e. earth potential. By adjustment of R8 the potential applied to the base of VT2 may be raised or lowered relative to earth, as the bridge is unbalanced.

The clamp pulses are normally timed to occur during the blanking interval of the video signal which corresponds to black, or bears a constant relationship to it. Thus the mean potential of the signal at the base of VT2 is controlled so that at the start of each line the absolute potential corresponding to black is constant and independent of the signal content.

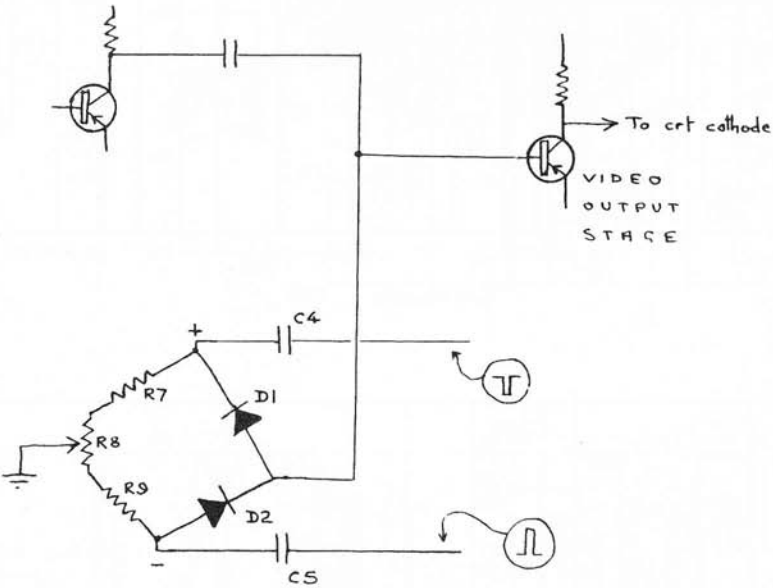
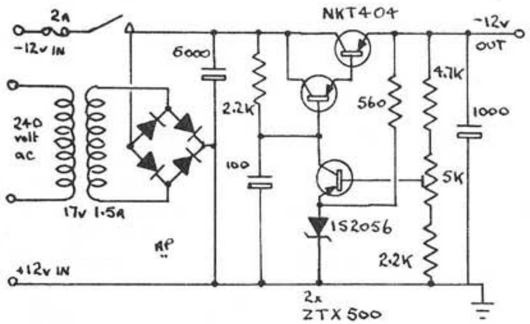
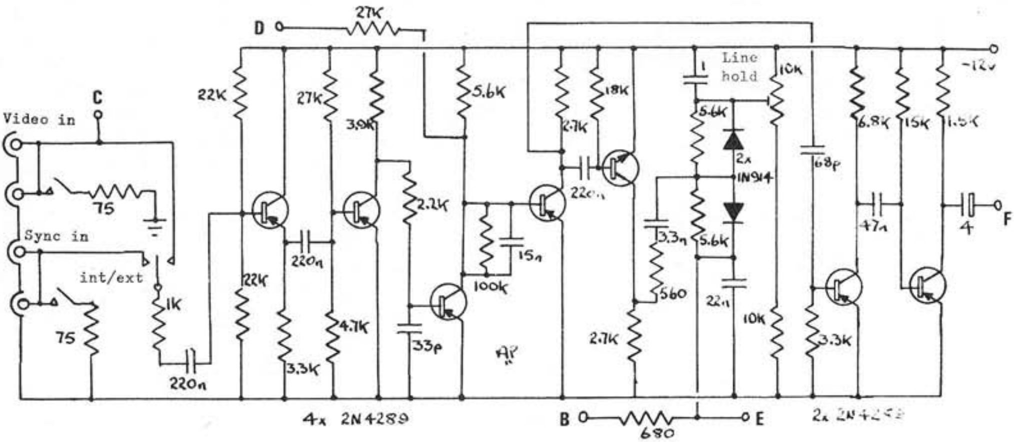


FIG 9

An interesting alternative way of using a domestic TV receiver as a monitor is to modulate the video signal onto a carrier and feed this into the aerial socket on the TV. Depending on the line standard the carrier would be in band 1 for 405 lines or band 4 for 625 lines. Tune the TV receiver for best "reception" and that's it. The TV requires no modification and

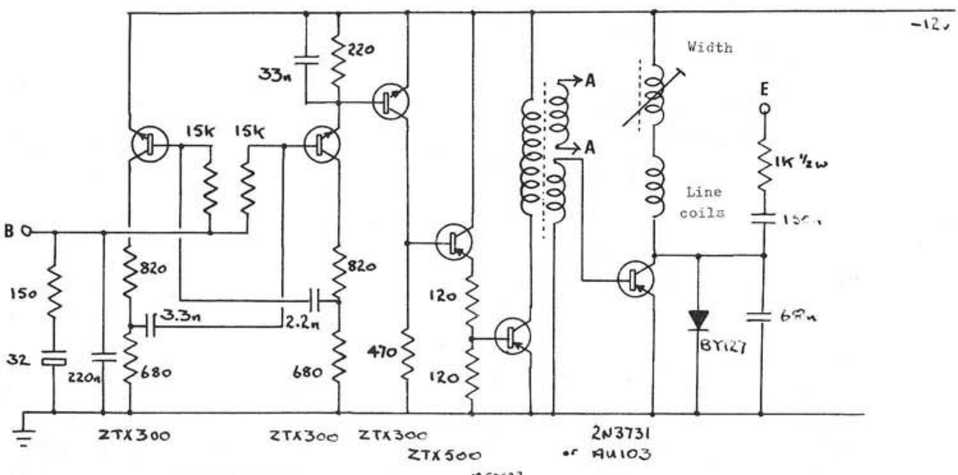


Power Supply

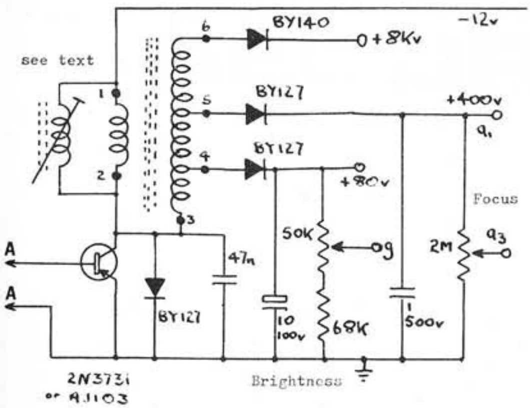


Sync Circuits

2N706

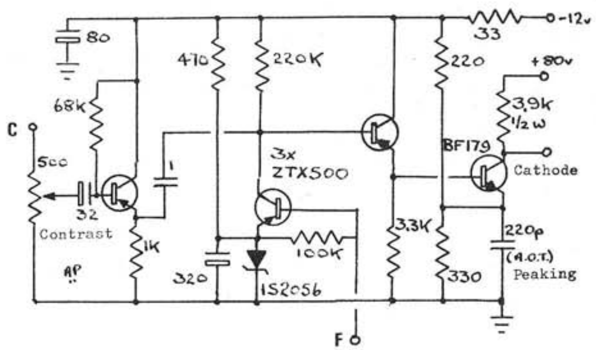


Line Timebase

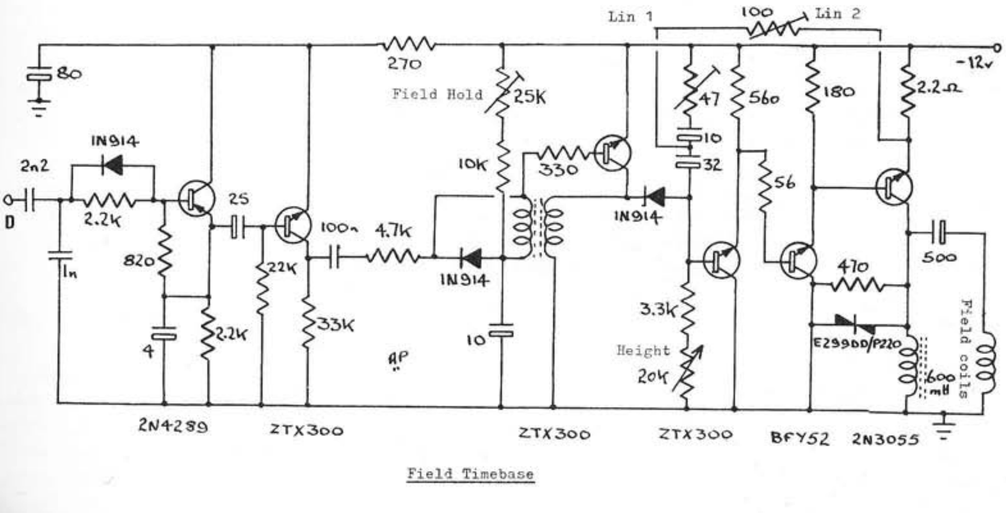


EHT Unit

FIGURE 8



Video amplifier



Field Timebase

this technique is very useful for the household TV. C Q - T V No. 76 has a suitable modulator described in it.

REFERENCES

A transistor monitor C Q - T V No. 76
A simple black level corrector C Q - T V No. 87
A video amplifier C Q - T V No. 80
A UHF video modulator C Q - T V No. 76
TV monitor "Television" August 1971.

chapter 8

RECORDING

By J.J. Rose M.R.T.S. G6STO/T

Introduction

The basic principle of recording electrical signals on magnetic tape is relatively simple. For recording sound, the sound signals, having been suitably amplified, are applied to a magnetic transducer, across the air gap of which magnetic tape is drawn at a constant velocity.

The tape consists of a plastic base material on one side of which is deposited a layer of oxide of a ferromagnetic material. The tape can therefore be magnetised but remains an electrical insulator. It will be realised that it is possible to vary the magnetic flux density along the length of the tape without it 'evening out' to one long magnet and so the electrical sound signals can be 'written' onto the tape in the form of a fluctuating magnetic field.

To recover the sound information from the tape it is again drawn across the air gap of the transducer, or head, and the varying flux densities on the tape induce varying electrical signals into the coil of the head, This is amplified to a useable level and fed to the loudspeaker, line, etc..

Unfortunately, even with sound signals, there are some other snags to be overcome. One such snag is the transfer characteristic of the head to tape and vice-versa, but this can be largely overcome by mixing with the signal to be recorded another signal some four to five times higher in frequency than the highest frequency to be recorded. This is generally called the bias signal.

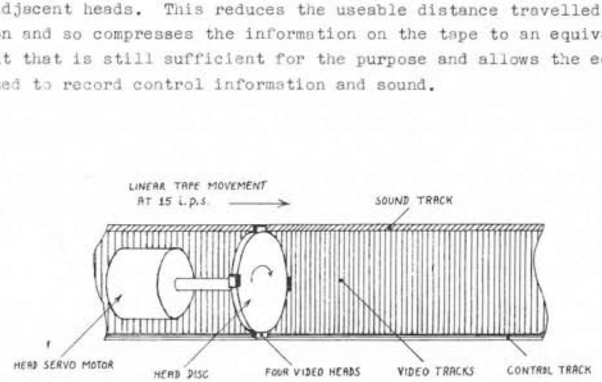
Another problem which must be countered is the rising response with frequency characteristic of the magnetic transducer or head, which causes the output to rise at a rate of some 6db per octave. This means that in the playback mode of the tape recorder the amplifier must be made to provide a falling response also at 6db per octave if a linear output is to be achieved

The limitation of frequency response of such a system is imposed both by the tape and by the transducer. If the tape is considered to be an assembly of very short magnets it will be appreciated that at high frequencies, where we require bands of dense magnets to be sandwiching bands of less dense magnets over a very short length of tape they will tend to 'even out'. Also, the magnets become so short that they tend to demagnetise themselves. The limitation imposed on the transducer is due to the fact that the air gap must have a finite width. Present-day transducers have a very narrow air gap, in the order of 0.00012 inches, but even so, there is a limit to how much detail it can write onto the tape and in fact, present-day technology allows recording at about 2KHz per one inch per second of tape velocity. A tape being transported past the transducer at a velocity of 3¾ inches per second would therefore permit recording and playback up to about 7.5KHz and 7½ inches per second would permit 15KHz. Increasing the tape velocity spreads out the information along the tape and therefore permits higher freqencies to be recorded.

Video Recording

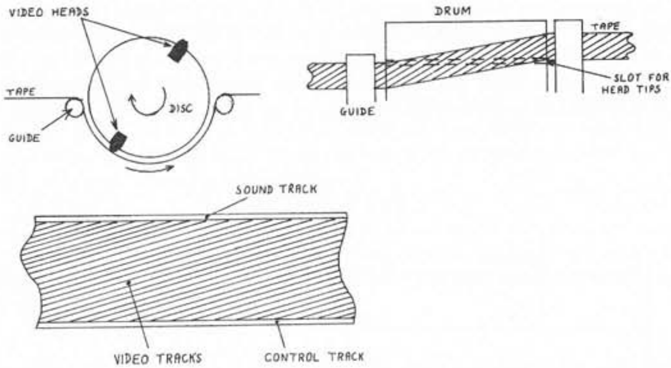
When recording sound signals a response of up to about 15KHz is required but for video signals a response of 50Hz to 3MHz or more is essential. This amounts to more than 15 octaves and such a range of frequencies is clearly quite impossible even if the tape is transported fast enough to respond to 3MHz. Therefore, two more problems must be solved to allow the recording of video signals. First, the effective head to tape speed must be raised to accomodate the high frequencies whilst retaining a practical linear tape speed and hence a reasonable period of recording time with a reasonable size of tape spool. Secondly, the number of octaves required to be recorded must be reduced without loosing any information.

One method of solving the head to tape speed difficulty which has been used professionally in broadcasting circles for quite a long time is the quadruplex system. For this, a tape 2 inches wide is used and is transported at 15 inches per soecnd. Four record/playback heads are used and these are fixed to the periphery of a disc which is driven by a motor such that the heads are drawn across the width of the tape. The head disc is driven at 15,000 revs. per minute and as each revolution sweeps each of the four heads across the tape sequentially this amounts to 8 inches per revolution. The effective head to tape speed is therefore 2,000 inches per second and more than adequate for the required frequency. In practice the information which is recorded by each of the four heads is made to overlap, at beginning and end of each sweep, that which is recorded by adjacent heads. This reduces the useable distance travelled by the heads to 6 inches per revolution and so compresses the information on the tape to an equivalent of 1,500 inches per second but that is still sufficient for the purpose and allows the edges of the tape to be erased and used to record control information and sound.



The main problem with quadruplex machines is that due to the very high speeds and high order of accuracies involved they are very expensive. From £30,000 upwards. In view of this the 'Helical scan' machine was developed, which is a compromise between a linear type, such as a sound recorder, and the quadruplex machine and is now the type most commonly encountered by the amateur.

The Heilcal scan machine is arranged so that the top edge of the tape leaving the supply spool is level with the bottom edge of the tape entering the take-up spool. The tape passes first across the face of a full tape-width erase head and onto the edge of a drum. In the process of being drawn around 180° of the drum circumference the tape guides cause the tape to be elevated a distance equal to the width of the tape. On leaving the drum the tape passes heads to erase the edges and to record control information along the bottom edge and sound along the top edge. The drum contains a disc to which are attached, usually two, diametrically opposed record/playback heads the tips of which protrude through a slot in the periphery of the drum. If the disc is rotating in a direction such that the head tips are travelling in a direction opposite to that of the tape the tips will meet the tape at the bottom edge and, after 180° of rotation, will leave the tape at the top edge. By current recording standards the drum is about 4 inches diameter so each head sweeps a diagonal path across the tape some 6¼ inches long. For convenience, the heads rotate at 25 revolutions per second and so each sweep will record one frame of the television picture; which has the secondary advantage of being able to stop the tape and view a still frame. The tape is transported at about 5½ inches per second and, allowing for the loss of the tape edge for the recording of other information, this gives an effective head to tape speed of about 825 inches per second and is quite adequate for most applications; allowing a top frequency in excess of 3MHz with suitably compensated amplifiers.



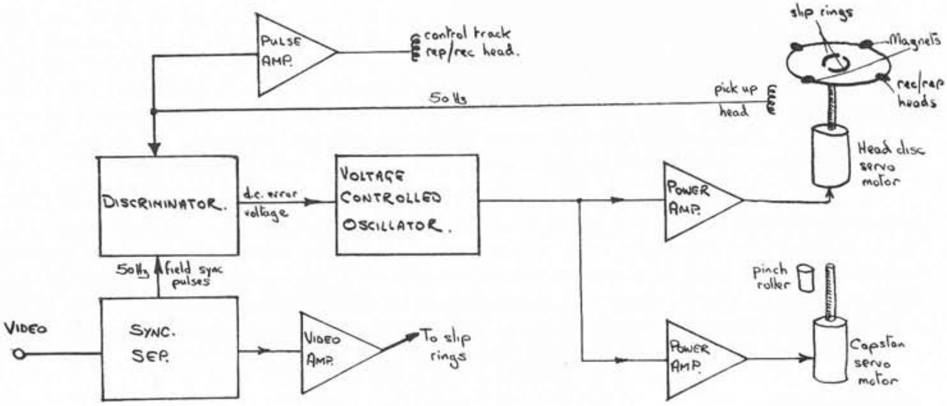
The problem of reducing the number of octaves which have to be recorded is solved in basically the same way for all types of video tape recording machines. Instead of recording the video signal directly onto the tape with an accompanying bias signal it is used to frequency modulate a carrier that is generated within the machine. The carrier is generally arranged, in small machines, to be at about 3MHz at the tip of the synchronising pulses and to be at about 4.5MHz for the signal at peak white and it may be seen that this is considerably reduces the range of frequency that is demanded of the tape.

Machine Control

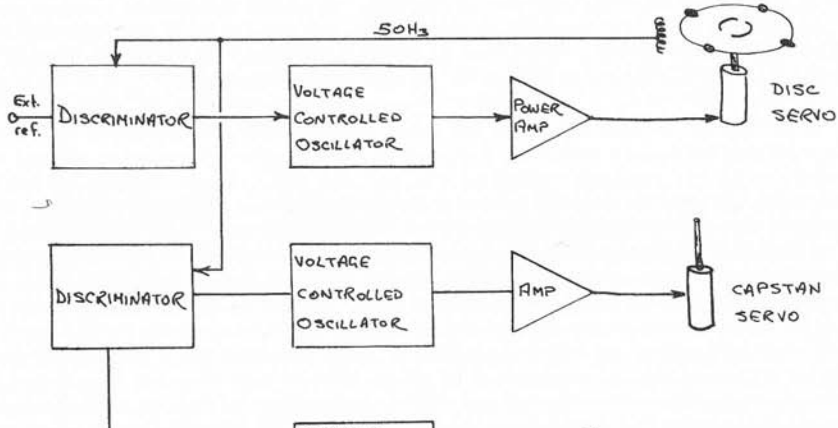
With a system that uses linear recording track and a stationary record/playback head the only requirement of the mechanical arrangements is to draw the tape past the head at a constant velocity equal to that at which it is recorded. However, with systems using moving heads it is more difficult to ensure that the conditions of head speed, relative head position and tape speed are exactly duplicated during playback. The video information recorded on the tape is insufficient for use in controlling the machine, and besides it is not available until the machine is running. Control information must, therefore, also be recorded to provide a reference for the speed of the tape with respect to the speed of the heads.

In order to closely control the speed of the head disc it is driven by a servo motor from a voltage controlled oscillator and power amplifier. The drive for the capstan for transporting the tape is similarly controlled. On the head disc there are mounted two small magnets which, when the disc is rotating, pass a fixed pickup head and provide a 50Hz pulse when the disc speed is correct. This 50Hz pulse is fed to a discriminator, the other input of which is fed with 50Hz field pulses derived from the video signal which is being recorded. The error voltage from the discriminator, if any, is used to control the frequency of the disc motor drive oscillator and therefore holds the disc speed fixed relative to the recorded video field pulses. The 50Hz pulses from the disc reference head are also recorded along the bottom edge of the tape for use during playback and this is referred to as the control track. The tape is transported through the machine by the capstan and on the flywheel of this there are also magnets to provide a reference pulse in an adjacent head for the speed at which the tape is being transported. During recording the capstan servo motor is controlled from the comparison between the video field pulse and the pulse from its own reference head output. During playback a speed reference is required and a sample of 50Hz mains is generally used, although in larger industrial and broadcast machines provision is made for deriving this reference from the station synchronising pulse generator. For the control of the disc motor during playback the external reference, i.e. the mains or S.P.G. field pulse, is compared to the output of the disc reference pickup head and any error voltage is used to correct the speed of the disc motor by altering the frequency of the voltage controlled oscillator. The capstan speed, however, must be held correct with respect to the speed of the head disc. This is the purpose of the control track. The disc speed

has already been determined, so the capstan can be controlled by comparing the disc pickup head **output with** the 50Hz output of the control track head and using that error voltage to control **the frequency** of the capstan motor driving oscillator. One small dificulty arises here in that **the phase of** the external reference signal cannot be guaranteed to be in agreement with the con**trol track signal**, nor indeed can it be guaranteed to be the samw on two different occasions if



ARRANGEMENTS DURING RECORDING.



ARRANGEMENTS DURING PLAYBACK

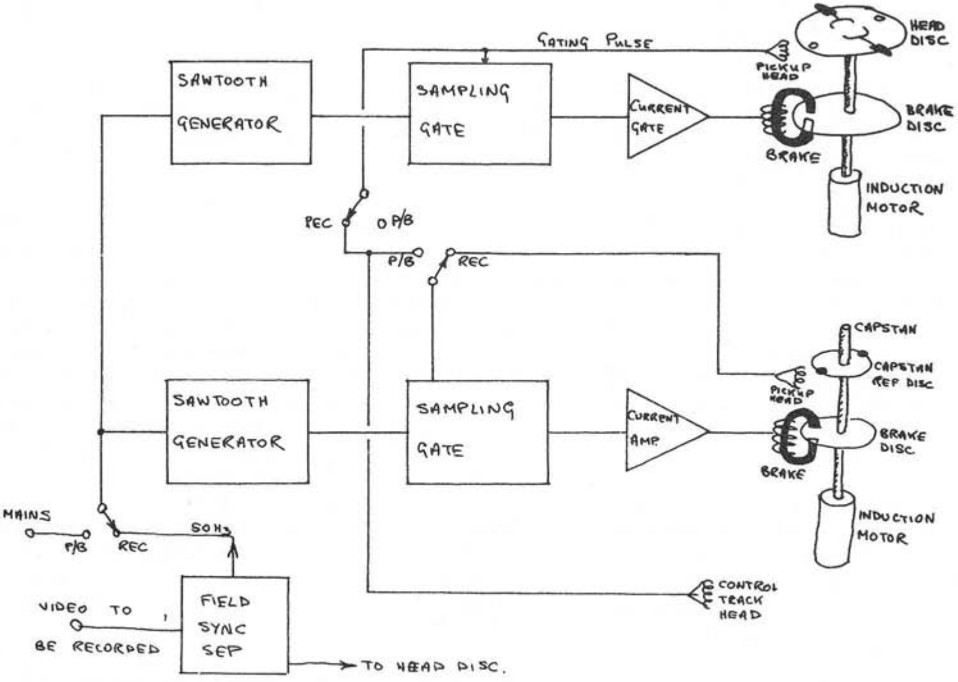
external cables, ect., have been changed. The consequence of incorrect phasing is that the record/playback head tips will be scanning the tape at some point between the recorded bands, the exact position being determined by the amount of the phase error, and a very noisy 'snowy') picture or no picture at all will result. To overcome this problem a variable phase-shift network is included in the signal path of the control track head on playback only and the control spindle of this is usually marked "Tracking". This control will effectively move the video heads precisely onto the recorded tracks on the tapes.

It is not absolutely essential that the servo loops are arranged in this way and it would be just as effective to apply the external signal to the capstan discriminator and the control track signal to the head disc discriminator although the former arrangement will probably stabilise quicker after switching on.

The servo system as described is used in all broadcast machines but usually in a far more elaborate form, with the option of having line by line reference to the station synchronising pulse generator and the ability to lock the machine to the S.P.G. on record as well as on playback. The machine will synchronise in a few seconds from switch on and its output can then be regarded in the same manner as that of a station camera in that it can then be faded in on the vision mixing equipment without picture breakup. Obviously, such machines are very expensive due not only to the very extensive electronics involved, but also to the very high standards of mechanical accuracy demanded by the tape transport and head disc mechanics. Even so, the standard of picture stability achieved by the helical scan machine is not good enough for broadcast use without further correction as there is no means of ensuring that the friction of the tape around the relatively long path of the head drum will remain constant. Also, the mass of the head disc is very large compared to that of the quadruplex machine and it is not possible to make quick changes in the speed of the heads due to this and in consequence the short term stability of such machines could not be relied on. Because of this almost all broadcast machines were of the quadruplex type until fairly recently when a new development made it possible to correct the errors in the mechanically cheaper helical machine. The device which made this possible was the "Digital Timebase Corrector".

In either form these machines are far beyond the price bracket of the domestic user and generally far too large to be accomodated. In a closed circuit environment the errors of the helical machine are of little consequence as most television monitors have "flywheel" sync and are very tolerant of slight changes in the timing or the picture. For the domestic market a simplified version of the servo circuits has been developed which obviates the need to use very expensive servo motors and motor drive amplifiers. The basic arrangement of the helical scan head disc and capstan remains the same but the servo motors are replaced by "squirrel cage" induction motors which, uncontrolled, will run at a slightly higher speed than is required. An aluminium disc is attached to the shaft of these motors, the edge of which passes through the air-gap of a magnetic core wound with a coil. This forms an eddy-current brake. The reference pulse, i.e. separated field sync for record or a sample of mains for playback, is applied to a saw-tooth generator in each of the motor control circuits. The saw-tooth is passed to a sampling gate which is normally closed. For the head disc motor the sampling gate is opened by the video head disc reference-pulse in either mode of operation and the amplitude of the saw-ttoth during the gating period is passed to a current amplifier feeding the eddy-current brake. The motor is therefore slowed down by the brake to the correct speed. For the capstan motor the sampling gate pulse is derived from the reference head coupled to a disc on the capstan motor shaft, on which are mounted magnets in a similar manner to that on the disc drive motor, in the record mode. In the playback mode the sampling gate pulse is obtained from the control track signal and in both modes the result is used to operate an eddy-current brake on the shaft of the capstan motor.

As has been previously mentioned the associated sound signal is recorded on the top edge of the tape. The record/playback head is similar to those used in a sound tape recorder and the same bias level and frequency limitations apply. So, at a tape speed of 5½ inches per second a high frequency responce of about 11KHz can be expected.



ARRANGEMENTS USING INDUCTION MOTORS

Editing

It is possible to edit videotape by simply cutting it and splicing the ends together as with a sound tape recorder. However, if the pattern of the recorded tracks on the tape is considered, it is obvious that severe disturbance of the picture will occur during the transition.

Ideally the tape should be cut along the dead space, or guard band, between the recorded tracks and a developing solution is available to make the tracks visible for this purpose. This process is difficult with a quadruplex machine where the tracks are almost straight across the width of the tape but with a helical scan machine, where the tracks run diagonally across the tape for a considerable length of the tape, it becomes almost impossible. Also, it must be remembered that the corresponding sound is quite a long way down-stream from the picture and cannot be edited synchronously by this method.

Many present-day video tape recorders, even domestic types, overcome this problem by the inclusion of an electronic editor. Such machines are equipped with a special video erase head which does not erase the control track edge of the tape. It must be remembered that to over-record a section of tape there would normally be a portion of double recorded tape at the beginning equal to the distance from the video erase head to the video record head. Similarly, there would be a section of blank tape of that length at the end of the section. An electronic editor allows the record mode to be initiated whilst the machine is running in the playback mode but it will delay the start of recording, though not erasing, for a time equal to that taken for the tape to travel from the erase head to the record head. Likewise, at the termination of recording, it will immediately switch off the video erase head, but will delay the switch off to the record heads for a similar time.

In the majority of available editor equipped machines there are switches to select three modes of operation - Normal - Insert - Assembly. Normal is for the machine to be used without the editor. Insert, as its name suggests, is for the insertion of material into a recorded section of tape and Assembly, is for the addition of material to the end of a section of recorded tape. In either mode record operation is manually initiated at a time earlier than it is required equal to the delay for the tape to travel from the erase head to the record head. The erase head will commence operation immediately but the recording will be delayed until the erase section reaches the video heads. When recording is ceased the erase head will again be affected immediately but the recording will continue until the point on the tape at which erasure ceased reaches the video heads.

The electrical differences between the Insert and Assembly modes lies in dealing with the control track. In the Insert mode the video erase head does not erase the control track and the control track signals on the tape from the original recording are used throughout the length of inserted section. This ensures that there is no disturbance of the motor control systems, and hence the picture, during the transitions from original to Insert and from Insert to original. When it is required to assemble a number of sucsessive sequences on a tape there are no control track signals available at the end of a previously recorded section and so in the Assembly mode new control track signals are recorded which are, as normal, derrived from the pulses from the head disc pick-up head.

For an example of the use of an electronic editor; it may be required to show an event which is occurring simultaneously with another, e.g. an indoor scene and cut to an outdoor event, then back to the inddor scene, followed by another shot of the outdoor event and finished by cutting back to the indoor scene. In this case the indoor scenes would be recorded all at one session with carefully timed gaps left on the tape for the other shots to be added later. The outdoor events would then be recorded either on another machine and added to the original as Inserts, or the same machine and camera may be taken to the outdoor scene and the shots recorded as Inserts in the gaps previously left for the purpose with a final sequence added as an Assembly at the end if required. It is possible by this means to build up a programme which looks as if it must have been made in a multi-camera studio with countless operators when in fact it was made by one person with a camera and an editor-equipped V.T.R.

Improving Stability

It has been stated that it is only fairly recently that helical-scan machines have been used by broadcsters due to the problems of iherent instability caused by a relatively heavy head disc and a long friction path for the tape. These problems manifest themselves as an occasional lean of the picture or a sudden sideways 'hiccup' of the picture. Much can be done to reduce this by maintaining an almost clinical standard of cleanliness on the tape deck, but although this makes it satisfactory for domestic use, it is still far from meeting the stringent requirements of timing accuracy demanded by broadcsters. Various ways of correcting the timing errors have been tried such as using magnetic discs spinning at constant speeds on which to record the signal from the V.T.R. and read it off a few microseconds later as an accurately timed signal, but all were very expensive and did not provide correction over a long enough period of time to completely correct the errors. The final solution was provided by computer technology in the form of the "Digital Timebase Corrector". This instrument analyses the picture signal by sampling it at 13.3MHz and representing the voltage at the time of the sample as an 8 bit digital word, which represents one of 256 possible voltage levels. The number of samples which represent a line of the picture are "written" into a memory and stored. The samples representing the next line are written into another memory and the next into another until, usually, five memories contain five successive lines. The sixth line would then be written into the first memory the seventh into the second memory and so on. This information is, of course, the signal from the V.T.R. complete with all its timing errors and the signals used to enter the digital words into the memories are derrived from this picture signal. However, these same control signals need not be used to retrieve, or read, the information from the memories and in fact the station synchronising pulse generator is used to read from the memories. With five line memories, the reading would be arranged to take place $2\frac{1}{2}$ line times after the writing at a constant rate controlled by the S.P.G. and would then be de-coded to the normal television signal. It may be seen that by doing this the V.T.R. signal and hence the digital word being written into the memories may vary in time by as much as $2\frac{1}{2}$ lines early or late and it will not interfere with the information being read out at a constant rate. This amount of time correction is sufficient to be able to bring the cheapest machines up to broadcast specification from the point of view of timing though of course the picture quality remains unchanged. The conversion from an analogue to a digital signal is fairly complex due to high speeds of the samples and therefore quite costly, as are the memories, but as the development of large scale integrated circuits progresses there is a good prospect of the price of such instruments approaching a sensible domestic level in due course.

Colour

Most readers will have seen small helical V.T.R.'s or video cassette recorders which are capable of recording and playing back colour signals. Whilst describing how the video signal was used to frequency modulate a carrier it was stated that this carrier was usually in the range of 3MHz to 4.5MHz from sync tips to peak white. Colour information is on a sub-carrier of about 4.433MHz and if this is considered with the fact that the video signal frequency must not be allowed to rise to a level where it will interfere with the modulated carrier it is obvious that the colour signal cannot be recorded directly onto the tape. The picture information actually recorded onto the tape in the form of a frequency modulated carrier does, however, leave a considerable amount of unused frequency space below 3MHz and this is pressed into service to record the colour information. This dictates that the frequency of the colour sub-carrier must be reduced for record and increased during playback, but in so doing its phase relationship to the picture must remain. Different manufacturers' methods of doing this vary in detail but follow a general pattern and have become collectively known as "colour-under" recording and a typical method of achieving it is as follows.

Two oscillators must be provided, one at sub-carrier frequency of 4.43361875MHz and one at an even multiple of line frequency, say 1.125MHz The sub-carrier oscillator is locked to the sub-carrier burst on the signal to be recorded in a similar manner to the way it is done in a colour receiver. The 1.125MHz oscillator would be divided by 72 to line frequency and compared to separated line sync.signals to derive a control signal to lock the oscillator to line syncs. The two oscillator output would then be added together to provide a signal of 5.5586187 MHz which would, ofcourse be locked to the picture. The colour sub-carrier would be extracted from the picture signal and subtracted from this frequency to provide a colour signal of 1.125MHz with the same relation to the picture as the original sub-carrier colour signal. This new colour signal can then be recorded directly onto the tape through a low-pass filter to the video record/playback heads and will utilise the picture signal as a bias signal. During playback the process is reversed but the 4.433MHz oscillator is allowed to free-run as it has no reference on which to lock. This can lead to a small amount of patterning if its free-running frequency is not precise or some variation in tape speed occurs for reasons previously given but it is not usually of any consequence to a domestic user.

Tape

The range of tape available for video recording is awe-inspiring but one should not be put off by this as there are some simple rules to ensure that the right tape is chosen. The manufacturer of a given machine is eager that the results obtained from it should be the best possible and for this reason will specify the tape to be used. Wherever it is practical, this tape should be used as the probability is that the characteristics of the machine have been designed around this tape and one can rest assured that the results will be the best possible given that the machine has been properly serviced and the required standard of cleanliness has been maintained. Where the correct tape cannot be obtained for some reason a tape as nearly equivalent as possible must be used and this is where some care must be taken. There are two main distinctions in type and it is of paramount importance that the correct choice of these is made. The two types are often referred to as i)Oxide and ii) High energy or High density, and there is a great deal of difference between them. The first type is, more correctly, ferric oxide tape and is, as its name suggests, a coating of fine grain ferric, or iron, oxide on a plastic tape and is usually easy to identify due to its light brown colour. The high energy or high density tapes are made of a deposit of chromium di-oxide on a plastic tape and in general, these are a dense matt black colour but although the colour is a good guide to the tape type, it can by no means be relied upon. The two types of tape require different operating conditions and poor pictures with possibly excessive head wear will result by using the wrong kind. High density tape requires a much larger level of signal from the video head to record the picutre at a level such that the natural noise of the tape is insignificant by comparison but that the signal does not saturate the tape at picture highlights. Also, the abrasive nature of the tape requires that video heads made of a ferrite material be used if a reasonable head life is to be expected. To use high density tape on a machine designed for ferric oxide tape will result in a "snowy", or noisy, picture and head life will be very short as, on the one hand, the level of the signal on the tape will be low and therefore the noise will be high by comparison and ,on the other hand, the friction of the tape on the comparitively soft ferric oxide heads will grind them away in a relatively short time. To use ferric oxide tape on a high density machine will not damage the heads, but the picture will be unviewable as the level of recording is so high that most of it would be recorded on the tape as peak white and this is clearly not satisfactory.

When the type of tape has been established the choice of brand is quite simple. Use the best quality available. Cheap tape is a waste of money as the quality of the picture is never good and often very bad, in addition to which the picture can frequently "pull" to one side or roll a frame due to varying tape friction caused by a non-uniform oxide coating. Good quality tape will have equal flexibility over its length, uniform coating thickness and the grain of the coating will be fine and orientated such as to do justice to the detail of thepicture.

Cleaning

The cleaning of the video tape recorder is very important and must be carried out regularly and carefully. Never use a proprietry solvent to clean any parts. The tape deck should be gently brushed with a soft bristled brush and the points at which the tape touches any part should be cleaned with a cotton-bud moistened with pure alcohol. This is very expensive, but a 50cc bottle from a chemist will last a very long time and is an investment when compared to the cost of the machine and the tape.

chapter 9

SLOW SCAN TV.

by C. Grant Dixon G8CGK

Slow Scan Television is a form of television originally devised by Copthorne Macdonald as a project at Kentucky University the aim of which was to see what sort of television pictures could be transmitted through a normal audio communication channel. It has since been adopted by many amateurs on a world-wide basis, enabling them to see their contacts as well as hear them.

With SSTV the images are transmitted at a slow rate and essentially a series of still pictures are transmitted so no movement is possible. In the future, with the advent of micro-processors and memory stores it is quite possible that this difficulty may be partially overcome. At the moment, however, it is still pictures and text which form the transmission material. This does not preclude the use of a live camera as these can be constructed to take a series of snap-shots, or alternatively the subject can endeavour to remain motionless whilst the picture is being sent. Text may also be sent by means of a keyboard and memory store.

SSTV originally was devised as an AM system, but it soon became apparent that greater immunity to interference was obtainable with an FM system and the parameters of the system now in use are shown in table 1. It will be noted that the American 60Hz mains gives a longer duration for line and frame and pictures from these areas merely appear somewhat larger on the monitor screen. Conversely, they will see our pictures smaller than usual. The number of lines per picture was orignally set as 120 but there is a growing tendency to use 128 lines as this division ratio can easily be obtained by seven binary stages. Whatever picture is received the line and frame amplitude controls should be adjusted to give 1:1 aspect ratio.

	50 Hz Mains		60 Hz Mains	
Line frequency	50 ÷ 3 i.e. 16.666 Hz		60 ÷ 4 i.e. 15 Hz	
Duration of line	60ms		66.666ms	
No. of lines in picture	128 ± 8		128 ± 8	
Duration of picture	7.2 s.	7.68 s	8 s	8.533 s
Line sync pulse	5 ms		5 ms	
Frame sync pulse	30 ms		30 ms	
Sync frequency	1200 Hz		1200 Hz	
Black frequency	1500 Hz		1500 Hz	
White frequency	2300 Hz		2300 Hz	

The amateur who takes up SSTV will naturally commence by building a monitor which will be coupled to the external speaker socket of his receiver. Designs for monitors range from the very simple to the extremely complex, and the performance is obviously linked to the complexity of the design. Most amateur-built monitors use the 5FP7 radar tube which has a blue trace and persistent yellow afterglow; commercial monitors (which are fairly expensive items of equipment) seem to use more modern tubes which may even have been produced especially for the manufacturer concerned. Recently there has been a growing interest in the construction of scan converters which will take a slow scan signal and display the picture on a standard TV monitor. This system has two main advantages; firstly the picture is on the screen the whole of the time with no fading taking place and secondly, the P4 phosphor of the standard TV screen gives a very much better rendering of the grey scale and the picture quality is vastly improved. The disadvantage of the scan converter is that the image must be retained in a digital store capable of retaining 65,536 bits of information and the integrated circuits for doing this are very costly if purchased new. It is anticipated that there will be a dramatic drop in the price of these memory I.C.s within the next few years and the picture may then look more attractive to the amateur constructor. Newcomers to SSTV would be well advised to tackle building a normal monitor initially and not be put off by the more sophisticated amateur, and expensive commercial gear.

The SSTV Monitor

Various circuits for SSTV monitors have appeared in the radio-amateur press - see references at the end of this chapter. It is perhaps a good idea to look at the various sections of the monitor circuit and quote some examples.

Video Processing

The incoming signal ranges from 1200 Hz to 2300 Hz and there may also be various interfering frequencies present. It is advantageous to pass the signal through a band pass filter to attenuate the interference. Fig. 1 gives a suitable filter using operational amplifiers; the gain is unity. Fig. 2 shows a circuit published in the German magazine "QRV" which uses a dynamic control voltage to attenuate all frequencies other than the SSTV frequencies.

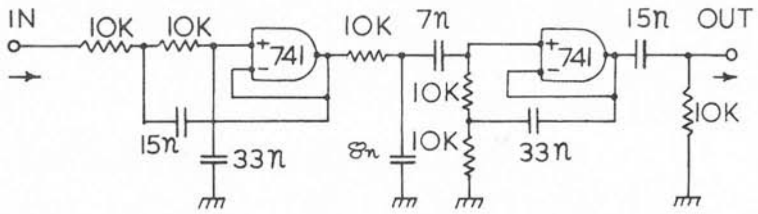


FIG 1, SSTV ACTIVE FILTER.

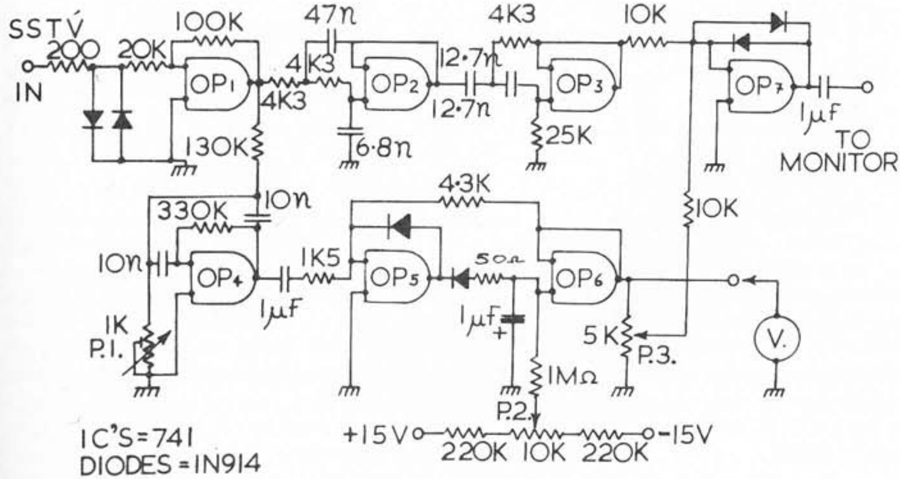
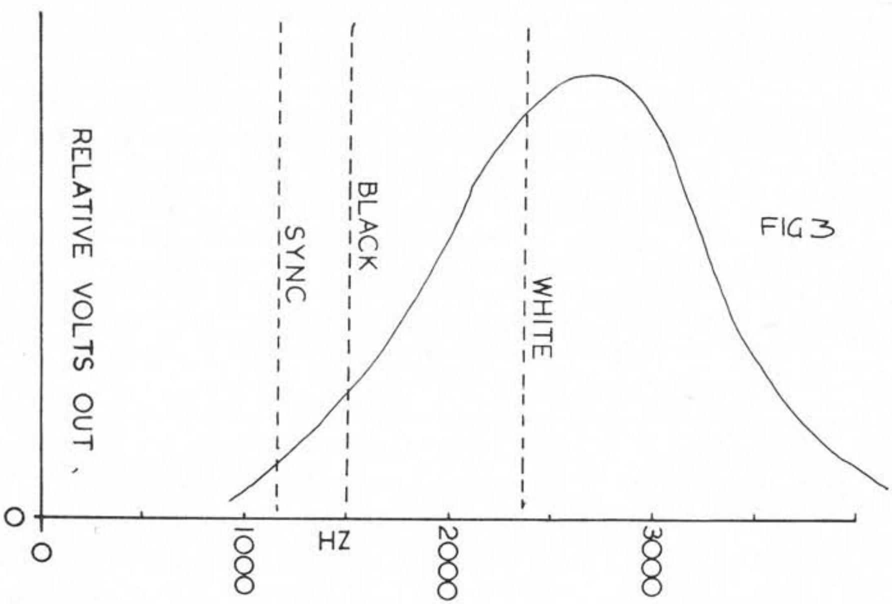


FIG 2, CONTROLLED ACTIVE FILTER

The video signal from a receiver or tape recorder may have any value from 50mV to 3v or more. The input circuit in Fig. 2 is typical in that a resistor limits the current through the diodes and the voltage developed across the diodes never exceeds 300mV. The first op-amp then provides a gain which is adjusted by the feedback resistor; in this case the gain is 100K÷ 20K= 5 times. OP2 and OP3 form a bandpass filter; OP4 is a tuned amplifier adjusted to sync frequency and OP6 is a peak detector.

FM to AM Conversion

In order to recover the AM signal some of the simpler monitors merely use the fact that a tuned circuit, which may, or may not, have some additional resistive damping, can be used as an elementary discriminator. Fig. 3 shows how a tuned circuit resonating at a frequency somewhat higher than the white frequency will give differences in amplitude for the SSTV frequencies - this arrangement also shows the merit that the lower audio frequencies of speech are attenuated by the circuit.



Now the actual video waveform, as opposed to FM carrier, has only got frequencies up to about 1KHz so a low pass filter will remove the carrier and leave the required video waveform. An alternative apporach is illustrated in Fig. 4. Here both positive and negative edges of the video waveform are used to trigger a monostable which produces a series of constant time pulses at twice the frequency of the incoming video. This pulse train now contains the L.F. components of the video waveform and the low pass filter U4,U5 and U6 will give the required SSTV video waveform for driving the CRT. The DC level of this may be adjusted by the brightness control.

CRT Connections

The 5FP7 requires an EHT of about 7Kv, of which more later; a +250v supply on G2 and a line voltage of about 40 to 50v between grid and cathode. A single transistor can provide the necessary gain and the arrangement shown in Fig. 5 has been used successfully by the author.

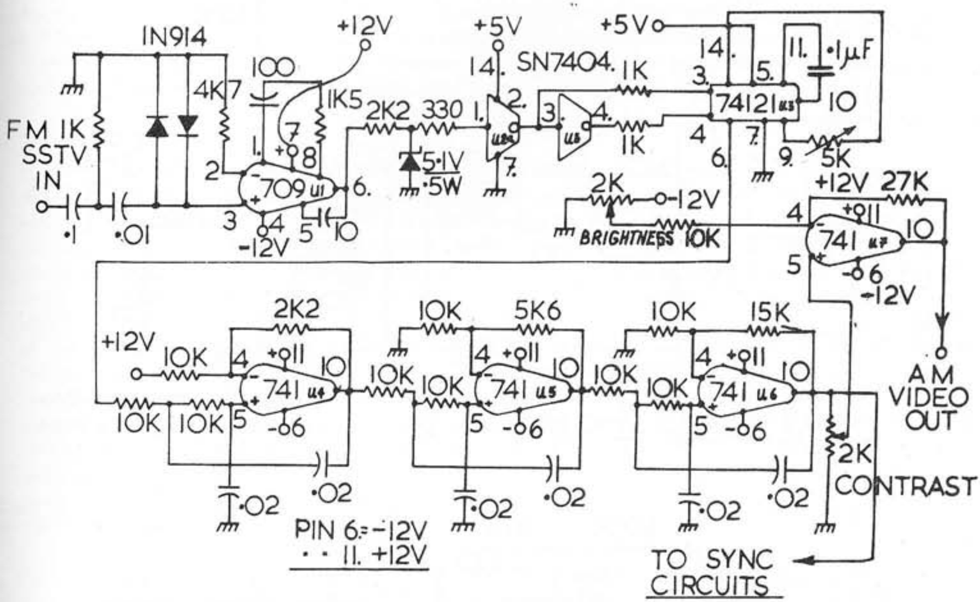


FIG 4, WB9LVI DEMODULATOR

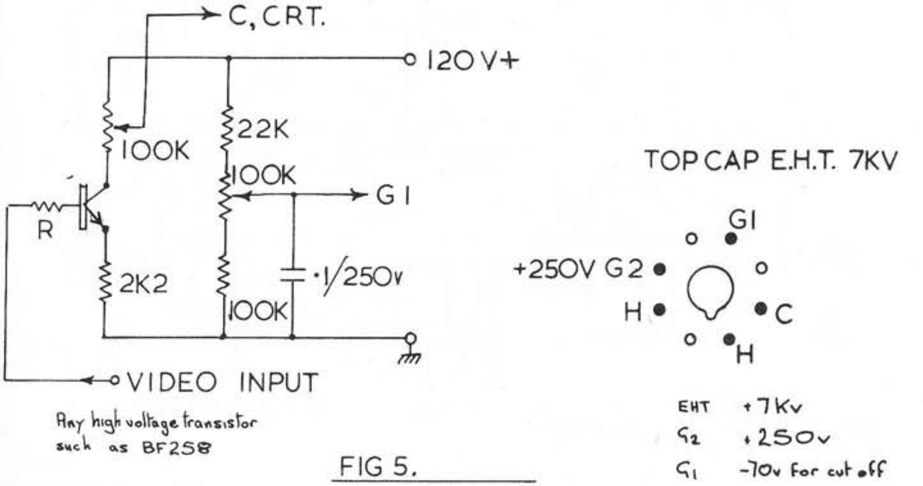


FIG 5.

The resistor R and the 2.2K emitter resistor set the input current which sets the voltage developed across the 100K collector resistor, this latter is actually the contrast potentiometer, the brightness being set by the grid volts separately. If the circuit of Fig. 5 were used with this the original contrast and brightness controls could be preset.

Sync Separation

The simplest method of recovering the sync information is to take the video waveform

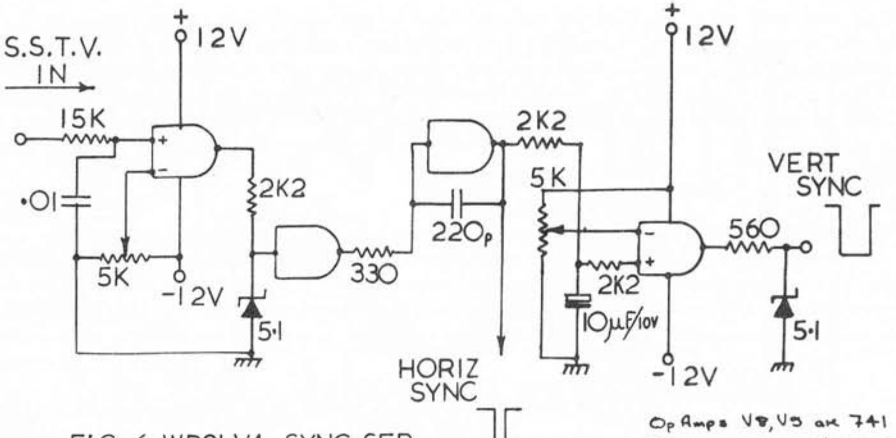
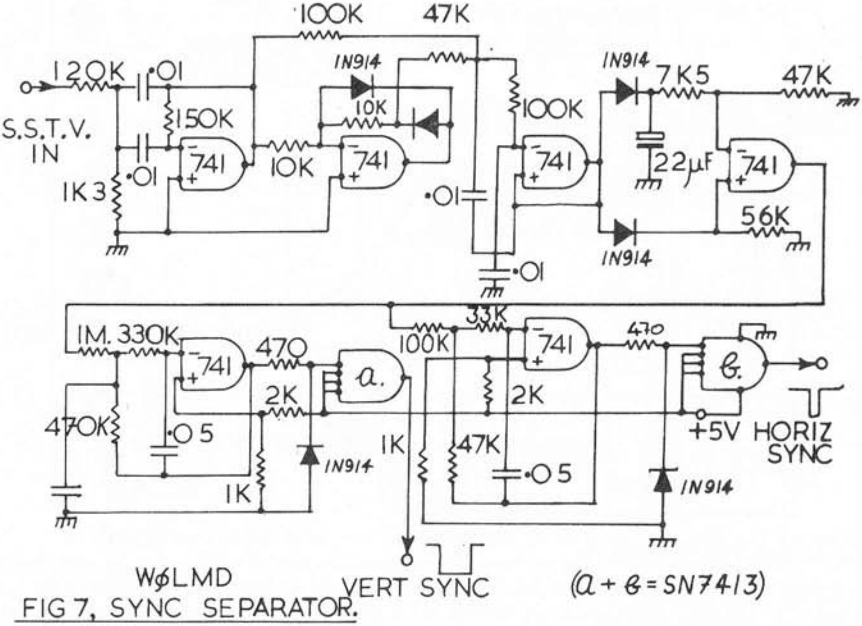


FIG. 6 WB9LV1 SYNC SEP



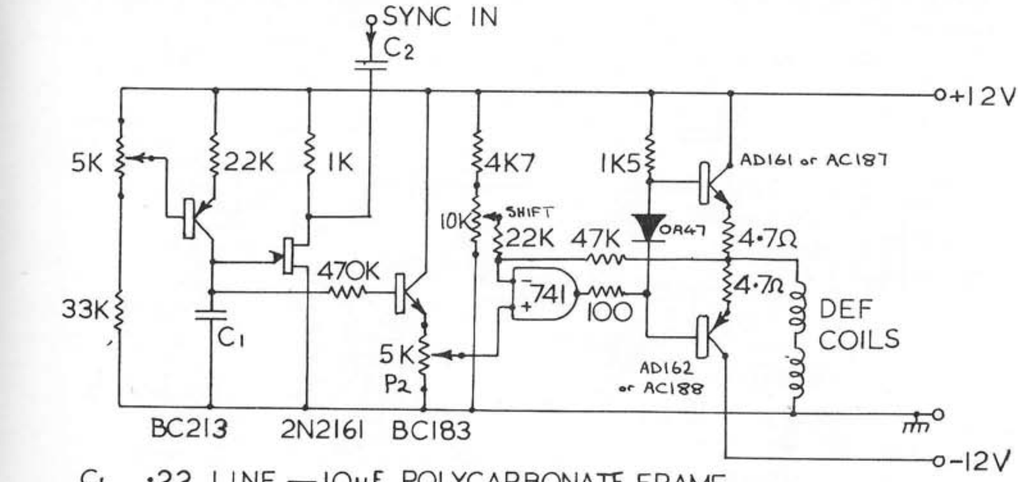
WØLMD
FIG 7, SYNC SEPARATOR.

at the output of V6 in Fig. 4 and clip off the negative going sync peaks; this will give adequate line sync pulses (see Fig. 6). A zener diode limits the pulses to 5v amplitude and the two gates acting as a Schmitt trigger clean up the pulses. An integrating RC combination then separates the longer frame pulse from the shorter line pulses and this is clipped off by V9. This circuit and that of Fig. 4 are due to WB9LV1. Another interesting way of dealing with the problem of sync separation is due to WØLMD whose circuit is shown in Fig. 7. The FM signal is passed through a low pass filter tuned to 1100Hz which ensures that the 1200Hz sync pulse is always at a higher level than the rest of the waveform. Two 741 op amps are then used to produce a full wave rectified signal which also doubles the ripple frequency. Another 741 is used as an "Auto-slicer". It performs a clipping action on the peak of the waveform and clips at a certain difference in level no matter what the actual level may be. The next two 741s are acting as tuned amplifiers responding to the frequency represented by the pulse length. Finally, the two gates of the 7413 Schmitt input IC give line and frame pulses with good rise times.

Timebases

As it is essential to couple the coils directly to the amplifier it is convenient to work from positive and negative supply rails. Almost any power transistor pair will do for the output, AD161/AD162 and AC187/AC188 have been used with suitable heat sinks. The simpler circuit designs have used driven timebases where the actual sync pulse is used to discharge a capacitor which has been charged through a variable resistor which connects it to the supply rail. The author much prefers the self-oscillating timebase and the one shown in Fig. 8 has the added advantage of superior linearity. Tr1 acts as a constant current source to charge up C1 at a constant rate; when the voltage across C1 reaches the trigger voltage of the unijunction Tr2 this will "fire" and discharge the capacitor. Tr3 is an emitter follower which presents low loading to the capacitor and the linearity is extremely good provided a good quality capacitor is used for C1. For line frequency a 0.22uF polyester one is suitable and for frame frequency a 10uF polycarbonate type is preferable; electrolytic types are not very good from a leakage point of view.

FIG 8 TIMEBASE FOR S.S.T.V.



C1 ·22 LINE.—10µF POLYCARBONATE FRAME.
C2 ·02 " ".— " TANTULUM " "

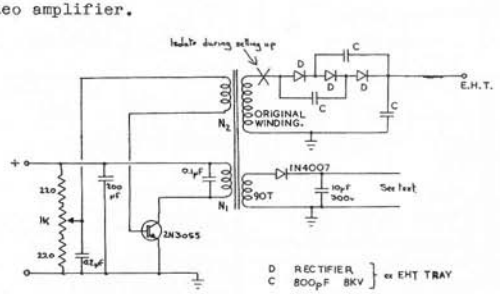
If any spurious pulses manage to get through the sync circuits the unijunction will not respond to them during the early part of the sawtooth unless they have an amplitude equal to the amplitude of the sawtooth. This provides a measure of noise immunity in the line timebase. In the case of the frame timebase however, it is essential for the frame pulse to trigger the scan no matter at what part of the scan it occurs; the amplitude of the frame pulse must be large, and it may be necessary to have an amplifying stage for this purpose. The 741 op-amp is used as a driver for the power output stage and a shift current may be conveniently added as shown. The amplitude may be controlled by the potentiometer P2 or alternatively, the gain of the driver stage may be controlled by substituting a variable resistor for the 47K feedback resistor.

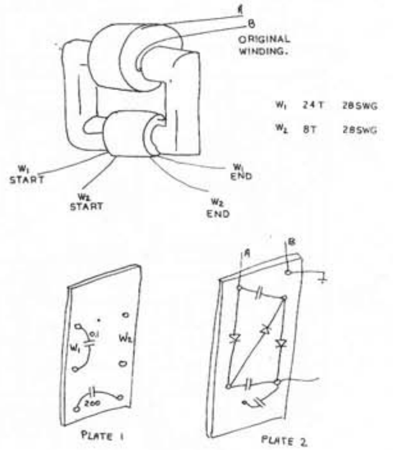
Deflection and Focus coils

This presents a slight problem to the amateur as the type of coil used to deflect the 5FP7 is no longer to be found in modern TV receivers. If you can get hold of a really old TV set the coils from this may possibly be suitable. The resistance of the coils should not be too low - 20 ohms is a good figure to aim for, but even if they are as low as 4 or 5 ohms the output stage of the timebase circuit will probably drive them, but the current taken from the power supply will be high. Remember that the coils which were parallel connected can be reconnected in series thus quadrupling the resistance. The focussing of the tube can be done with a permanent magnet or a focus coil or even a combination of both. The voltage of G2, nominally 250v, may also affect the focus. Some experimentation withthe position of the focus assembly may be helpful in overcoming any difficulties.

EHT Supply

As the line frequency of the SSTV system is so low, there is no possibility of generating flyback EHT as with a normal TV. A separate EHT oscillator has to be built for the purpose and a suitable circuit, described by G3LPB in C Q - T V No. 92 is shown in Fig. 9. G3LPB says that a standard TV line output transformer is dismantled and all windings discarded except the high voltage winding. The 2N3055 collector winding of 24 turns is wound onto the other limb of the transformer and, taking care with insulation, the base winding of 8 tunrs is added - both windings of 28 swg. On switching on, if oscillation does not immediately occur, the connections to one of these two windings should be reversed. The 90 turn winding shown in the diagram provides a +250v supply for G2 of the 5FP7 and, with suitable decoupling the lower voltage for the video amplifier.





Normal current at 6 Kv: 80 - 120 mA

FIGURE 9

Generating a Picture

The various methods of generating an SSTV picutre are:

i. Flying Spot Scanner using transmitted light (transparencies)
ii. Flying Spot Scanner using reflected light (cards etc.)
iii. Special types of TV cameras using Plumbicons or special Vidicons
iv. Modified fast scan TV camera with a sampler unit
v. Digital scan converter used with a standard unmodified TV camera

Methods i. and ii. may be used for cheapness and some excellent pictures have been produced by these methods. Method iii. has a lot to commend it but Plumbicon tubes are very expensive and not easily obtained. Method iv. has the disadvantage that the camera has to be turned on its side and internally modified. Method v. gives such excellent results and as it can be used with any TV camera the author is sure that this will be the method of the future and makes no apology for presenting a design by DL2RZ see Figs. 10 to 13.

FIG 10

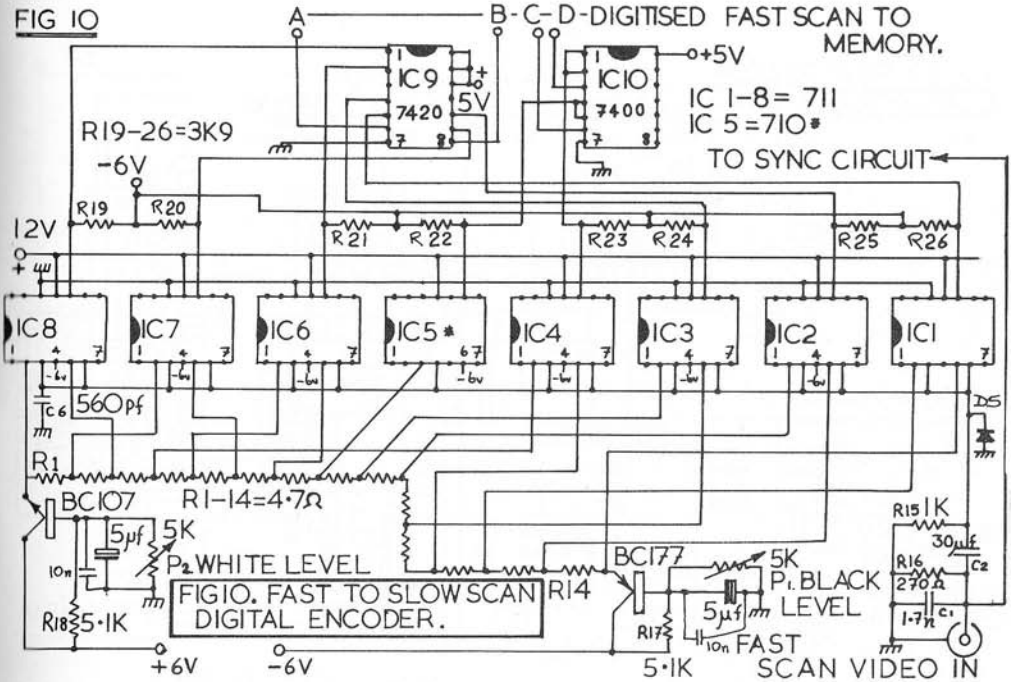


FIG10. FAST TO SLOW SCAN DIGITAL ENCODER.

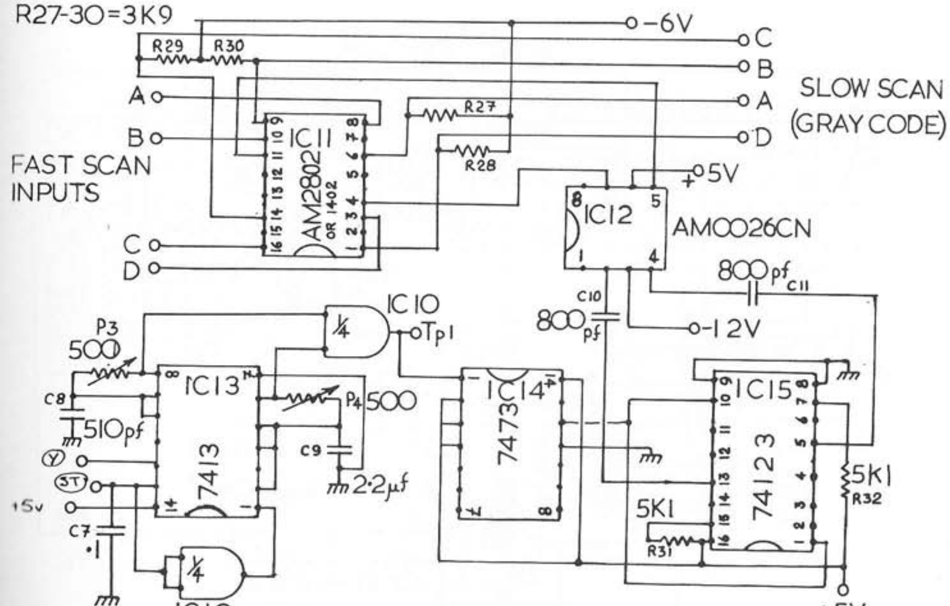
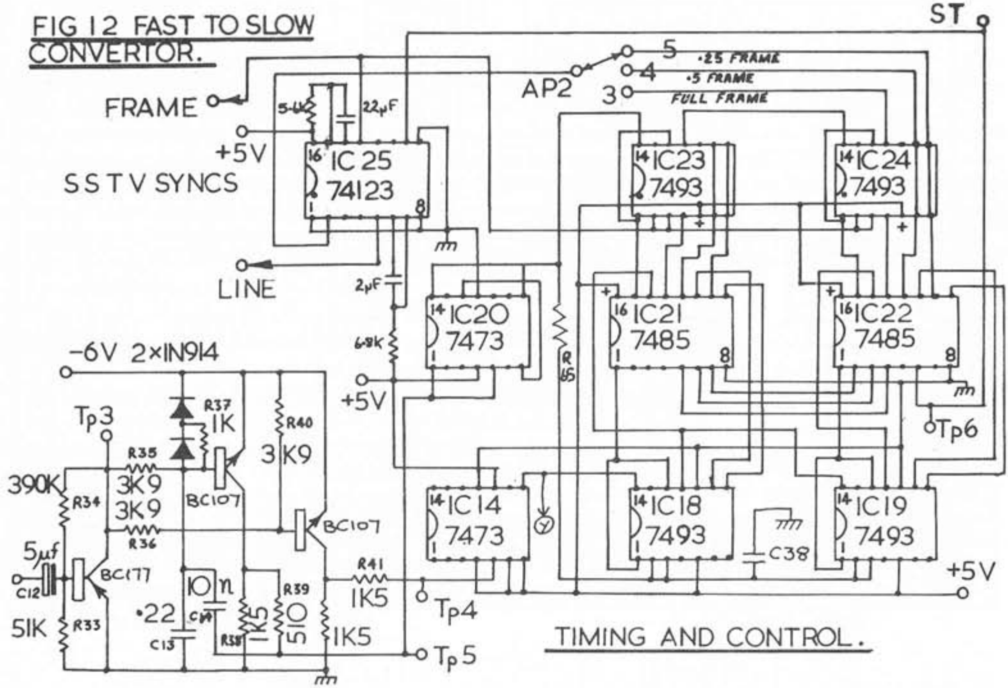


FIG 11.

FAST TO SLOW SCAN CONVERTOR MEMORY & CLOCKING

FIG 12 FAST TO SLOW CONVERTOR.



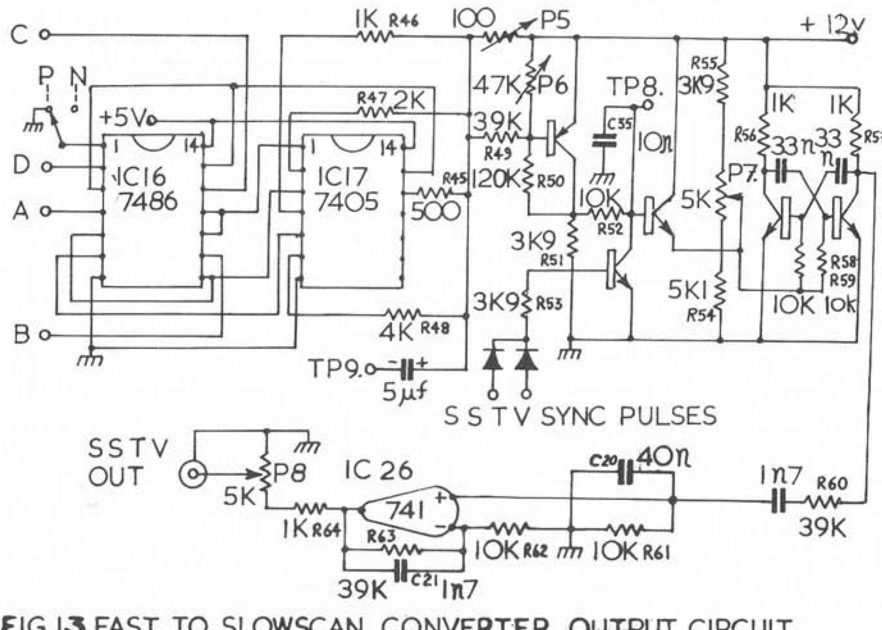


FIG 13 FAST TO SLOWSCAN CONVERTER OUTPUT CIRCUIT.

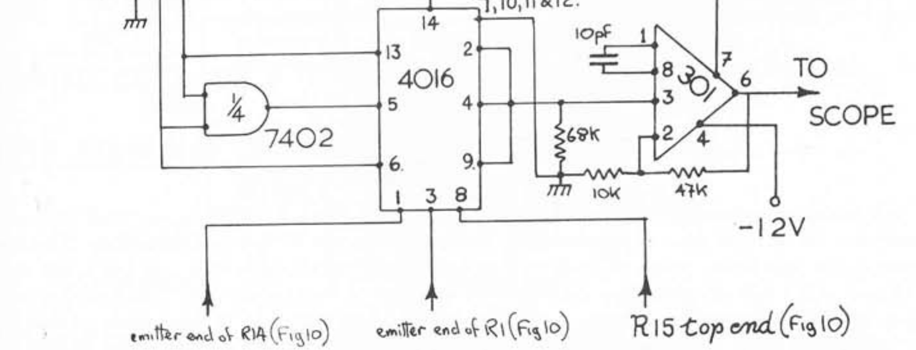
The incoming waveform is applied to a string of comparators which are also fed from a resistor chain. The outputs of these are encoded by IC9 and IC10 to give a digital representation of the video signal in Gray code. The actual levels of white and black may be set by P2 and P1.

The digits are fed to four 256 bit shift registers - IC11 - which is driven by a special clock driver IC12. IC13 generates both fast and slow clock frequencies and these are selected in turn by the signal (St). The principle of operation is that one line of video is clocked into the shift registers by the fast clock, then during the next three frames it is clocked out slowly to generate a slow scan line. The next line to be fed into the store is 2 lines further down the fast scan picture so the 128 slow scan lines are selected from the first 256 lines of the fast scan picture. 50Hz frame pulses are divided by 3 in IC20 to give the slow scan line rate and the fast scan line pulses are divided by 2 in IC14. These two signals are then connected in the 7493 counter chains and equality is detected by the 7485's; this indicates a further line to be selected from the video and the signal (St) accomplishes this. The output from the memory is fed to a 7486 which renders the signal into binary code and also allows the selection of positive or negative pictures at will. The 7405, with its associated load resistors, regenerates an analogue signal across P5 which controls the amplitude of this signal.

Q9 and Q10 are connected as a voltage controlled oscillator and I.C.26 is a low pass filter to ensure that harmonics are not fed to the transmitter. P6 sets the black frequency, P5 the white frequency and P7 the sync frequency, but it should be noted that these are somewhat interdependent.

A circuit due to G8CGK for the correct adjustment of P1 and P2 is given in Fig. 14. This takes the line frequency and divides it by 3, the output of the divider suitably decoded, give three gating signals which are sequential. These signals are used to close three electronic switches in the 4016 and this presents to the output I.C., white level, video and black level in turn.

FIG 14 FAST TO SLOW CONVERTOR



When viewed on the oscilloscope running at the frame rate one sees the video waveform with a line above and one below; adjusting P1 and P2 will move these lines to enclose the waveform as shown in Fig. 15. The waveform over several lines is shown in Fig. 16.

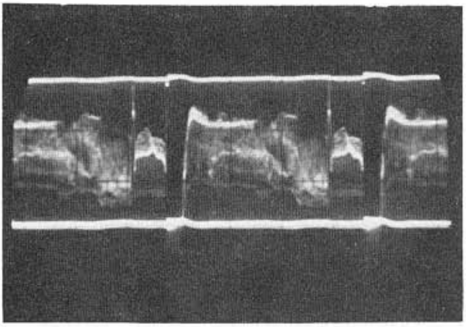


FIGURE 15

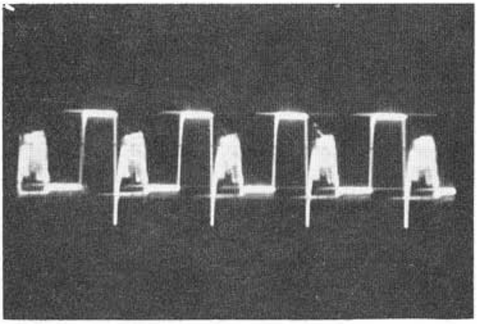


FIGURE 16

Correct Frequencies

It cannot be too strongly urged that an audio frequency spectrum analyser is an essential tool for the serious SSTV experimenter. As the range of frequencies to be measured is fairly small a simple circuit is possible when used with an oscilloscope for display. This will enable accurate setting of the three standard frequencies 1200, 1500 and 2300 Hz. A complete instrument is described in the "SSTV Handbook" published by "73 Magazine" and the circuit of Fig. 17 was inspired by this. The positive edge of the waveform triggers the first monostable of the 74123 and the trailing edge of the pulse is used to lock the oscilloscope timebase; the duration of the pulse thus provides a delay in starting the timebase. The negative edge of the waveform triggers the second monostable in the 74123 package which produces a short pulse whose position depends on the duration of the SSTV waveform - hence also on the frequency; Fig. 18 will make this plainer. The tops of the short pulses look like a dotted line and the position of the dots is related to frequency, a fact which can easily be checked by feeding an audio oscillator into the input of the circuit and watching the pulse slide across the screen as the frequency is raised.

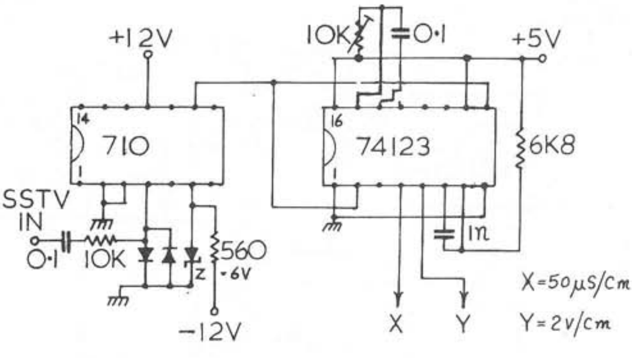
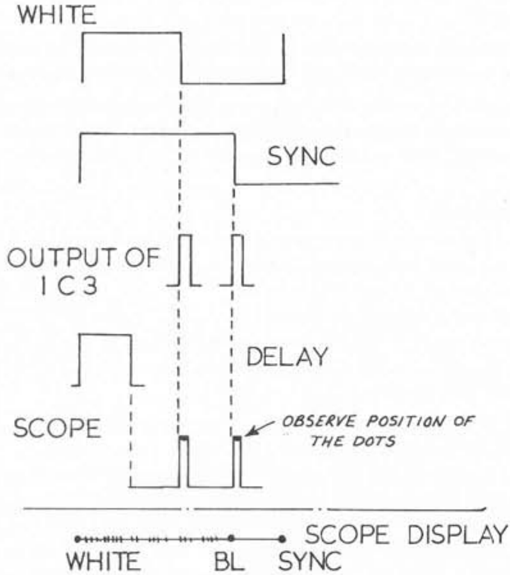


FIG 17. SSTV SPECTRUM ANALYSER.

FIG 18



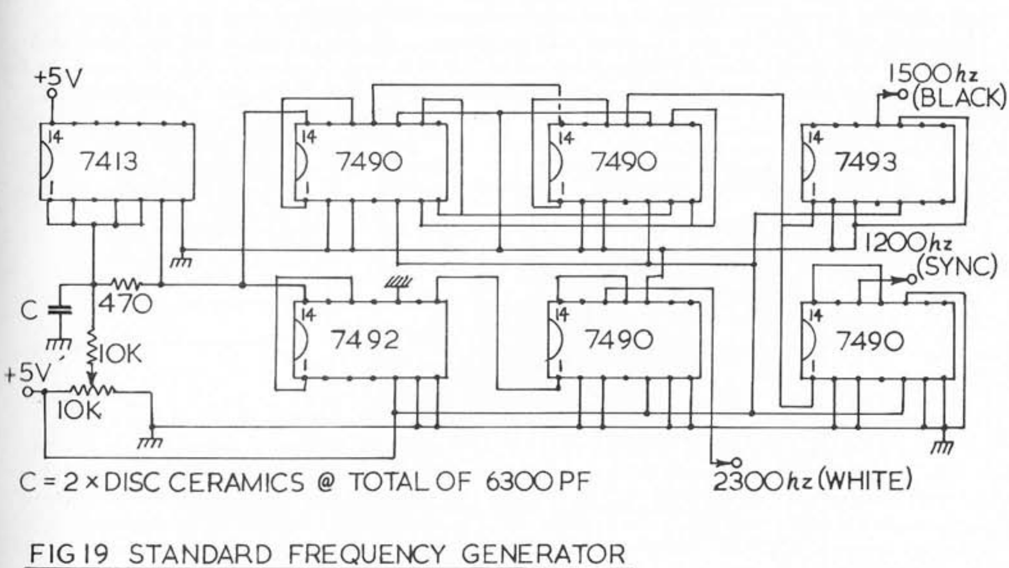


FIG 19 STANDARD FREQUENCY GENERATOR

An SSTV picture will give a display consisting of random dots between the white and black positions and a faint dot on the sync position; there should be only very occasional dots between black and sync positions. Calibration may be done with an audio oscillator or a standard frequency generator. This last piece of gear was described by the author in C Q - T V Nos. 85 and 86 and is shown in Fig. 19. The generator is based on a standard frequency of 276 KHz which can be obtained from a 7413 as shown or, with increased precision, from a crystal oscillator.

Division ratios are as follows:

276,000 ÷ 10 ÷ 12 = 2300

276,000 ÷ 23 ÷ 8 = 1500

276,000 ÷ 23 ÷ 10 = 1200

The ÷ 23 function is best done using two 7490 decade counters, detecting the presence of 22 and using this to reset to 99, one further pulse will then give 00.

It is suggested that the master oscillator may be accurately set on 276 KHz by the use of a communications receiver to pick up the 13th harmonic which is on 3.588 MHz, a frequency in the 80 meter amateur band.

Pulse and Pattern Generator

Further division of the 1200 sync signal gives accurately timed signals which can trigger monostables to give line and frame pulses. The division scheme is as follows:

1200 ÷ 9 ÷ 8 = 16$\frac{2}{3}$ Hz for 50 Hz mains areas or

1200 ÷ 10 ÷ 8 = 15 Hz for 60 Hz mains areas

Taking either line frequency, ÷ 15 ÷ 8 = 120 line picture or

÷ 16 ÷ 8 = 128 line picture.

Fig. 20 shows how this can be done.

It will be noted that the division is effected in much the same way as to make available square wave signals at line frequency (L), twice line frequency (2L), and four times line frequency (4L); also F, 2F and 4F for the frame frequency. These signals can be used to generate patterns as follows: the 4F signal is used as a switch to select the 4L or the inverted 4L signal and this produces a chessboard pattern when is used to switch between black and white. An early attempt at an entirely TTL pattern generator used the switching signal to gate the standard frequencies generated earlier. This proved to be unsatisfactory and was abandoned in favour of a system whereby the digital signals are converted to analogue form and are then used to control a VCO. This has the advantage that by adding L, 2L and 4L signals one can generate 4 step or 8 step grey scales which are very useful for setting-up purposes. Fig. 21 shows how the chessboard is generated and how the 4 bank 5-way switch is wired up to give 1. black raster,

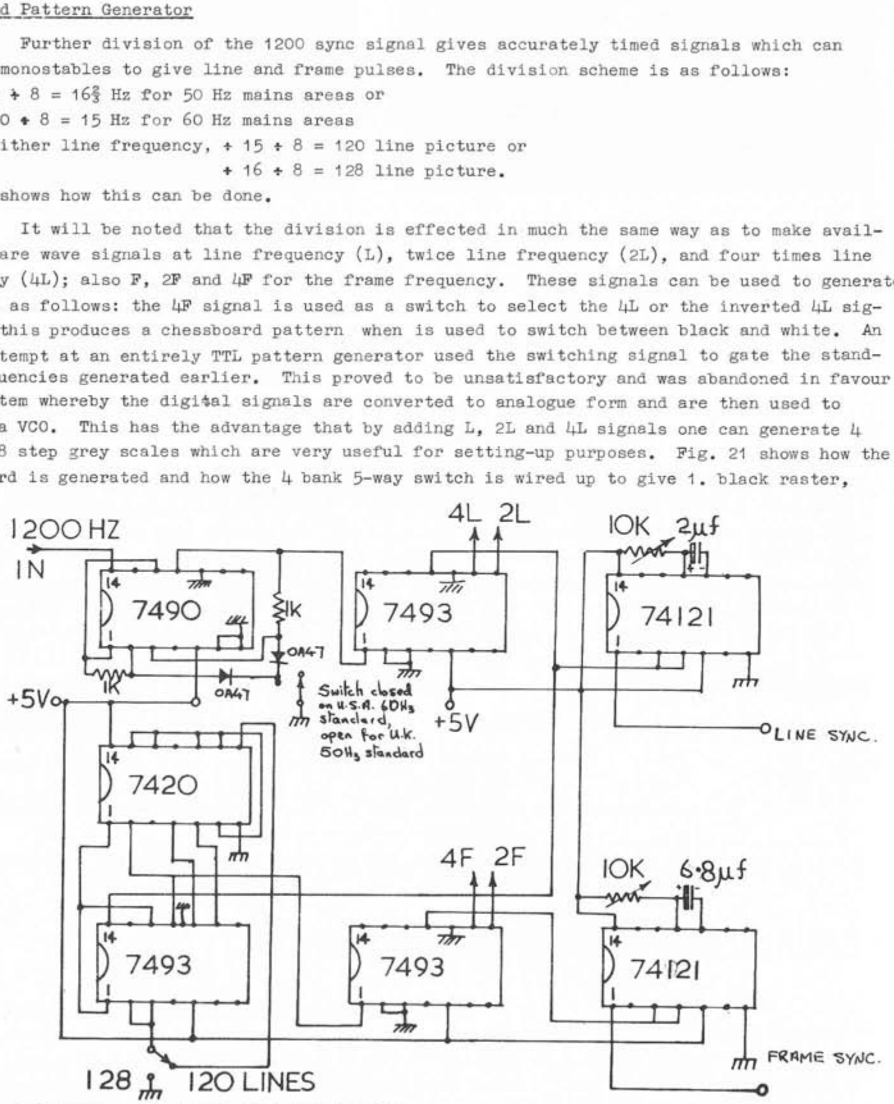
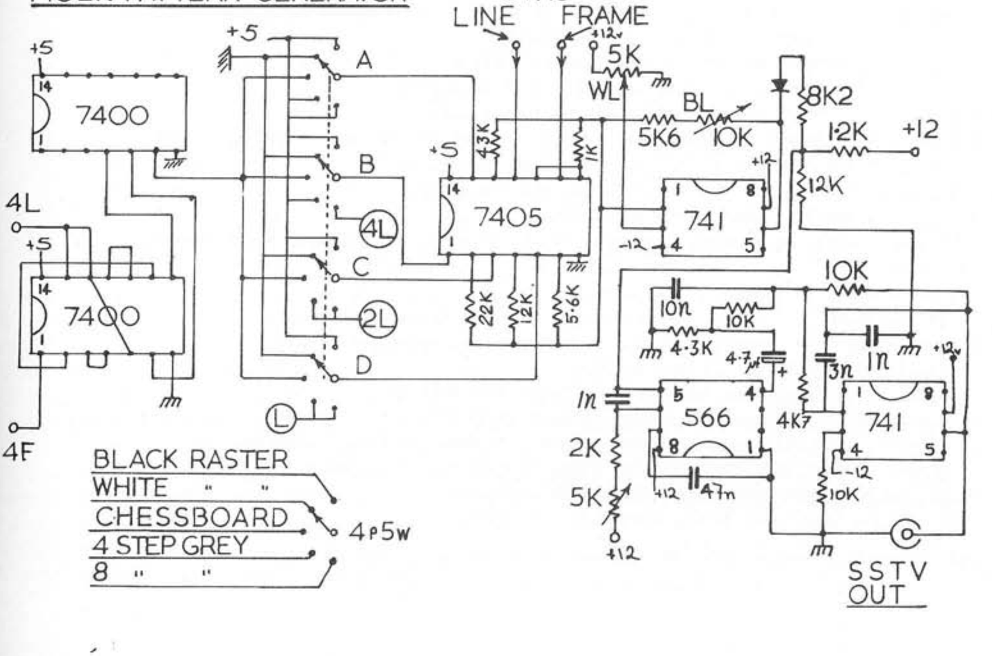


FIG 20 PULSE GENERATOR

2. white raster, 3. chessboard, 4. 4 step grey scale, 5. 8 step grey scale. The grey scales do not extend fully up to the white, if 16 levels are available with the 4 bit binary representation then 0 is black level and level 15 is white. The 4 step scale gives 0,4,8 and 12; while the 8 step scale gives 0,2,4,6,8,10,12 and 14, but as the step is only $\frac{1}{8}$ of a line long the first step is lost in the sync pulse. Nevertheless, the equally spaced steps of grey are of considerable assistance when adjusting the contrast and brightness controls of the monitor.

The 7405 open collector I.C. with its associated load resistors, which are in the ratio 8:4:2:1 for the digital inputs, generates an analogue signal which, after addition of sync pulses, is used to control the frequency of the 566 voltage controlled oscillator. The final 741 is used as a low pass filter.

FIG 21. PATTERN GENERATOR



Final Note

SSTV is a growing aspect of amateur radio and it is impossible to cover all aspects in this short chapter, but from a careful study of transmissions in the 20 metre band it is fairly obvious that a lot of SSTV operators are unaware of the potential of the system. One German amateur put it succinctly when he said that "SSTV operators are anxious to send RTTY!" Anyone setting up an amateur SSTV station would do well to ask themselves "What visual material can I send which could not otherwise be sent through a normal radio channel?" Clearly photos of the operator and his family, his shack, his house and garden and general views of the locality will be of great interest to the viewer at the other end. Scribbled information such as "FB 5 and 9" or "WX SUNNY" can be better transmitted by normal speech, though if illustrated with amusing cartoon drawings it would be eminently suitable for SSTV.

Circuit diagrams are also of interest but are rather difficult to transmit unless they are drawn with a wide pen and even then, it is often possible to transmit only a portion of a diagram. The use of close-up lenses on the camera (or a zoom lens for the affluent) enables smaller photos, diagrams and test cards to be used and this makes for a compact layout in the shack; a properly designed illuminated stand will also ensure good pictures. A single lamp placed at one side is not sufficient as the level of illumination will vary across the picture, a fact which the camera will notice even if the eye does not. In general, experiment with this new means of communicating and enjoy your SSTV!

REFERENCES

C. Macdonald "QST" Aug & Sept 1958, Mar & April 1960 original AM system
"QST" Jan & Feb 1961 FM system.
"QST" Mar 1964 Compact valve monitor.
"QST" June, July, Aug 1965 Vidicon camera.
Don Miller "CQ" August 1968 Sampling techniques.
Ake Backman "Radio Communications" Feb 1971 SSTV Monitor (see also July 1976)
R.F.Stone W3EFG "Ham Radio" July 1971 Sampling converter.
R.Tschannen WQLUO "QST" March 1971 solid state monitor.
E.Goodwin G3MNQ "Spacemark" SSTV Monitor.
Bert Arnold G3RHI "Slow Scan Television 1st & 2nd editions, B.A.T.C. Publications.
Bert Arnold G3RHI "C Q - T V" No. 81. Flying Spot Scanner.
SSTV Handbook "73" Magazine. Editors
R. Suding WØLMD "73" Magazine. December 1972. Audio Spectrum Analyser.
Winkler W6WMI "73" Magazine. March 1973. Mechanical print out system.
D. Plant "CQ" May 1973 "SS Mark A" Monitor.
R. Taggart "73" Magazine August 1973. Basic SSTV Monitor.
R. Suding WØLMD "73" Magazine August 1974. Fast to Slow Scan Converter.
J. Pietsch "ATA International" Nos. 12 and 13. Sampling Scan Converter.
G. Steber WB9LVI "QST" March and May 1975. Slow to Fast Scan Converter.
R. Suding WØLMD "CQ" September 1974. SSTV Keyboard.
T.M. Ellison "QST" July 1974. Character Generator.

See also "International ATV-SSTV-FAX Bibliography", published by K6IIS,
17576 Pinedale Avenue, Fontana, California 92335 U.S.A.

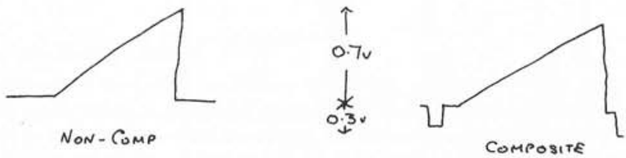
chapter 10

COLOUR TV.

by Nigel Walker G6ADK/T G8AYC

This chapter will deal with how an Amateur may construct equipment for use with the U.K. standard colour system, i.e. PAL. It is not intended to give a deep theoretical study of the system as this is adequately dealt with in a number of textbooks that are available. The basic principles, however, will be outlined.

Anyone working with monochrome television will know what its waveform looks like:



Now, what about colour? Well, there are basically two forms a colour signal can take. The first of these is very easy to understand and consists of three non-composite signals. Each one of these signals looks just the same as the non-composite monochrome 0.7v p-p signal pictured above. One of these signals is allocated for red, one for green and the third for blue. By varying the amplitude of these three signals it is possible to produce any colour the TV system is capable of reproducing. For instance, if a signal was present on the red channel only then a red picture is produced. If equal amplitudes of say, red and green were generated, a yellow picture would result. A peak white signal would be produced if the red, green and blue channels were all fed with 0.7v of signal. Furthermore, if the red, green and blue amplitudes were kept equal, it would be possible to display any amplitude monochrome signal. i.e. if R=G=B, a monochrome signal will always be produced. Thus, our colour equivalent to the waveform shown earlier, to produce a monochrome sawtooth on a colour monitor is:

RED GREEN BLUE

Note that the RGB form of colour signal is <u>always</u> non-composite. Thus to feed a colour monitor you have four wires; red, green, blue and syncs.

<u>A Colour Bar Generator</u>

When setting up colour signal equipment some kind of test waveform is <u>essential</u>. The commonest form of waveform is 'colour bars' which is used mainly to align colour coders and decoders. A colour bar generator produces 0.7v square waves in such a way that, across the television line all the primary and secondary colours and black are produced in sequence. The bars are normally arranged in order of decreasing brightness levels across the line. The waveforms are shown in Figure 1.

Figure 2 shows a circuit for generating the colour bar waveform. It uses the outputs of the last three divide by two in the 74193 to generate the desired waveform. This particular integrated circuit was used for two reasons. Firstly, it is a synchronous divider, which means that all the waveform transitions occur at the same time. Secondly, it is used in the 'count down' mode to produce the correct sequence of the bars, i.e. after reset, first count produces all 1's etc. The two transistor output stages produce glitch-free 0.7v outputs into 75 ohms.

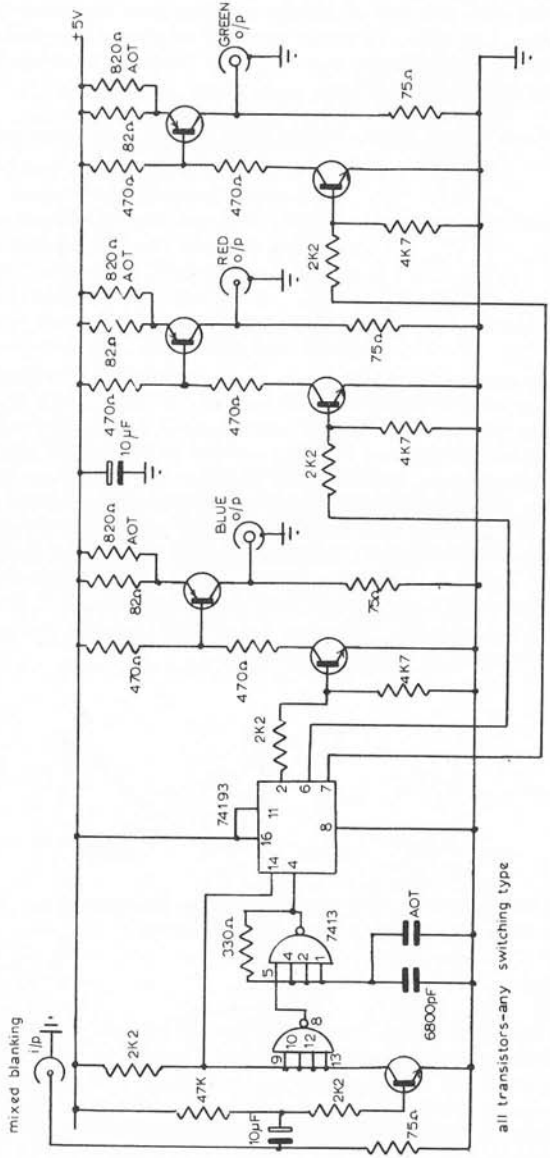


Fig. 2 Colour bar generator

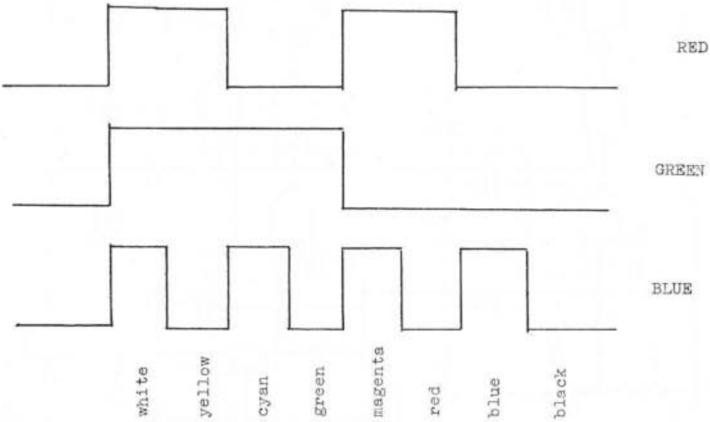


Fig. 1

Generation of Colour Images

Naturally the point of colour television is to reproduce live scenes in colour with the aid of a suitable camera. A colour camera is a fairly complicated device to make and imposes some difficult problems especially on the optical side. For this reason we will look into other methods of producing colour pictures which are not of live scenes, but do give some interesting results.

The generation of colour pictures electronically is called "colour synthesis" and embraces a variety of techniques. The colour bar generator described previously represents a single form of colour synthesiser which just generates different coloured verical bars.

It is a fairly simple matter to generate colour captions using an ordinary black and white television camera. In the simplest case, one could feed the output of the camera into the green(say) input of a colour monitor, and leave the red and blue inputs open. This would then produce a green and black caption on the monitor. One could go a step further by looping the output of the camera through the green input of the monitor and on to an inverting amplifier, and after reblanking, feed that output to the red and blue inputs to the monitor. This would then produce a green caption on a magenta background. The set-up is shown in Fig. 3.

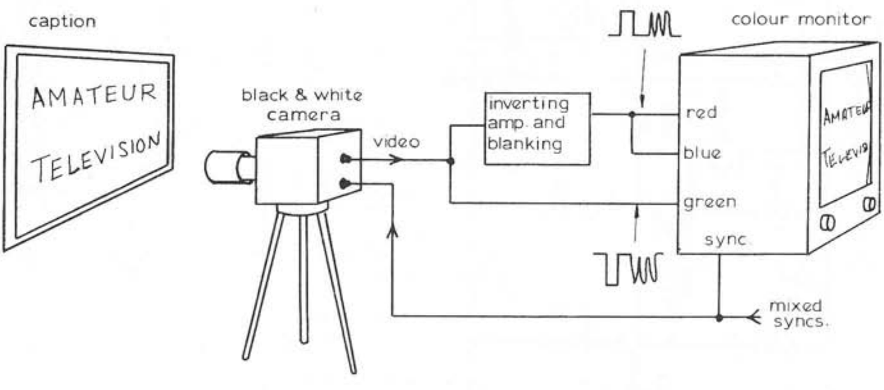


Fig.3 A simple way of making a colour caption

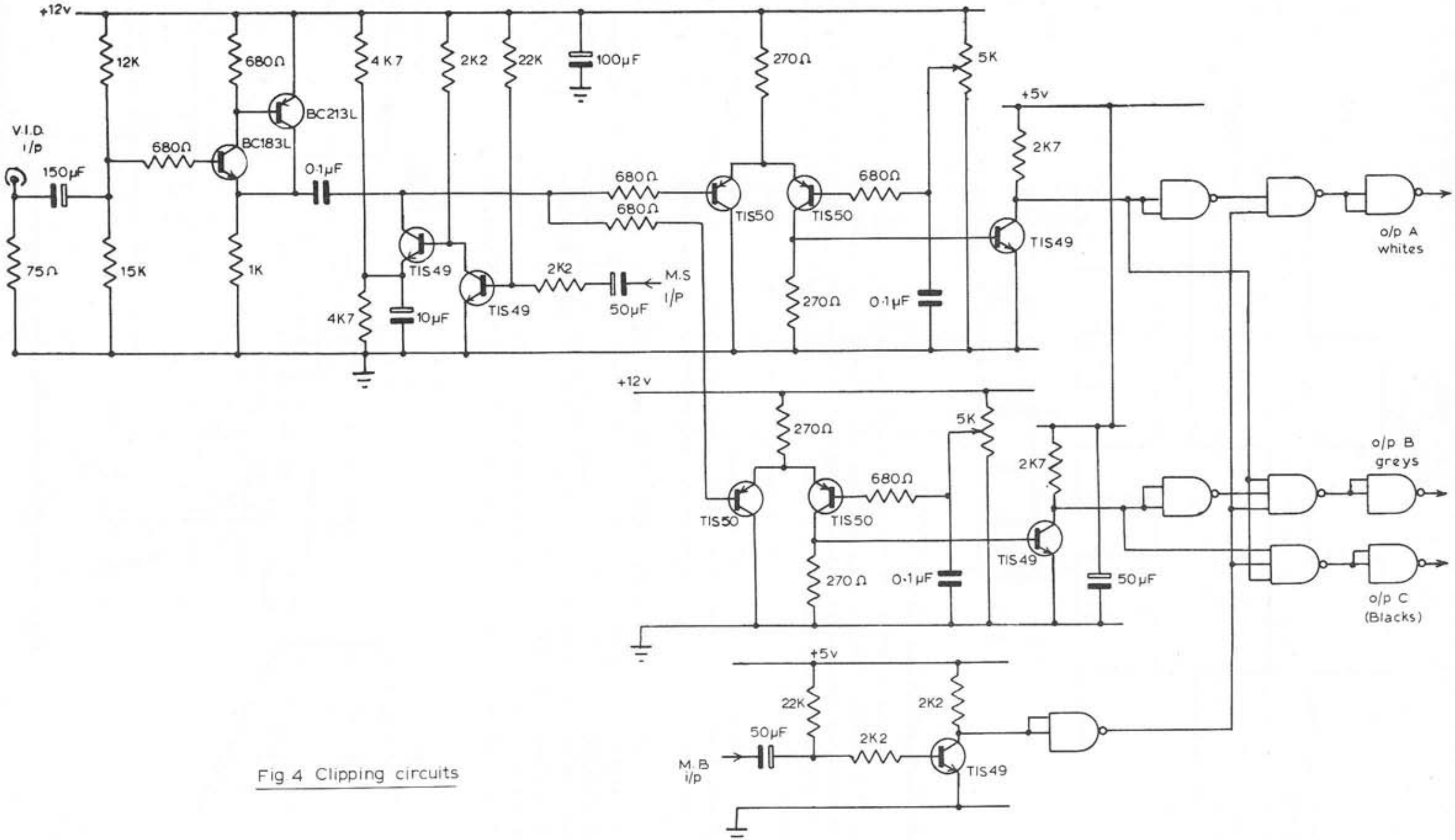


Fig 4 Clipping circuits

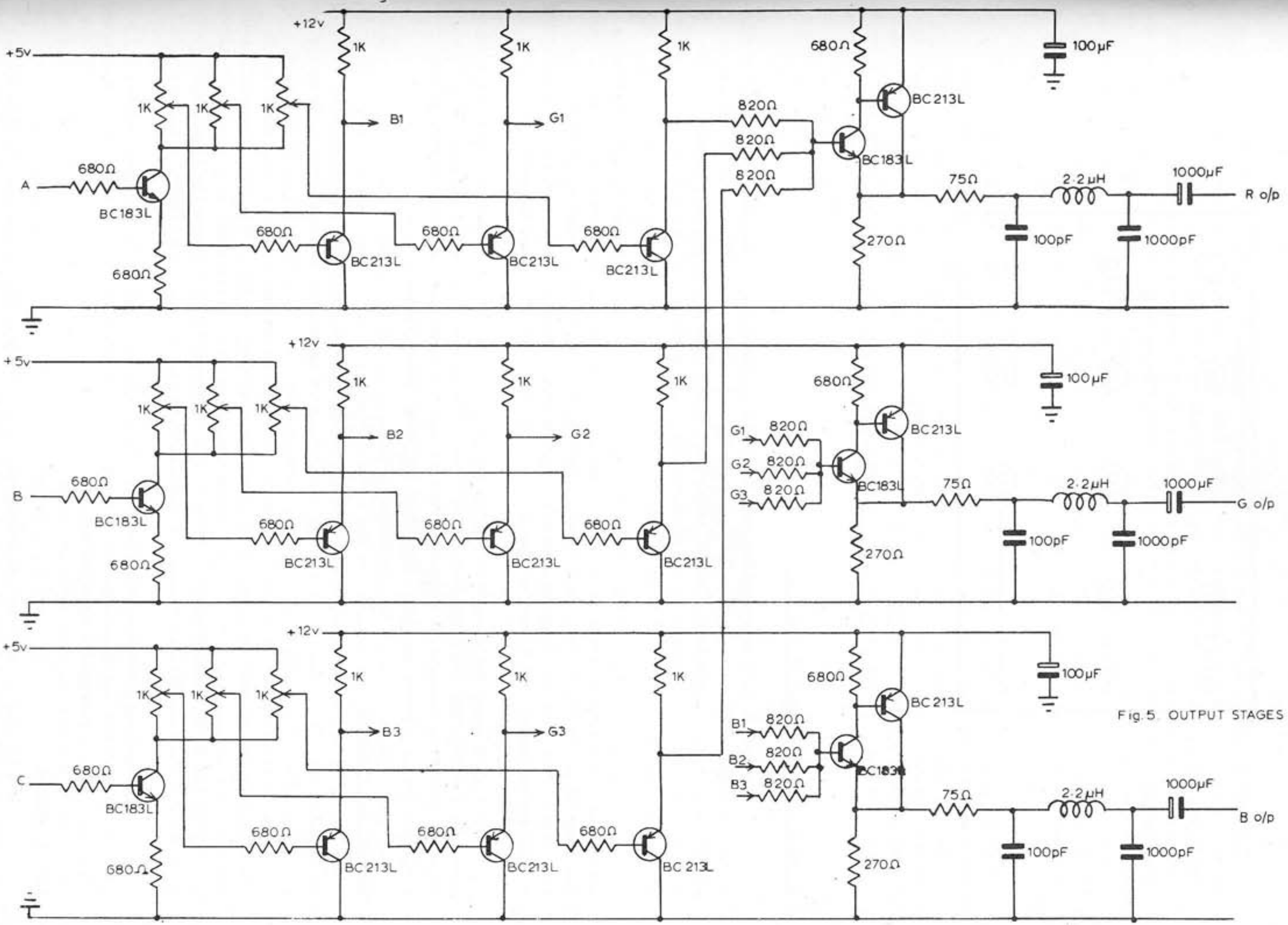


Fig.5. OUTPUT STAGES

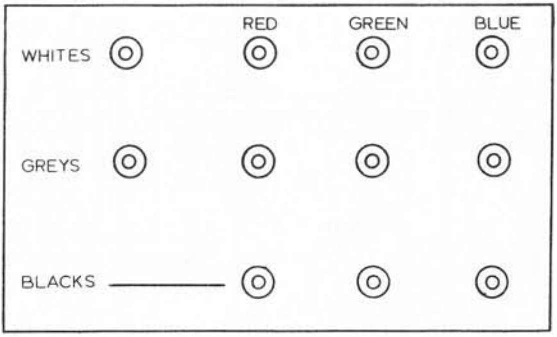


Fig. 6. Front panel layout for 3 level synthesiser

A Three Level Colour Synthesiser

The method just described represents a very crude method of synthesising colour captions. The synthesiser to be described provides an infinitely variable control of the colour of the caption and independantly of the background. In addition it generates a third colour corresponding to the mid-greys in the picture. It incorporates clipping circuits to define the switching point which also 'crispen up' the caption.

Fig. 4 shows the circuit of the clipping circuits. The unit accepts a non-composite monochrome input from a camera or any other source. The vieo is first clamped and then fed into two long-tailed pair clippers. One clips at near white level and the other clips at the mid-grey level. The outputs of the clippers feed gating circuits which produce outputs corresponding to the whites, greys, and blacks of the picture. The gating also blanks the waveform.

Fig. 5 shows the circuit of the output stages. The output of each clipper feeds three pots; one for red, one for green and one for blue. This makes three sets of three RGB pots all together providing independant control of the colour of the whites, greys and blacks of the picture. Fig. 6 shows a suggested layout of the front panel controls.

Coding and Decoding

Up to now we have only dealt with the colour television signal in its RGB form where it differs little from monochrome signals except that it is done in threes. This form of signal is suitable if you have one source feeding a RGB monitor. Undoubtedly this is the best system as the signals do not become distorted due to any deficiency in the coding-decoding circuits. If the colour signal needs to be transmitted over the air or fed into a domestic receiver (via a modulator), or if there are several sources to be switched or mixed, then the RGB signal has to be coded. The process of coding produces a single composite signal which provides all the information necessary to reconstitute the original RGB signal, after decoding.

As said earlier, a rigorous account of colour theory will not be made, however, a rough outline of how the PAL system was developed will be given as this will assist in the understanding of the operation of the coder and decoder.

The Y Signal

Use is made of the very important fact that the human eye cannot resolve fine colour detail, only detail in terms of brightness, irrispective of colour. Now, in a monochrome system there is already a signal which defines the brightness of a scene. This signal (the normal video output of a monochrome camera) is of sufficient bandwidth to define the fine detail of the scene. In colour terms, this signal (the black and white information) is called the <u>luminance</u> signal and is usually given the symbol Y. To produce a compatible composite colour signal, the colour information must somehow be added to the Y signal. The various colour systems, such as SECAM, NTSC and PAL all use some form of r.f. modulation of a carrier which is then superimposed on to the Y signal. Now use is made of the fact, stated earlier, that the colour part of the signal need not be of such a wide bandwidth on the Y signal. In practice, the Y signal bandwidth is of the order of $5\frac{1}{4}$MHz whereas the additional colour information has a reduced bandwidth of $1\frac{1}{2}$MHz.

We have an RGB colour source, how do we get the Y signal and colour information from these three wires? Each colour has its own brightness level, and the red, green and blue signals all contribute to the brightness levels of the scene. Therefore, by adding together defined proportions of the RG and B signals it is possible to obtain the Y signal. The actual relationship is $Y=0.299R + 0.587G + 0.114B$ so we can drive the Y signal with the circuit shown in Fig. 7. So with this we can observe the monochrome component of the RGB signal with a black and white monitor or oscilloscope.

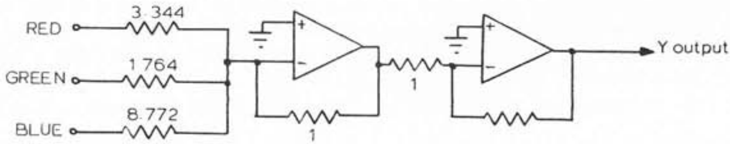


Fig.7 Generating Y from R,G, and B

Colour Difference Signals

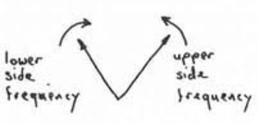
As we have now obtained a luminance signal the colour information must be derived and somehow added onto this signal. There is no point in including the Y signal in the colour information. Therefore the Y signal is subtracted from the RGB sources to provide signals containing only the colour information. Thus the colour signals produced are R-Y, G-Y and B-Y. These are aptly called, colour difference signals.

If it is studied, it can be seen that it is only necessary to transmit two of these signals in addition to the Y signal and the necessary information will still be recovered. This becomes apparent by studying the following relationships:
Suppose we transmit Y, (R-Y) and (B-Y), then at the receiver we can obtain R and B by

$$R= (R-Y)+Y =R$$
$$B= (B-Y)+Y =B$$

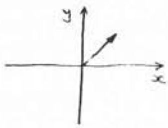
but Y = R+G+B. Thus the green signal can be obtained from the other three signals, i.e. G=Y-R-B. So what we have said so far it is necessary to transmit two additional signals for colour: B-Y and R-Y each having a bandwidth of 1.5MHz. The PAL system is an adaptation of the NTSC system, so for the moment we will look at the NTSC system and afterwards explain how it has been modified into PAL to get over some problems associated with its use.

To add the colour signal onto the Y signal they are modulated onto a carrier. To explain how this is done, first consider a double sideband suppressed carrier system modulated with a sine wave source. Below are shown vector diagrams of the modulator output. (These diagrams are rotating at the carrier frequency).



The resultant signal is seen to have a phase which is either 0° or 180° with respect to the carrier. The amplitude is a function of the modulating signal voltage and its phase (0 or 180°) is a function of the polarity of the modulating signal. A second DSB modulator fed with a different modulating signal and a carrier 90° out of phase with the original producing a resultant vector as shown below:

The outputs of the two modulators can now be added together. This produces a resultant signal of variable amplitude and phase;



As the two components, x and y, are in quadrature it is possible to demodulate them back into two independant signals. This is achieved with two synchronous demodulators working in quadrature (i.e. fed with ϕ and 90° subcarrier). In the NTSC system the (B-Y) signal is modulated onto the x axis and (R-Y) onto the y axis. Fig. 8 shows in block form how the colour signal is generated. A big advantage in using a suppressed carrier form of modulation is that the lower the colour content of the picture (saturation) the lower is the amplitude of the subcarrier, and in fact, in the absence of colour, the subcarrier disappears completely and the signal reverts back to its monochrome form. This fact is important as the subcarrier is within the video band and results in patterning on the television screen. The spectrum of the colour signal is

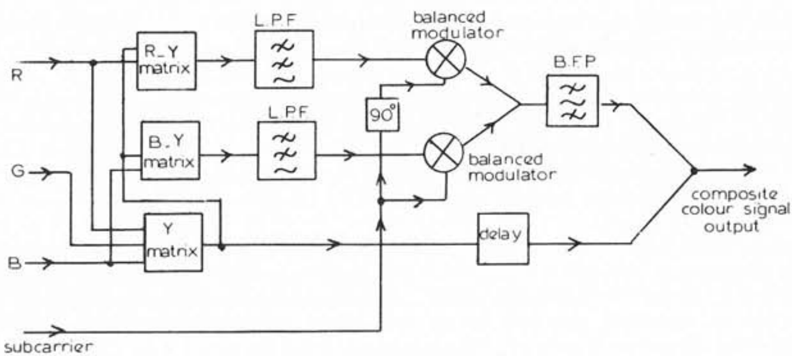


Fig 8. Simplified block diagram of NTSC coder

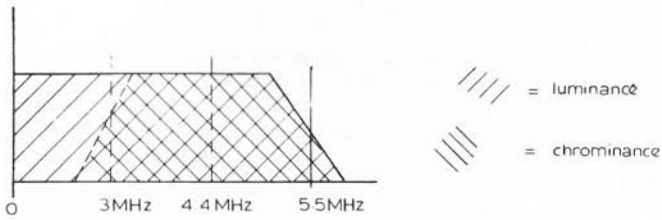


Fig. 9 The spectrum of an encoded colour signal

shown in Fig. 9 and illustrates how the chrominance occupies the upper part of the luminance bandwidths.

Regenerating the Subcarrier

So far no mention has been made as to how the subcarrier for the decoder synchronous demodulators is obtained. Well, at the coder a 'burst' of subcarrier is added to the signal as within the back porch period in NTSC the phase of this burst is constant and is on the -(B-Y) axis. At the decoder a phase locked loop is used comprising of a varactor controlled crystal oscillator and a gated phase detector. The phase detector is arranged to compare the phase of local and received subcarrier only during the period of the burst. This is called the Burst Locked Oscillator. Fig. 10 shows the arrangement for decodeing the composite NTSC signal.

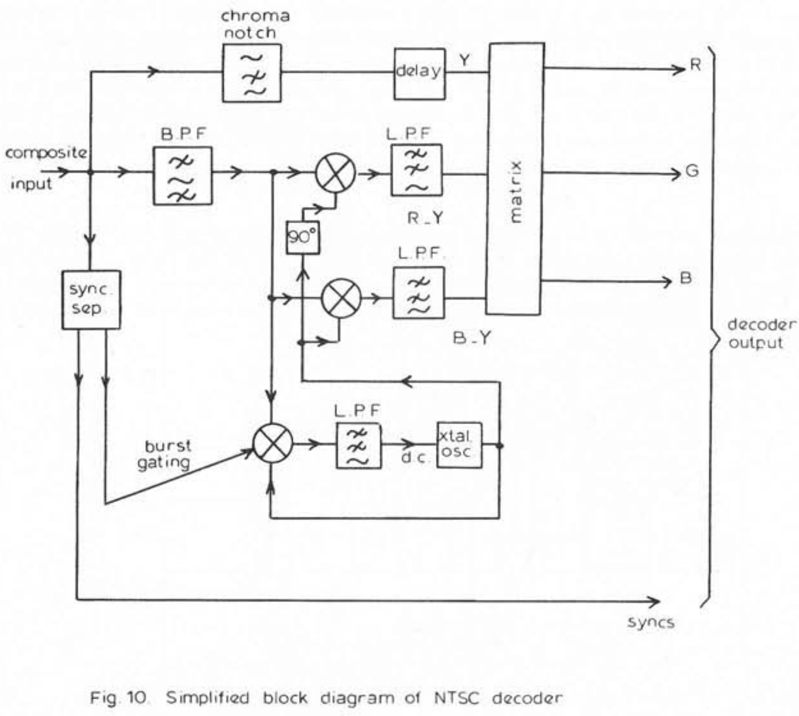


Fig. 10 Simplified block diagram of NTSC decoder

The PAL System

Everything that we have talked about in the NTSC system is identical to PAL. The PAL system has, however, one distinct difference. In this system the R-Y axis is reversed in polarity on alternate lines, at the coder. In the decoder, the subcarrier feed to the R-Y demodulator is reversed in phase in step with the coder. It can be seen that this arrangement produces exactly the same signals as before. So what's the point? There is a distortion which a colour signal can suffer which is termed differential phase. This is the effect whereby the phase of the subcarrier component varies depending on the level of the luminance signal it is sitting on. This means that a colour object in the picture could well have the "wrong" phase with respect to the burst which is sitting at black level. In NTSC this error would result in an incorrect colour being reproduced. In PAL on a given line we have (assuming we have picked the right one out of the two) an identical situation as in NTSC where incorrect colour is reproduced. Observing the next line, the signal suffers the same phase error but, as the axis of R-Y has been reversed, this results in a colour error in the opposite direction to the preceeding line. This means taking the average of two consecutive lines results in the correct colour being reproduced. In a single system this averaging can be achieved by observing the picture at a distance where two lines tend to merge and the averaging is done by the eye. If the errors are too great, an effect called 'Hanover Bars' results produced by large colour differences on alternate lines. To overcome this problem the signals on alternate lines are averaged electronically. This has the requirement that the signals from two lines be available at the same time which means a one line delay has to be used. Fig. 11 shows how this is done. The arrangement shown also provides a rough separtion of the signal into its R-Y and B-Y components prior to the synchronous demodulators.

Ident

The alternating subcarrier feed for the R-Y demodulator is derived from a balanced modulator which is switched by a 7.8KHz ($\frac{1}{2}$ line frequency) square wave. This is obtained by dividing separated line syncs by two in a flip-flpp. With this arrangement there is a 50/50 chance that the flip-flop will start in the wrong phase. To prevent this from happening, the burst at the coder is made to swing + and - 45° about the -(B-Y) axis. The decoder has circuits to detect the phase of the first and set the divide by two into the correct phase. The time constant of the burst locked oscillator loop is made sufficiently long to make the oscillator lock to the average phase of the burst, i.e. the -(B-Y) axis.

The other circuit usually built into a decoder consists of a 'colour killer' which switches off the chrominance circuits when no colour is present on the input. The colour killer usually detects the presence or absence of a signal in the ident circuitry. Additionally the burst cignal is blanked, otherwise it would appear as an incorrect pulse at the output, during the blanking period.

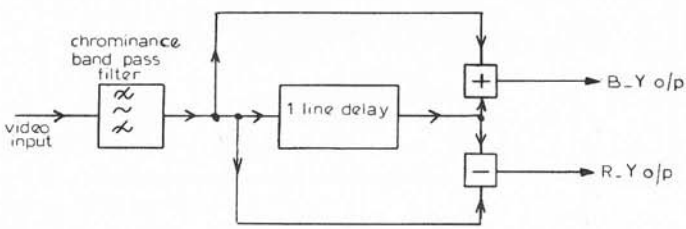


Fig.11 The arrangement in a 'Delay line' PAL decoder

A PAL Coder

Having outlined the principles of the PAL coding and decoding systems, a coder will now be described.

Fig. 12 details the luminance stages. The red, green, blue and syncs are resistively added at the input to provide a composite luminance signal. An emitter follower then drives a delay line. This line is a conventional decoder type which can be obtained relatively cheaply

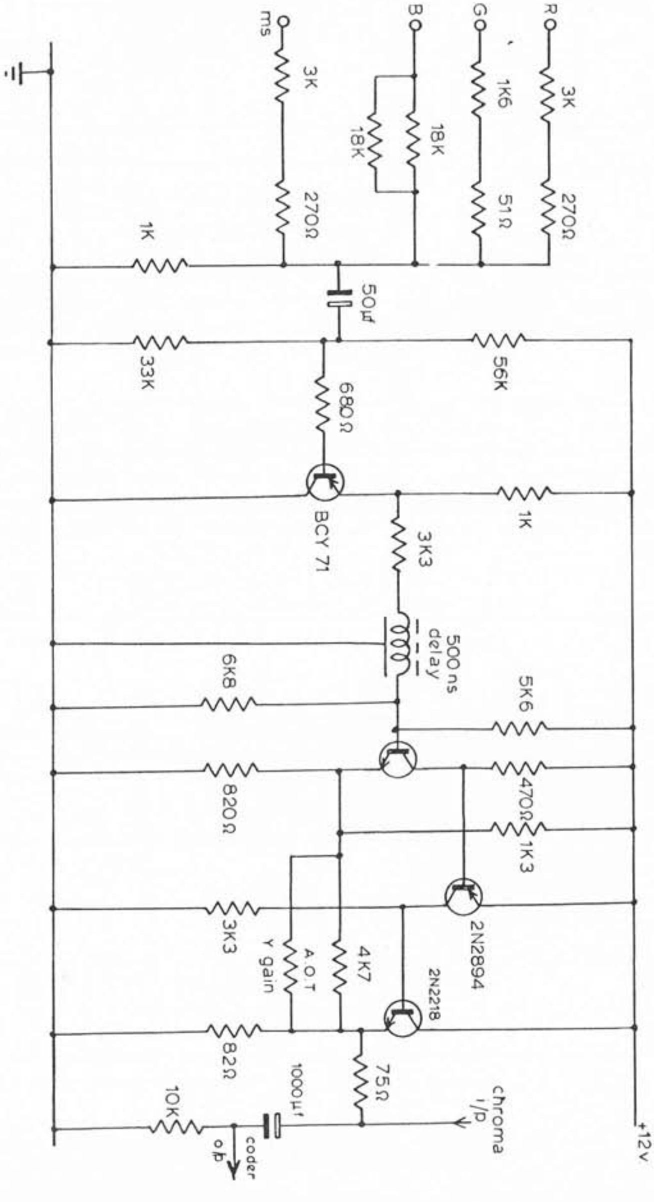


Fig. 12 Luminance stages

As an alternative a 'lumped constant' block delay line can be used by changing the terminating impedance. After the delay line is an amplifier to bring the signal amplitude up to 1 volt into 75 ohms. Having built the luminance part of the coder this can be tested straight away by feeding appropriate inputs and viewing the output on a monochrome monitor.

The rest of the coder processes the colour part of the signal and adds it to the luminance at the output. Fig. 13 and 14 matrix the red, green, blue and burst gate signals into -(B-Y) and -(R-Y) respectively.

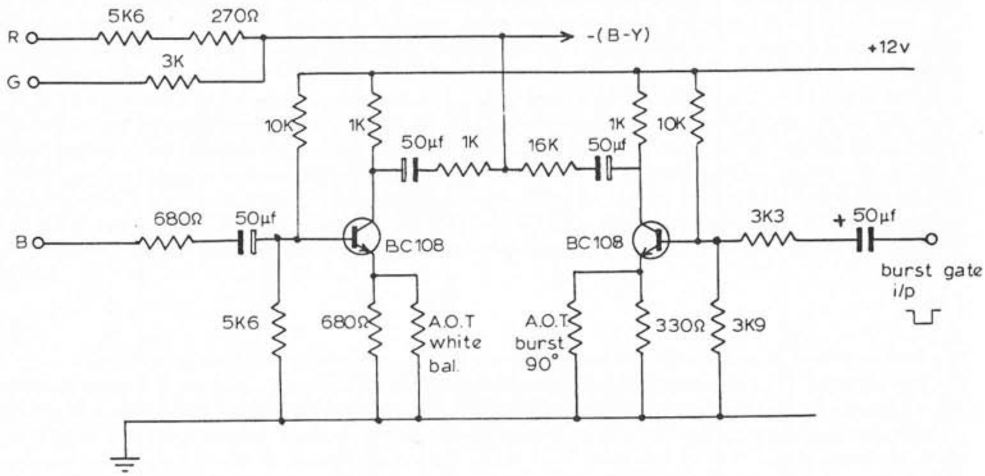


Fig.13. B-Y matrix

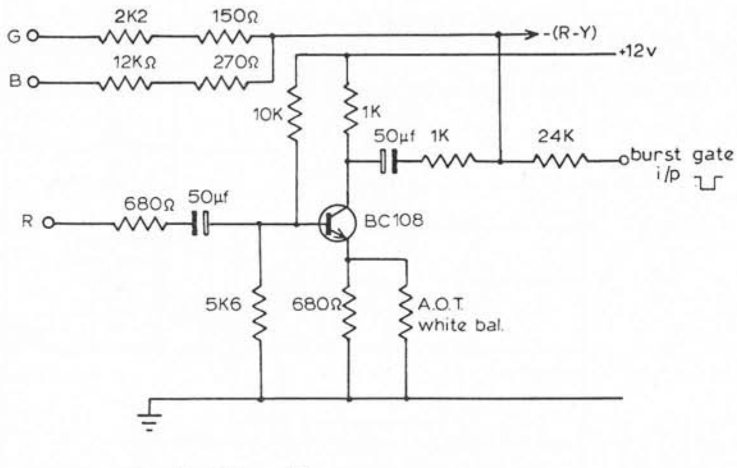


Fig 14. R-Y matrix

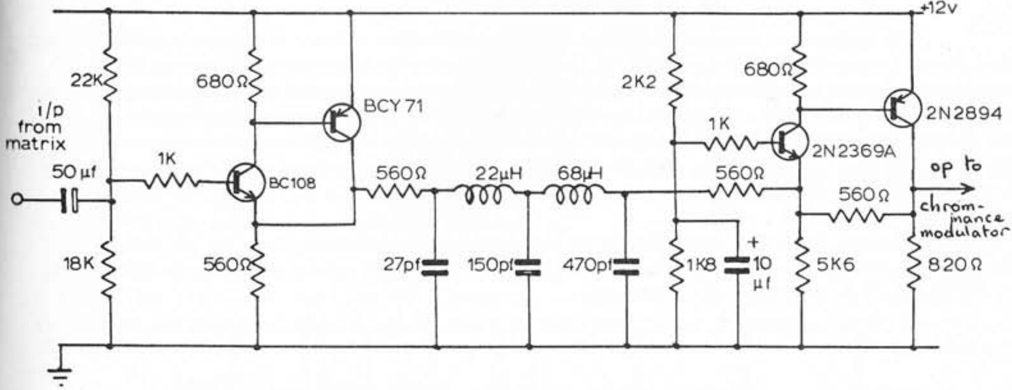


Fig. 15. Colour difference amp / filter
(2 required)

Fig. 15 shows the 1.5MHz bandwidth restricting filters for the colour difference signals together with their drive amplifiers. The stages after the filters match the filter, and invert the negative colour difference signals to provide the correst polarity, and provides a low impedance for driving the clamps preceeding the modulators.

The modulators are shown in Fig.16. Since the colour difference signals are non-composite and blanked, mixed syncs can be used directly for clamping purposes. An emitter follower provides a high impedance to follow the clamp which then feeds the MC1496 modulator. The input to the modulator is differential and a voltage (approximately equal to the black level d.c. of the colour difference input) is applied to the other input. A fine adjustment of this voltage is provided and is finally adjusted for minimum subcarrier at the output during black level.

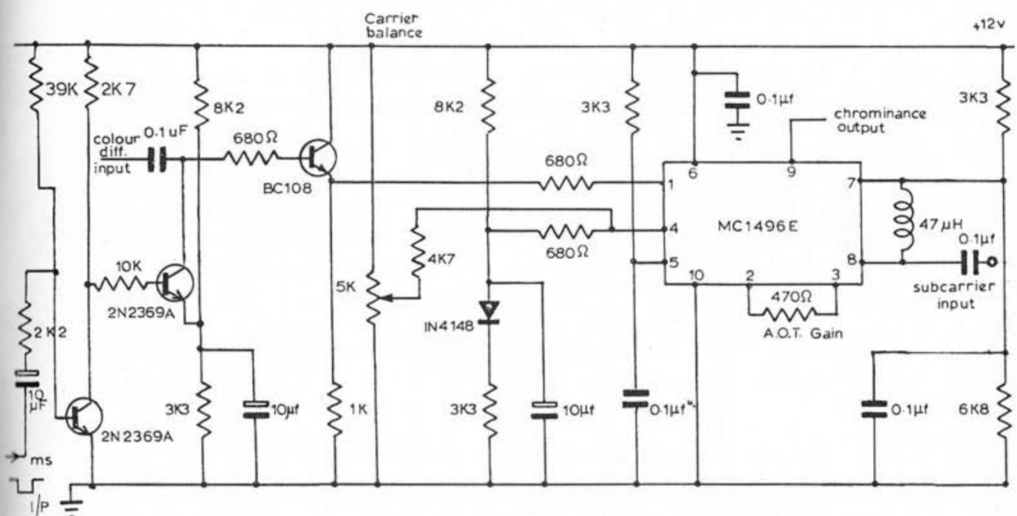


Fig. 16. Chrominance modulator
(2 required)

The outputs of the modulators are from the collectors and are therefore high impedance. This means they can be directly parallel and share a common 750 ohm load shown in Fig. 17. A low pass filter follows which filters the out of load products generated by the modulators. The 47uH coil across the output of the filter has a high impedance to the chrominance components but rejects any residual base-band signals that find their way through the modulators. After the filter is an amplifier which then current-adds the chrominance signal onto the 75 ohm output from the luminance stages.

Fianlly, Fig. 18 details circuitry which accepts a subcarrier feed and provides the two feeds at 90° for the two modulators. The MC1496 provides the necessary 180° phase reversed on alternate lines for the (R-Y) modulator.

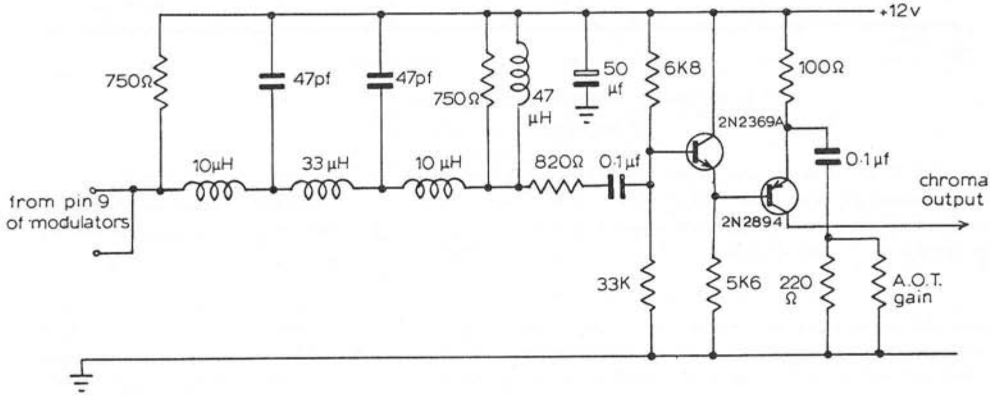


Fig. 17. Chrominance filter/amplifier

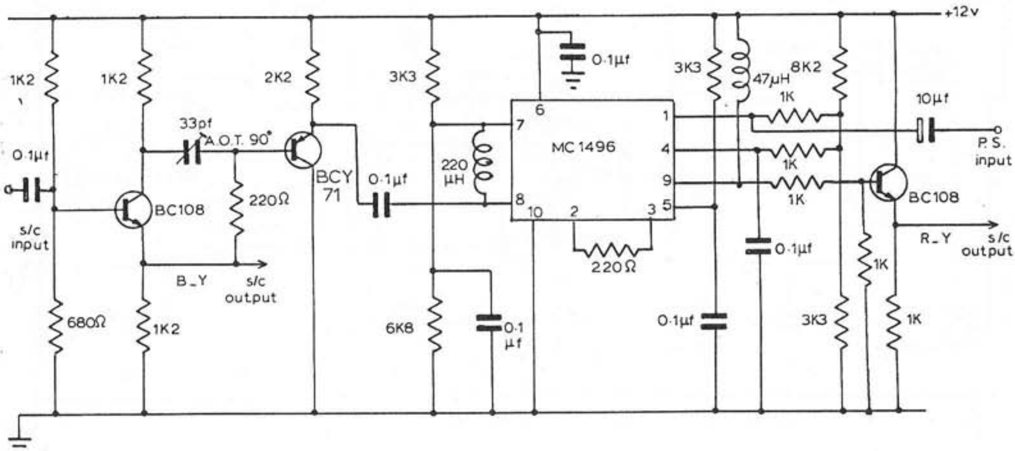


Fig. 18. Subcarrier processor

Setting Up

To make it absolutely clear how the coder is put together, Fig. 19 shows how the circuits are interconnected. As the matrix circuitry was simplified by matrixing directly at the inputs to the coder, the impedance of the RGand B inputs are fairly low, and a terminating resistor somewhat higher than 75 ohms is required to make the impedance correct. The resistance required is found by feeding in a known 0.7v into 75 ohms source and adjusting the resistor until a level of 0.7v at the input is obtained. This is done for all three inputs. Note that the power must be on for this adjustment to be made.

Now feed in colour bars and check for a luminance output, Fig. 12. This should look like Fig. 20d with colour bars applied. Check for colour difference signals at the output of the R-Y and B-Y matrices, Fig. 13 and 14 again at the input to the chrominance modulator, Fig. 16. The latter should be of the form shown in Fig. 20. Check that the clamps in the modulator

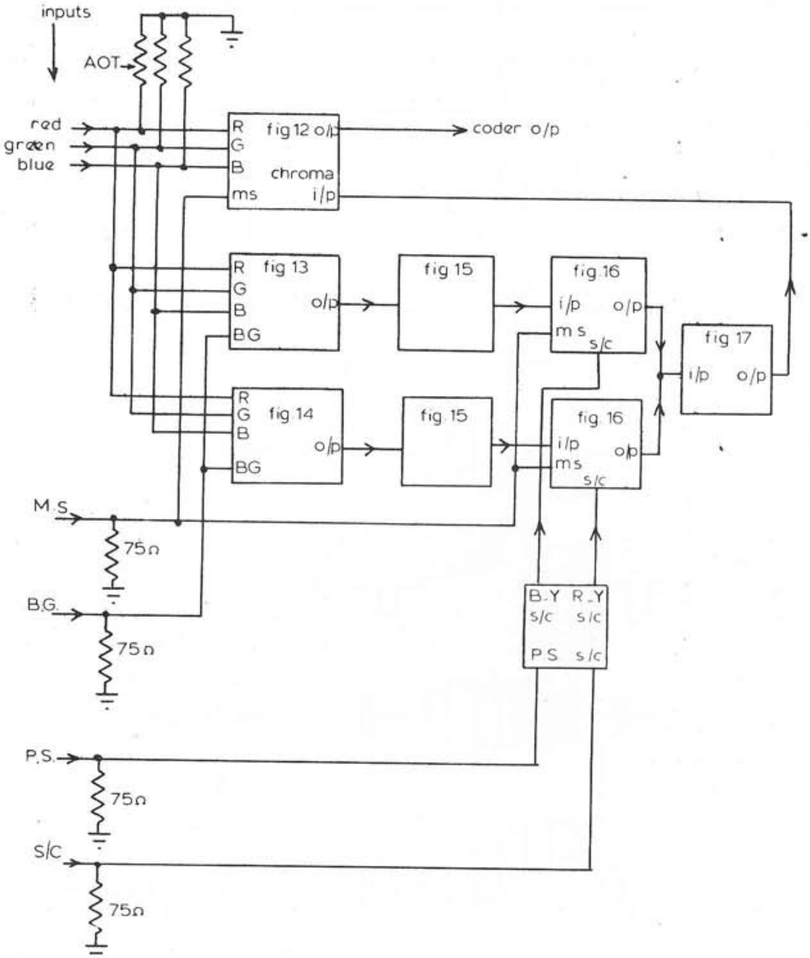


Fig 19 Arrangement of circuits

boards are working and that it is possible to make the d.c. level on pin 1 and 4 of the MC1496 the same by adjusting the carrier balance control.

Look at the output of the chrominance filter, Fig. 17 and check that it is similar to the waveform shown in Fig. 20. Temporarily connect a 100 ohm resistor across the "AOT gain" pin in Fig. 17. Now observe the coder output which should look similar to Fig. 20. Adjust the "AOT 90°" capacitor on the subcarrier processor, Fig. 18 for minimum alternate line jitter in the amplitude of the chrominance. Next adjust "AOT burst 90°" on the B-Y matrix for minimum jitter of the burst. Adjust the R-Y and B-Y carrier balance controls for minimum subcarrier during black level and adjust "AOT white Bal" for minimum subcarrier on the white bar of the waveform. Finally adjust "AOT Gain" on the chrominance filter/amplifier, Fig. 17 for the

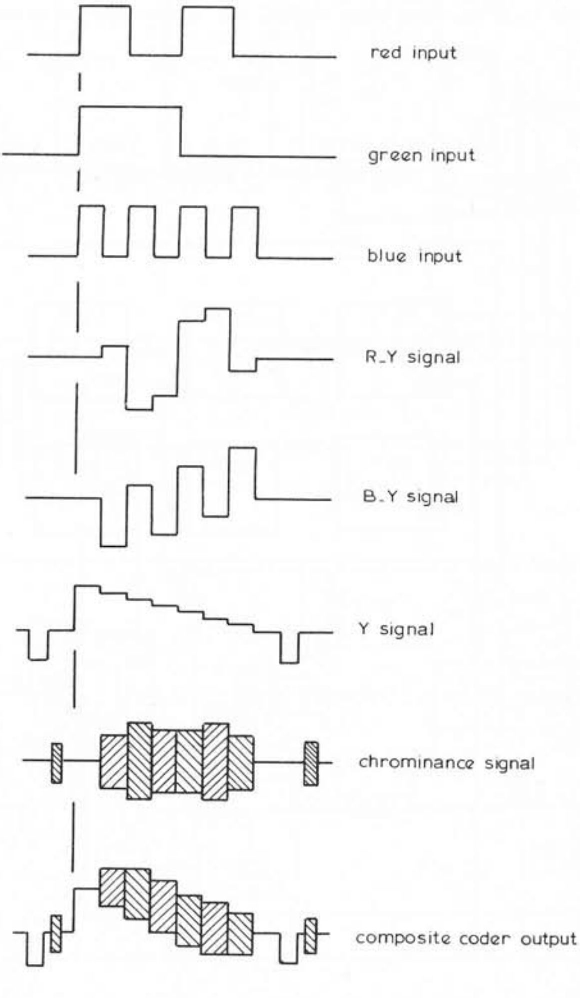


Fig 20 Coder waveforms

correct level of chrominance as shown in Fig. 2.

The coder is now set up and can be fed either striaght into a colour monitor or via an r.f. modulator into the aerial socket of a domestic television receiver.

Colour television is a vast subject, but it is hoped that this chapter has dealt with some of its mysteries. It should enable the amateur with some monochrome experience to begin experiments with colour.

THE BRITISH AMATEUR TELEVISION CLUB

The club was founded in 1949 to inform, instruct and co-ordinate the activities of amateur radio enthusiasts experimenting with television transmission, and to liaise with other enthusiasts engaged on similar work overseas. The club is affiliated to the Radio Society of Great Britain, and has a membership of approximately 1,000.

Experiments carried out by BATC members have been mainly in two directions: R.F. and video. Other aspects of the hobby which have been pursued by BATC members include television astronomy, slow scan TV, video tape recording, special effects generation and colour TV by both sequential and simultaneous methods.

Club Standards

In the UK members are recommended to use a video waveform similar to the one used by the BBC-IBA. This means that a domestic TV set can be used to receive amateur TV transmissions by the simple addition of a slightly modified UHF tuner unit. For compatability in the UK members are recommended to arrange all video outputs at the one volt level, whites-positive, syncs-negative; pulses at the two volt level negative going with all signals at 75 ohm impedance. Both 405 and 625 lines standards are used in the UK with 625 lines becoming more popular. Where RF transmission paths are difficult there is some advantage to be gained by using 405 lines as the smaller band width required enables a better signal to noise ratio to be obtained.

Camera Tubes

Vidicon camera tubes, rejected by the manufacturers for minor blemishes, are available to Club members for a nominal price and can be sent to any part of the world. Information on the procedure for ordering a tube, and for ordering vidicon scan and focus coils can be obtained from the Club Sales Officer.

Flying-Spot Scanning

Satisfactory results can be obtained with cheaper equipment such as a flying-spot scanner using a 5FP7 Cathode ray tube and 931A photocell. These units will handle positive or negative transparencies, and can be adapted for telecinė.

Club Publications

A quarterly magazine, "CQ-TV", is issued free to members, containing circuits, constructional articles, photographs and news of members activities. Contributions to the magazine are welcome and members are asked to send in news of their activities, and in particular, to send in articles or any practical hints they may pick up in the course of their amateur TV experiments.

Club Facilities

The club provides a service to its members by supplying various special items, such as Vidicon camera tubes, Vidicon camera tube scanning and focus coil assemblies, camera tube bases, special mounting flanges for use with "C" mount 16mm lenses, vision reception reporting charts, headed members' correspondence notepaper, envelopes and lapel badges etc.

Some back copies of CQ-TV are available at 25p each (20p each to members) from B.A.T.C. publications, and earlier editions up to and including CQ-TV Number 70 are available on 35 mm film strips, each of which consists of ten issues of CQ-TV. Full details of how to order any of these items are given in CQ-TV.

Equipment Registry

For the benefit of members B.A.T.C. runs an equipment register which consists of a register of members' requirements and surplus equipment from which it is endeavoured to put members with like needs and surplus requirements in touch with each other.

TV References

New members may find the following books helpful:

BBC TV Engineering series (4 vols.). Amos and Birkinshaw. Published by Iliffe.
TV Engineering, D. G. Fink. Published by McGraw-Hill.
TV Engineering Handbook. Edited by D. G. Fink. Published by McGraw-Hill.
Colour Television, P. S. Carnt and G. B. Townsend. Vols. 1 and 2. Published by Iliffe.
Sound & TV Broadcasting — General Principles. K. R. Sturley. Published by Iliffe.
Introduction to Solid State TV Systems. Gerald L. Hansen. Published by Prentice Hall.
Source Book of Electronic Circuits. John Marcus. Published by McGraw-Hill.
Slow Scan Television — Arnold. Published by B.A.T.C.
Slow Scan Television Handbook — Miller and Taggart. Published by 73 Magazine. (Available from B.A.T.C.)

Club Activities

Some amateur TV achievements are:

May 1952—The first two-way amateur TV contact in the world (G3BLV/T—G5ZT/T).
August 1953—G3GDR received G2WJ/T at 34 miles range with only two watts peak input.
December 1953—Amateur colour pictures produced.
Spring 1956—Colour pictures transmitted two ways over a 12 mile path. (Great Baddow-Dunmow).
Spring 1956—Monochrome pictures exchanged over a 38 mile path.
22nd November 1959—Slow-scan TV pictures from WA2BCW in New York received by G3AST in Yeovil.
Autumn 1963—Two way pictures exchanged over a path in excess of 200 miles (G3ILD—G3NOX/T).
October 1966—First amateur 3 tube colour TV camera demonstrated at BATC Convention in London by M. H. Cox.
April 1968—First amateur P.A.L. colour TV transmission on 70 cms. by G6ACW/T to G6LEE/T.
September 1972—First International amateur TV contest.
October 1972—First two-way SSTV contact via Oscar 6 amateur satellite.
November 1972—First English International SSTV contact (G3ZG0 to SV1AB in Athens on 14.230 MHz).

Current members experiments are directed towards better cameras, slow scan TV developments, the use of micro wave links, the development of portable equipment, colour television and so on.

Club Convention

The club holds a Convention once every two years at which members are invited to display their equipment and have an opportunity to exchange ideas and discuss their problems.

During the Convention the General Meeting of the club is held when the officers of the club are elected and any other business is discussed.

Membership

Membership in the United Kingdom costs £2.00 per annum, payable on 1st January each year, for which Bankers' Order forms are available upon request. New members are asked to enclose 20p for each month remaining of the current year (up to a maximum of £2.00) plus £2.00 for the following year's subscription. Overseas members may send the equivalent in their local currency, if no sterling funds are available, at the rate of £2.00 per year, plus 50p for the additional postage incurred. All cheques and money orders etc., should be made payable to the British Amateur Television Club. CQ-TV can be sent overseas by air mail for an additional surcharge, details of which will be given upon request.

If you wish to join the British Amateur Television Club please fill in the application form, detach it, and send it to the Hon. Membership Secretary, B.A.T.C.,

13 Church Street
Gainsborough
Lincolnshire.

The British Amateur Television Club.

Send this form together with your remittance to the Hon. Membership Secretary, B.A.T.C.
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Gainsborough
Lincolnshire U.K.

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ENROLMENT FEE The enrolment fee also applies to persons rejoining the Club and to members who have not renewed their subscription by the 31st March each year.	£ .50
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No.......Back issues of CQ - TV at 50p each The current issue of CQ-TV, which is quarterly, is sent free to members upon joining the Club.	£
No.......Pre 1976 back issues of CQ - TV at 25p each (as available)	£
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I enclose a cheque / postal order / M. O. made payable to B.A.T.C.

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NOTES

CREDITS

This book was first thought of by the B.A.T.C. Committee in 1975 as a successor to Mike Barlow's book of the same title published in 1956.

The authors in this edition are named at the head of their chapters; this book would have been impossible to produce without their help, for which the Editor is very grateful.

Drawings are by Miss E. Mummery, Peter Johnson G6AFF/T and in some cases by the authors of the particular chapter.

The Editor would like to thank his wife for her help in typing the manuscript, and the members of B.A.T.C. who assisted in proof reading.

It is hoped that no errors remain, but if a few have managed to creep in, we apologis sincerely. Comments on the book (and any errors) would be gratefully received by the Editor, for the purpose of correcting future reprints.

The British Amateur Television Club Sales Department

The following items are normally held in stock, for sale to Members of B.A.T.C. only:

Camera tubes	1 inch English Electric	P849	Amateur Grade Vidicon
	E.M.I.	9677	Amateur Grade Vidicon
	E.M.I.	9728	Amateur Grade Vidicon
	$\frac{2}{3}$ inch E.M.I.	9831	Amateur Grade Vidicon
	$\frac{1}{2}$ inch E.M.I.	9777	Amateur Grade Ebitron
	$4\frac{1}{2}$inch E.M.I.	9565	Amateur Grade Image Orthicon

Coils 1 inch B.A.T.C. Coils
$\frac{2}{3}$ inch E.M.I. Coils

Paxolin Vidicon sockets
'C' Mounts for lenses

Charts B.A.T.C. Test Card 12 x 9
E.E.V. Camera Chart 12 x 9
B.A.T.C. Reporting Chart

Badges Lapel Badges
Adhesive Badges for decorating equipment
Club Windscreen stickers

Other items sold by B.A.T.C. are advertised in the Club's Journal, C Q - T V. Current prices and mail order charges also appear in C Q - T V, but are also available from

B.A.T.C. Club Sales
"Kyrles Cross"
Peterstow
Ross on Wye
Herefordshire.

to which address all orders should be sent.

B.A.T. C. Publications

This separate department of the Club only deals with material published by B.A.T.C. Back numbers of the Club's Journal, C Q - T V together with photo-copies of particular articles are sold, as well as books published by the Club. Further copies of this book can be purchased from the same address. For full details of currently available titles, see the current issue of C Q - T V, or write to: B.A.T.C. Publications
64 Showell Lane
Penn, Wolverhampton
West Midlands.

Other departments of B.A.T.C. include a Library and an Equipment Registry which assists Members in the sale and purchase of "hard to get" amateur items. Full details of these services are available only to members.

LIST OF CHAPTERS

INDEX OF SUBJECTS

"Amateur Television" is published by the British Amateur Television Club.
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Edited by Andrew Hughes T.Eng(CEI) MITE.

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