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JULY 1963

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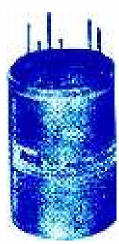

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Practical Television

AND TELEVISION TIMES

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Contents

Theory in Practice

AMONG professional service engineers there is a wide divergence in competence. In the extremes, some have the ability to repair set after set in an apparent casual manner while others are frequently baffled, if only temporarily. Among amateurs the variations are even more marked.

Why should this be? "Green fingers" is a convenient explanation but it is far from realistic. The answer rests, in fact, on a combination of contributory factors. Temperament is one, for while it is arguable that good engineers are born and not made, it is certainly true that one must have, or acquire, a lucid, "unflappable" approach.

Experience, too, is a natural keynote. Certain symptoms indicate standard likely causes just as certain receivers develop stock faults. The keen professional or amateur is quick to learn these recurring faults and keep them at the back of his mind.

An experienced practical man can also learn a good deal about a piece of faulty equipment by a cursory physical inspection, prior to testing. The senses of sight, touch—and even smell—all play their part in diagnosis, apart from the actual symptoms displayed.

By a combination of these ingredients, and applied common sense, it is no wonder that some operators inspire awe into new recruits and lead to talk of a "magic touch." But there is, alas, no magic about such a prosaic thing as diagnosing faults in electronic equipment!

The person who can consistently find faults quickly is being deceptively casual. For behind any quick-fire diagnosis, apart from a background of experience, usually lies a sound theoretical knowledge. The basic concept of fault finding demands a clear, logical approach and this in turn demands a clear idea of how and why the equipment functions.

It used to be said that one needed about 90% practice and 10% theory, but (in the professional sphere at least) the days of the purely practical service man are numbered. The complexity of modern equipment and methods demands both practical and academic ability, with a greater emphasis on theory.

This is underlined by the importance that the Radio Trades Examination Board place on the written papers for their servicing examinations. The failure of engineers generally to accept the necessity of a good theoretical knowledge is reflected by the large number of candidates failing the examination and by the acute shortage of new service engineers.

One can still, of course, derive a good deal of enjoyment from television as a hobby with only a limited theoretical background, but those considering serious amateur work or contemplating television as a profession will find that some solid "mugging up" of theory (which need not necessarily be difficult or dull) will pay great dividends.

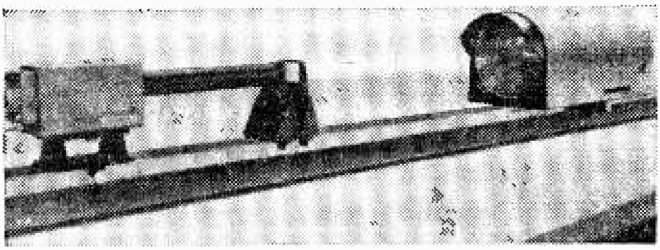
Our next issue dated August, will be published on July 19th.

TELETOPICS

A NEW ROLE FOR CCTV

A NEW device, known as a "spray particle analyser", has been developed by the manufacturing associates of Rank Kalee. This device will eventually find many applications for measuring, counting and classifying particles occurring in a widely varying range of substances. It could, for instance, classify bacteria or count blood cells; it could even count the number of bubbles in a magnum of champagne!

The device, which consists basically of a closed circuit TV camera and a digital computer linked together, is an improvement on previous methods of executing the same task. In use, the particles pass between the special lens of the camera and a strobe flash unit which illuminates the spray, sufficiently "freezing" the motion of the individual particles for the camera to pass on to the computer a video signal of the light image. Fed with this video signal, the computer can gather all the information required and present the data in the form of a distribution graph of quantity against size.



This photograph shows the TV camera and strobe flash unit used in a new device known as a "spray particle analyser".

TELEVISION FOR LONDON'S COUNTY HALL

THE council chamber of the LCC's County Hall headquarters is to be linked by closed circuit television to 12 receivers situated in various parts of the principal floor. This equipment —to be supplied by EMI Electronics Ltd.—will be used to show the name of the committee report under discussion at any time, and also the name of the speaker.

This innovation will allow members outside the chamber to know of any particular discussion the moment it begins and thus leave them free to proceed with other business in the intervening times.

Insecticides demonstrated on TV

AT the Pyrethrum Board's stand at the Royal Society of Health's Exhibition held in Eastbourne recently, a demonstration of the effects of pyrethrum-based insecticides was staged. Several species of insects were sprayed with the insecticides and onlookers were able to witness the effects either first hand or, if they were unable to see close enough, on a screen, on to which a live picture of the whole operation was projected over a closed circuit television system.

The "Vidiaids" CCTV equipment (Automatic Information and Data Service Ltd.) which was used for the demonstration, employed a camera with a close-up lens so that the pictures that appeared on the screen, showed the insects several times their actual size.

DANISH STUDENTS VISIT BRITAIN

ON a visit to this country recently was a party of 32 students from Aarhus Technical College, Denmark. Part of their time over here was spent in visiting some of the leading electrical firms, and during a tour of Marconi's Chelmsford works they were able to examine closely one of the Mark IV television cameras on test there.

New Interview Studio for Edinburgh Centre

THE BBC Broadcasting House in Edinburgh has recently been equipped with a new television news and interview studio. The studio equipment is of simple design, and includes one vidicon camera and a single microphone chain. This simplicity removes the need for any permanent technical staff and the programme output from the studio is carried by s.h.f. radio link to the Kirk o' Shotts transmitting station.

MOBILE 625-LINE TRANSMITTER ON TOUR

THE BBC's 625-line programmes are scheduled to start in April next year, and although test transmissions in the new system are now fairly regular, only a limited number of people living within the service area of the London transmitter, have, until now, had a chance to see "live" 625-line pictures.

To remedy this, a mobile test station equipped by Pye to transmit 625-line pictures on low-power, recently began a tour of the Midlands and the North. Stopping in towns and cities for a week at a time, the test station enables the public to witness, first hand, the new system in operation. Electrical dealers in the locality of the station are able to receive the programmes and to demonstrate at the same time the new dual-standard sets already on the market.

This mobile TV station has been arranged in co-operation with the G.P.O. and under suitable geographical conditions, the transmitter will have a range of four miles.

This mobile test station will give more people living outside the service area of the BBC's London transmitter, a preview of 625-line pictures.

TELEVISION RELAY STATION CHAIN COMPLETE

THE final link in the BBC's chain of relay transmitters built in the south-western Highlands of Scotland, will be forged when the Secretary of State for Scotland, the Rt. Hon. Michael Noble, M.P., opens the new station at Oban, Argyll, on 22nd June.

These low-power stations which have been built to improve the reception of BBC television and v.h.f. transmissions in this area of the Highlands, have also brought these services within the reach of an additional 16,000 people.

The service area of this latest relay station includes the coastal regions bordering the Sound of Mull as well as Oban itself and its environs.

The television transmissions from Oban, which will be vertically polarised, will be on channel 4 (vision 61·75Mc/s, sound 58·25Mc/s).

New Mast Begins Transmissions

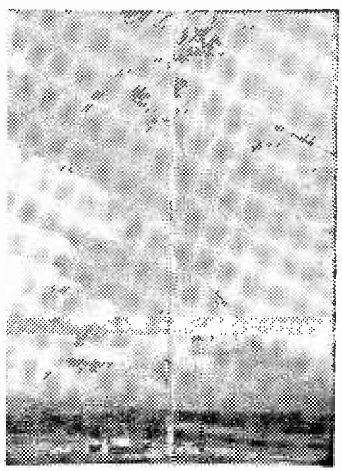
WEST ULSTER'S new television mast recently began programme transmissions. The mast has been built for the Independent Television Authority at Strabane, Co. Tyrone, by the British Insulated Callender's Construction Co. Ltd.

E.M.I. Electronics Ltd. were the main contractors for this new landmark, which towers 1,000ft above the ground.

TV Inspection of Aircraft in Flight

THE prototype BAC One-Eleven aircraft has been fitted with Marconi television cameras to aid its flight testing programme by allowing observers aboard the plane to view parts of the air frame that would normally be out-of-sight. One camera is mounted under the fuselage and the other on top, next to the fin.

A 14in. monitor will show pictures from either camera to observers in the aircraft's cabin. Both cameras have automatic sun-shutters to protect the vidicon tube from damage due to direct sunlight falling on the lens, and the camera mounted beneath the fuselage has a remote-controlled periscope which enables several different points to be examined.



The ITA's new 1,000 ft. mast in Co. Tyrone.

TOWARDS 625

A Guide to TV Conversion

PART ONE OF A NEW SERIES DESCRIBING THE CONVERSION OF VINTAGE 405-LINE SETS TO RECEIVE 625-LINE PROGRAMMES

by D. ELLIOTT

THIS short series of articles is meant for the home constructor and experimenter—in short, the television enthusiast—as distinct from the professional technician and engineer. Over the past months the author has given considerable thought to the possibility of rebuilding a somewhat "vintage" 405-line only set so that it will pick up the experimental 625-line test signals and subsequently, of course, the new or duplicated programmes on the 625-line standard.

At the outset it must be stressed that it would be far from good economics—and would almost certainly disturb domestic equilibrium—to tear the main household receiver to pieces so as to follow these experiments. There are plenty of five-to-ten year sets about and available for only a few pounds. One of these should be acquired, and it does not really matter if it is not working provided that the picture tube is serviceable.

It is impossible to set up this series in the form of a list of instructions appertaining to all models of 405-line five to ten year-olds. We have thus taken a sample receiver of such vintage (which will remain unidentified for obvious reasons), and one which is thoroughly representative of the majority which were produced over that period.

CHOICE OF SET

There are one or two things to have in mind when selecting a receiver for these experiments: the model should possess a v.h.f. tuner covering Bands I and III (not because the v.h.f. tuner itself is essential, but because a set with a tuner of this kind features a vision i.f. circuit which is less complicated to adapt for the 625-line passband than, for instance, a set tunable only over the five Band I channels or one like that with an add-on Band III *adaptor*); it should also have EF80 type or equivalent valves in the i.f. stages; there should be

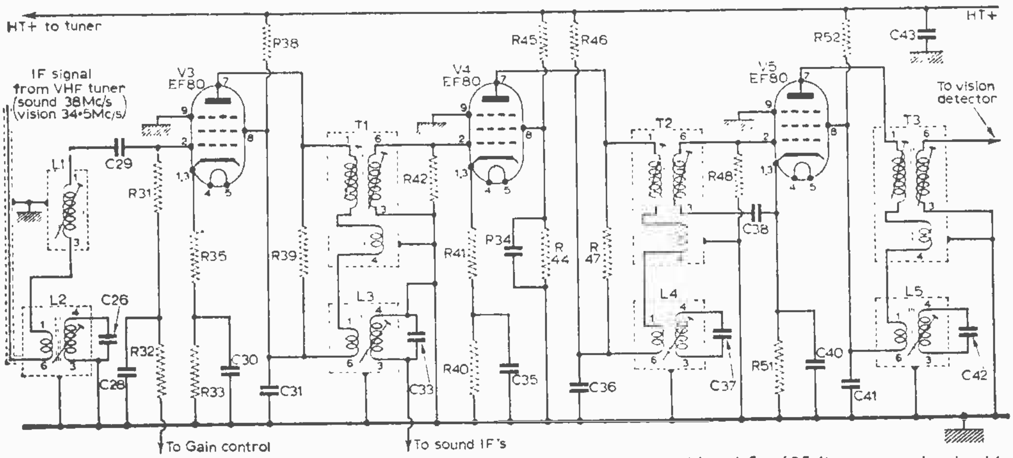


Fig. 1—The i.f. stages of a typical 405-line receiver of the type which is considered for 625-line conversion in this article.

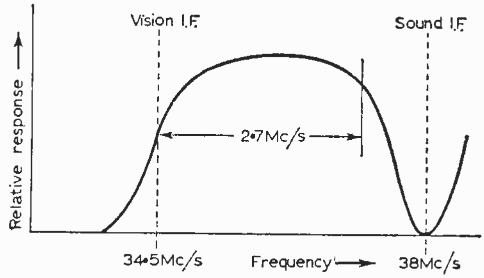


Fig. 2—The vision i.f. response of the circuit in Fig. 1.

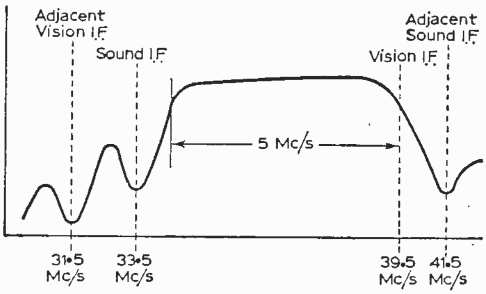


Fig. 3—The overall i.f. response of a 625-line receiver suitable for British standards—i.e. sound/vision carrier spacing 6Mc/s.

SEVEN AREAS

Approximately seven areas in the experimental receiver will have to be modified or rebuilt. These include (i) the front end, for on 625 lines the u.h.f. channels are initially to be exploited (it is understood that a commercial u.h.f. tuner will be available, and in a later article notes on the requirements for this section of the receiver will be included); (ii) the vision i.f. stages (whereas with 405 lines these have a somewhat restricted passband and sound rejectors, on the 625-line standard the passband is considerably widened and the sound rejectors are eliminated since the stages are purposely designed to pass a little of the sound signal —at the natural sound i.f.—along with the vision signals to facilitate the intercarrier sound function); (iii) an intercarrier sound section to replace the existing sound i.f. channel, and while the former will operate at 6Mc/s (the British intercarrier standard), the latter may be operating at 19 or 38Mc/s, depending upon the choice of receiver; (iv and v) vision detector and video amplifier stages, to be changed from positive to negative modulation and to give an intercarrier sound take-off; (vi) the sound detector, to be changed from a.m. to f.m.; (vii) the line timebase, to be changed from 10,125c/s to 15,625c/s.

START WITH VISION I.F.

For the purpose of this experiment we will start operations in the vision i.f. amplifier stages. In Fig. 1 is a circuit of these stages of a typical

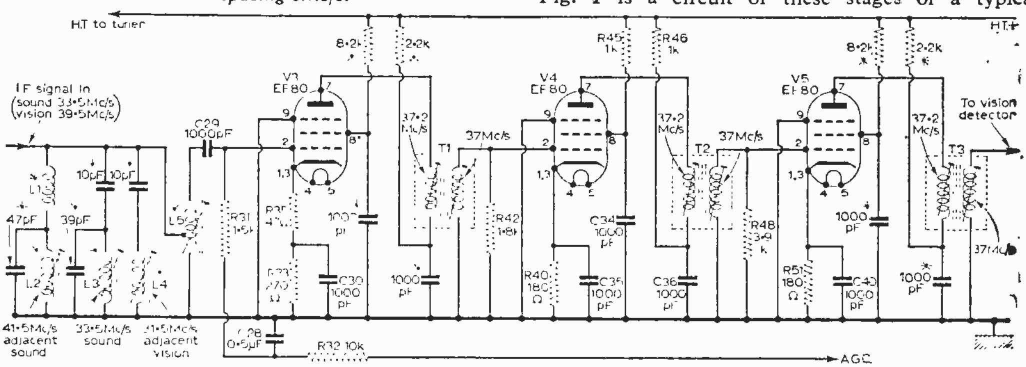


Fig. 4—Showing how Fig. 1 is modified to give the 625-line requirements of Fig. 3. The tuned frequencies are shown by the coils, and details of their construction are given in the text. Note that where a component is equivalent to that in Fig. 1 it is given the same reference number. Components which differ substantially in function from those in Fig. 1 are indicated by an asterisk. Although of the same function, component values in the modified Fig. 4 circuit may differ from those of the original Fig. 1 circuit; use the values shown in Fig. 4.

three vision i.f. stages or two plus a stage common to both sound and vision; the model chosen for the experiment should *not* feature printed circuit boards as these are almost impossible to modify.

The sound channel is not unduly critical from the conversion aspect, and a model with either one or two such stages at i.f. is suitable. The frame circuits will remain almost unmodified, but the line timebase will require considerable modification for the best results. For that reason a set *without* flywheel line sync is the best bet from the conversion angle, in spite of the fact that flywheel line sync is considered desirable on the 625-line standard—but more will be said about that later.

receiver of the nature already outlined. All the valves are EF80's and the first —V3—is common to both sound and vision, while V4 and V5 are concerned essentially with the shaping of the overall vision i.f. passband.

The tuned circuits are so arranged that a vision i.f. passband of about 2·7Mc/s is achieved, as shown in Fig. 2. It will be seen that a high degree of attenuation is introduced at the sound i.f. (38Mc/s), and this is accomplished by the sound rejector circuits, which are L3, L4 and L5. The vision i.f. (carrier) is tailored to fall on the sloping low-frequency side of the response curve to provide normal single sideband operation.

625-LINE REQUIREMENTS

Now, the requirements for 625 lines are shown in Fig. 3. Here we have a passband at the 3dB points of about 5Mc/s, which is necessary to accommodate the high-frequency video sidebands arising from the enhanced definition of the 625-line system. While the overall attenuation at the sound i.f. on the 405-line system is in excess of 40dB (100 times), as a means of avoiding sound-on-vision interference, on the 625-line system the sound signal is only about 26 to 30dB down in relation to the average response.

This means, then, that an appreciable amount of sound signal accompanies the vision signal in the i.f. stages; but here sound-on-vision interference is not bothersome since the sound is frequency modulated. Indeed, the two i.f.s must be carried in the i.f. stages to produce the 6Mc/s intercarrier sound signal. Note that the 6Mc/s value is obtained by beating of the two carriers (sound and vision i.f.s.) which are displaced by 6Mc/s.

It is important to observe at this juncture that if the sound i.f. signal is too far down on the vision i.f. signal, the sound balance will be affected, while if there is insufficient attenuation so-called intercarrier buzz may cause trouble. This latter effect is rather like vision-on-sound interference as experienced on misaligned 405-line sets.

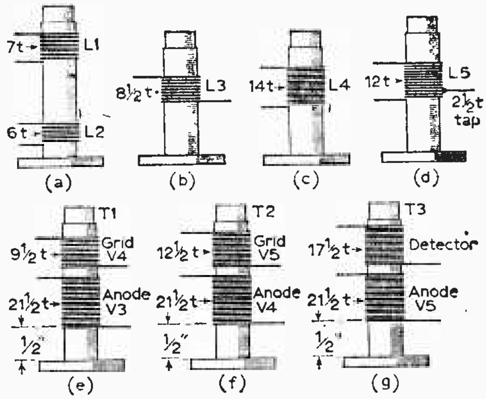


Fig. 5—Details of coils and transformers. For (a), (b), (c) and (d) 23s.w.g. enamelled-covered wire is used, while for (e), (f) and (g) 32s.w.g. enamelled-covered wire is used. All windings close wound. Spacing between windings of T1 and T2 is $\frac{1}{16}$in., while between the windings of T3 the spacing is $\frac{3}{32}$in. Maximum separation between L1 and L2 is achieved by winding at the extreme top and bottom of 2in. former. Formers (b), (c) and (d) are 1in. and (a), (e), (f) and (g) 2in.

POINTS TO OBSERVE

In Fig. 4 is revealed the circuit of Fig. 1 modified to give the overall response of Fig. 3. There are several points to observe: (i) that the circuit is designed to accept sound and vision signals of 33·5Mc/s and 39·5Mc/s respectively, these being the standard British 625-line i.f.s; (ii) that the sound rejectors of Fig. 1 are deleted; (iii) that filters L2, L3 and L4 are incorporated prior to the first stage to put the dents into the response at the frequencies shown in Fig. 3; (iv) that T1, T2 and T3 are bandpass filters centred at approximately 37Mc/s, with T1 and T2 a little overcoupled to give two peaks and with T3 designed for a single peak between the two peaks of T1 and T2—further response shaping is accomplished by the tuner/first i.f. stage coupling, so as to provide the ideal flat top of Fig. 3.

When comparing Fig. 4 with Fig. 1 it should be noted that components common to both circuits are given the same reference number, while components which differ in function are not numbered but are marked by an asterisk in Fig. 4. However, this must not be taken to indicate that common components have like values in both circuits. It is, of course, impossible to say what the actual value of a component in the experimental receiver is likely to be, and for that reason values are not given in Fig. 1, but it is important that the values given in Fig. 4 are adhered to.

THE COILS

The basic design of the coils and transformers is given in Fig. 5, and these are self explanatory. The best plan is to remove all the coils and transformers from the i.f. stage of the experimental receiver and modify T1, T2 and T3 accordingly. L1, L2, L3, L4 and L5 will then be available for making up L1, L2, L3, L4 and L5 of Fig. 4.

Most sets of the vintage under discussion employ Aladdin 2in. and 1in. coil formers of type PP5957/6 and PP5938/6 respectively, and it is just a matter of rewinding these. However, if some entirely different formers are embodied in the chassis, then these will need to be changed for the Aladdin type.

WIRING MODIFICATION

When rearranging the circuit and components of the experimental receiver to conform to the circuit of Fig. 4, extreme care must be taken to avoid long anode and grid connections to the coil and transformer windings. The best idea is to leave the component layout as far as possible per the original pattern. Decoupling components must be positioned as close as possible to the actual circuits being decoupled, avoiding long chassis return connections. Resistors and capacitors should have ratings corresponding to those of the original components of similar function.

If dismantled and rewound sound and other rejector coils are used for the traps of L1, L2, L3 and L4, they must be re-positioned on the chassis so as to be as close as possible to the input of V3—that is, between the tuner input and the signal grid of V3. One must never be tempted to leave them in their original positions—which is within the centre of the i.f. strip—and connect them to the first stage via long leads. Such action will almost certainly result in instability and alignment difficulties.

The aim this month should be to modify the existing vision i.f. strip in close agreement with the foregoing, including winding the coils and securing the best possible layout.

Next month we will deal with the vision detector, video amplifier and reveal how the intercarrier sound signal is extracted.

CONTINUED NEXT MONTH

BY
K. ROYAL

AN S-METER
for setting-up and adjusting tv aerials

MANY do-it-yourself television enthusiasts and readers of this magazine like to make their own aerials, but are presented with a problem when it comes to comparing one make and design with another. There is also the difficulty of orientating the finished array for the best possible signal pick-up. One way out of the latter difficulty might be to turn the set-connected aerial until the best picture is received; but this is a possible solution only with "vintage " receivers.

The majority of sets made during the last six to seven years feature reasonably effective automatic gain control (a.g.c.) on vision as well as on sound. This means that the picture and sound try to hold constant even though the signal applied to the set may rise and fall widely as the aerial is adjusted for direction.

As the aerial is turned and the signal rises, so the "noise" or grain on the picture reduces due to the improvement in signal/noise ratio. The picture does not usally become very much brighter; nor does it dim much as the aerial passes away from the direction of maximum signal pickup.

Difficulty may thus be encountered by endeavouring to employ the set as a signal level indicating device. If the set is stood by a window or even outside so that the man at the aerial can see the screen, a small change in picture noise just cannot be discerned, and a considerable error in aerial orientation is likely to result. Turning up the sound will not help either, for this will barely change in volume as the aerial is turned through a full 360°.

The professional aerial rigger overcomes these problems by the use of a signal strength meter, which is an instrument capable of reading the actual signal strength at the end of the coaxial downlead on any particular channel — sound or vision. The instrument employs an ordinary moving-coil movement calibrated direct in millivolts and microvolts. Thus the aerial is connected to the input socket of the instrument which is then tuned to the correct channel and adjusted for maximum signal. The signal voltage is then revealed and it becomes a simple matter to turn the aerial to secure the maximum reading.

These instruments are rather expensive, and unless a lot of aerial work is proposed it would barely pay the average enthusiast to purchase one. However, it is to be shown in this article how an indicating meter may be fitted to any television set to record relative signal strengths, and a circuit will also be given for a signal strength meter.

Basic Signal Strength Meter

Before we go to these items we should understand briefly how the commercial type of signal strength meter operates, for the same general principles will also apply to our equipment—as, indeed, to any equipment of this kind.

The block diagram in Fig. 1 gives the general idea. Here we have a tuner which selects the signal to be measured and converts it to an i.f. (intermediate frequency). This signal is fed to an i.f. amplifier, the anode current of which is monitored on a milliammeter. A "set zero" control is also incorporated in the i.f. amplifier circuit so that with the aerial (or signal) removed from the tuner, the i.f. amplifier current can be adjusted to give exactly full-scale deflection on the movement. This deflection corresponds to zero signal.

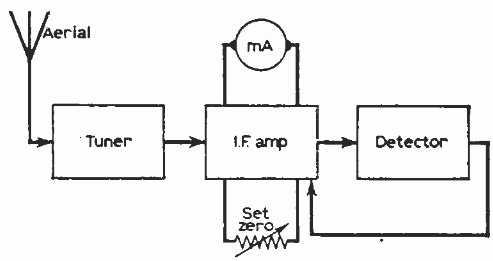


Fig. 1—Block diagram of commercial signal strength meter. The operation of the instrument is explained in the text.

Now the i.f. amplifier feeds a diode detector (rectifier) stage which is arranged so that the i.f. signal after rectification produces a negative potential across the detector load resistor. This negative potential is fed back as bias to the i.f. amplifier. Thus as the signal strength increases so the negative bias increases and the anode current of the i.f. amplifier valve *decreases*. This decrease in current from full-scale deflection as registered on the milliammeter indirectly corresponds to signal voltage, and the scale of the meter may be calibrated accordingly.

Set Signal Strength Meter

It is quite easy to adapt any television set so that it also will give a similar indication of signal

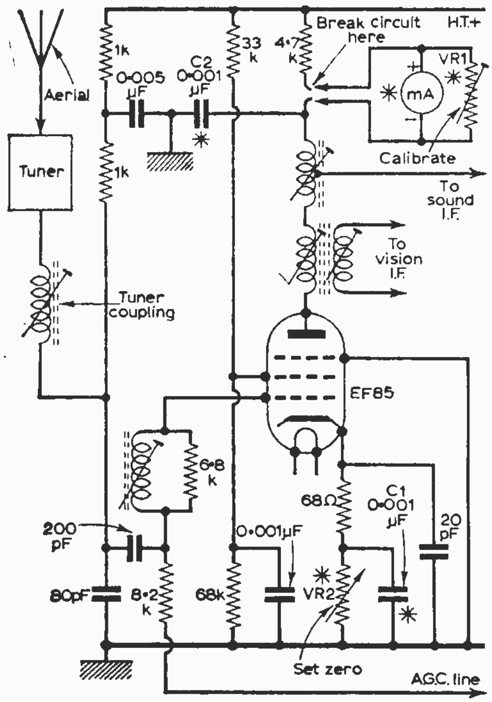


Fig. 2—The common i.f. stage of a typical television receiver showing how a milliammeter may be connected in the anode circuit to provide relative indications of signal strength. Components marked with an asterisk are the extra ones required.

strength. In Fig. 2 is given the circuit of the common i.f. amplifier stage as found in many receivers. While there may be small differences in circuit and tuned coupling detail, the essential features are always the same. The common stage receives i.f. signals from the tuner, and this stage invariably has a.g.c. applied to it. The valve may be an EF80 or similar pentode, instead of the EF85 of Fig. 2.

Movement Shunt

The anode current of the common i.f. amplifier valve with no a.g.c. bias applied is about 10mA, so the anode current meter should read, at least, up to this value of current f.s.d. The best idea is to employ a 0-1mA movement, as these are readily available in all sizes and the movement can be shunted with a variable resistor as a means of calibration (VR1 in the circuit).

A 100Ω 0-1mA movement requires a shunt of 1·01Ω to give 0-10mA, and a 1Ω resistor shunted by a 10Ω pre-set have been found suitable by the author. Although there is very little full-scale variation given by the preset, sufficient is available for the purpose of the exercise. If possible, several 1Ω resistors should be measured for resistance and one with a slightly higher than 1Ω value should be selected.

Both of these components are available from Radiospares Ltd.—the 1Ω rated at 3W for about 1s. 6d. and the slider preset at 10Ω for about 2s. (Note that Radiospares supply only to dealers, so the parts will have to be obtained from a dealer.)

If the movement has a resistance other than 100Ω the correct shunt value can be found from the following expression: Shunt ohms = r/(n-1) where r is the internal resistance of the meter and n the ratio between the original and the new full-scale deflections. The whole idea, of course, is to secure exactly full-scale deflection on the meter when the aerial is removed from the set and with the contrast control full on.

Set Zero

Now when this condition has been established with the meter connected in the low signal potential side of the anode load a variable resistor should be connected in series with the cathode resistor of the stage (VR2 in the circuit). This will provide a main control of anode current and will allow the movement to be set to zero under a wider range of conditions (note that "set zero" means full-scale deflection—see the description of the signal strength meter in the earlier paragraphs). This resistor should have its spindle brought out to the rear or the side (or the front if required) of the set so that it is easily adjustable and its value should be 100Ω. A suitable component is the 100Ω wire-wound volume control (3W rating) by Radiospares at about 6s. 9d.

Connection from the cathode circuit to the variable resistor should be kept as short as possible and capacitor C1 should be included to rid the circuit of stray i.f. signals. The capacitor should be connected as close as possible to the valveholder and not to the control end of the lead.

Meter Connection

The meter movement can either be mounted on the receiver cabinet somewhere convenient or it can be mounted in a small box so that it can stand on the top or close to the set and be connected to the set through a screened lead. If mounted externally the leads must be kept short and C2 decoupling employed. It is a good idea to include C2 even though the meter may be mounted on the set.

Not all sets will have the type of anode circuit shown in Fig. 2, but the idea is to connect the meter in the h.t. feed to the anode of the valve at the h.t. side of any coils that may form the anode load. The circuit, of course, is first broken, as shown in Fig. 2, and the gap is bridged by the meter movement with the positive side of the movement to the h.t. line side of the circuit. Decouple the movement at the *negative* side with C2.

Operation

After the set has properly warmed up the aerial should be removed and the contrast turned to maximum. The "set zero" control should then be adjusted to give exactly full-scale deflection on the meter. When the aerial is connected the reading will back off by an amount governed by the signal strength. A very strong signal will cause the meter to read almost zero current (owing to the resulting heavy negative a.g.c. bias), so it is impossible to damage the movement by too strong a signal.

Exact signal strength calibration is possible if one has a signal generator with an accurate attenuator and which tunes over the television bands. The scale on the meter may be changed for one made out in microvolts or a graph can be drawn giving signal strength against meter reading.

Since surplus receivers can now be obtained for a few pounds the experimenter may consider it worth while to purchase a specimen solely to convert into a signal strength meter. The sound and vision need not work properly provided the a.g.c. and common stage, including the tuner, are fully active. However, it is desirable to be able to monitor the sound and vision signals from the loudspeaker and on the tube as a check for interference and ghosting, which are factors that the meter movement is not able to disclose. Note that although the current in the common state is metered it is only the vision signal that is measured, since the meter deflection is a function of the a.g.c. bias which is derived from the vision signal.

The set must, of course, have some sort of a.g.c. system, but if this is not present on vision, the current in the anode of the sound i.f. stage may be measured (provided sound a.g.c. is employed). Here, though, there is less sensitivity and it is best to use the vision signal if at all possible. On a very old model one may consider it worth while to add vision a.g.c. from the sync separator control grid circuit if it is not featured on the set as it stands.

It will be found that the meter reading alters as the contrast control is adjusted. This is because on mean-level type of a.g.c. systems the negative bias produced by the signal at the sync separator is countered by a positive potential applied to the a.g.c. line from the h.t. line via the contrast control. This is of no consequence provided the contrast is first set before adjusting the " set zero " control.

Signal Strength Meter Circuit

A circuit specifically for a signal strength meter is given in Fig. 3. Here a television tuner feeds two stages of i.f. amplification. These stages need not be broadly tuned as in the vision channel of a television set and for that reason considerable gain is possible with two stages. The first stage is the controlled one and the control bias is derived from a GD3 or equivalent germanium diode; it is also a good idea to take the control to the tuner as well to avoid overloading on very strong signals.

The switch S1 acts as a 10-times (20dB) attenuator; in the position shown the voltage across both R1 and R2 in series is used as control, while in the other position the voltage across R2 only is utilised—this, of course, is the 20dB position.

It will be seen that the circuit operates in exactly the same way as considered in the foregoing paragraphs. While a signal strength meter or comparator is highly desirable for aerial tests in Bands I and III (and the f.m. Band II) such an instrument will be almost essential when Bands IV and V—in the u.h.f. regions—get under way. Tuners for u.h.f. will then be readily available, so it will only be a matter of adding one of these to the i.f. circuits of Fig. 3. ■

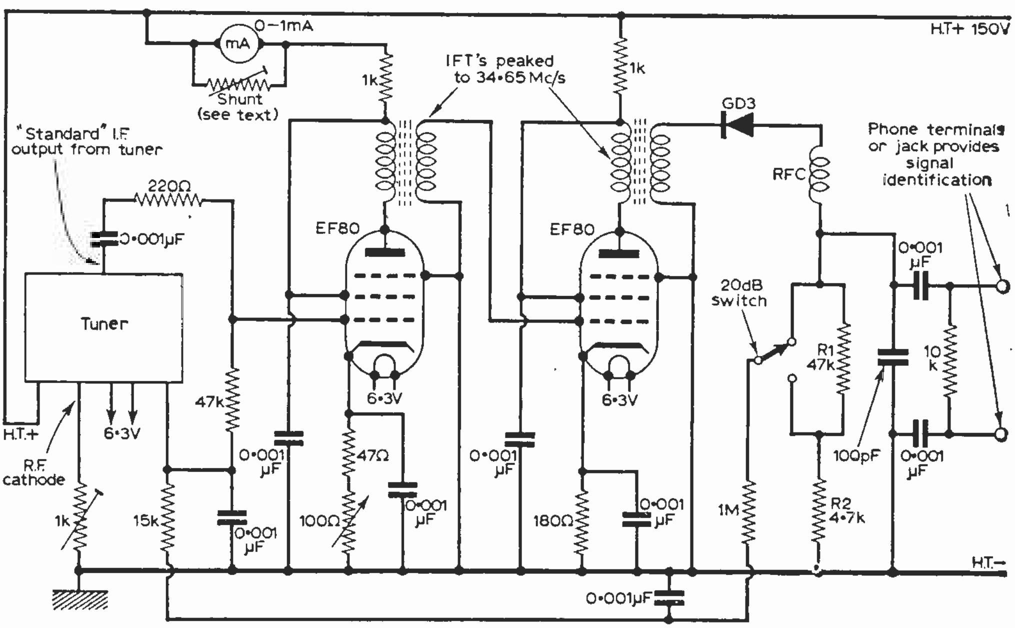


Fig. 3—Circuit diagram of signal strength meter for comparative tests. The milliammeter may be calibrated direct in millivolts and microvolts or a graph may be produced giving signal volts against meter reading. For u.h.f. signals in Bands IV and V, the tuner would tune over the u.h.f. channels and the a.g.c. control would be removed from that section.

SERVICING TELEVISION RECEIVERS

By L. Lawry-Johns

No. 91: ALBA T655

CONTINUED FROM PAGE 419 OF THE JUNE ISSUE

THIS month's article continues the list of fault symptoms and their cures.

Inability to Lock

If the picture runs into lines and the horizontal hold control is at the end of its travel check R62. This had a value of 82kΩ in early versions but was changed to 56kΩ in later production runs. Use the latter value when replacing. Check V10 by replacement. If the picture rolls and the vertical hold is at the end of its travel check V11 by replacement and R48 (470kΩ). If both holds are difficult to lock due to weak sync pulses check R22 (4·7MΩ) and V9.

Overheating in the Video Stage

When there is no picture signal and signs of overheating are evident around V4, check R18 which sometimes falls in value causing R17 damage. R18 is a 47kΩ and R17 a 330Ω.

Loud Arcing Noises

If the picture is absent or intermittent and loud discharge can be heard similar to the cracking of a whip, the insulation of the EY86 base cover and e.h.t. lead from the base to the tube should be checked. This lead passes under a saddle soon after leaving the EY86 base and quite often the insulation at this point fails. Removed from the saddle and suitably sleeved, the discharge may not recur; however it may be necessary to fit a new length of lead in which case the soldering to the EY86 base and to the tube clip will have to be done carefully to avoid further discharge or corona.

If the discharge is from the EY86 base itself there is little alternative to replacing the base complete.

No Sound

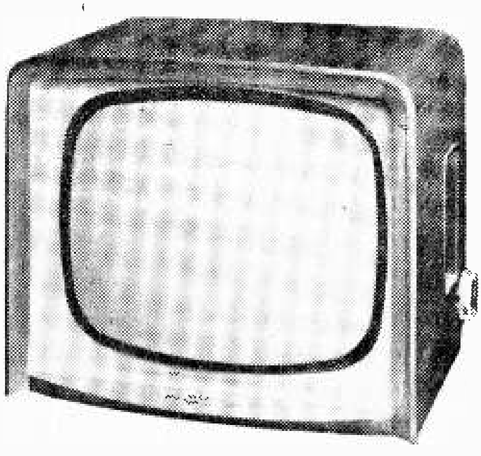
Check V8 PCL83 which is very often the sole cause of this fault. Check the h.t. supply to pin 6 of the base in order to check the T6 output transformer primary winding.

Distorted Sound

If the distortion is worse when the signal is strong, e.g. when the contrast or sensitivity controls are advanced but clears on a weaker signal, check R35 (1MΩ) and D3 GEX34.

Poor Switching

If the station or channel selector does not fully engage with a definite action, i.e. if the switch has



The Alba T655.

to be rotated off its correct point to bring in the desired channel, remove the bottom cover of the tuner and thoroughly clean the turret silver plated contacts. If the contacts are not tarnished or if cleaning does not help, check the bow springs to ensure that these have not been distorted by some ill-informed previous repairer. Clean and oil the locating wheel and adjust the leaf spring if necessary.

Weak Signals

Check the setting of the sensitivity controls marked Band I (BBC) and Band III (ITV) to see that these have not been accidentally moved. Check the PCC84 (V2) valve and clean the V3 valve pins if the results are intermittent.

Weak Contrast

If the sound is in order and the brilliance of the raster is satisfactory but a known good signal produces only a flat picture lacking contrast (but is not grainy) check the D1 GEX34 vision detector diode, R18, R17 and R19 in that order; check V7, V5 and V4, and the voltages of these valves at pins 1, 7 and 8 if necessary. Check the continuity of L1 (across R15) as this could be o.c. at one of its end connections.

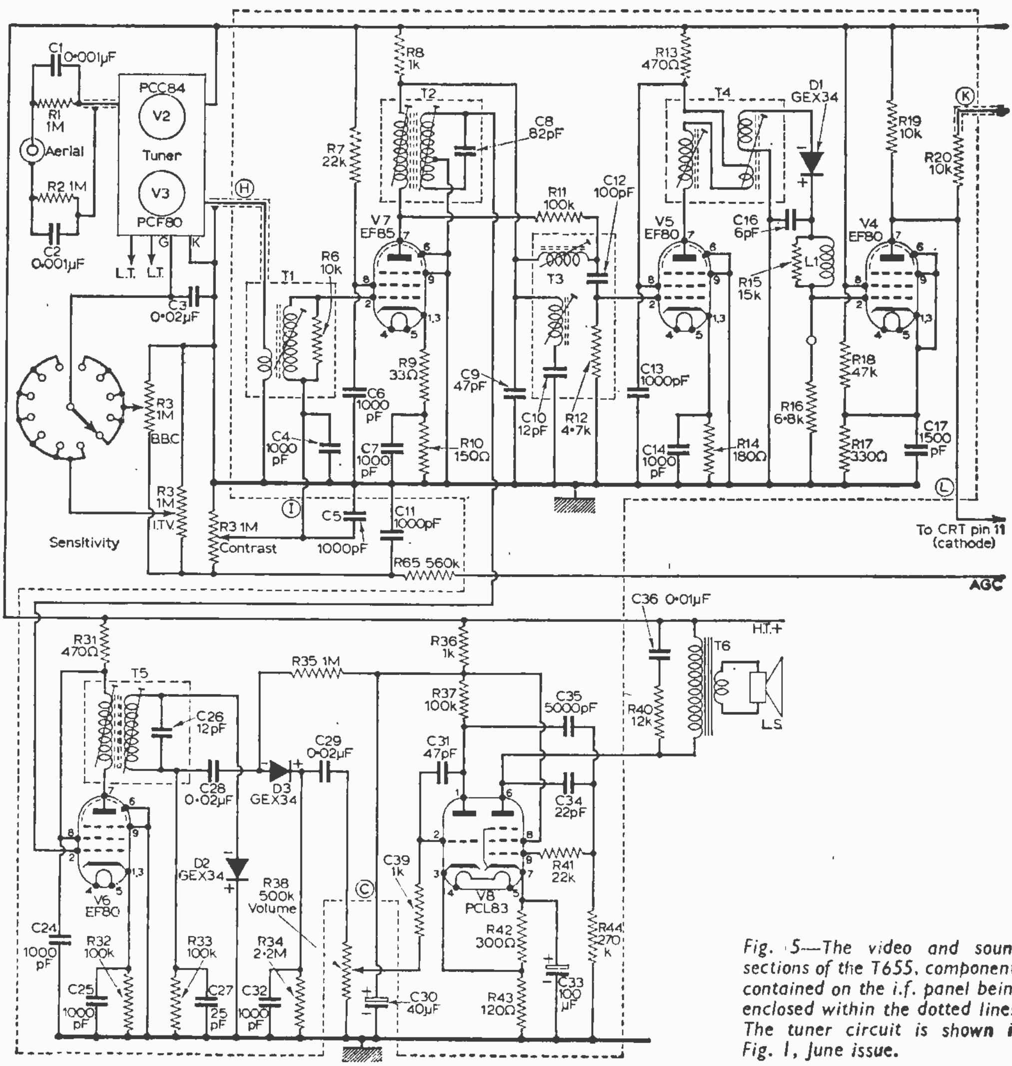


Fig. 5—The video and sound sections of the T655, components contained on the i.f. panel being enclosed within the dotted lines. The tuner circuit is shown in Fig. 1, June issue.

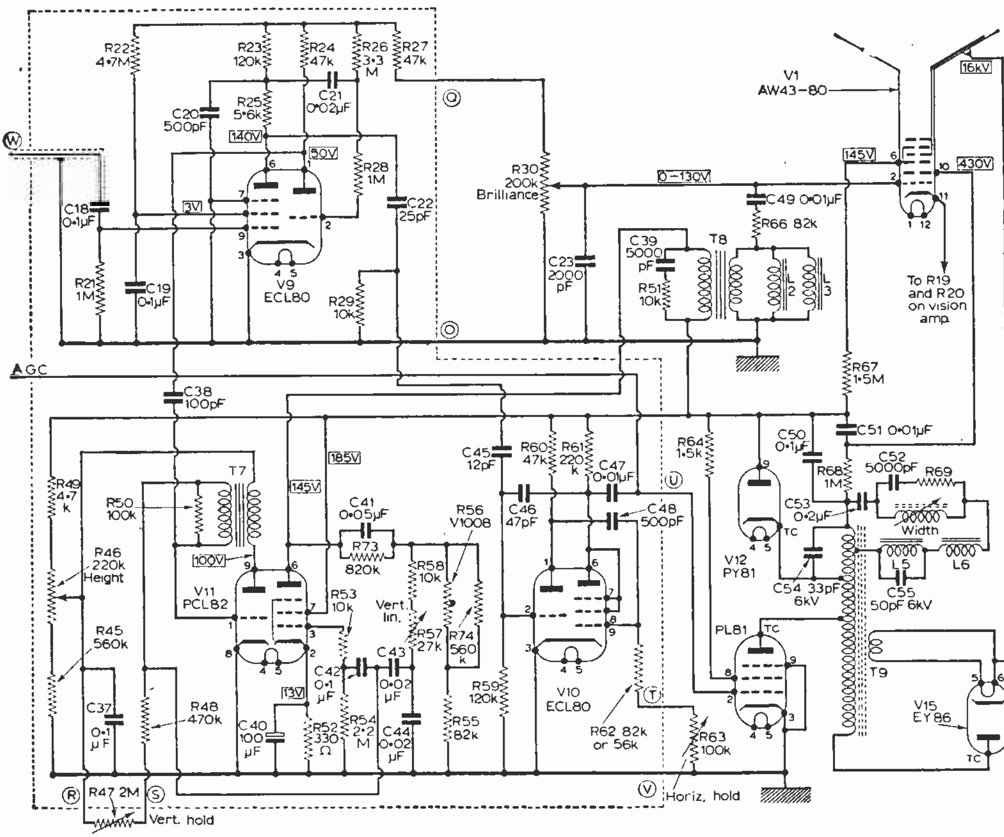


Fig. 6—The sync separator and timebase circuitry, components contained within the dotted lines being contained on the timebase panel.

Less Common Faults

If the fuse blows after a short period after switching on (say after the sound has come through) it may be found that momentarily before the fuse fails the PY32 heater glows brilliantly. This should direct attention to the PY81 efficiency diode which may develop a heater-cathode short as it warms up.

Lack of Width

If the PL81 is not at fault and the ECL80 and PY81 valves are in order, attention should be directed to R61 (220kΩ) which can change value. Its value may rise very high before any severe loss of width is apparent.

Vertical Rulings or Striations

These occur down the left side and show as bars fading in intensity towards the centre. Check R69 (700Ω) and C52 if necessary. Waviness on the left side can be due to C55 50pF 6kV becoming o.c.

No Picture. Line Whistle Strained

Check EY86 for shorts and then check C50 and C54 (latter 33pF 6kV).

Tube Faults

A low emission tube usually shows the well-known symptoms of poor contrast with the images becoming negative when the contrast or brilliance controls are advanced. Also the picture may appear at first with curled edges gradually opening out after a time or as the brilliance is advanced.

The 430V 1st anode supply to pins 7 and 10 (10 first anode, 7 focus electrode) should be checked as the symptoms may be aggravated by low voltage to these pins caused by R68 going high or C51 becoming leaky. An inter-electrode leak in the tube can also result in a low first anode voltage and if there is doubt the supply lead to pins 10 and 7 should be removed and the voltage rechecked at the lead end.

In view of the value of R68 (1MΩ) a good quality meter must be used for the measurement as the shunting action of a low sensitivity instrument can produce a false (low) reading. ■

THE HENLOW wide-band OSCILLOSCOPE

A high quality instrument specially developed for television application

designed and described by

D. R. BOWMAN

Part Two

IT will be convenient to commence construction of this oscilloscope by installing the heavier and bulkier components on the lower deck and then completing the wiring of the power supply circuit. When this operation is finished, work on the upper chassis can be started. Consequently the portion of the instrument to be first described in detail will be the power section, and this will be followed by the time base circuits.

Mains Transformers

The mains transformer T1 should have the following secondary windings: 0—300V 100mA, 0—900V 5mA, 6·3V 2A and 6·3V (tapped at 4V) 1A. Since this second l.t. winding supplies the c.r.t. heater, double insulation is desirable here. The primary should be shielded from the secondary winding by an electrostatic screen.

The 2A l.t. winding is used to supply the heaters of valves V1 to V7 and V14.

The Y-amplifier valves V8—V12 are supplied from a small auxiliary heater transformer T2. This is also used to provide the voltage-calibrating waveform, for reasons to be discussed later. It should be noted that this heater transformer is not shown in the circuit diagram (Fig. 5). However, no difficulty should arise on this account, as the actual wiring arrangements will be clearly indicated in subsequent diagrams.

The heater of the cathode ray tube VCR 97 requires 4V at 1A, and if only a 6·3V winding is available a series resistor of 2·3Ω will be required. This may be made from a short length of eureka resistance wire, wound on a ceramic former and fitted with fairly heavy-gauge copper wire leads. This assembly should be placed inside a Pyrex test tube or similar housing to afford good insulation—it will be remembered that this series resistor is at a potential of 1,300V relative to the chassis.

Arrangement of Components

Fig. 5 shows the circuit diagram of the recommended power supplies. If a mu-metal box is available for containing the mains transformers T1 and T2 these, together with the rectifiers, chokes and resistance voltage droppers, are mounted on the bottom deck of the double chassis. This puts weight at the base of the oscilloscope and makes it very stable in use. One practical point in construction is to place the heavier components symmetrically so that the carrying handle can be fixed centrally—otherwise a very odd appearance can result!

The power supplies are not stabilised, although this would be very desirable in general terms. However, since both X and Y axes are calibrated (time and voltage respectively) there is little lost by the use of simpler circuits, and the added cost and extra heat produced are avoided.

The only thermionic valve used in the power supplies is an EY51 high-voltage rectifier (V14). Since a negative e.h.t. is required the heater of this valve may be run in parallel with those of the timebase generator valves, and so earthed to chassis.

Smoothing of the e.h.t. supply is performed by two high-voltage capacitors (C44, C45) and a 470kΩ resistor (R51) of low rating. Both C44 and C45 have a capacitance of 0·25μF and carry a high charge; a shock from these components can be extremely unpleasant and even dangerous, so during construction the power should never be switched on for tests unless the cathode ray tube chain of bleeder resistances is connected. (Fig. 6). This resistance chain will discharge the capacitors to a safe voltage a few seconds after switching off. Care is still needed, and the testing of this section of the apparatus should always be a leisurely affair, with plenty of time for thought before each operation. The e.h.t. of −1,300V is connected to the junction of VR9 and R57 in Fig. 6.

H.T. Smoothing

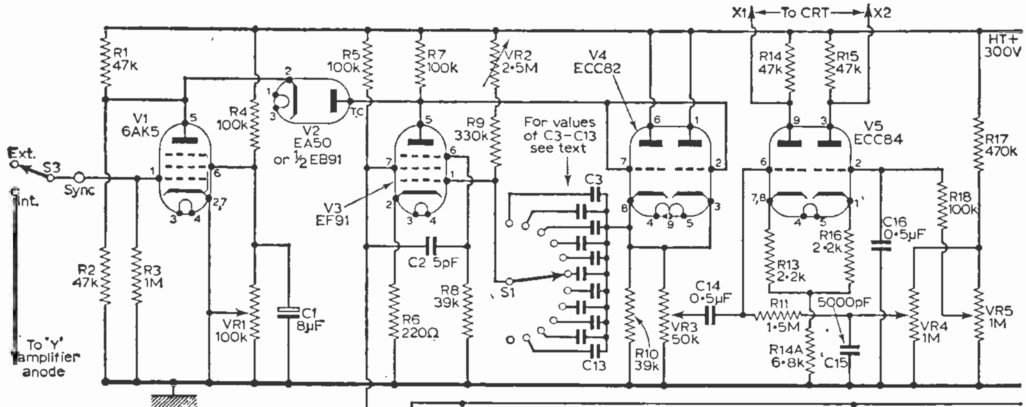
The timebase generator and associated circuits need 300V at about 30mA, and the smoothing has to be really excellent. Elaborate arrangements are therefore made for reducing ripple on the h.t. supply: two chokes (L14, L15) are used with three capacitors (C40, C41, C42) in a double smoothing circuit which reduces ripple to less than 1mV.

The chokes should be preferably of the low-resistance type as used in television receivers, and they need to be rated for about 100mA since the Y-amplifier current is also supplied through them.

The rectification of the 300V supply is carried out by a pair of silicon diodes in series (MR1, MR2). Because with these rectifiers there is no warming-up period, it is necessary to delay switching on the h.t. until the valves are warmed up ready to take current; otherwise about 450V would be applied to the smoothing capacitors on switching on power. With the arrangement of Fig. 5 capacitors of 300V rating can be used without risk, and these are very much cheaper and more readily available than higher voltage types. The actual value of the smoothing capacitors is not critical, but larger values should not be used; the reservoir capacitor (C43) should be as specified.

The silicon rectifiers need protection in two ways from current surges.

In the first place R52 limits the current flowing into the smoothing section—of which the most important here is the reservoir capacitor C43. On first switching on h.t. this capacitor acts as a dead short across the rectifiers and the current flowing is limited only by the total series resistance. R52 needs to be of adequate rating since heavy currents flow in it. The initial surge current is well over 1A, but this is within the surge current rating for 500mA silicon diodes.



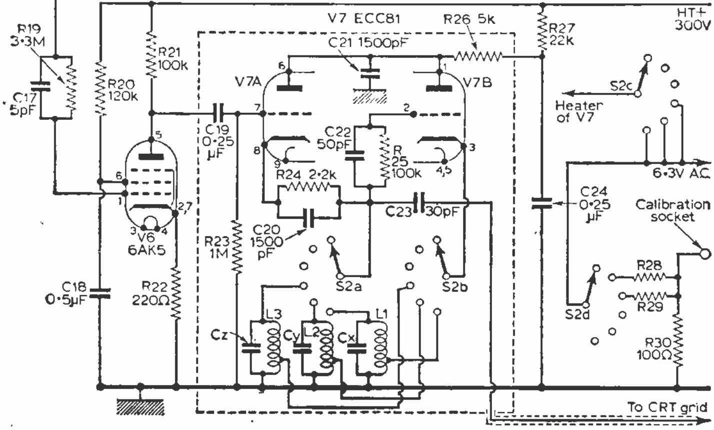


Fig. 2—Timebase generator and amplifier; sync amplifier and time marker.

In the second place there is always the possibility that an electrolytic capacitor may fail catastrophically, and if this happens the current flowing may rise sufficiently to destroy the rectifiers. For this reason a fuse is inserted in the common earth return of the h.t. transformer winding. A 6V or 12V 0·5A motor parking light bulb is used, since this will pass the normal current surges, which last only for a fraction of a second, while it will "blow" if an excessive current flows for one or two seconds.

Two Series-connected Diodes

The silicon diodes specified are rated at 1,000V p.i.v., and it might be thought that a single one would do. This is definitely not recommended. The smoothing section C41, L14, C42, L15 is virtually a lumped-parameter delay line whose iterative impedance is about 230Ω. On first switching on, C40 represents an initial "dead short" and

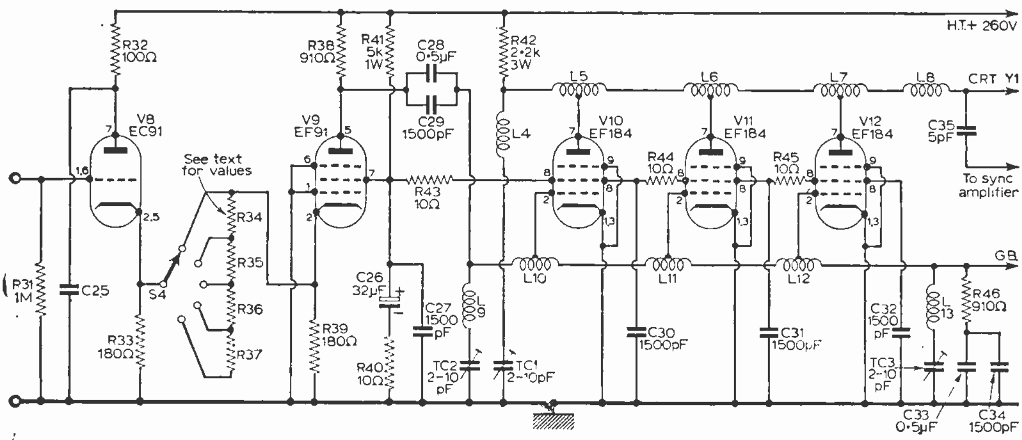


Fig. 3—Attenuator and Y amplifier. Note that C25 is a 16µF electrolytic capacitor.

the line is thus terminated in R49, 1,000Ω. The sudden application of 300V h.t. therefore causes a pulse to be sent down the line towards the termination, and since the line is terminated in a resistance higher than its iterative impedance a reflection of the pulse, without change of sign, takes place at the termination. A pulse of about 250V then comes back along the line, eventually arriving at the rectifier. The worst probable situation at the silicon diode is then as follows:

Voltage across C43	300V
Negative swing of transformer = $300\sqrt{2}$ =	425V
Pulse returning from smoothing circuit	250V
	975V

This is only a fraction below the maximum rating for the diode and leaves nothing in hand for transformer winding tolerances, mains surges, noise voltages on the mains and so on. Two such diodes are therefore specified, and to equalise peak inverse voltages each is shunted by a 560kΩ resistor of low wattage rating (R53, R54).

A small panel-mounting neon indicator (V13) is used as a pilot light to show when h.t. is switched on.

Hum-balancing Voltage

The small circuit at the extreme left of Fig. 5 is interesting in that an adjustable small alternating voltage is impressed on one of the Y-deflectors of the cathode ray tube, as well as the variable d.c. potential which provides Y-shift. The reason for this is the fact that the valves of the Y-amplifier (to be described later) are r.f. valves and are therefore not especially well-suited to low-frequency amplification in that the hum induced from the heater is not minimised in manufacture to the extent to which such precautions are taken with (for example) the audio pentode EF86. Consequently, however well-smoothed the h.t. supply, there is always a few millivolts of hum in the output, and this is independent of the gain setting of the Y-amplifier.

By taking a tapping on a 6·3V winding by means of the potentiometer VR7, and applying this hum voltage to the other Y plate of the cathode ray tube, the effects of the two alternating voltages can be made to cancel very accurately. The effect is best seen, and the adjustment made, with a very low time base speed synchronised with the mains. It is very much better if the waveform of the hum and of the correcting voltage are sinusoidal, because then there are no worries about phase differences between components of the two waveforms. It is best therefore to feed the Y-amplifier, and derive the correcting voltage, from the auxiliary heater transformer. The presence of rectifier pulses in the main transformer causes quite severe distortion in the waveforms found even in the heater windings. For this reason the voltage calibrating waveform also is taken from this separate heater transformer.

The 260V high tension supply is for the Y-amplifier. The EF184 valves need an anode voltage of about 180V, but the extra 80V is dropped across the anode load resistors.

Voltage Divider Chain

When wiring up the voltage divider chain for the cathode ray tube, the network D2, R57, R59 and C47 should be added. The purpose of this, which will be explained fully later, is to protect the tube when beam-modulation is used; its purpose will not be self-evident during preliminary tests.

The chain of resistors shown in Fig. 6 is correct for the VCR97 but may not be very suitable if other types of tube are used. In particular, the "position" in the chain of VR10 may need to be altered; this may be accomplished easily enough by a little experiment with the value of R56 (up or down in value), as the focus requirements of the substitute tube demand. It may be noted that the resistor chain takes about 250μA while the cathode ray tube focus anode takes a negligible current. Consequently tube current need not be considered in estimating the "position" of VR10.

However, brilliance and focus are interdependent to a small extent, and both are dependent on the position of the slider of VR11, the astigmatism control.

In this circuit VR11 controls the tube final anode voltage and is used to optimise the latter in relation to the mean potential of the deflector plates. In practice there is no difficulty in securing a well-focused trace at any reasonable brightness by the simultaneous adjustment of focus and astigmatism controls. Thereafter there is no need to alter the astigmatism controls except when brightness is altered materially, one of the shift controls is used to effect a very great change in trace position, or a very large scan is used for some special purpose.

Timebase Generator

The timebase generator section of this instrument comprises the valves V1 to V5 (see Fig. 2).

V1 is the sync amplifier, and for this application the valve 6AK5 (EF95) has been chosen. It has not only the advantage of low inter-electrode capacitances but is also economical of heater current. VR1 enables the screen voltage, and thus the amplification of the valve, to be varied. The screen is decoupled by the electrolytic capacitor C1, and thus a simple d.c. control of synchronisation voltage is obtained.

It is especially important to avoid r.f. in the control leads wherever possible as all the controls have to be brought out by way of fairly lengthy leads to the front panel. Owing to the relatively high anode load resistance of 23·5kΩ—the resistors R1 and R2 are in parallel with respect to the anode signal—the amplification rises with decrease of signal frequency, and this helps to compensate for the very small capacitance used to couple V1 grid to the Y-amplifier. Useful amplification is obtained up to a frequency of at least 25Mc/s and sync at the highest frequencies is easy to obtain.

Internal or External Sync

Either internal sync from the Y-amplifier, or externally applied sync, is available. Selection of the service required is made by means of a single-pole changeover switch S3. Here the presence on the front panel of a component carrying r.f. can hardly be avoided, and to keep the leads as short as possible it is arranged that V1 is as near as may be to the front panel. Priority in position has however to be given to another circuit (to be dealt with later) in which short leads are even more vital.

V3 is the transitron-Miller sweep generator, and V4 is a cathode follower so arranged as to give a very rapid flyback Coupling between screen and suppressor of V3 is by way of a fixed 5pF capacitor

(C2), and this proves sufficient to give reliable oscillation over all the frequency ranges covered. While this provision simplifies switching it does result in a very limited voltage sweep. The voltage varies a little from one range to another, but is about 40V—enough for the purpose required since push-pull amplification is arranged in the following stages V5a and V5b.

The valve EF91 is not intended for use as a suppressor-gated valve, and it might be thought preferable to use one designed for the job, such as the 6F33. The 6F33 works well in this circuit, but needs a larger screen-suppressor coupling capacitor of about 22pF or a little less. Twelve samples of the EF91 have been tried out in the prototype and have given consistent results, so the constructor can use this type with every confidence.

Rapid Flyback

The cathode follower V4 consists of both halves in parallel of the valve ECC82 and it speeds up flyback in the following way. In the simpler transitron-Miller sweep generator the timing capacitor—

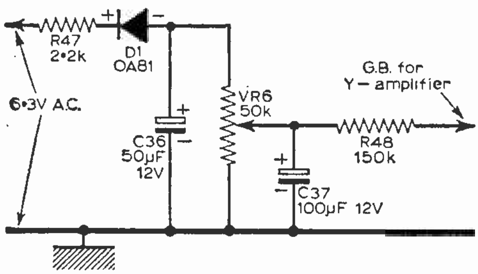


Fig. 4 (above)—Grid bias supplies for the Y amplifier.

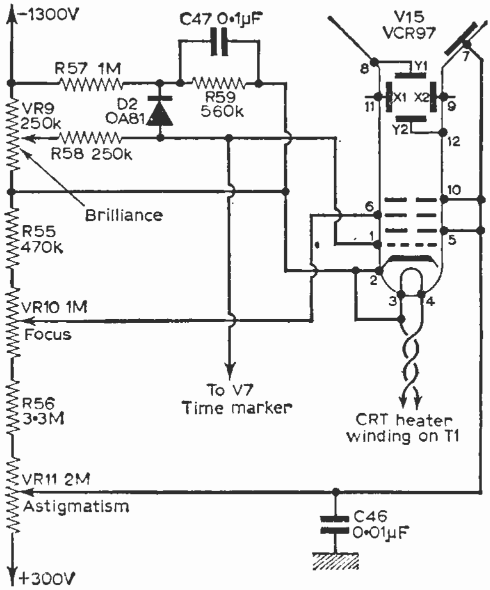


Fig. 6—C.R.T. power supply network.

one of the series C3 to C13—is connected between anode and grid of the valve, and a high resistance connects the grid of the valve to h.t.

During flyback this capacitor has to discharge, and it does so via the anode resistor and the grid

—continued on page 453

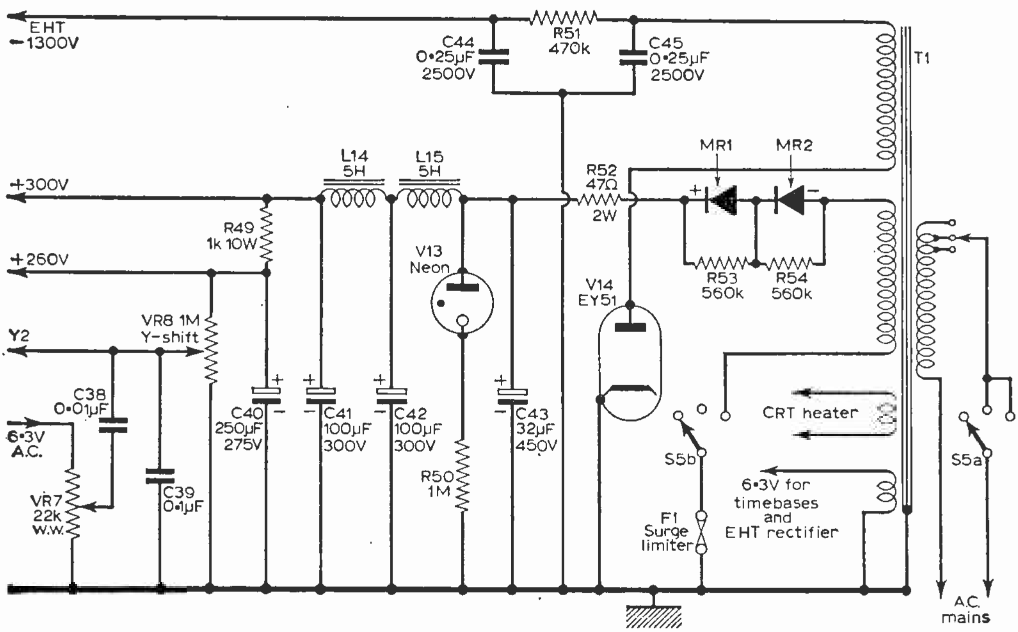


Fig. 5—Power supplies.

—continued from page 450

resistor in series. Because the latter is normally quite high the time of discharge is relatively slow. In this circuit, when the timing capacitor has to discharge it does so through the output impedance of the valve V4, which is 1/gm in parallel with the cathode resistor and amounts to about 200Ω, and the grid-cathode resistance of V3 under grid current conditions—about 1,000Ω. The total resistance in series with the capacitor is about 1,400Ω, and discharge is extremely rapid. Flyback thus occupies only a small fraction of the sweep, even at the highest frequencies where stray capacitances tend to lengthen flyback; at the lower frequencies it occupies a quite negligible proportion of the sweep.

A very fast flyback means that except at the highest frequencies the return trace is invisible unless brightness is much increased. Consequently it has not been found necessary to include flyback blanking of the trace. On the two highest frequency ranges the return trace is visible, but at much reduced intensity. It is considered an advantage that in fact no part of the complete cycle is irretrievably lost, especially when the number of cycles displayed is to be counted. If desired, however, a small capacitor may be used to couple the anode of V6 to the cathode ray tube grid, when complete blanking may be achieved. The capacitor used must have an ample voltage rating, and a suitable component can be made by twisting together lightly a few inches of p.v.c. covered connecting wire. However, owing to the presence of distributed inductance and capacitance in the circuit the flyback pulse is delayed in arrival at the cathode ray tube grid, and the first part of the trace itself is lost. This may not be considered a disadvantage, as there is ample scan in any case.

Scan Speed

The prototype instrument has eleven ranges of frequency; within each range the scan speed is controlled by VR2, a 2·5MΩ linear law potentiometer. The values of timing capacitor are are as follows:

		sweeps per second (approximately)		
C3	1μF	2	to	10
C4	0·5μF	5	to	25
C5	0·15μF	12	to	50
C6	0·05μF	50	to	250
C7	0·01μF	200	to	1,000
C8	2,000pF	1,000	to	5kΩ
C9	500pF	4kΩ	to	20kΩ
C10	200pF	6kΩ	to	30kΩ
C11	50pF	20kΩ	to	60kΩ
C12	22pF	40kΩ	to	200kΩ
C13	strays	150kΩ	to	500kΩ

The extra contact on the switch S1 is connected to chassis direct. When this position is selected the timebase generator is out of action and an external timebase generator may be used if desired. A socket is provided for the timebase generator output, connected to the slider of VR3, and this does duty also as the input for an external timebase voltage. For this application the slider should be turned as for maximum output and the external generator—if of high impedance—should be connected to the socket via a cathode follower. The input impedance at this terminal is about 200Ω.

Differential Amplifier

The timebase amplifier V5 is a differential amplifier of the "long-tailed pair" type. As well as providing push-pull deflection voltages for a single input, an X-shift potential exists at the anodes which can be varied by altering the d.c. potential of one of the grids by means of the potentiometer VR5.

VR4 varies the timebase voltage fed to V5a grid and this is valuable for expanding the X-deflection. The un-bypassed cathode resistors R13 and R16 virtually lengthen the grid base of the valves to about 5V. As the timebase output is about 40V an eight-fold expansion is available on most ranges. The required part of the waveform displayed can be brought to the centre of the tube face by means of the Y-shift control VR5, providing the degree of expansion is not too great.

Physical Layout

The circuits comprising the sync amplifier, timebase generator and sweep amplifier are built along one side of the upper chassis so as to bring the X-amplifier anodes as close as possible to the base of the cathode ray tube. This avoids excessive circuit capacitance and minimises the length of leads which at the higher timebase speeds carry high-frequency currents and may give rise to unwanted coupling between X and Y plates of the tube.

The leads and controls so far discussed and brought out to the front panel are as follows:

VR1	...... sync amplification
VR2	...... X speed
VR3	...... X expansion
*VR4	...... X shift
*VR9	...... brilliance
*VR10	...... focus
*VR11	...... astigmatism
S1	...... X range
S3	...... sync switch
*S5	...... power supplies
Coaxial socket	... X output

Those marked with an asterisk * are d.c. or mains frequency items and the length of lead is unimportant. The remainder carry timebase frequency currents and the length of lead should be as small as possible. They should be unshielded to minimise circuit capacitance but should consist of twisted flex to carry "go" and "return" currents. The exception to this is the case of the leads to the sync switch, where even the self-capacitance of twisted flex is unacceptable. The front panel should not be relied upon for an earth return except for d.c. controls only. The remaining panel controls are concerned with time and voltage calibration and the Y-amplifier. These will now be discussed.

Marker Oscillator

Along the same side of the upper chassis is built the marker oscillator (V7). Because this generates high frequencies at considerable voltage its necessary controls on the front panel must at all costs be connected by the shortest possible leads. Thus the valve nearest the front panel on this side is associated with this oscillator circuit.

In Fig. 2 the portion of the circuit around V7 is

COMPONENTS LIST

Resistors:

R1	47kΩ
R2	47kΩ
R3	1MΩ
R4	100kΩ
R5	100kΩ
R6	220Ω $\frac{1}{2}$W
R7	100kΩ
R8	39kΩ
R9	330kΩ
R10	39kΩ
R11	1·5MΩ
R12	—
R13	2·2kΩ
R14	47kΩ
R14A	6·8kΩ 1W
R15	47kΩ
R16	2·2kΩ
R17	470kΩ
R18	100kΩ
R19	3·3MΩ
R20	120kΩ
R21	100kΩ
R22	220Ω $\frac{1}{2}$W
R23	1MΩ
R24	2·2kΩ
R25	100kΩ
R26	5kΩ
R27	22kΩ $\frac{1}{2}$W
R28, R29	See text
R30	100Ω
R31	1MΩ
R32	100Ω
R33	175Ω $\frac{1}{2}$W
R34, R35, R36, R37	See text
R38	910Ω $\frac{1}{2}$W 5%
R39	180Ω $\frac{1}{2}$W
R40	10Ω
R41	5kΩ 1W
R42	2·2kΩ 3W 5% H.S.
R43	10Ω
R44	10Ω
R45	10Ω
R46	910Ω $\frac{1}{2}$W 5%
R47	2·2kΩ
R43	150kΩ
R49	1kΩ 10W
R50	1MΩ
R51	470kΩ
R52	47Ω 2W
R53	560kΩ
R54	560kΩ
R55	470kΩ
R56	3·3MΩ
R57	1M
R58	250kΩ
R59	560kΩ

All 10% $\frac{1}{4}$W, except where otherwise indicated.

Variable Resistors:

VR1 100kΩ carbon potentiometer
VR2 2·5MΩ carbon potentiometer
VR3 50kΩ carbon potentiometer
VR4 1MΩ carbon potentiometer
VR5 1MΩ carbon potentiometer
VR6 50kΩ carbon potentiometer
VR7 22kΩ wire-wound potentiometer
VR8 1MΩ carbon potentiometer
VR9 250kΩ carbon potentiometer
VR10 1MΩ carbon potentiometer
VR11 2MΩ carbon potentiometer
All the above are linear law.

Capacitors:

C1 8μF electrolytic 250V
C2 5pF silver mica
C3 1μF paper 150V
C4 0·5μF paper 200V
C5 0·15μF paper 200V
C6 0·05μF paper 200V
C7 0·01μF paper 200V
C8 2,000pF silver mica
C9 500pF silver mica
C10 200pF silver mica
C11 50pF silver mica
C12 22pF silver mica
C13 (strays)
C14 0·5μF paper 200V
C15 5,000pF silver mica
C16 0·5μF paper 200V
C17 5pF silver mica
C18 0·5μF paper 300V
C19 0·25μF paper 250V
C20 1,500pF silver mica
C21 1,500pF silver mica

Capacitors (contd.):

C22 50pF silver mica
C23 30pF silver mica 2500V
C24 0·25μF paper 250V
C25 16μF electrolytic 300V
C26 32μF electrolytic 250V
C27 1,500pF silver mica
C28 0·5μF paper 300V
C29 1,500pF silver mica
C30 1,500pF silver mica
C31 1,500pF silver mica
C32 1,500pF silver mica
C33 0·5μF paper 300V
C34 1,500pF silver mica
C35 5pF silver mica
C36 50μF electrolytic 12V
C37 100μF electrolytic 12V
C38 0·01μF paper 300V
C39 0·1μF paper 300V
C40 250μF electrolytic 275V
C41 100μF electrolytic 300V
C42 100μF electrolytic 300V
C43 32μF electrolytic 450V
C44 0·25μF paper 2500V
C45 0·25μF paper 2500V
C46 0·01μF paper 300V
C47 0·1μF paper 150V

Variable Capacitors:

TC1 2—10pF concentric type trimmer
TC2 2—10pF concentric type trimmer
TC3 2—10pF concentric type trimmer

Inductors:

L1-13 See text
L14 Smoothing choke 5H 100mA low resistance
L15 Smoothing choke 5H 100mA low resistance

Transformers:

T1 Mains transformer. Tapped primary. Secondaries: 0-900V 5mA; 0-300V 100mA; 6·3V 2A; 6·3V (tapped at 4V) 1A
T2 Heater transformer. Tapped primary. Secondary: 6·3V 2A

Switches:

S1 1-pole, 12-way rotary switch
S2 4-pole, 6-way rotary switch
S3 1-pole, 2-way toggle switch
S4 1-pole, 5-way rotary switch
S5 2-pole, 3-way rotary switch

Valves:

V1	6AK5	V9	EF91
V2	EA50	V10	EF184
V3	EF91	V11	EF184
V4	ECC82	V12	EF184
V5	ECC84	V13	Neon 210—250V
V6	6AK5	V14	EY51
V7	ECC81	V15	VCR97
V8	EC91		

Rectifiers:

MR1, 2 Silicon power rectifier 500mA 1,000 p.i.v. (E250C50)
D1 OA81 germanium signal diode
D2 OA81 germanium signal diode

Miscellaneous:

Two coaxial sockets. Two terminals. Valve-holders: five B7G; six B9A; one B3G. Lampholder. Panel-mounting holder for neon tube. Base for c.r.t. Perspex sheet 6$\frac{1}{4}$in. square.

shown enclosed in a screening can and in the prototype it was found possible to construct the whole marker oscillator, including valve socket, on the lid of a small tin (actually a salted peanut tin) secured to the chassis. The tin itself then formed the removable screen. The most thorough isolation of this circuit from the rest of the wiring proved necessary and hence not only is the circuit screened but all the leads for power supplies—including heater wiring—as well.

The oscillatory voltage from this unit, used to modulate the cathode ray tube beam current, is carried to the tube grid through a section of coaxial cable; the outer braid is earthed at only one point, as close to the oscillator circuit as possible and actually on the valve socket itself. Certain leads cannot, of course, be screened effectively; one of these is the wire carrying a timebase pulse from the anode of V6, where the capacitance of even a short length of coaxial cable would distort the pulse unacceptably. Here a short lead is necessary, well separated from any other connecting wires.

The operation of the circuit is as follows: V7b is a cathode-Hartley oscillator whose frequency of operation is determined by the value of inductance (L1 to L3) switched into circuit by means of S2a and S2b. The valve V7a is a cathode follower whose cathode resistor (2·2kΩ shunted by a 1,500pF capacitor) is attached direct to the "live" end of the tuning inductor in circuit. If the grid of V7a is at such a potential that the valve draws anode current, cathode follower action takes place across the tuning inductance and very heavy damping is imposed on it—sufficient to prevent oscillation. Also the "live" end of the tuning inductor is held at very near earth potential.

On applying a positive pulse to the grid of V6 a negative pulse of increased amplitude appears at the grid of V7a. This cuts off the valve V7a and the damping resistance in its cathode circuit is immediately removed. Oscillation now begins with the transfer of energy from the inductor to its tuning capacitor on the first half-cycle. Oscillations thus begin with practically full amplitude and always start in the same phase.

If this were not arranged and the oscillator allowed to start in random phase the markers produced would not occupy the same position on each trace; except by luck they would not be seen at all. The same would apply in the case of a continuously-running oscillator whose output to the cathode ray tube was "gated" by a timebase pulse.

Pulse Shaper

The pulse shaper and amplifier V6 is direct-coupled to the screen of the Miller sweep generator whose screen generates a negative pulse on flyback. The capacitor C17 ensures only that the steep leading edge of the pulse is not lost, while the d.c. connection provides that when there is no screen pulse the grid of V6 is clamped to very nearly earth potential. The anode and screen load resistors are such that during the screen pulse V6 is cut off and this ensures that a pulse of constant amplitude is passed to the grid of V7a.

Because V7b is driven hard its output waveform is not sinusoidal but very peaky—just the sort of wave needed for use as a time marker. On arrival at the grid of the cathode ray tube the varying potential causes a variation in beam current which in turn alters the brightness of the trace. Since the marker oscillator always starts at the beginning of the trace in the same phase the trace appears to be composed of a series of dark and light patches; the bright dots represent the tips of the modulating wave and are therefore separated by the time interval corresponding to one cycle of the wave. In Fig. 6 the diode D2 is so arranged as to conduct when the grid potential approaches that of the cathode. With the components specified the diode conducts before the grid voltage becomes positive and so the tube is well protected from damage.

Inductor Details

The inductors L1 and L2 are wound on the same former to conserve space. This is a bakelite tube 2·4in. in length and $\frac{9}{64}$in. diameter—the inner former of a popular type of canned assembly widely obtainable.

L1, the 1Mc/s oscillator coil, consists of 150 turns of No. 40s.w.g. enamelled copper wire in three layers of 53, 50 and 47 turns respectively. The cathode tap is at 53 turns from the earthy end of the winding. A dust iron slug is used for trimming and a fixed capacitor of 50pF for tuning is connected across the whole coil. This winding is placed near the bottom of the former.

L2, the 100kc/s oscillator coil, consists of 1,600 turns of the same wire, pile-wound between cheeks $\frac{5}{8}$in. apart. This winding is tapped at 300 turns from the earth end. A tuning slug and a capacitor of 200pF are provided. L2 should be situated on the former as far away from L1 as possible.

For L3, the inductor for 10kc/s, a different technique has to be used in order to economise in space. A few laminations from an old speaker transformer were selected; they measured $2\frac{1}{4}$in. x $\frac{3}{8}$in. x 0·32in. Five such strips were cut up into three of equal size except for one of double length which was drilled with a $\frac{1}{8}$in. hole and bent over at right-angles for mounting purposes. Thus a stack of 14 laminations about $\frac{3}{4}$in. x $\frac{1}{2}$in. x $\frac{3}{8}$in. was obtained.

On this stack was mounted a pair of end cheeks, the whole was dipped in a solution of shellac in methylated spirit and allowed to dry thoroughly (this took over 24 hours) before winding the coil.

Then 1,600 turns of No. 40s.w.g. enamelled copper wire were wound on, tapped at 400 turns from the earthy end for the cathode tap. With the laminations used a capacitor of 0·001μF was found to give a close approximation to the frequency required, with a final adjustment (arrived at by trial and error) by an extra capacitor, nominally 82pF, in parallel.

The constructor will need to experiment a little in this circuit. The keen ear can arrive at precisely the television line frequency of 10,125c/s by direct comparison with a synchronised receiver. This is only $1\frac{1}{4}$% in error and may be sufficiently accurate.

If the ear is not sensitive enough a synchronised TV receiver can be used in any case, by feeding a little of the oscillator voltage direct to the cathode of the picture tube and adjusting for zero beat as seen on the tube face. This calibration is the most difficult in practice and the full drill for all ranges will be given in detail later.

CONTINUED NEXT MONTH

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The First of a New Series of Informative Articles

OF recent months colour television has leaped into the headlines and the various happenings concerning the future of television broadcasting have made it fairly clear that colour television is at long last past the horizon. Now that the number of lines to be used in the future has been fixed, coupled with 625-line u.h.f. tests by the BBC, we have at last something definite on which to base colour television. Colour test transmissions by the BBC on 625-line u.h.f. are already in hand and it is unlikely to be long after the start of the regular 625-line u.h.f. transmissions in 1964 that colour will also start on a fairly regular basis.

At the time of writing there are two feasible systems, each using the tricolour shadow mask picture tube, one called the NTSC system—devised originally for the American 525-line system but later modified for British 405-line and 625-line working—and the other the SECAM (or Henri de France) system. SECAM stands for "sequential and memory", while NTSC stands for "National Television Systems Committee". The NTSC system was developed in America and was first demonstrated at the end of 1953. It was subsequently adopted in America and has since been in operation for about eight years.

The SECAM system transmits the same basic information as the NTSC system but there are various differences in detail between the two. For example, the SECAM system transmits two signals of colour information in alternate line periods, using a delay system at the receiver to "hold" the first colour information until the second arrives, while with the NTSC system two signals of colour information are transmitted simultaneously and these are extracted independently by a rather special kind of detector in the receiver.

These features will be considered at their proper time but at this stage it is prudent to have in mind that there is not a great deal of difference between the two proposed colour systems, a factor which makes it possible to review both systems within the compass of this series of articles.

Bird's-eye Picture

It has been uttered—rightly or wrongly—that colour television is extremely complex. A lot depends, of course, on whether you are going to design and make a colour receiver, invent a new system or just set up a colour set and keep it in good trim. That there is more to it than black-and-white television (called "monochrome" as distinct from "colour") is not denied, but in the author's opinion colour is really an *extension* of the monochrome principles (see the previous series, "Principles and Practice of Television", commencing in October, 1962, issue of PRACTICAL TELEVISION) with a few new ideas thrown in, and as such it is not necessarily any more complicated than monochrome, once the additions and the new ideas are fairly well understood.

There is, of course, the extra complexity of the theory of colour itself but, generally speaking, any experimenter, enthusiast or service technician who is keen to advance and who has a fair knowledge of the workings of the monochrome system can gain an understanding of colour television fundamentals—at least sufficient for setting up and servicing commercial models—without excessive brain fatigue and without getting too bogged down in theory and mathematics.

The first two articles of this series will give a sort of bird's-eye picture of the present state of the art as a whole while also guiding the reader along the road of colour theory; later articles will have greater emphasis on detail and will "look" at some of the circuits of modern colour receivers.

Basic Colour

The basic difference between a monochrome receiver and a colour receiver can be stated briefly as follows: the monochrome receiver gives the scanning spot on the screen of the picture tube an instantaneous brightness value, this being directly governed by the brightness of that part of a picture

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BY G. J. KING

element under the scanning spot of the camera tube; the colour receiver gives an instantaneous colour value as well as a brightness value. In effect then, a colour receiver has all the attributes of a monochrome set *plus* features to bring in colour. It is nice to know that a colour receiver is pretty well the same as a monochrome set up to the vision detector. This is because a colour receiver has to be "compatible". That is it has to be able to give a picture in black-and-white from a monochrome transmission, but more about that later.

It is obviously impossible to have all the colours of the rainbow immediately available on the screen of the colour picture tube. Like the artist a colour receiver has to mix two or three colours to secure the precise shade or hue required.

Without being too scientific, almost any colour of any "saturation" can be created from the three "primary colours", which are *red*, *green* and *blue*. These are the *real* primary colours and they must not be confused with the so-called "artist's primary colours", which are yellow, blue and red or, more correctly, yellow, cyan (bluish hue) and magenta (reddish hue).

The term "saturation" refers to how bright the colour is displayed. A saturated red, for example, is a very bright red which can be made no brighter in terms of actual colour. Now if white is added to a saturated red it becomes "desaturated" until eventually it is totally desaturated by the addition of so much white and ends up as white. Remember, though, that the process of saturation or desaturation does not alter the hue.

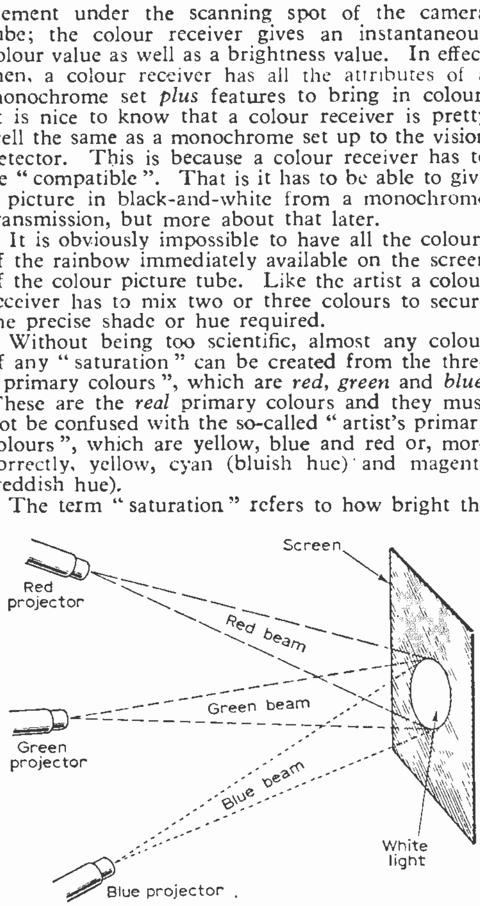


Fig. 1—If lights of the three primary colours are projected on to a common screen, white light is produced. Note that colours are mixed additively in this way, as distinct from colour filters interposed between a white light and the eye, when a colour is subtracted from white light.

Since any colour can be produced from the three primary colours, it follows that white light can be split up into a spectrum of component colours of varying wavelengths. Conversely, the same colours added together will produce white light. White light can be split by an optical prism, as is well known, and if a similar prism is used to combine the colours so obtained white light is again produced. It will probably be recalled that a prism produces not only the three primary colours but also a wide range of colours of the full spectrum. The theory of this need not worry us unduly, for all we need to know at this time is that the three primary colours alone, provided they are combined in varying proportions, can be made to reproduce the widest range of colours for all practical purposes. This is clearly revealed in colour photography, which today is almost one hundred per cent, but colour television can be equally as good as high class colour photography.

Colour Mixing

At this stage it must be made perfectly clear that there are two distinctly different ways of mixing colours. One is by adding them together, as it were, and the other is by subtraction—that is, subtracting a certain colour from white light to give a final required colour.

The most obvious way of adding colours is by projecting coloured lights on to a common screen so that the areas of colour overlap. Fig. 1 shows how this can be done and that when the three primary colours are added the result is white light on the screen.

When red and green lights are added, the result is yellow (Fig. 2), with green and blue we get cyan and with blue and red we get magenta (Figs. 3 and 4). The three resultant colours are called "complementary colours".

Those with memories of water-colour paint mixing will know that a mixture of red, blue and

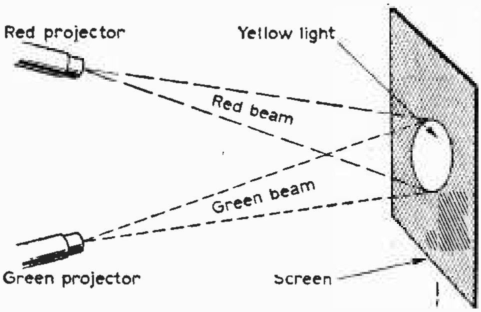


Fig. 2 (above)—The addition of red and green lights gives the complementary colour yellow.

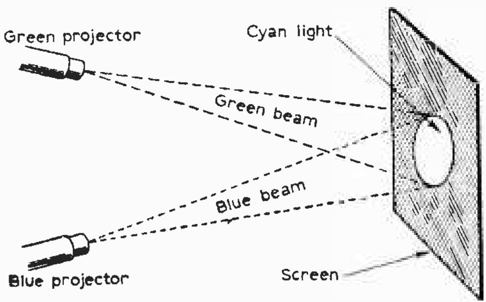


Fig. 3 (above)—The addition of green and blue lights gives the complementary colour cyan.

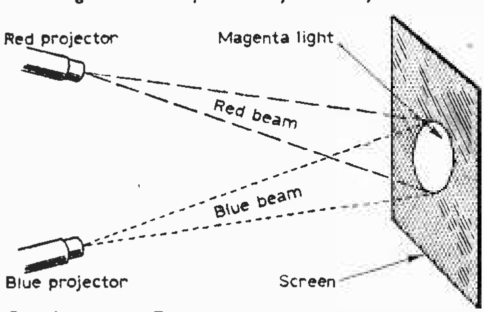


Fig. 4 (above)—The addition of red and blue lights gives the complementary colour magenta.

green paint certainly does not produce white paint! Also that mixing red and green paints do not produce yellow. The reason for this apparent confliction arises, as already mentioned, from the fact that there are two basic systems of colour mixing. The additive system is concerned with the mixing of light sources, and is the system used in television, while the subtractive system (which includes the mixing of paints) interposes a colour filter between the light source and the eye, thereby subtracting from white light. Although subtractive mixing is not suitable for colour television (not yet anyway) it will, nevertheless, be looked upon briefly for the sake of completeness.

By the interposition of a colour filter, as described, certain colours are subtracted and the eye sees what remains. Consider a yellow filter—a colour which is complementary of red and green (Fig. 2)—held between a white light and the eye (Fig. 5). This filter obviously passes red and green but blocks blue. The eye thus sees yellow. Similarly, a magenta filter—whose complementary colours are red and blue (Fig. 4)—will pass red and blue but block (or subtract) green, thereby passing on to the eye red and blue which add to produce magenta, as shown in Fig 6.

This process can be continued by interposing two or three filters. In Fig. 7 (for example, a yellow and magenta filter are used, the first cutting off blue and the second cutting off green from yellow, thereby passing only red to the eye. The process is continued to its logical conclusion in Fig. 8 with three filters, the yellow one cutting off blue from white light, the magenta subtracting green from yellow leaving red and the cyan filter subtracting red from red, thereby cutting off all light and leaving black.

Black and White

The lesson here, then, is that when the three primary colours are added we get white light and when they are subtracted we get black. As a final example, if a blue filter is laid upon a yellow, the light penetrating the two filters will be green (subtractive) while if a yellow light is mixed additively (by projection) with a blue light, the result is white. This angle should be remembered,

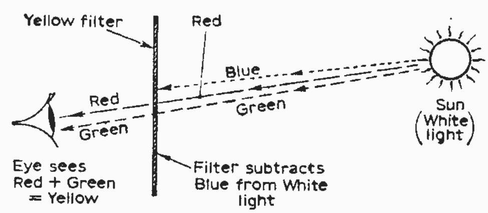
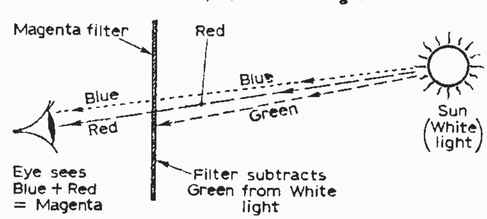


Fig. 5 (above)—A yellow filter passes the primaries red and green, but subtracts blue.

Fig. 6 (below)—A magenta filter passes the primaries blue and red, but subtracts green.



since yellow being made up of the red and green primaries, which together with blue, give white light! This technique is adopted in colour television as we shall see later.

Before going away from colour mixing it should be noted that when we add paints and inks we get an action similar to that of colour filters. Yellow, for instance, appears yellow because it absorbs blue light and thus reflects red and green which add (Fig. 2) and give yellow.

Remember that since a colour is absorbed it is effectively subtracted, so the mixing of pigments is a subtractive process. When two pigments are mixed we get an effect similar to that with colour filters. For example, a mixture of yellow and magenta would appear as red (see Fig. 7) since these colours absorb both blue and green, thereby leaving red. These two systems of colour mixing are often not fully understood when launching out into the realm of colour television and thus cause confusion.

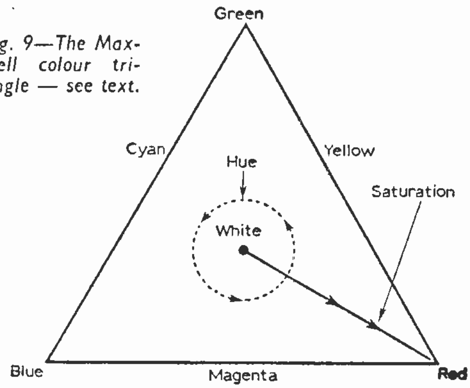


Fig. 9—The Maxwell colour triangle — see text.

Colour Triangle

One cannot get far in colour television without coming up against the colour triangle (Fig. 9). This depicts the so-called "trichromatic" method of colour synthesis graphically, as evolved by Maxwell. The sources of the three primary colours are placed at the corners of the triangle. Owing to the *addition* of the primary colours the complementary colours are formed along the three vertices of the triangle (which, incidentally, is equilateral).

The actual brightness of any component ranges from zero along the opposite side of the triangle to maximum at the vertex and is measured perpendicularly to the opposite side. The point representing white lies at the exact centre of the triangle, and this is the desaturated state of all the colours, as previously defined, remembering that the saturation of any colour is governed by how much white light is mixed with it.

It should also be remembered that the hue is not changed of any colour by adding white light, and that towards desaturation the colours diminish from brilliant to pale or pastel shades; this means that the "energy" of the colour itself is reduced. We shall have more to say about light energy next month.

SERIES TO BE CONTINUED

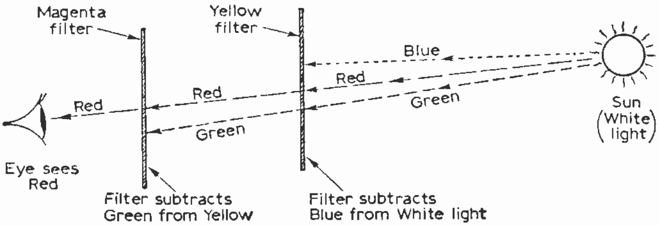
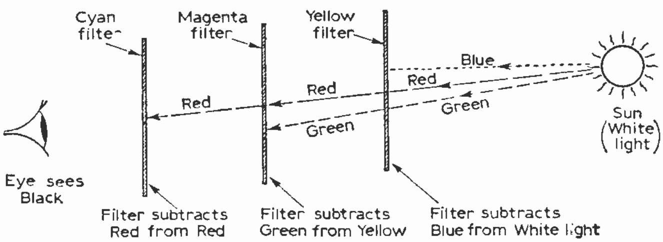


Fig. 7 (above)—With magenta and yellow filters only red light is passed to the eye.

Fig. 8 (below)—With filters of the three complementary colours all light is subtracted.



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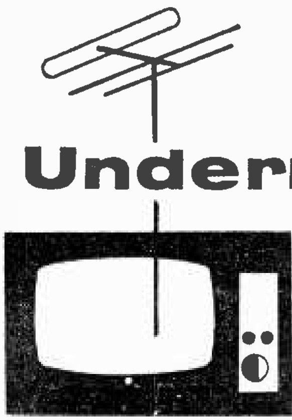


A MONTHLY COMMENTARY

Underneath the Dipole

"COLOUR Causes Headaches" could be a misleading headline. When colour first became a practical proposition in the cinema, a prominent non-teetotal British film director was asked by journalists his opinion of colour cinematography. "Colour?", he answered, "I can't be bothered. There are enough headaches in Black and White!". The journalists appreciated the double response and the headache headlines duly appeared.

They are likely to appear again, this time for television because the problems of production, colour coding, line standards, bandwidths, network distribution, transmission and colour receiving sets, are far more complex here than in any other country in the world.

That is our handicap for pioneering the first public television service, before world line standards were decided. This is a risk the pioneer has to take. Colour television is a practical proposition, especially for the countries that waited a while before starting their services. The headaches are British headaches.

Royal Wedding and Colour

Colour films at the cinema of the Royal Wedding were most impressive. By comparison, the BBC and ITV direct transmissions and videotape replays, were visually anaemic. And yet the elaborate camera coverage of both organisations was excellent, and it is hard to decide which gave the best coverage. On the whole, my vote would go to the BBC, not especially for the visual side, but because of the superb commentary by Richard Dimbleby.

Mr. Dimbleby has been criticised in the past for being slightly pompous or unduly reverent on Royal occasions (a criticism with which I disagree), but this time he certainly tempered his colourful descriptive comments with some delightful off-the-cuff asides of a most informal character. This was an occasion on which "Auntie BBC" recovered a little of her soiled reputation. (Later on the same week, she lost it again when irresponsible references were made about Royal Weddings in another programme.)

By comparison, the ITV commentators seemed overawed and slightly unsure of themselves. I would like to have heard Dimbleby's rich colourful descriptions over a colour television broadcast.

The Golden Rose

The Golden Rose Television Festival has come around again, and with it the migration of television critics, personalities, producers and directors to Montreux. Britain was not so lucky this time, though the BBC's entry, the Michael Bentine Show "It's a Square World", was very well received.

Entries were received on tape of various standards, on 35 and 16mm film, and on 35mm film photographed with television techniques. I haven't heard of any photographic tele-recordings being shown, though the BBC have achieved a high technical standard in this very difficult process.

One must admit that, with few exceptions, there is serious degradation of quality when transfers are made from videotape to film, and few companies like to chance this method in competition at Montreux with direct filming. "TWTWTW" was received with yawns, and some foreign critics were frankly puzzled by the tone of the show. However, an American version called "What's Going On Here?" has recently appeared on television in New York, featuring a number of young English satirists at present in that city. It is not a pleasant thought.

A.T.V. Drama

Associated Television have long been noted for "Sunday Night at the London Palladium" and dozens of other television productions of a light character, including shows produced on the stages of the old Empire music halls at Wood Green and Hackney.

Lately they have been winning themselves a high reputation for taut drama, mainly the result of the association of A.T.V. with the famous theatrical firm of H. M. Tennent Ltd. Some TV plays that emanated from Tennent's tended to lack the slickness and polish of similar shows from the BBC or A.B.C.'s Teddington Studios, and the subject matter seemed to line up more with the specialised tastes of the smaller London theatres than with the popular mass TV audience. On the whole, TV audiences are "square" about plays, inasmuch as they are bored by aimless chatter and an inconclusive ending. That phase has obviously ended, for we have had several slick crime dramas in quick succession which stood comparison with the best on television.

A typical "taut" play was "Double Stakes" by Victor Canning, a 90-minute (less commercial breaks!) drama of steadily increasing tension which must have kept a lot of viewers on the edge of their seats. An ex-convict ex-actor comes out of prison, determined to keep to the "straight and narrow", but, failing to find work, falls once more into crooked company. His likeness to the manager of a Bond Street jewellers' shop prompts the head of a gang to groom him as a "stand-in" for the manager. He is coached with all modern aids (including photographs, films and tape recordings) to give a life-like imitation of the manager, sufficient to fool the commissionaire, the cashier and even his own secretary. It has all the signs of being a perfect crime, with thousands of pounds' worth of diamonds and jewellery as the prize—until a number of little things start to go wrong, culminating in his being shot in mistake for the genuine manager.

Nigel Davenport played the dual roles of real and phoney manager with great skill, and ingenious methods were used to cover the few scenes in which both of them (or their bodies) were in the same scene together.

This tense play was not without humour, mainly introduced by the manager's secretary, played by Joan Sims. Direction was by John Hale and sets by Patrick Robertson—both being first-class, and the camera work and technical qualities reached a very high standard.

Drama '63

A.T.V.'s Drama '63 series is keeping up the pace, too, even though the subject matter sometimes reverts to the overworked theme of the teenage layabouts. "The Freewheelers", a well constructed original play by Giles Cooper, was skilfully produced by Dennis Vance. It started off as a rather unpromising story of the irresponsible behaviour of a group of eight teenagers, who "borrow" cars for fun for point-to-point racing from London to provincial towns and back.

The plot thickens when their game is discovered by a young thief just out of prison, who quickly realises its potentialities for his own purposes. The tension rises as he turns the car borrowing "game" into a source of supply for regular car thieves, but, inevitably, the whole scheme comes to grief and brings home the moral.

Television plays like these productions from A.T.V.'s magnificent Elstree Studios, must have a very wide appeal, not only in this country but all over the world. They were both videotaped and, I presume, will be transferred on to 35 or 16mm film by telerecording for export. Pity! Very few telerecordings really measure up to the quality of the original videotape recordings on 405 lines, and the cost of repeating the show on tape for 525 lines for U.S.A. and Japan, or to 625 lines for the rest of the world must be prohibitive. In the meantime, American television play producers concentrate their energies to putting their product directly on to 35mm film, and are able to supply 35 or 16mm film prints to TV stations everywhere.

"I'm Not Stopping"

The BBC's drama department presented a Sunday night play by Ronald Ayre which had the unattractive title of "I'm Not Stopping".

After about 20 minutes of viewing, I had the violent urge to take the advice proffered in the title and switch over to the other channel, but I stayed to the bitter end. "I'm Not Stopping" was set in a Yorkshire mining village threatened with a shut-down of some of the pits in the neighbourhood. The reactions of the miners to the prospects of redundancies and the build-up of suspicion and distrust between the men who are laid-off and those who are retained, should have made strong drama. It was a promise unfulfilled. Beautifully played and photographed, the drama failed to retain one's interest because of inconsequential dialogue and poor sound. Part of the time I spent trying to find why my receiver had lost "top" on the sound, but when the next item came on, it was crisp enough without adjustment. It must have been a dead loss for intelligibility on the many modern TV receivers which have tiny loudspeakers around the side or back of the set, wasting weak sibilants in the folds of a curtain.

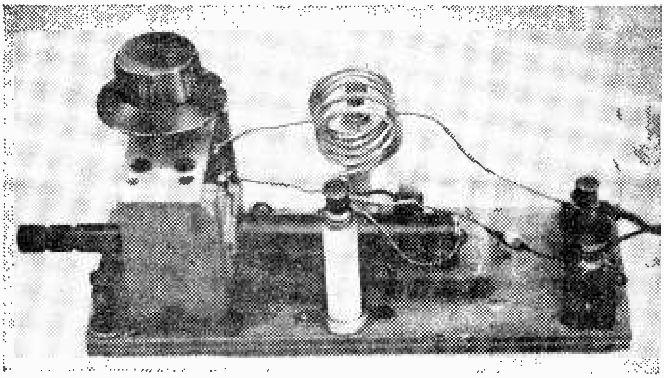
The Shape of Studios to Come

A number of magnificent television studios have been built in Britain during the last three or four years. World travellers who have seen the best studios in America, Japan and Europe say that our studios are well ahead of all the others in both design and equipment. Even before the introduction of colour television, colour influenced to some extent the shape and design of new television studios, particularly as regards the height and the ventilation systems. As with colour photography in film studios, a great deal more light is required which brings with it a great deal more heat. That is one of the reasons why there seems to be a lot more clearance height between the floor and the lighting grid. With over 90% of television settings and scenery no higher than about 10ft, the clearance of 30ft or more seems excessive, requiring very long telescopic suspensions or other supports for lamps. With the intense heat dissipated by the lights, the extra space enables it to rise and keeps the temperature reasonable at ground level.

Studio Utilisation

Studios have to cope with widely differing requirements, particularly as regards acoustics. Musical shows require a fair amount of reverberation, unless playback is used of music sessions recorded in special music studios. Plays require studios with as little reverberation as possible. Audience participation shows require seating and plenty of exits. Some settings with staircases require wells or tanks in the stage, which can be utilised for such staircases or for water effects—but the smoothness of the floor is usually considered to be of greater importance for rolling the cameras about, and stage tanks are mainly confined to film studios.

The high utilisation factor of television stage space leaves little time for the actors to rehearse in the actual settings of a play. Rehearsals are carried out elsewhere, until the final rehearsals. For instance, "walk throughs" and early rehearsals of "Coronation Street" take place from Monday to Wednesday each week. On Wednesday night, all the sets are erected on one of the Granada stages at Manchester. Final and lighting rehearsals on the sets occupy Thursday and Friday morning, and on Friday afternoon two half-hour episodes of "Coronation Street" are recorded on videotape. The settings are "pack-struck"—dismantled—during Friday night, and are stored away in the scene dock until the following Wednesday night. Settings do not remain standing for weeks on end. Stage space is too valuable to use for lengthy rehearsals. A good utilisation factor is the objective of the studio managements.



SIMPLE SOUND-ONLY TV RECEIVER

By H. Russell Jones

WANTING to record the BBC Saturday morning stereophonic transmissions, a simple and cheap way of dealing with the right-hand channel, which is transmitted on the TV sound frequency, was sought. The left-hand channel (on BBC Third programme) was adequately covered by a Quad v.h.f.-f.m. receiver, but the sound output from a very ordinary TV set left a good deal to be desired.

As the writer lives only about five miles (as the crow flies) from the Wenvoe transmitter, before going to the trouble of trying a number of complicated circuits, a straightforward semiconductor diode detector circuit was tried. Results were entirely satisfactory. So much so that apart from the stereo recordings (which on a Tandberg Stereo 6 Recorder at 3¾in./sec are first-class) the receiver has been incorporated in an all-purpose amplifier and fed to a separate loudspeaker system for musical items on TV.

The Circuit

The theoretical diagram is shown in Fig. 1 and a practical layout in Fig. 2.

Apart from the "Aladdin" former, named components are not specified—for a very good reason. They were obtained from the writer's junk box and one item is at least 40 years old! However, any reputable brand of component of the values shown will suit, but there may be slight difficulty in obtaining the exact type of variable capacitor actually used for the rejector circuit. Any miniature variable capacitor of about 20pF will, nevertheless, serve, but the layout may not be so compact as that shown.

COMPONENTS LIST

R1	100kΩ ¼W
C1	10pF ceramic
VC1	20pF air-spaced variable
VC2	15pF air-spaced variable
D1	Crystal diode
L1, L2	see text and Fig. 1

Miscellaneous:

Aladdin miniature former with adjustable core (Blue). Two insulating pillars, 2in. high. Two-way terminal block. Length of 20s.w.g. tinned copper wire. Plywood, hardboard or Paxolin for base and supports.

The Coils

The coil turns are given for the Wenvoe frequencies (vision 66·75Mc/s, sound 63·25Mc/s) and may require adjustment for other BBC transmitters.

—*continued on page 467*

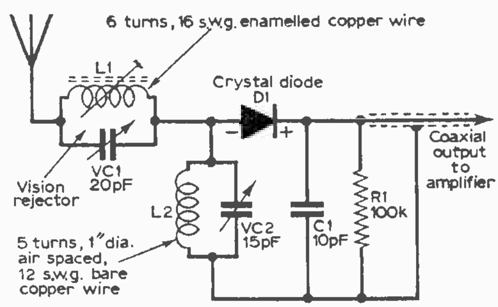
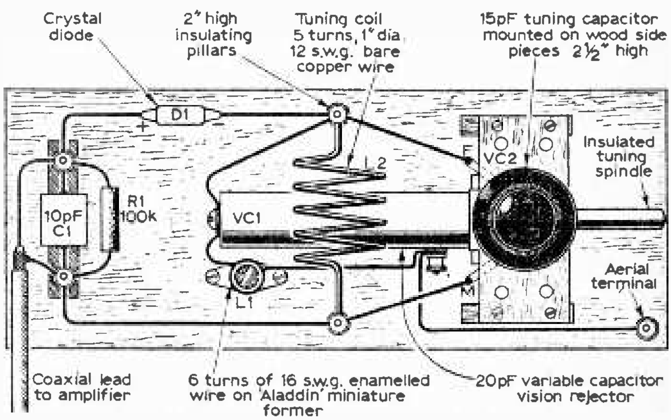


Fig. 1—The circuit and coil winding details.

Fig. 2—The component layout diagram.



CIRCUIT PRACTICE AND DESIGN PRINCIPLES FOR

OSCILLOSCOPE TIMEBASES

Historical circuits, starting with the simple "neon-flasher" are described to show the gradual improvements made as new circuits were invented. Those of the enormous variety of modern circuits which have reached any great degree of usefulness and popularity, are then selected for full discussion, largely ignoring those which remain mere curiosities without great practical significance. In this way, it is hoped, this article will present the reader with the information enabling him to design and build his own oscilloscope-timebase circuits and to understand their functioning thoroughly.

BY
M. L. MICHALIS

FIG. 1 gives some information on current build-up in a coil, for comparison with the analogous process of voltage built-up on a charging capacitor. In Fig. 1(a) the ultimate current, V/R amp, is reached exponentially, i.e. after a time very much greater than the characteristic time of L/R seconds. If we leave the switch closed only for a *very short* time compared to L/R, then the final current is nowhere near reached, and we remain on the small initial portion of the exponential rise, which is virtually *linear* as required.

The arrangement in Fig. 1(b), dealing with the analogous case of a charging capacitor, again builds-up the ultimate voltage on the capacitor in an exponential fashion, reaching it after a time very long compared to the characteristic time-constant of CR seconds. Leaving the switch closed only for a time, small compared to CR seconds, again

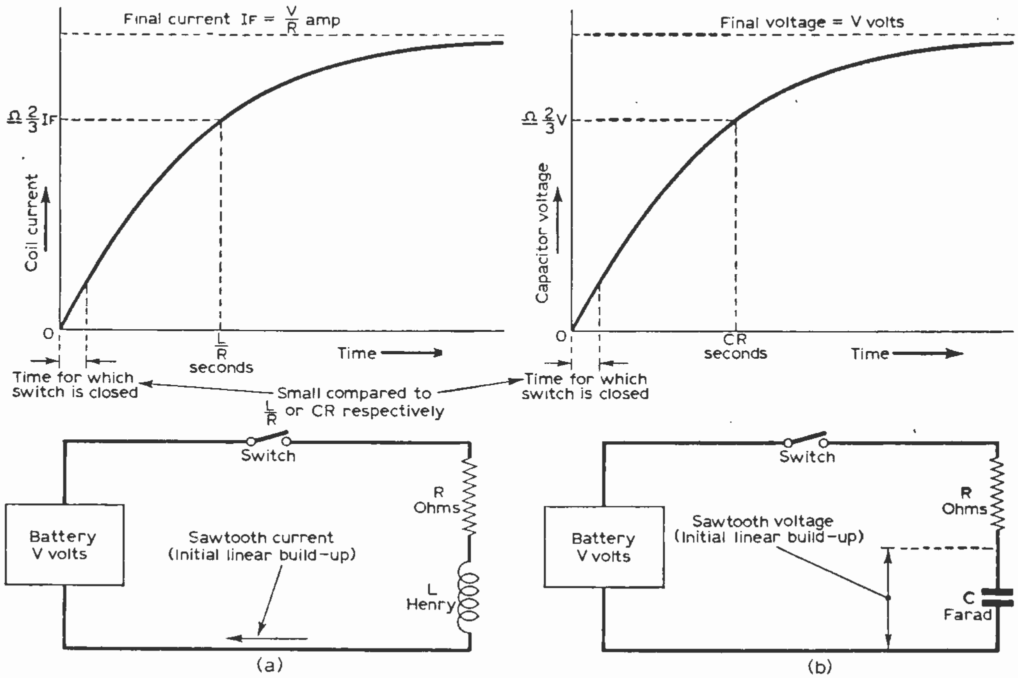


Fig. 1(a)—Showing the exponential build-up of current in an inductance: (b)—showing the exponential build-up of voltage on a charging capacitor. These arrangements form the basis of all timebase circuits for magnetic deflection and electrostatic deflection c.r.t.'s, respectively.

confines us to the practically linear start of the exponential rise.

All practical circuits must then arrange to open the switch *and* to discharge the capacitor as fast as possible (flyback) in preparation for a new cycle, after a charging time short compared to the CR-time.

Apart from mere description of all the various circuits devised to perform these functions in practice, the theme of this article will remain right through to point out in each case the charging capacitor and its charging resistance, and measures taken to improve performance, i.e. to increase linearity over larger output amplitudes, in each case.

The "Flashing Neon" Oscillator

The simplest "switch" for the circuit of Fig. 1(b) is a neon tube, as shown in Fig. 2(a). Here the supply voltage is permanently connected, and charges the capacitor exponentially until the *striking voltage* of the neon is reached, usually about 150V. The discharge then commences in the formerly extinguished tube, and represents a virtual short-circuit across the capacitor C. This causes rapid discharge of C, without any need to disconnect the supply voltage, as this supplies current through the high resistance **R** much slower than the neon draws current from C when struck.

However, the neon cannot discharge the capacitor anywhere near completely, extinguishing again at the so-called "extinguishing voltage", only slightly less than the striking voltage. As soon as it has extinguished, exponential re-charge through R takes place again, until the striking voltage is reached once more, Fig. 2(b) shows these relations clearly.

Provided that the supply voltage (would-be final voltage in the absence of a neon-tube) is at least twice the neon striking voltage, the actual sawtooth excursions between striking and extinguishing are limited to a small portion of the whole exponential, i.e. contain a virtually linear rise of voltage with time, as required.

It should be noted that any small portion, *at any position* on an exponential capacitor-charging curve, represents virtually linear rise. The selected portion need not be at the very start, as shown here.

However, one great disadvantage of the simple neon-timebase is already clear from Fig. 2(b). The available output amplitude is very small, because no neon tube has a very great difference of voltage between strike and extinguish. Amplifiers are thus required subsequently, and a relatively high h.t. supply voltage is required. Also, linearity, especially after amplification, is by no means perfect, as no correcting devices at all are used.

Thus one never finds this circuit in any form in modern oscilloscopes, though it is still frequently employed as a very simple test-oscillator for audio-amplifiers, or as a visual time-interval indicator by means of placing the neon-tube on the front panel of the apparatus, so that the flashes during the regularly repeated flybacks are visible.

Frequency Limitations

There is a further, more subtle reason which renders the neon oscillator relatively useless for modern oscilloscopes. If we look at the anode characteristic curve (shown idealised) of a typical neon tube, Fig. 2(c), we see two important regions of current-magnitudes. The region between A and B involves negative anode resistance, because it shows increasing current with decreasing voltage; it is consequently unstable and promotes oscillation. The region between B and C is normal, and promotes stabilisation rather than oscillation.

It is thus necessary to keep the would-be operating point of the neon within the region A, B. In other words, the value of R must be sufficiently large to draw a current, if connected straight across the h.t. supply, not exceeding point B. Otherwise the neon will simply strike once the capacitor has charged enough, and remain struck with a current between B and C, without oscillating, because **R** is bringing new charge as fast as the neon removes it, and no flyback is then possible.

To increase frequency, we must reduce both C and R, to speed up the charge-time dictated from

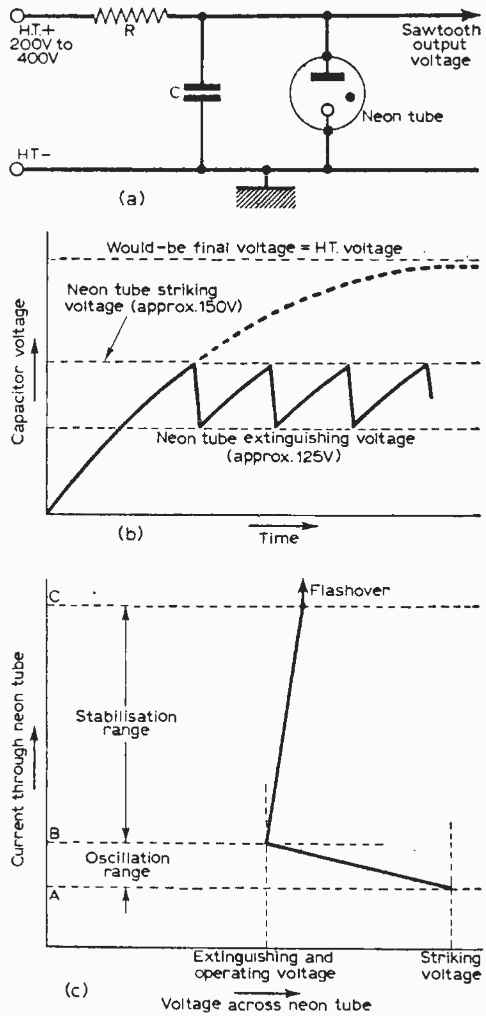


Fig. 2(a)—The simple flashing neon timebase. (b)—The output waveform of the neon-timebase. (c)—The anode characteristics (idealised) of a typical neon tube.

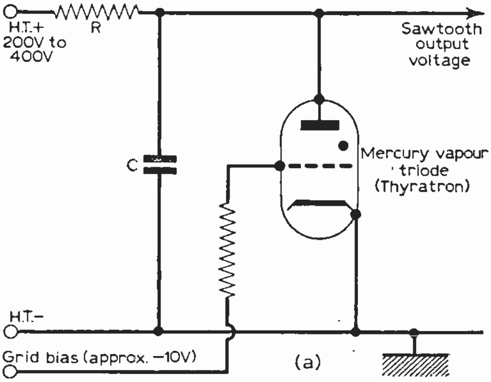
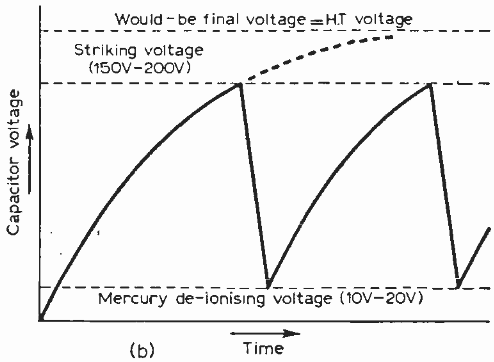
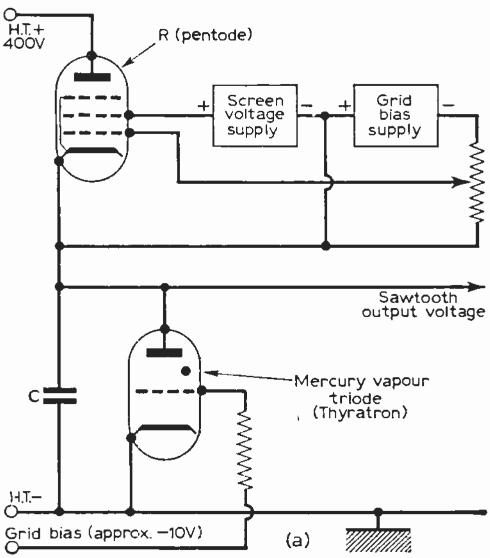


Fig. 3(a) (above)—The basic Thyratron timebase, with the output waveform shown in (b) (below).





their product. C cannot be less than the circuit and tube stray capacities, and we have seen that R cannot be less than a value raising current above point B in Fig. 2(c). Thus there is a definite upper limit above which frequency the circuit will not oscillate. This, taking also the delaying-effects of the ionising and de-ionising of the neon gas into account, usually lies at around 10kc/s, and is far too low for modern high-speed oscilloscopes for pulse-observations.

Those readers wishing to make simple test oscillator circuits on these lines may use virtually any neon-tube device, provided any series-resistor included in the base is removed first.

The Thyratron Timebase

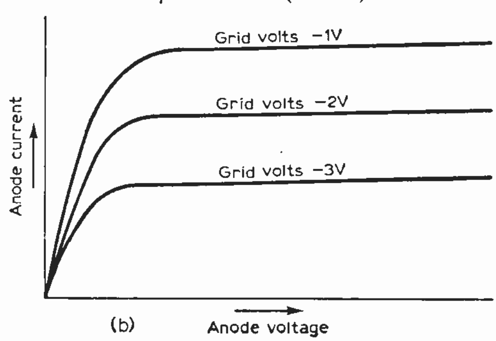
The next development made, to overcome some of the major disadvantages of the neon tube pointed out above, was to employ a grid controlled mercury-vapour triode (Thyratron) in place of the neon.

The chief advantage of this compared to the neon tube is the very much greater difference between striking and extinguishing voltage, giving greatly increased output amplitude. The grid is biased strongly negative, to a value maintaining cut-off until the anode voltage, supplied from the charging capacitor, has risen to a major fraction of the h.t. supply voltage. Up to this point, the grid maintains normal control, exactly as in a vacuum-triode. But once the anode has risen sufficiently for cut-on, the valve breaks down completely to a virtual short-circuit because of gas-discharge effects, and the grid loses control completely until the anode-voltage has fallen sufficiently for de-ionisation of the mercury vapour. This does not occur until the anode, and thus the capacitor voltage, have fallen to a mere 10 to 20V.

The principle disadvantage of the circuit as it stands is the very considerable non-linearity because a *large* portion of the exponential is here used. This was overcome in practical circuits by replacing R by a pentode valve and setting the operating point of this in the usual region of high dynamic anode resistance (anode current/voltage curves virtually horizontal, Fig. 4(b)). This involves choosing a fairly high h.t. supply voltage leaving sufficient anode-to-cathode voltage on the pentode even when C is already charged to the point of breakdown of the thyratron.

Fig. 4(a) (left)—Use of a pentode valve in place of a charging resistance to improve linearity.

Fig. 4(b) (below)—Anode characteristics of a typical pentode valve (see text).



We see then, from Fig. 4(b), that the anode current of the pentode, which is the charging current of the capacitor C, is largely independent of the anode voltage across the pentode, and is constant. But constant charging-current is the condition for absolutely linear rise of voltage on a capacitor. The normal exponential rise in a simple charging circuit was caused by the current through R diminishing progressively as the charge advances, because the remaining driving voltage, given by the h.t. supply minus the actual voltage already on the capacitor, is continually falling.

The circuit of Fig. 4, using a pentode valve in place of R, effectively reduces R in a compensating manner as the drive-difference voltage falls, keeping the current stabilised and thus the rise of voltage on the capacitor linear. This is one very important method of "linearising" a large-amplitude section of a voltage-exponential, and it provided circuits such as shown schematically in Fig. 4 and as practical examples in Figs. 5(a) and 5(b), which were very common and successful in early oscilloscopes. The pentode-controlled thyratron timebase of Fig. 5(a), or variations thereof, was very common in oscilloscopes about ten years ago, but is hardly ever found nowadays.

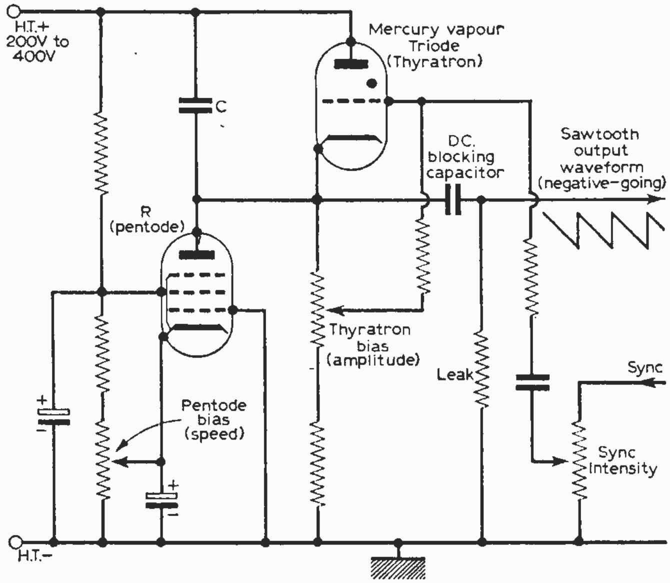
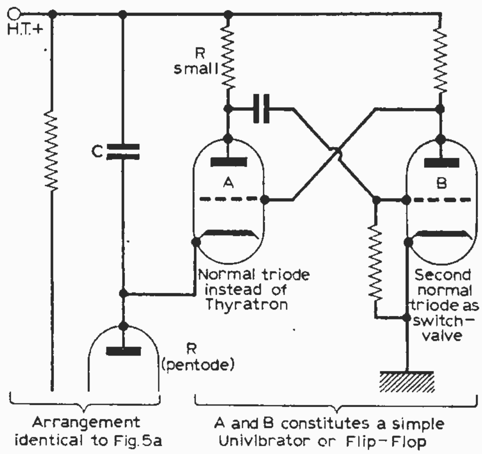


Fig. 5(a) (above)—A practical form of a pentode-controlled thyratron timebase.

Fig. 5(b) (below)—The Puckle timebase; the first linear sawtooth timebase invented, using entirely vacuum valves.



The Puckle Timebase

The reasons for discarding thyratrons in timebases when new developments became available were again connected with the relative slowness of the de-ionising processes of the mercury vapour, which limited the useful maximum frequency of operation to about 10kc/s. This was quite satisfactory in the days of chiefly audio frequency work, but was quite inadequate for modern fast oscilloscopes for television, radar, etc.

It was realised that all timebases involving gas-filled discharge devices were inherently frequency-limited, and methods of getting sawtooth waveforms from devices employing entirely vacuum tubes had to be developed before operation up to megacycles per second was possible.

The first timebase circuit employing entirely "hard" valves was the Puckle circuit, shown in Fig. 5(b). This is, in principle, virtually identical to the pentode-controlled thyratron circuit of Fig. 5(a), except that a pair of vacuum triodes replace the thyratron. The arrangement of the condensor C and the charging pentode R is identical in both Figs. 5(a) and 5(b), and is thus only repeated in sketch in Fig. 5(b). The triode A is used to discharge C on the flybacks. It is given a small anode load for extracting a replica of the flyback transient of sufficient amplitude for driving the grid of triode B, yet small enough not to interfere seriously with the speed of discharge.

Initially C is discharged, so that triode A has no anode-cathode voltage. Triode B is conducting heavily, so that its anode is well below h.t., and so is, therefore, the grid of triode A. This represents heavy cut-off bias on triode A even when C has slightly charged and the cathode of triode A falls progressively below h.t. However, there will ultimately come a point where C has charged so far that the cathode of triode A has fallen below h.t. to an extent to enable anode current to start, i.e. the difference between triode A cathode and triode B anode has become less than the grid-base.

The slightest start of anode current in triode A gives a negative stroke at its anode, which is fed in a sense to cut-off triode B at its grid. This causes a sharp positive rise at triode B anode, fed to triode A grid. This causes triode A, by a cumulative process as described, to be cut-on hard to saturation immediately any anode current starts, i.e. it behaves in this respect exactly as the thyratron did, and discharges C very rapidly until the initial conditions are restored for the next cycle.

The new feature in this circuit is that it uses no gas effects, and is thus extremely fast; it gives satisfactory performance up to a repetition rate of 2Mc/s when carefully designed.

Relaxation Effects

All sawtooth oscillators employ so-called *relaxation effects* to give the initiation of the flyback, i.e. a sudden change of salient circuit conditions. We saw that the initiation of a gas discharge was formerly the only successful relaxation effect for use in these oscillators. We saw how this led to the neon timebases and the thyratron timebases, with their inherent slowness (relatively speaking) of the gas relaxation.

Here in the Puckle timebase we have the first example of a non-gaseous relaxation effect in an electronic circuit, using the instability effects of a two stage amplifier with the output coupled back to the input. This, basically, is all that the triodes A and B represent in Fig. 5(b), and the circuit is thus the forerunner of the wide class of *multivibrators*, which all produce relaxation effects by utilising the instability produced when excessive positive feedback from output back to input of an amplifier is employed. This class of circuits, which has been developed to include a vast variety of individual devices, provides some of the most important bricks for modern designs in this field, and we shall have a lot more to say about them in the course of this article.

Harmonic Generation

A few words about the nomenclature. The term "multivibrator" for circuits using "excessive feedback amplifiers" is derived from the idea of simultaneous oscillation at many (harmonic) frequencies.

The excessive feedback overdrives the valves during the resulting oscillation, so that no sine wave is produced, but some distorted wave containing the relaxation transients. This distorted wave is always mathematically equivalent to a pure sine wave of the same fundamental frequency present simultaneously with a number of its harmonics with appropriate phases and amplitudes.

This is more than a mathematical curiosity; it is hard practical fact, for if tuned circuits are used to examine the output, the presence of all these many harmonic frequencies can be confirmed. This, in fact, formed an early, and still present, use of multivibrators. A good multivibrator operating at, say, 25kc/s fundamental frequency will produce outputs harmonically spaced at 25kc/s intervals, right up through the radio frequency bands, and thus forms a useful simple multi-frequency test oscillator.

If a multivibrator is so biased that it oscillates free, without the need for external drive to produce an output, we usually refer to it as a multivibrator, whereas if the biasing is such that one valve of the amplifier is normally cut-off, needing a drive signal to cause cut-on and one relaxation cycle output in response, before a return to cut-off takes place, we speak of a "univibrator", or "flip-flop". The reasons for the names are self explanatory! The Puckle timbase of Fig. 5(b) clearly uses a univibrator, as it requires the drive from the capacitor and pentode section.

Drive signals for a univibrator are commonly known as *trigger signals.*

If the relaxation oscillator is free-running, i.e. is a true multivibrator in the present class, the exact frequency may still be influenced by feeding in external signals, the fed-in signals locking the times of the relaxation transients to their own times, i.e. they control the phase of the relaxation transients. Signals fed in for this purpose are called *synchronisation signals.*

In many cases there is no difference in waveform or method of production between a trigger signal and a sync signal; the difference is merely in the application.

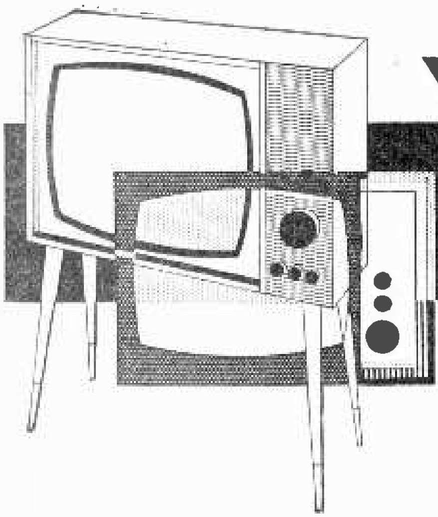
TO BE CONTINUED

Simple Sound-Only TV Receiver

—continued from page 462

Tuning as such is not very critical, but the adjustment of the vision rejector needs to be done with care. First tune for maximum sound on the main capacitor. Strong video signals will probably accompany this and they should be cut out by adjusting the rejector capacitor very slowly.

One or two points of interest: be sure to use a *blue* core former for the rejector coil, and see that the rejector capacitor has a fairly long isolating tuning spindle. A 7ft indoor aerial is more than adequate for strong signals in the writer's neighbourhood; but the arrangement is for areas of high signal strength and it would be interesting to hear of the experience of readers who may try it at greater distance than five miles from a transmitter. ■



Your Problems Solved

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying surplus equipment. We cannot supply alternative details for constructional articles which appear in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. The coupon from p. 472 must be attached to all Queries, and a stamped and addressed envelope must be enclosed.

ULTRA VT917

The picture suddenly starts rolling and stops half way. The flyback lines appear and the rolling starts again. The hold control is very critical, only a slight touch being necessary to start the trouble. I have tried a new 20L1 but without any improvement. — S. Woodward (West Bromwich).

Replace the 200pF capacitor connected to pin 6 of the 20L1 frame oscillator valve. If the trouble persists, check the main smoothing electrolytics.

MURPHY V310

I have fitted channel 8 coils to this receiver, but I can only get a very weak picture with the sensitivity and contrast fully advanced. There is no sound, only a buzzing noise. By adjusting the coil core this noise can be made louder or softer. On BBC sound and picture are very good.—D. J. Pugh (Aberystwyth).

We advise you to try another set of channel 8 coils first. Check that both the ITA and BBC sensitivity controls are turned up and also have the two tuner valves tested as poor performance is usually noticed first on the higher channels.

K-B MV60

The trouble is sound-on-vision, which on loud passages of music causes horizontal line tearing from the right of the picture. Alteration of the fine tuner will not correct this fault although the tuner is working.—J. Autry (Leeds, Yorkshire).

This is probably caused by misalignment of the vision i.f. channel. Unfortunately, there is no simple method of aligning successfully without instruments and full alignment data, so this may be a job that would be best done by a dealer.

DECCA DM35

Three faults have developed on this receiver. (1) Continuous loss of frame hold on Band III. The rolling is reduced at full travel of the external frame hold control. On Band I frame hold can be obtained only at high contrast settings and at full travel of the hold control. (2) Rippling of the picture, presumably sound-on-vision, on Band I, reduced at low contrast and optimum fine tuner settings. (3) Band III is normally clear and steady but of low contrast. This may be due to local shielding.—E. V. Mellor (Farnborough, Hants).

To increase the Band III gain, the PCC84 valve in the tuner could be replaced by a 30L15 with a slight adjustment to the top studs of the tuner. Band I cross modulation should cease when the r.f. gain is reduced—adjust L16 if necessary. For the loss of frame hold, adjust the VR4 interlace control on the upper centre of the chassis and check the resistor associated with the hold control if necessary. Check V6 (PCL84) and V7 (ECL80) if necessary.

FERGUSON 506T

On this set the figures are distorted, being too tall and very thin. The height control is very critical, the slightest adjustment causing the picture to jump up and down as much as an inch or more. —S. Turner (Leeds, Yorkshire).

This indicates fairly conclusively that the height control is in need of replacement. When this is working correctly, the correct vertical form can be obtained on Test Card C by adjusting the frame linearity control in conjunction with the height control.

PETO SCOTT 1719T

The picture height is continually changing and occasionally it will shift either up or down, especially when the picture content changes from a dark scene to a bright one.

I have changed the frame output valve but to no avail.—J. D. (Liverpool).

Replace the e.h.t. rectifier V19 (EY86). Check the PL81 if necessary.

The fault is apparently caused by fluctuating e.h.t. on changes of brightness. See that the ion trap magnet on the rear neck of the tube is adjusted for maximum brilliance.

The fault is unlikely to be in the frame timebase.

H.M.V. 1824 A

The picture and sound quality is good, but the picture is very much elongated. Adjustment to the width control makes no difference.—J. B. McGuire (Cannock, Staffordshire).

You do not say whether the picture is of adequate width or whether there is a black strip at either side. If width is lacking, check the PL81 (N152) line output valve. If the bottom is also compressed, check the 14A86 metal rectifier; the d.c. output of this to the h.t. line should be over 200V.

If the width is adequate reduce height and adjust the frame linearity (vertical form) if necessary.

PHILIPS 17TG100U

This set is not giving full frame amplitude. I have changed the ECL80 and the PCL82 associated with it, with very little effect. The fault has developed over a period of time and may be associated with the long time taken to obtain a picture after switching on.—A. Heywood (Manchester).

The frame oscillator is energised from the boosted h.t. line via several high value resistors in series with the height control. The trouble probably lies here somewhere. Check the 2MΩ height control potentiometer. If this is in order, check the values of the resistors mentioned and if they have gone they should be replaced. Also check the associated decoupling capacitors for insulation resistance.

PYE V4

Recently I have fitted a new tube to this set and the picture quality is very satisfactory, however, there is one fault with the picture which was present before. Immediately upon switching on the horizontal hold control needs adjustment. After the set has warmed up (and throughout the viewing time) readjustment of the control is necessary.—G. J. Thomas (Swansea, Glamorganshire).

We would advise you to try replacing the ECL80 valve just in front of the " black box " and also suspect the 1MΩ pre-set line hold control, which may be noisy.

ULTRA V1780

Lately the picture has been very jerky on the right-hand side of the screen, leaving a blank strip which varies from about ¼in. to 1in. wide but never filling the screen. I am also wondering if you think it possible for me to obtain reception of Grampian TV here in Glasgow. Local dealers say they don't think it possible.—G. Willox (Glasgow).

With the horizontal hold control at the centre of its range, adjust the coarse control for optimum line lock. If the effect persists, replace the 12pF capacitor connected to pin 1 of the 30FL1 line oscillator valve. It sometimes pays to increase this to 22pF.

We can only suggest that you be guided by your dealers' observations regarding the reception of Grampian TV. There is no simple and inexpensive way of achieving DX television. An extra-special aerial system is absolutely essential.

BUSH TUG26

I have successfully retuned this set from channel 2 to channel 1, but I am unable to bring in channel 12. The set is fitted with a converter and has its own Band III aerial.—J. H. Richardson (Penzance, Cornwall).

We presume that the Band III tuner is a Bush TC184. If you remove the four 4BA screws securing the bakelite cover, you will observe how the oscillator coil core is actuated by the nylon driven drum. You will also see that the core is graduated and capable of adjustment beyond the limits of the fine tuning. Adjust this core for maximum Band III sound with the actuator set mid-way and adjust the cores associated with the PCC84 coils for optimum vision.

EMERSON 708

It is almost impossible to get the horizontal hold to lock the picture. It is set at the middle of its travel and the picture moves at any change in scene. Also, any advancement of the brilliance control causes it to break up into a mass of distorted horizontal lines. This condition is worst after the set has been on for about half an hour.

Also, the volume control has to be fully advanced to obtain sufficient volume.

I have had to remove the screening can from the line output transformer because the two leads which enter through it are continually shorting through the can.—C. Wilson (Dover, Kent).

With regard to the line hold fault, check and replace, if necessary, the 12pF capacitor from pin 6 of V5 (PCF80) to pin 1. If the 12pF is not at fault, check associated components.

To trace the sound fault, check the sound valves V6 (PCL82) and V4 (EBF89) and the alignment of the i.f. coil cores.

The screening case should not be left off and the wires should be bushed with rubber grommets to prevent breakdown if it is not practical to use more heavily insulated leads.

INVICTA 137

There is considerable fold-over of picture at the bottom part of the screen. I presume the trouble lies in the frame circuit and therefore I have changed the PCL82 numerous times. A new valve corrects things for a week or two, but then the same fault reappears.

I have checked most of the components in the frame circuit but I cannot find the cause of the fold-over. On pin 2 of the PCL82, instead of the specified 14V bias, there is 25V, and when checking whether this is applied to the grid of the valve, I find that there is no voltage reading at all.—F. C. Passey (Hinckley, Leicestershire).

Check the R91 bias resistor which should be 470Ω. In this receiver it often changes value. Then check C73 (0·25μF) and C67 (0·1μF) for leakage. The present PCL82 may require replacement if one of the above components is found to be defective.

ALBA 724FM

The trouble is with the f.m. sound. When any of the three f.m. stations is tuned in there is a loud buzz on the sound. This fault is not present on television sound.—A. Heywood (Rotherham, Yorkshire).

The trouble could be due to excessive signal input if the transmitter is local, or to a faulty valve. Check the EB91 ratio detector on the left side and both the tuner unit valves, PCC84 and PCF80.

ULTRA VT8-15

I wish to fit a new U25 rectifier in this set, but I would like to know how to take out the existing one, as at the moment it is covered in wax at the heater and anode ends. When I do replace the new component do I have to cover the leads with wax once again?—T. Holley (Glasgow).

The wax must carefully be removed from the tags on to which the valve wire ends are soldered. The wax must also be removed and softened around the glass envelope. It will then be possible to ease the valve away from the transformer. Take care to avoid pointed soldered connections when fitting the replacement and there is usually no need to re-wax to the original extent.

PYE VT4

I wish to replace the tube in this receiver. Can you tell me the correct procedure?—J. C. White (Littlehampton, Sussex).

Remove the tuner and chassis after disconnecting the leads to the scancoils, loudspeaker, tube base and anode. Lay the cabinet face down, remove the ion trap magnet and take cut the four large screws holding the focus and scanning gantry to the cabinet woodwork. Lift out the whole assembly and the tube may then be withdrawn.

Thoroughly clean all parts before reassembling in reverse order.

KB KV50

This set had been on for about two hours when the screen suddenly went black. I could smell burning, and upon investigation I noticed that two capacitors near to the 300Ω resistor to the cathode of the line output valve (6CD6) were charred. Also the heater of this valve was open circuited.

I replaced the valve and capacitors and can now get a picture. However, I have found that the resistance of the e.h.t. winding on the line transformer, between the anode of the 6CD6 and the e.h.t. rectifier EY51, is only 125Ω. I understand that it should in fact be about 300Ω. I replaced the 15kΩ resistor in series with this winding and the 6CD6. This valve is now showing a current reading of 120mA at its cathode.

Is it correct to run this set in this condition, or is a new transformer called for?—L. Myers (Leeds).

The line output transformer is not defective. If it was you would not get an acceptable picture at all.

Check the 3·3kΩ resistor to pin 8 of the 6CD6G valve base and ensure that the horizontal linearity control is correctly adjusted. The 300Ω bias resistor should also be checked if it appears damaged.

DECCA DM3C

When first turned on the picture is normal but it soon fades, leaving the screen blank. If the set is then left on, the PL81 overheats, and a new valve only temporarily cures the fault. The line whistle is always present, but when the picture fades, the EY86 goes dimmer. This valve has also been replaced with no improvement, as have most valves in the line timebase. Many of the components have been substituted and I now suspect the line transformer.—R. A. Phillips (Pontypool, Monmouthshire).

Check the screen resistor to pin 8 of the PL81. This should have a value of 4·4kΩ. It will probably have dropped to about 500Ω. Use a wire-wound 5W resistor of between 3kΩ and 5kΩ for replacement.

FERGUSON 546T

This set uses printed circuit construction. I have found that the line oscillator valve (an ECC82), which is on the lower deck, far in, is mounted in a very loose holder which is in the habit of moving, with appalling results.

To change the valveholder would be a difficult operation as all the soldered joints would have to be heated at once. Is there any other way of overcoming this fault?—C. F. W. Mangold (Liphook, Hampshire).

Unfortunately, if the valveholder is defective the only solution is to replace it. Usually, however, the sockets can be tightened by using a pointed tool, such as a scriber, and carefully inserting this at the edge of the hole, in such a way that the spring clips within the sockets are squeezed together, thereby giving greater pressure on the valve pins.

ULTRA V17-70

The fault which has developed in this set is common to the ITA channels 6 to 13, with the exception of channel 10. The main symptoms are fine vertical lines over the screen, which can be reduced by altering the contrast or brightness controls. Both valves in the tuner have been replaced, but with no improvement. The lines appear as a two inch wide bar for up to three minutes after switching on, later reducing to about ½in. wide.—D. Jennings (Londonderry).

If Band III channels other than channel 10 are distance channels, then the effect could well be caused by co-channel interference. That is, the reception of more than one distance station sharing the same channel number. Unfortunately, there is no absolute cure for this but improvement is sometimes possible by using a higher gain aerial accurately orientated for the required station.

McMICHAEL M72 HFC

Could you please let me know the procedure for removing and refitting the c.r.t. on this set? —C. Webster (Coventry, Warwickshire).

Remove the rear cover, the bottom chassis fixing screws and the left side panel. Slide out the chassis complete with the tube. Remove the tube base and ion trap magnet and the e.h.t. lead from the side of the tube.

Release the front tube fixing and remove the tube from the chassis frame. Reverse the procedure when fitting the new tube.

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PRACTICAL TELEVISION, JULY, 1963

TEST CASE -8

Each month we provide an interesting case of television servicing to exercise your ingenuity. These are not trick questions, but are based on actual practical faults.

? *In an endeavour to improve the sound quality, an experimenter replaced the original, rather small elliptical loudspeaker in his television set with a more substantial, better quality unit. This modification certainly gave better sound and less distortion, since the greater sensitivity of the replacement unit made it possible to secure the original level of sound at a smaller setting on the volume control. Unfortunately, however, it also upset the picture.*

The picture took on a somewhat "drunken" effect with the top edge slanting down towards one side and well out of parallel with the bottom edge. What was the cause of this and what could have been done to correct the trouble?

See next month's PRACTICAL TELEVISION for the solution and for another problem.

SOLUTION TO TEST CASE—7
(Page 427, last month)

Cogging on a Test Card almost always means that the composite video signal from the output of the video amplifier valve to the control grid of the sync separator valve suffers a high-frequency loss. This results in the line oscillator being triggered a little late when the scanning line ends in white picture content, and displacement of that particular line or lines (in the case of Test Card C) is to the right.

The symptom is thus usually accompanied by a poor display of the higher frequency gratings on Test Card C, and in some instances, the bars above 1·5Mc/s may be just a blur or very poorly defined.

Misalignment often proves to be wholly or partly responsible, and in persistent cases of the symptom it is essential that the vision i.f. alignment is checked before one can be sure whether the trouble lies in the signal stages or after the vision detector. Some early sets employed a metal clad coupling capacitor to the control grid of the sync separator valve, and if this was clamped tight to chassis, the top video response was badly affected, resulting in the symptom. Even on modern sets it is as well to ensure that this part of the circuit is free from excessive capacitive loading. The grid feed capacitor should not be positioned close to the chassis and the associated leads should be kept away from "earthed" objects and as short as possible.

Stray capacitances in the grid circuit of the sync separator valve may not impair the high frequency grating resolution on the Test Card, though may be sufficient to cause the cogging effect.

If the lines which terminate in white are displaced to the left, however, this signifies that the line timebase is "firing" too soon—on picture content. Here the trouble usually lies in the sync separator stage proper. Alteration in the value of a capacitor or—more often—screen, grid or anode resistor, is a frequent cause of the trouble. Poor grid/cathode insulation in the sync separator valve is another cause, but note that cogging can occur only on sets using direct sync, and not on sets fitted with flywheel sync. A slightly different form of fault may take place on the latter type of set, however, as revealed, for example, in Test Case 5 (April issue).

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PY80	6/-	UABC80	6/-	W107	20/5	OC74	8/-
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PY82	5/6	UB41	12/-	X41	15/-	OC76	8/6
PY83	6/6	UBC41	7/-	X65	7/9	OC77	12/-
PY88	9/-	UBC81	7/9	X78	26/2	OC78	8/-
PY800	9/-	UBF80	7/6	X79	40/9	OC81	8/-
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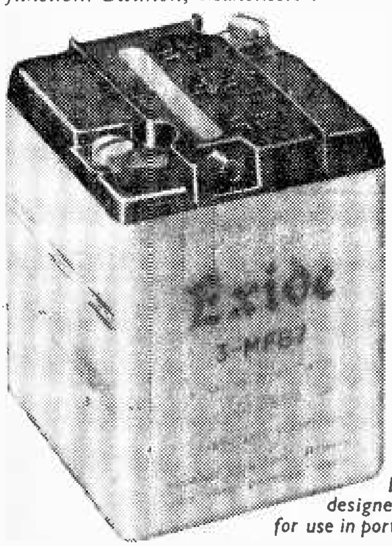
Trade News

New Battery for Portable Sets

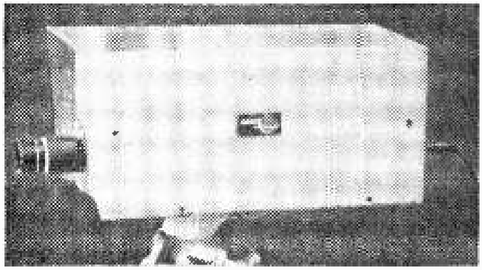
THE makers of Exide batteries—Chloride Batteries Ltd.—have just developed a new 6V battery to be used specifically in Portarama portable TV receivers, made by Perdio Ltd., which will, however, also find applications in other portable equipment. Two of these batteries (type 3-MFB7) will be connected in series when in use in the Perdio receiver to form a 12V assembly for portable operation and be kept charged by a built-in trickle charger when the set is being run from the mains.

The battery's polystyrene container is translucent (which makes the level of the electrolyte clearly visible) and is also tough, which is always an advantage in portable equipment. The dimensions of a 3-MFB7 battery are $3\frac{3}{16}$in. x $3\frac{3}{16}$in. x 4in. and each one has a capacity of 6 ampere-hours at the 20-hour rate of discharge.

The manufacturers of these batteries—which can be obtained from any Exide service agent—are *Chloride Batteries Ltd., Exide Works, Clifton Junction, Swinton, Manchester.*



The new Exide battery designed specifically for use in portable TV sets.



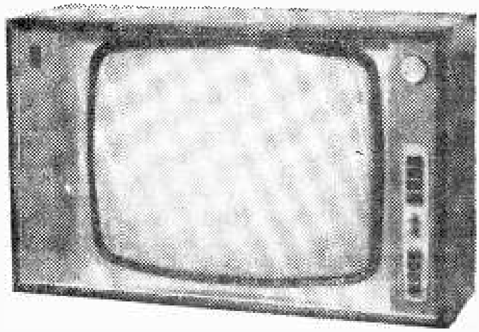
An assembled Beukit TV camera.

Transistor Camera Kit

A COMPLETE closed-circuit TV camera kit is now available from Beulah Electronics, which can be assembled without the need for special test equipment. The Beukit—as it is called—is a transistor design employing printed circuit construction and, when completed and connected to a standard receiver, forms a self-contained CCTV unit.

When in use, the receiver is switched to an unused channel and connection to the camera is made via the set's aerial socket. The camera will operate efficiently in normal room lighting, and can be used effectively in conjunction with a microscope.

The Beukit can be purchased as a complete kit (less vidicon tube and lens) or in four separate kits. The total cost of the kit, tube and lens is £71, and the manufacturers are *Beulah Electronics, 126 Hamilton Road, West Norwood, London SE27.*



One of the latest receivers from Murphy—the 23in. V873.

U.H.F./V.H.F. Receivers

DIRECT switching to u.h.f. channels is the main feature of the latest Murphy receivers. The switching is accomplished by push-buttons which eliminate completely the need for manual tuning. Four 625-line/u.h.f. and four 405-line/v.h.f. channels are provided for, although each one of the new receivers is available without the u.h.f. tuner, at a saving of 8 guineas. (These sets can subsequently be fitted with the tuner.)

All the sets are table models and both the 19in. model (V879) and the 23in. model (V873) are veneered in mahogany and cost 75 guineas and 86 guineas respectively. These new models are made by *Murphy Radio, Bessemer Road, Welwyn Garden City, Hertfordshire.*

—continued on next page

SPECIAL NOTE: Will readers please note that we are unable to supply Service Sheets or Circuits of ex-Government apparatus, or of proprietary makes of commercial receivers. We regret that we are also unable to publish letters from readers seeking a source of supply of such apparatus.

The Editor does not necessarily agree with the opinions expressed by his correspondents

TELEVISION PHOTOGRAPHY

SIR,—I would like to offer the following hints to your correspondent Mr. D. V. Chapman (June issue) on the subject of photographing television pictures.

The only essential is a camera with a shutter speed of 1/25 sec (so as to record one complete frame) although 1/30 sec will usually give satisfactory results. The majority of simple cameras and box cameras have shutter speeds of between 1/35 and 1/50 sec and thus are not suitable. The camera should also have a reasonably wide aperture —say *f*5·6 or wider—and should focus to 30-36in.

The television receiver should be adjusted for normal viewing with the room lights on. These lights should be turned off when the exposures are made, and the camera should be set about 30-36in. from the screen.

Several different films can be used: Kodak Tri-X, at an aperture of *f*4 or Ilford HP3 at an aperture of *f*4 are two examples. Ilford HPS at *f*5.6 will prove suitable for the first trials.

Of course, it may be necessary to make slightly different camera adjustments depending on the camera and processing conditions, etc.

The best subjects for photographing are those which remain relatively still as the afterglow effect and the interlaced scanning cause blur on rapidly moving objects. Portrait shots therefore generally make good photographs.

These techniques have provided good results from both a Pye VT4 (14in.) receiver and also a 17in. Decca receiver. — A. R. HUNTER (Acklam, Middlesbrough, Yorkshire).

NEW STANDARDS ARE NO SURPRISE

SIR,—W. Berssenbrugge's article in the June issue, in which he describes his experiences of u.h.f. TV on the Continent, was, I thought, very revealing in so far as it made all the publicity given recently to the prospect of higher frequencies and new line standards seem unwarranted when it is realised that for a considerable time people living in Belgium and other countries have been able to receive several programmes, each using a different standard. One is prompted to wonder if all the excitement caused by the imminent changes is merely the result of the long wait to which the public was subjected before any decisions were made and not of any surprising differences to which the new system will introduce us.—JAMES RICHARDS (Leatherhead, Surrey).

HUSH-HUSH BBC

SIR,—A recent newspaper report of a convention of a radio association seems to support my own suspicions that the BBC is purposely being secretive about their future plans, especially with regard to putting into practice the decisions made by the Government on changes in our system of broadcasting. They certainly seem determined to keep their intentions to themselves and it is my opinion such reluctance in a public body to part with information is to be condemned. I should have thought it the BBC's obligation to keep the public as well informed as possible and yet all we ever hear of are mysterious "experimental transmissions" from Crystal Palace.

I suppose we will eventually be told what is happening, but I, for one, resent continually being kept in the dark.—P. K. EDWARDS (Gillingham, Kent).

[I understand that the new transmissions which will begin regular programmes in April next year will, in fact, be the BBC's second television programme.—Ed.]

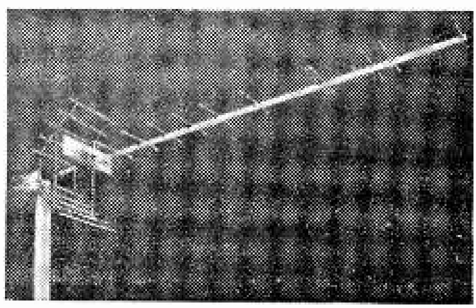
TRADE NEWS

—continued from previous page

U.H.F. Aerial

A NEW high-gain, u.h.f., dual-channel aerial has been announced by Fringevision Ltd. This aerial features phase correction and employs 14 elements. It has been designed to give maximum performance and gain on two separate channels whilst maintaining maximum matching characteristics to a standard 70Ω coaxial cable.

The price of this new aerial is £5 15s. and the makers are *Fringevision Ltd., Elcot Lane, Marlborough, Wiltshire.*



Fringevision's new u.h.f. aerial.

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TV53, TV56, TV57, TV58, TV62, TV63, TV66, TV67, etc.	94/-
TV80 with EY51	109/-
COSSOR: 930 and T931 933-4-5, 937, 938A, and F, 939 and A and F	61/6
943T, 940-946, 945 945B	58/6
954F, 947, 949	68/6
DECCA: D17 and C	68/6
DM1, DM2C, DM3, DM4/C	74/-
DM5, DM14, DM17, 444, 555	74/-
DEFIANT: TR1453, TR1753	58/6
DYNATRON:	
EKCO: T893, TC8102, T8105, T8114, TRC124, TC138, T8188, T8193	54/-
TRC139, TC140, T141, TV142	78/6
T161, TC162, T164, T165, etc.	78/6
TC208, TV209, T231, T221, T231F, T248, T283, T284, T293, etc.	58/6
FERGUSON: 103T, 105T, 113T, 135T, 145T	65/6
941T-953T inclusive	58/6
991T-997T inclusive	68/6
306T, 308T	4/-
FERRANTI: 14T3, 14T3F, 13TA	47/6
17K3 and F, 17T3 and F	17/6
17K4 and F, 178K4 and F	47/6
17T4 and F	47/6
14T5, 178K5, 17K5	47/6
G.E.C.: BT1251, BT1252, BT1746, BT1748, BT4743	48/6
BT4643, BT5147, BT5246—48	88/6
BT5348–BT5643R inclusive	48/6 and 88/6
H.M.V.: 1824 and 1 to 1831 inclusive	66/6
1840, 1841, 1842-1848	66/6
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INVICTA: T118, T119, T120	54/-
All other models available.	
K.B.: LFT50, LVT50, LFT60, MV60	106/6
All models available.	
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McMICHAEL: Most models in stock.	
MURPHY: V200, V202C	56/-
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PAM: 908, 909, 952, 953, 958	54/-
PHILIPS: 1768U, 2168U	104/-
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SETS 1R5, 1S5, 1T4, 3S4, 3V4, DAF91, DF91, DK91, DL92, DL94 .. Set of 4 for 17/-
DAF96, DF96, DK96, DL96 .. .. 4 for 25/6

1A7GT	9/-	6SN7GT	4/9	AC/TH1	19/6	ECF80	7/-	N18	7/-	U291	11/-
1D5	7/6	6U4GT	9/9	AZ1	12/6	ECF82	7/9	N37	10/-	U301	12/-
1H5GT	8/6	6V6G	3/11	CBL1	12/-	ECH35	6/6	PC95	9/-	U801	18/-
1N5GT	8/9	6V6GT	6/6	CCH35	13/6	ECH42	8/3	PC97	9/-	UABC80	5/9
1R5	5/-	6X4	5/-	CL33	9/6	ECH81	6/9	PCC84	6/3	UAF42	8/-
1S4	7/6	6X5GT	6/9	CY1	12/6	ECL80	6/3	PCC85	7/6	UBC41	6/11
1S5	4/-	6/30L2	8/6	CY31	5/9	ECL82	7/9	PCC89	8/-	UBF80	7/9
1T4	3/-	7B7	8/-	DAC32	8/6	ECL86	9/-	PCF80	6/9	UBF89	7/3
3A5	6/9	7C5	7/9	DAF91	4/-	EF37A	6/-	PCF82	6/9	UBL21	13/6
3Q4	5/9	7C6	7/6	DAF96	6/6	EF39	3/9	PCF86	8/6	UC92	7/6
3S4	5/-	7H7	5/9	DCC90	6/9	EF40	11/-	PCL82	7/3	UCC84	11/3
3V4	5/9	7S7	9/-	DF33	8/9	EF41	7/3	PCL83	9/-	UCC85	6/9
5U4G	4/6	7Y4	6/-	DF91	3/-	EF42	6/3	PCL84	5/9	UCF80	10/9
5V4G	8/-	10C1	9/6	DF96	6/6	EF80	4/3	PCL85	8/6	UCH21	13/6
5Y3GT	5/-	10C2	13/-	DH76	4/3	EF85	5/-	PENA4	11/6	UCH42	7/6
5Z4G	8/9	10LD11	10/9	DH77	4/9	EF86	6/9	PEN36C	8/-	UCH81	7/6
6AL5	2/6	12AT6	4/9	DK32	9/-	EF89	5/-	PL36	9/3	UCL82	8/9
6AM6	3/3	12AT7	4/9	DK91	5/-	EF91	3/3	PL81	7/9	UCL83	10/9
6AQ5	6/-	12AU7	4/9	DK92	6/9	EF92	2/6	PL82	5/9	UF41	7/3
6AT6	4/9	12AX7	4/9	DK96	7/-	EF184	8/9	PL83	5/9	UF89	6/3
6BA6	5/3	12K7GT	4/3	DL33	7/3	EL33	7/6	PL84	7/6	UL41	7/9
6BE6	5/3	12K8GT	9/6	DL35	9/6	EL41	7/9	PX4	9/6	UL44	10/6
6BG6G	13/6	12Q7GT	4/3	DL92	5/-	EL42	8/6	PX25	8/6	UL46	9/6
6BH6	5/9	12Z3	8/6	DL94	5/9	EL84	6/-	PY32	9/3	UL84	6/3
6BJ6	5/6	14S7	14/6	DL96	6/6	EM34	7/3	PY33	10/-	UR1C	7/3
6CD6G	26/6	19BG6G	13/6	EABC80	6/-	EM80	7/3	PY80	6/-	UU7	8/6
6F1	9/6	20L1	15/-	EAF42	8/-	EM81	8/-	PY81	6/-	UY21	11/-
6F13	9/6	20P4	13/11	EB91	2/6	EM84	8/3	PY82	5/6	UY41	5/9
6F14	9/6	20P5	14/9	EBC33	5/-	EM85	9/3	PY83	6/6	UY85	5/9
6K7G	1/11	25L6GT	6/-	EBC41	7/3	EY51	6/6	R16	17/-	VP4B	9/6
6K7GT	4/3	27SU	17/6	EBF80	7/3	EY86	6/6	TH21C	15/-	VP41	5/-
6K8G	4/3	30L15	10/3	EBF89	7/6	EZ40	6/-	U24	15/-	W76	4/-
6K8GT	7/9	30P4	12/3	EBL21	13/6	EZ41	7/6	U25	9/9	W77	2/6
6L6G	6/6	30P19	13/-	EBL31	17/-	FZ80	5/6	U26	8/3	W729	14/-
6L19	10/-	30PL13	11/-	ECC40	8/6	EZ81	5/-	U47	9/9	Z77	3/3
6LD20	5/6	35A5	14/-	ECC81	4/3	GZ32	8/6	U50	4/6		
6P25	8/-	35L6GT	7/9	ECC82	4/9	KT32	6/6	U52	4/3		
6Q7G	4/9	35Z4GT	4/11	ECC83	7/-	KT61	7/6	U191	11/-		
6Q7GT	7/9	50L6GT	7/-	ECC84	6/9	MU14	6/-	U281	9/6		
6SL7GT	5/9	185BT	19/6	ECC85	7/3	MX40	13/6	U282	14/6		

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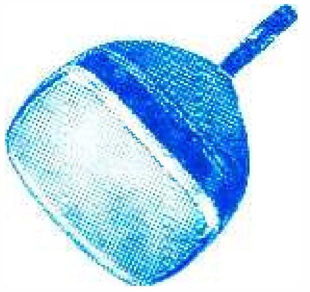

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