Practical TELEVISION

APRIL 1966

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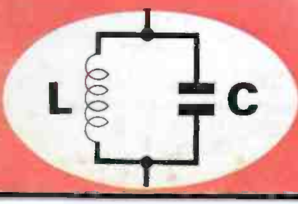


PICOMETER

other, normal, components of the circuit, then to look up the barrier layer capacitances of the semiconductors in the data available from the manufacturers (for the intended operating point), and finally to combine the values arithmetically.

Resonance Measurements

The g.d.o. or any other type of dipper, is basically a resonance meter. It will give direct readings *only for the resonant frequency* of a tuned circuit tested therewith, and it can not be used for making measurements on any other circuit device apart from tuned circuits, i.e. L and C combinations. Thus no dipper will give *direct* readings of capacitance or inductance alone. However, it is clear that any available *known* inductance L may be connected across an unknown capacitance C_x which is to be measured and the resonant frequency f of the parallel combination may be determined in the usual way with a dipper. The value of C_x may then be determined from the resonance formula for a tuned circuit:

$$f = \frac{1}{2\pi\sqrt{LC_x}}; \qquad (1)$$

transposing:

$$C_x = \frac{1}{4\pi^2 f^2 L} \qquad (2)$$

It may in general be inconvenient or impossible to find a suitable coil of known inductance L for use in this method. It is then possible to make use of the implicit relationship contained in formula (1), that the resonant frequency is inversely proportional to the square root of the capacitance, as long as all other quantities are kept constant. In other words, if we measure the resonant frequency of an *arbitrary* coil in parallel with a known capacitor of value C (frequency f_c) and then measure the resonant frequency of the *same* coil in parallel with the unknown capacitance C_x (frequency f_x), we have the valid relationship:—

$$\frac{f_c^2}{f_x^2} = \frac{C_x}{C},$$

transposing:

$$C_x = C \cdot \frac{f_c^2}{f_x^2} \qquad (3)$$

The arbitrary coil can be a makeshift twist of a few turns of insulated connecting wire wound round the fingers and subsequently secured with Sellotape. It will normally resonate somewhere in the shortwave range with capacitance values between about 20 and 500pF. Its inductance need not be determined, as is evident from formula (3).

Both C_x and C must be large with respect to the self-capacitance of the arbitrary test coil, so that errors remain negligible. For the *actual* tuning capacitances are $C_x + LC_o$ and $C + LC_o$ respectively, where LC_o is the self-capacitance of the coil. Strictly speaking, these exact values should be used in formula (3) above. This leaves a twofold choice to our discretion. Either we ignore LC_o entirely and use the simple formula (3): then C_x must be much greater than LC_o, i.e. much greater than a few pF in the general case for reasonable accuracy of its measurement. This makes it impossible to cover C_x values lower than about 10pF, i.e. we are faced with the same limitations as operative for an a.c. bridge method and we might as well use a bridge and save ourselves the laborious arithmetic. Or we use the absolutely correct relationship:

$$C_x + LC_o = (C_1 + LC_o)\frac{f_1^2}{f_x^2} \qquad (4)$$

This corresponds to one known capacitance C_1 and its resonant frequency f_1 with the arbitrary test coil. The resonant frequency f_2 with another known capacitance C_2 must then be found, and a second equation of the form (4) set up correspondingly. The pair of equations must then be solved simultaneously to eliminate LC_o and determine the exact value for C_x which is then accurate down to as low a value as one pleases.

This procedure obviously involves laborious sequences of arithmetical calculation, particularly when one is trimming some circuit design for a particular or for lowest possible capacitance (stray capacitances). Although it will finally lead to the correct results (assuming one makes no arithmetical errors), the method is obviously tedious and slow.

A Standard Tuned Circuit

If we now pause to consider the implications of the theory presented in the previous section, rather than plunging right away into figures and calculations, we immediately see that its underlying principle is simply that a *suitably calibrated tuned circuit* is all that is required in conjunction with any dipper in order to make it give direct readings of capacitance and inductance as well. The LC-Picometer is thus nothing more than a specially calibrated tuned circuit. The theory of the previous section is used to calibrate this tuned circuit *once and for all*, where after capacitance and inductance readings may be taken directly on its dial. This leads to an extremely quick, efficient and surprisingly accurate method, which is eminently

TABLE 1

Determination of Zero-Scale Capacitance of Tuning Capacitor C_o
(See text)

Resonance Formula for Tuned Circuit:

$$f(c/s) = \frac{1}{2\pi\sqrt{L(\text{Henry}) \times C(\text{Farad})}}$$

Thus:

$$f^2 = \frac{1}{4\pi^2 LC}$$

$$\therefore \frac{f_1^2}{f_2^2} = \frac{C_2}{C_1},$$ where f_1, f_2 are resonant frequencies of *same* L with C_1, C_2 respectively.

Let $f_1 = f_{\text{zero scale}}$, $f_2 = f_{\text{full scale}}$ } Measure with grid dip meter

Then $C_1 = (C_{\text{zero scale}})$ Absolute
$= "C_o"$: *required to be determined*
$C_2 = (C_{\text{full scale}})$ Absolute
$= C_o + C_{\text{scale range}}$
$= C_o + \underbrace{(C_x)_{max}}_{\text{known from } C_x\text{—scale calibration}}$

We now have:

$$\left(\frac{f_{\text{zero scale}}}{f_{\text{full scale}}}\right)^2 = \frac{C_o + (C_x)_{max}}{C_o}$$

Rearranging:

$$C_o = (C_x)_{max}\left(\frac{f^2_{\text{full scale}}}{f^2_{\text{zero scale}} - f^2_{\text{full scale}}}\right)$$

suitable for continuous monitoring of improvements when trimming and experimenting with new circuits. The prototype proved to give reliable readings down to values as low as 0·06μH or 0·6pF, whereas the upper limits are 6mH or 430pF (with simple extension, 1000pF). This covers all small values which are ever likely to be of interest yet possibly present difficulties with a conventional a.c. bridge circuit, i.e. all larger values are easily measured even on quite simple bridges. Note that the values 0·06μH/0·6pF correspond to a pair of alligator clips, i.e. already very small objects associated with centimetric frequencies, so that the picometer method permits rational measurements in u.h.f. cavities and similar devices where the resonance points and distributed parameters may not be immediately obvious from geometric considerations. This is just one example of the wide scope of the method, covering long-wave circuits and audio-amplifier high-frequency cut-off stray capacitances as examples of applications at the other extreme.

The grid dip meter is probably the cheapest of all r.f. meters to buy or construct, and the LC-picometer need cost only a few shillings to construct if judicious purchases are made. This proves the point made at the outset, that there is nothing to prevent the amateur making rational measurements of very low C and L values. Such measurements are not limited to expensive professional measuring equipment. Careful execution of the calibration procedure for the picometer, coupled with the selection of a good-quality tuning capacitor of high stability and a good slow-motion dial for it, will lead to a surprisingly high accuracy which is at least as good as that of the dipper.

Operation of the Picometer

The picometer is essentially intended to give direct readings of four parameters which are repeatedly required in general electronics design work, including radio and television:

1. The value of an intentional or stray capacitance *in situ*, down to a fraction of 1pF (C_x).
2. The value of an inductance, down to that of short pieces of connecting wire. (L_x).
3. The self-capacitance of any coil, range 0-90pF. (LC_o).
4. The value of capacitance required to tune an unknown coil to a predetermined frequency. (C_{res}).

The fifth important circuit parameter, the resonant frequency of a given tuned circuit, can be determined directly with the dipper alone:

5. The resonant frequency of a given tuned circuit. (f_{res}).

Construction

Fig. 2 shows the theoretical circuit of the picometer. This consists of a high-stability tuning capacitor VC1 coupled to a good slow-motion dial and connected across a pair of combination terminals (suitable for wanderplugs, spade terminals or bare wires) to which the unknown capacitance or inductance to be measured can be connected externally. The unit also incorporates a standard coil in the form of a ferrite rod aerial with a standard medium wave winding, as used for pocket or portable receivers of the not-too-miniature variety. A switch is incorporated which disconnects and shorts out (to

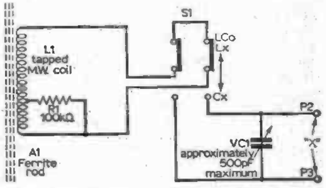


Fig. 2—Theoretical circuit diagram of the LC Picometer.

prevent spurious stray resonances) this standard coil in the one setting, required when an external coil is connected to the "X" terminals for measurement. The dipper is then applied to inject a signal into this external coil. When external capacitances are connected to the "X" terminals for measurement, the switch is set to the other position, placing the internal ferrite-rod coil in parallel with the tuning capacitor and the "X" terminals. The dipper is then applied to inject a signal into the ferrite rod, by holding its probe coil against a suitably marked point on the sloping panel of the picometer opposite to one end of the ferrite rod.

Choice of Medium Wave Ferrite Rod Aerial

Several considerations led to the choice of this component as standard inductance for the picometer. Firstly, it is very readily available and immediately usable as it stands, without any need for coil winding or other complications. Some transistor radios use 350pF tuning capacitors, others 450pF and still others 500pF or even 550pF. The corresponding medium wave ferrite rod aerials are thus on the market in a range of inductance values. Any one thereof is equally suitable for the picometer, and it is not necessary to specify or know which one is purchased. It is merely necessary to make sure that the winding is intended for the medium wave band in conjunction with a standard tuning capacitor of the type used in receivers. If there is also a long wave coil on the ferrite rod, this should be stripped off. If intending to wind one's own coil on an initially blank ferrite rod, try a single layer of 40 to 80 turns thin enamelled copper or litz wire. Adjust the exact number of turns by trial and error until the resonant frequency when connected to the selected tuning capacitor with the vanes fully open lies between about 1·2 and 1·5Mc/s (use dipper applied to ferrite rod). This is not in any way critical. Do not forget a layer of insulation between the ferrite rod and the winding. Tap the winding about 5 to 10 turns from one end; the exact position is not critical, merely leading to different values for R1 (see below). A ready wound medium wave ferrite rod aerial almost always possesses a suitable tap, since the input transistor has to be tapped down on the coil in receiver circuits. If the coupling winding is a separate insulated winding, leave it as such, connecting R1 across it. The length of the ferrite rod is not in any way critical. Mount it such that one end is close to the marked point on the sloping panel for g.d.o. application. The position of the winding along the length of the ferrite rod is unimportant, as long as it is firmly anchored prior to calibration. Needless to say, the casing of the picometer must be of bakelite or some other suitable insulating material. Wood is dubious, since its dielectric properties are liable to change with atmospheric conditions. Plastics are suitable. Flat pieces of plastic or bakelite screwed or glued together with cornerpieces afford an excellent construction. If using screws, keep to brass screws, avoiding iron ones. The same applies for screws fixing the components.

Adjusting the Absorption Factor

There is an optimum combination of coupling factor and circuit damping leading to the best absorption factor giving clearest responses on the dipper. A ferrite rod offers effective coupling to the dipper in this respect, which represents the second reason for its choice. The circuit damping is then adjusted by appropriate choice of value for R1. If R1 is too large, the dip will be shallow and very sharp—it may even be missed if tuning is too rapid. If R1 is too small, the dip will be deep and broad.

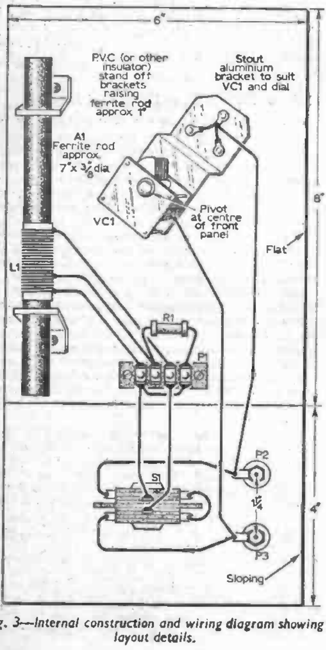


Fig. 3—Internal construction and wiring diagram showing layout details.

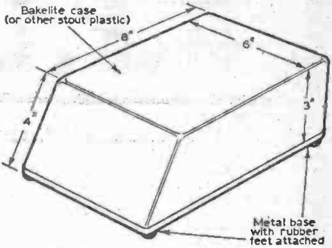


Fig. 4—Dimensions and appearance of case.

giving indefinite readings. Adjust R1 such that the dipper dips full scale with a positive-backed (difference indication) dipper, or quarter to half scale with a simple dipper, when the probe coil is right up against the marking on the panel opposite the end of the ferrite rod and a resonance point is tuned in with the vanes of VC1 nearly fully open.

This adjustment is important for accurate readings below 1pF during subsequent use, since it makes sure that conditions move well away from dip-minimum when VC1 is altered by only a fraction of 1pF near minimum setting. In the prototype, a change of 0·5pF in the setting of VC1 near minimum capacitance moved right out of dip resonance, i.e. the grid dip meter no longer showed any response, so that clear readings were possible even for much smaller capacitances. It is not necessary to move right out of dip for a reading, but merely to obtain a clear shift of dip minimum, i.e. of the point of greatest dip.

Capacitance Measurement

We will now describe the manner of taking readings for each parameter. The way in which the respective scales are calibrated in the first place will be described subsequently.

One of the scales on the slow-motion dial for VC1 runs from zero at minimum setting (vanes fully open) to some maximum value (430pF in the prototype) with the vanes fully enmeshed. This gives the *increase* of capacitance in pF for each setting, relative to the zero position. The actual capacitance at each setting is for the moment of no direct interest; it will be greater than the scale reading by some constant amount C_o, which is the residual capacitance at the zero setting, made up of the residual capacitance (minimum capacitance) of VC1, the self-capacitance of the switch and ferrite-rod aerial and other circuit strays.

For all capacitance measurements, the switch is set to bring the ferrite rod aerial into circuit. We know that resonance is expected somewhere in the region of the medium waveband, so the appropriate probe coil must be plugged into the dipper, which is then applied to the ferrite rod at the marked point.

The tuning capacitor of the picometer (VC1) is now set exactly to the zero mark on the capacitance scale, the unknown capacitance connected to the "X" terminals and the dipper tuning dial adjusted

—continued on page 324

A.F.C. PART 2

A Discussion on Automatic Frequency Control Circuits

By S. George

LAST month we covered those a.f.c. line circuits in which various types of discriminator fed a slight positive or negative voltage change to a conventional sawtooth oscillator whenever it tended to drift away from synchronisation.

All sawtooth oscillators, multivibrator or blocking transformer are sensitive to grid voltage changes, so that is they speed up or slow down, a negative or positive grid voltage will restore their original frequency of operation.

Although these systems are simple and reliable quite a few modern receivers are now utilising sinewave line generators but adapted to produce the required sawtooth waveform in their anode circuit.

The great advantage of the sinewave generator compared to the sawtooth is its much superior frequency stability, as in normal circumstances, even without synchronising signals, they stay close to the original switch-on figure. Their two disadvantages from the timebase point of view is that (a) they must be considerably modified to give the required sawtooth waveform to the line output stage and (b) they are more or less insensitive to voltage changes at grid or anode, so that it is useless to apply the discriminator output directly to them.

The only satisfactory way to control their frequency and keep them "spot on" is to parallel the actual oscillator coil or transformer with a "reactance valve", which behaves as a variable capacitance and shifts its frequency up and down as the discriminator output varies its bias.

But first let's see how a sawtooth output can be obtained from a sinewave oscillator.

Basically three factors are involved as follows:

1. The valve must be biased to class C.
2. The anode h.t. supply is via a comparatively high value load resistor feeding into a "reservoir" capacitor.
3. Wave shaping by carefully selected values of R and C is accomplished in the anode circuit of the oscillator or the grid circuit of the line output pentode.

This class C bias is obtained from the rectifying action of the grid by means of a low-value capacitor and high-value grid leak, so that only the positive tips of the sinewave circulating in the grid circuit (as in Fig. 5a) affects the standing anode current (as in Fig. 5b).

Normally the anode voltage waveform would have a similar outline but due to the h.t. supply being via a comparatively high value resistor feeding into a small "reservoir" capacitor the anode voltage rises only slowly back after each positive grid pulse temporarily lowers the anode potential. A positive grid pulse, of course, results in a negative going amplified pulse at the valve anode, so that such an input simultaneously lowers anode voltage. The resulting anode voltage waveform approximates to the required sawtooth shape and, after further shaping and linearising, becomes ready for subsequent amplification by the line output stage.

Sometimes also a degree of feedback is introduced from the latter to idealise the flyback and onset of the scanning stroke. However, as previously stated, L-C oscillators are almost completely unaffected by variations in anode or grid voltage. The only way to change their frequency is by significant L or C variations and in practice the only feasible way is to vary the circuit capacity with a reactance valve. Such a valve functions like a capacitor in that it takes a current almost 90° in advance of the applied voltage, with its apparent capacitance being easily variable by varying its grid bias.

In a reactance valve circuit this varying bias is, of course, the varying output voltage of the

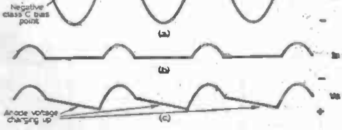


Fig. 5: Sine-wave line generator operation. With the sine-wave grid voltage at (a) impressed on the Class C bias, only the positive tips as at (b) affects the no-signal anode current. Due to the oscillator anode being fed via a long time-constant h.t. supply, its voltage charges up relatively slowly between pulses as at (c) forming a basic saw-tooth for further shaping and linearizing.

associated discriminator. The reactance valve, usually a high-mu pentode, is shunted directly across the oscillator tuned circuit as in Fig. 6. Normally the anode current of a valve so connected would be in phase with the applied voltage since it is purely a resistive path, but in this case its control grid is fed with an input 90° advanced so that the anode current is similarly advanced and behaves like the current flowing through a capacitor to supplement the total tuned circuit capacity. This quadrature phasing is achieved in a very simple way.

A series combination of capacitor and resistor is connected across the tuned circuit (as is the valve), chosen to have an impedance dominantly reactive. In other words its capacitive reactance must be many times greater than its resistance—the greater the ratio of reactance to resistance the closer the current/voltage angle will approximate to a right-angle.

The voltage developed across the resistor though, of course, only a fraction of the total e.m.f. from the tuned circuit, is in phase with the current and thus drives the valves' anode current in phase with itself but almost 90° in quadrature with the applied e.m.f. Obviously, if the capacitive reactance/resistance ratio is made too great, an insufficient proportion of the total e.m.f. will be developed across the resistor, thus inhibiting the valves' operation.

Mathematically the impedance Z of a series C-R combination to an a.c. current is given by the formula $Z = \sqrt{X_c^2 + R^2}$

where Xc is the reactance of the capacitor to the frequency involved, while the angle of lead θ is given by $= \tan \frac{Xc}{R}$,

so that in a typical instance where the reactance of the capacitor might be 190,000Ω and the value of R 10,000Ω the angle of lead would be $\theta = \tan \frac{190,000}{10,000} = \tan 19 = 87°$ approx., more than sufficient for adequate circuit operation. Equally obvious the greater the mutual conductance of the pentode the greater will be the apparent capacitance change of the valve per grid volt input change.

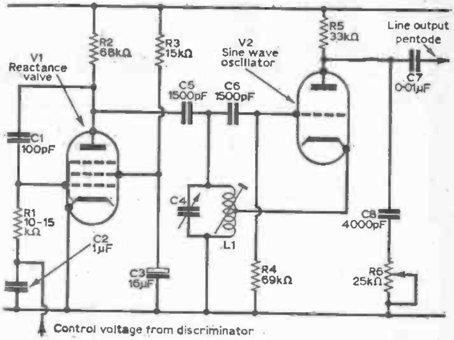
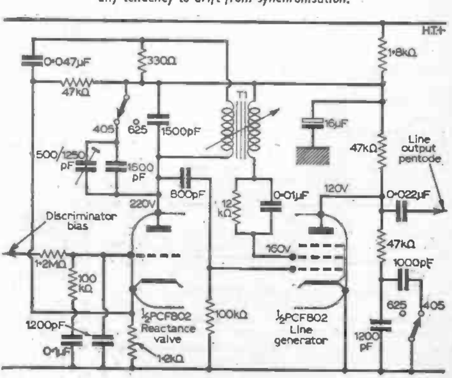


Fig.6 (above): Basic sine-wave line generator reactance valve circuit. Frequency of V2 is determined mainly by C4-L1 values but can be varied by altering bias to reactance valve V1 shunted across the tuned circuit. The reactance of C2 is very low and can be ignored, but the reactance of C1 being many times the resistance of R1, makes the combination predominantly reactive and so causes the current to lead the voltage by almost 90°. The voltage across R1 being in phase with the current, causes the pentode anode current to be also almost 90° ahead of the voltage, so that it behaves as a capacitance, variable by the control voltage derived from the discriminator.

Fig. 7 (below): Sine-wave oscillator reactance valve circuit used in many Regentone, K-B, RGD receivers. The PCF802 pentode operates as a triode line generator by using its G1 and G2 as grid and anode respectively, the sine wave produced appearing in the anode circuit as the required output saw-tooth. PCF802 triode is the reactance valve varying the capacity of T1 primary circuit with variations of input discriminator bias thus cancelling any tendency to drift from synchronisation.



The circuit shown in Fig. 6 is a simplification of all reactance valve a.f.c. systems and, although there may well be modifications and additions to commercial circuits, the underlying principle is the same. Although we have referred to a series combination of resistor and capacitor being shunted across the tuned circuit to produce the quadrature phase change to drive the pentode, in this illustration will be seen a further capacitor, C2, between the bottom of the resistor and chassis.

However, the reactance of this capacitor is so low that it takes no part in the functioning of the valves' operation and is only included to decouple the discriminator rail and enable the control bias to be supplied to the grid from the "earthy" end of the resistor.

In Fig. 7 will be seen the complete sinewave a.f.c. circuit as used in many STC receivers (Regentone, RGD, K-B, Argosy) and includes many interesting features. A single PCF802 triode-pentode fulfils all functions, the triode section being the actual reactance valve and the pentode operating as the sinewave oscillator, although in the guise of a triode, with its grid G1 and G2 operating as control grid and anode respectively. To facilitate this deployment the pentode-anode voltage is kept substantially lower than the G2 voltage, actually 120 to 160, by using a 47kΩ h.t. feed resistor.

The only other components in the pentode-anode circuit are a further 47kΩ resistor and two pF-value capacitors which form a wave-shaping circuit to completely change the anode voltage waveform to a perfect sawtooth outline for subsequent amplification by a conventional PL81 output stage.

The triode reactance valve is paralleled directly across the T1 primary by having its anode connected to one end of the winding and its cathode to the other end via a 0·047μF capacitor. The discriminator output, fed as the bias to the triode, then varies the valves' apparent capacitance and restores its LC value to the original should it drift due to thermal effects on the relevant components.

Should this PCF802 valve be replaced or any important component changed, requiring that the line oscillator be completely reset, the procedure given in the table below should be followed.

TABLE 1

1. Switch to 625.
2. Connect PCF802 grid (pin 9) to a low-impedance supply of 3V positive to chassis.
3. Adjust dust core of T1 till a stationary picture is obtained.
4. Switch to 405 and adjust the 500/1,250pF trimming capacitor till a stationary picture is obtained.
5. Remove bias and seal both adjustments.
6. Adjust the common line hold control to the centre of the pull-in range.

■

UNDERNEATH

THE DIPOLE

IF you are a householder approaching the termination of the lease of your home are you filled with apprehension? Are you confronted by your landlord with possible eviction, increased rent, restriction of occupational privileges and frustrations of today—plus the rising spiral of the cost of living?

No need for me to comment upon this uncomfortable state of affairs, nor upon the not dissimilar situation which could possibly face the 14 independent television companies which are licensed under the jurisdiction of the Independent Television Authority. This is a particularly difficult moment for the ITA to deal with such political matters. especially when the technical problems of colour television are under consideration.

Colour TV

No specific date has yet been announced for the start of public broadcasting in colour television. This awaits the final decision on the system to be used. A month or so ago it looked as though the German PAL system might be adopted throughout Europe on 625 lines, but yet another runner has entered the race: a combination of PAL and SECAM plus additional sophisticated (not to say exotic) contributions from BBC and ABC-TV (Britain) and the Russian television organisation. Colour television tests on PAL by the BBC are already well established, but this will not prevent the introduction of the final tweakings of a number of brilliant electronic engineers.

It can't be long before the PMG announces the critical decisions and considers the ways and means of making such a service viable. The BBC is already carrying a financial overload with BBC-2 black-and-white programmes without taking into account the much bigger operational costs of colour.

Independent television companies have not rushed forward to face the heavy initial costs of transmitting 625-line colour on u.h.f. without associating it in some way with the well-established 405-line transmissions. One of the most logical solutions of these difficulties was made in the *Open Letter to the Postmaster-General* addressed by the Editor of *Practical Television* in the January issue, which attracted considerable attention in the television industry. Meanwhile progress is being made by technicians of ABC-TV and Tyne-Tees, while TWW is already embarking on a training scheme for its engineers and is ordering equipment for its studios at Cardiff.

Colour Films for TV

The mainstay of colour television programmes at peak hours in the USA seems to be off film. No less than 16 television series on 35mm colour film and one on 16mm colour film are being produced and broadcast there at the moment, plus a number of similar coloured films, specifically photographed for television, that are being made in Britain and other parts of the world.

Britain is likely to play an important part in the telecine equipment necessary for this part of the technical requirements such as the colour version of the Cintel Flying-Spot twin-lens apparatus, which is probably the best in the world, added to which is the Plumbicon TV camera, of which the basic elements come from Philips, Holland. Colour television is certainly developing into an international effort. What will be the next step?

The focus of attention will be upon the Postmaster-General, who will be subject to pressures from all sides from the point of view of colour television. These pressures include the now famous "Open Letter" from the Editor of this journal, mentioned above. This was a practical suggestion which bears looking at again from a neutral standpoint. From whence are likely to come other pressures? From the British Radio Equipment Manufacturers' Association? Yessir!

Their members are responsible for the design and manufacture of domestic television sets, the beauty of their cabinets, the long life of their c.r. tubes, their simplicity of operational controls, their preoccupation with the intricacies of automatic gain control and mean level control.

Artistically the producers of television programmes are horrified with the degradation of picture and sound on many of the domestic TV receivers compared with what they see on their TV studio monitors. Therefore TV technicians—and also the cameramen who photograph films specifically made for television, particularly members of the British Society of Cinematographers—literally turn pale at the prostitution of their art by the contrived automatic bleach applied to their low-key scenes and fade-outs.

Even the actors' faces automatically turn dark with anger(?) when the camera pans across a scene bringing a white tablecloth into the picture. A moonlight scene with the lovers walking beside the delicate glints of a babbling brook (as seen on the studio's telecinė) takes on the rheumy atmospheric background of a display of damp squibs in a fog (as seen on many domestic TV receivers). No wonder both film and TV lighting men develop liver complaints or high blood pressures.

It is said that in some countries the retention of d.c. restoration in domestic TV sets is practically a criminal offence. In Britain d.c.

restoration was championed by Douglas Birkenshaw of BBC Engineering division and the British Kinematograph, Sound and Television Society. The penny is beginning to drop with some set designers, a most important trend when it comes to good colour television reproduction.

Pressures on PMG

Other pressures? yes, plenty of 'em. Financial pressures to be made by the BBC to extract more money from television licences. Pressures from the ITV companies for the unfortunate PMG to make up his mind about anything at all, including the extension of their licences. Pressures from the 'Marat-Sadatans' who hate censorship and resent conforming to standards of any kind of civilised behaviour.

Pressures from the retailers for reduction of HP restrictions. Pressures from the Arts Council and other do-gooders (?) for expansion of arty-crafty plays, comprehensive education in a university of the air, more religion, less religion, no religion, more swearing, less swearing, and so forth.

Meanwhile, the PMG fiddles while Rome burns. And you can hardly blame him for that, when you come to think of it! Still, *tempus fugit*, but the public look upon television as an entertainment, a tranquiliser in an age of competitive grab and vicious spirals. Something has to be done by the PMG about all these technical matters in addition to dealing with the dangerous trend of irresponsibility in certain small cliques on the programme side of both BBC and ITA.

At this point in my sermon, I will not call for a hymn to be sung! Instead, I will ask older readers to recall that poignant music-hall ditty sung by that great artiste Marie Lloyd, which begins:

My old man
said "Follow the van,
and don't dilly dally by the way!"

Readers of PRACTICAL TELEVISION who know the tune, should sing (to themselves, I hope) the following new lyric:

Wedgwood Benn
Must take up his pen,
And not dilly dally with TV!
Industry waits for decisions this minute,
Whatever the system he's all ag'in it.
So he dillies and dallies,
Dallies and dillies,
Lost from GPO to BBC.
For the boffins new fixture,
Is political mixture,
Of SECAM, PAL and NTSC.

What is the difference between burlesque and satire? My answer is conditioned by the country concerned. In USA the name burlesque was applied to an early type of strip show, with lots of glamourous girls, near-the-knuckle sketches and leering comics. This was back in the days of prohibition. Today, variations of this formula are seen in club and pub shows on BBC and ITV. But the British version of "burlesque" was initiated at the old London music halls, such as the Alhambra, the Empire and the Tivoli, when Dan Leno, Little Tich, George Robey and Wilkie Bard topped the bills.

Burlesque and Satire

Today, the BBC give examples of burlesque and satire on Saturday nights, when Peter Cook and Dudley Moore appear in *Not Only . . . But Also* followed a little later by BBC-3 in which John Bird gives amusing but rather unkind representations of the Prime Minister (whatever party he happens to belong to) and other members of his cabinet. Peter Cook and Dudley Moore are brilliant comedians who write a lot of their own material of the British burlesque type. Their "send up" of the BBC's recent serious documentary about the trials and tribulations of the making of Alexander Korda's *I, Claudius*, they transposed into a burlesque of the filming of a version of *The Hunchback of Notre Dame* with Dudley in the title role and Peter Cook (with turban, riding breeches and whip) as the irate German film director (Peter Cook thinly disguised as von Sternberg) and Peter Cook, appearing not so thinly disguised as pin-striped compere Dirk Bogard and also of commère Merle Oberon (sat in front of her English castle) was burlesque of the real original type, free from Hollywood home, a kind of the malevolence which afflicts "BBC-3".

Not Only . . . But Also was an exposition of good timing, of good fun, not only in "cod" dialogue but in movements, reactions and motivations essential for cumulative clowning.

Editing

Comedy on the live stage, screen or television is dependent mainly on the actors, but it is also a matter of team work. In the live theatre, the actors may vary the timing of "gags" from show to show, varying with the reactions they get from the audience. In live or taped television, a live audience is helpful, and this instant reaction can be expanded with audience, noises provided from discs or tapes. Filmed material is partly dependent in its timing on the expertise of the film editor, who can add or subtract seconds by cutting.

Two of the great advantages of using feature programme material for programmes are (a) the film can be edited, music and sound effects and a general polishing up and shaping can be carried out, with precision. (b) The final film, on 16 or 35mm, can be shown at any television station in the world, reshaped and resynchronised, if necessary, with different languages. The continuity of visuals can be manoeuvred from shot to shot in editing.

This fluidity is sometimes used in reverse and results in confusion to persons seeing the programme for the first time.

For example, BBC's musical art programme about the composer, Holst, included picture sequences to synchronise with various examples of Holst's music. Some of these sequences had clips of shots so unrelated that one's mind was taken off the music by the assortment of clips, which the editor had evidently shuffled like a pack of cards. Other sequences were very good. But the whole programme had a discouraging shape leading inevitably to the "off" switch.

Iconos

FAULTY INDUCTORS

— THEIR EFFECT IN TV RECEIVERS —

F. A. GRINDTHORPE

THE fact that chokes and transformers work at all depends upon the variation of current through them. We are not really concerned with the theory in this short series but a painless spoonful may help understanding their function and why they are put there in the first place. All purists about turn, this is not for you! A current passing through a coil erects a magnetic field around it. If the current does not vary the magnetic field stops where it is and has little further effect on the coil. As the current falls or stops, the magnetic field collapses, cutting the coil and thereby inducing a further current into it, the direction of this current opposing the change creating it. Since the change is the fall, the induced current tends to keep it going. Thus although the driving voltage is removed the current fall "lags" behind, which is opposite to the effect of a capacity circuit. Thus the action of a smoothing choke tends to iron out the rising and falling ripples. The iron core concentrates the magnetic field and the fact that the core is made up of separate pressings or laminations is to stop "hysterics" which would take place in a solid mass of iron, due to the interaction of circular currents which would tend to "eddy" around.

Thus a large number of turns wound in a slab and put on to a laminated iron yoke will induce a "keep going" effect on itself, and if other windings are wound onto the same former will induce voltages in these according to the number of turns and the position of these windings. The smoothing choke then becomes a transformer. Provided the current does not change too frequently this type of construction is quite efficient and is used in most circuits to do with the mains supply (50 changes per second) and other low frequency applications. Where the rate of change is higher the losses in the core material become serious and laminating in strips is no longer effective. The core is therefore made up of pressed separate particles in the form of dust iron or the more refined material known as "ferrite". These materials feature low losses until the rate of change or frequency reaches millions of cycles per second. A coil or choke will offer less opposition to a slowly changing current than to a rapidly changing current, and this provides a means of filtering or damping. The "lagging current" chracteristic of a coil can be married with the "leading current" characteristic of a capacitor (or the capacity if its own turns) to produce an almost infinite impedance to the current of a particular frequency which is handy to say the least, or to produce an almost zero impedance, neither being wholly practical due to other factors, but these combinations make tuning possible.

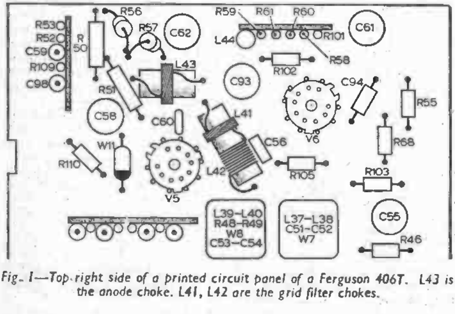


Fig. 1—Top right side of a printed circuit panel of a Ferguson 406T. L43 is the anode choke. L41, L42 are the grid filter chokes.

The windings of transformers are usually made up in layers. It is quite common for layers to short across, thus producing "shorted turns" often referred to in the parlance of radio and television engineers and kindred trades. The result of such a fault is not only loss of efficiency but also overheating, wax dripping etc. In the case of TV receivers this fault is most frequently met in line output transformers where the overheating may not be obvious but the effect is to damp the stage to non-operation. A not so frequently met fault but which seems to affect some recent *Thorn* chassis is a primary-secondary

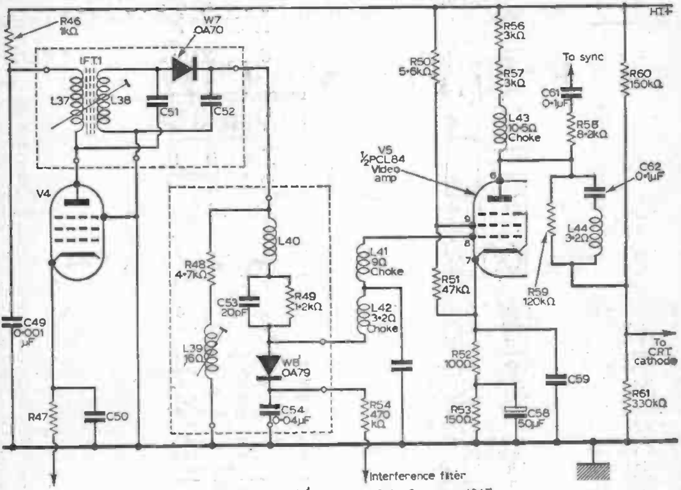


Fig. 2—Video amplifier circuit of the Ferguson 406T.

short in the field output transformer resulting in a direct h.t. to chassis short, blowing the fuse and probably open circuiting the input surge limiting resistor. Care should be exercised in wiring up a replacement transformer as this may not have the same connections as the original.

Transformer Winding Faults

Transformers also seem prone to develop an open circuit primary winding, these usually being the sound or field output transformer. Confirmation is obtained when voltage is indicated at one end of the primary (h.t. end) but not at the other (valve anode end). Not only output transformers are so affected, many receivers mainly of the 1950—1958 vintage seemed prone to developing an open circuited oscillator transformer winding—usually the h.t. winding. A pitfall for the unwary here was the possibility of different connections in a replacement whereby it was necessary to reverse either the primary or secondary connection (but not both) in order to get the correct phase for oscillation and turn that irritating horizontal white line into a nicely spread raster. To briefly summarise, therefore, it may be said in general terms that mains input transformers tend to suffer from shorted turns indicated by overheating and wax emission (check circuits for shorts before condensing), line output transformers—shorted turns resulting in loss of efficiency—no e.h.t., low boost voltage, etc. Field output transformers usually go open circuit in the primary winding but occasionally suffer from primary-secondary shorts. Oscillator transformers also develop open circuit windings but can still function with high resistance windings giving loss of hold and poor sync.

High frequency transformers such as are used in i.f. and r.f. circuits usually consist of a pair (or more) of windings in near proximity tuned to accept or reject a chosen frequency by iron dust cores or associated capacitors. This form of transformer rarely gives trouble due to the few number of turns employed and the spacing of the windings, but the insulation of the former on which the coils are wound does sometimes break down or the coupling capacitor may become leaky.

Chokes

A low frequency choke is often used for smoothing purposes, and is wired in series with the main h.t. line working in conjunction with electrolytic capacitors. These items are fairly trouble-free but can develop a short to core which is normally earthed, thus causing an almost direct short across the output of the rectifier.

High frequency chokes usually take the form of a coil wound either on insulating material or on a resistor which has a damping effect on the coil. These devices may be found in different parts of a receiver circuit. Where they need only consist of a few turns they may be made of thick wire, open wound and self supporting, being directly soldered to a valve base or tag. They are often found used in this manner in tuner units. Apart from dry soldered connections, improperly cleaned ends, etc., this type

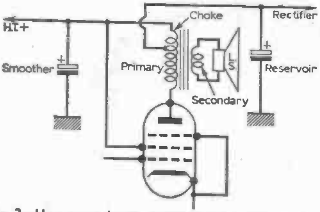


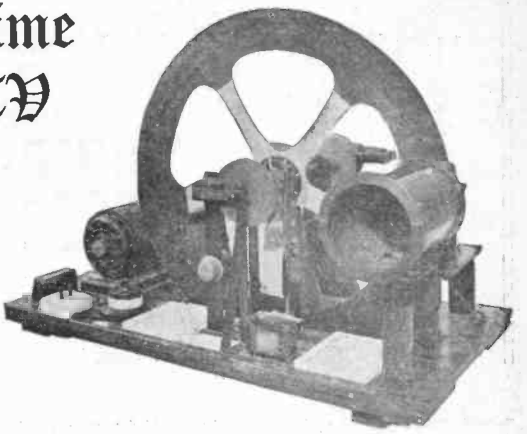
Fig. 3—How a sound output transformer can have a topped primary to function as a smoothing choke.

requires no comment. Where they do give trouble is in the detector and video circuits. Many Pye-Pam-Invicta models of the 1955—57 vintage suffered from loss of picture due to an o/c choke in the screened section or leading out of it. The usual trouble was that they had never been properly cleaned off and trimmed at the soldering posts in the first place. In later years the *Thorn* series Ferguson 406T etc., suffered similar troubles with the chokes used in the PCL84 video amplifier circuit. Either the single anode choke or the grid circuit double coil filter choke could intermittently go o/c giving rise to some weird and initially misleading effects. Most often it was only necessary to detach the end of each winding, scrape it clean, properly turn it and wind it back in the post where a final dab with a hot iron permanently cured the fault. These small chokes are often overlooked when the symptoms of no picture or very faint and negative picture are presented. A quick check on this type of choke is to short it across. Whilst this may introduce ringing or oscillation it should at least prove whether the choke is o/c or not.

Transformer Chokes

A common practice, mainly in radio receivers, is to use an overwind of the primary of the audio-output transformer to act is a smoothing choke. This is usually augmented by additional resistor smoothing. ■

Old Time DX-TV



30-line TV scanner constructed in 1932

THIS item consists of a thin aluminium disc pierced with 30 square holes arranged in a spiral, the disc is rotated by means of an electric motor at 750 r.p.m., with a plate neon lamp arranged behind it, the resultant pattern when viewed from the front consists of a rectangle made up of 30 vertical lines, the rectangle size being limited by the fact that its diagonal corners are positioned by the vertical and horizontal distance between the first and last hole in the spiral.

The plate neon is connected in series with the secondary of a transformer and a suitable d.c. supply as a "strike" voltage, the primary of this transformer forms the anode feed to a broadcast m.w. receiver, (see below), the superimposed modulation then appears as a change in light intensity on the plate neon, and when scanned by the spiral holes a low definition picture results, the size of this image is approximately 1¼in. by 1in., this is magnified to about the size of a cigarette card by means of a lens and viewing funnel.

With a mechanical scanner of this type the main difficulty lies in maintaining the correct speed at 750 r.p.m., in practice the drive from the motor is arranged to be a little in excess of this, the speed is then roughly regulated by means of a mechanical brake, then more finely adjusted by an "eddy current" magnetic brake consisting of a brass disc, a solenoid and 2 pole pieces, with a variable resistance current control, the final speed synchronisation being obtained by an 8-toothed wheel with pole pieces and solenoid supplied with a 50 cycle mains supply. (This worked well when both transmitter and receiver were on same sector supply as they were in the original area. BBC obtained their frame pulse from the mains frequency.)

The old British Broadcasting Company transmitted 30-line experimental pictures in the early thirties, two nights per week between 11 and 12 p.m. using m.w. London regional for vision, and m.w. Midland regional for vision, and two broadcast sets, one for sound and the other for vision were used.

The quality of the 60-line image was of necessity of a low order but it was at least a start some 3—4 years before the regular 405-line service started in the London area!

This set was used at Chelmsford, Essex, and a small charge was made for anyone to view! So a profit was made from the BBC, in exchange for some publicity for BBC-1 before it arrived.

It was also on one occasion transported to Leeds, Yorks., and BBC London was successfully received, this constituting Mr Rafarel's first DX-TV success at over 200 miles!

Mr. Rafarel has been over to the Paris studios of Radio Television Francaise, where he and his wife were given VIP treatment and entertained before they made a presentation of the 30-line TV set which is to be kept as a permanent exhibit in the Museum of the History of Radio and Television, ORTF, Paris, in the Avenue de President Kennedy.

Mr. Rafarel describes the 30-line set as the "bacon slicer" and says that it could only be operated with risk of physical injury!

When the set was made in 1932, Charles Rafarel was working as an electrical apprentice and since those days he has been an ardent listener to French radio and now is a regular viewer of French Television.

Two points that Mr. Rafarel would like to make clear, are that parts are no longer available for building up this set, and that there are no mods for conversion to 625-line or colour! ■

Dealing with those

★ HIGH TENSION ★

SHORTS

by V. D. Capel

NEARLY all television receivers are fitted with a fuse of suitable rating in the h.t. line circuit. The first intimation of trouble arises when the user finds his set completely dead and then finds that the h.t. fuse has blown. The temptation is to fit another, possibly a higher rating, and hope for the best. On occasions this has the desired effect and no further trouble is experienced and the user may have concluded that the fuse itself was faulty.

Although rarely the case, yet this is not unknown. A dry joint at the fuse cap may have caused arcing. Over a period the local heat caused by this arcing could have burnt through the thin fuse wire and caused it to go open-circuit.

Current surge

A more likely reason is a momentary current surge in the equipment itself. This sometimes occurs when the set has been switched off and then switched on again within a few seconds. The moral here is clear: if ever the set is switched off, even if accidentally while adjusting the volume, allow a few minutes for it to cool down before switching on again. It may mean missing part of a programme. but even more will be missed if a fuse blows as a result!

Build-up of h.t.

A surge does occur when switching on normally, especially if metal or silicon rectifiers are employed. These do not give a gradual build-up of h.t. as do the valve types and as the valves are cold, hence passing no current, the applied voltage will be much greater than during normal running. Under these conditions the charging current through the various electrolytic reservoir, smoothing and decoupling capacitors can exceed the rating of the fuse, which will then blow. Ideally this effect should be overcome by increasing the value of the series surge limiting resistor. The snag here is that the h.t. voltage will be reduced during normal operation and especially in older sets, this could mean difficulty in obtaining sufficient width and height. In such cases and providing the trouble is not actually due to a fault the rating of the fuse can be increased by a small amount. If this may produce a twinge of conscience, consolation can be obtained from the fact that many manufacturers have had to do exactly the same thing! As an alternative anti-surge fuses could be tried, but in the writer's experience these are only moderately successful and are not completely proof against all surges.

Fuse examination

Examination of the blown fuse can often give a clue as to the cause of its demise. If the wire is still bright over most of its length and has just gone o/c at the end where it is soldered into the cap this would indicate that it had not carried current in excess of its rating and that possibly the fuse itself was defective, as we have described. Where the wire is broken in one place but intact over the rest of its length, and this accompanied by slight darkening, it would appear that a current only slightly in excess of the fusing current had been passed. This would point to a surge, in which case the above measures can be effected, although a fault causing an abnormal current could also be responsible.

When the wire has completely disintegrated, leaving a few blobs of metal on the inside of the glass cartridge, then something more than just a surge of a moderate rise in h.t. current is indicated. This is a full short and usually is the easiest to trace.

Physical signs

Often physical signs of the trouble can be seen without the need to use any test gear. Burnt or discoloured resistors are the most frequent ones. Usually the resistor is a decoupling component to the screen or anode of a valve in the receiver section and the associated capacitor will be found to have gone s/c. Other resistors may also be found to have discoloured. These are decoupling resistors connected in series along the h.t. line and therefore were also in the path of the excess current. These will be of lower value than the final one, hence will not have suffered so much power and therefore will not have suffered so much damage. Usually the discoloration is all that is wrong with them and they can be left in circuit. The final screen or anode resistor will have burnt badly and if not burnt out will have changed value and so will have to be replaced along with the offending capacitor. The lesson from this is: do not attack the first discoloured resistor and its associated capacitor you see, the real culprit may be farther along the line and the one that is burnt the most is the one to go for.

The source of an h.t. short is not *always* visually obvious, in which case the test meter must be brought into use. Switched to the ohms range, a low-resistance reading will be obtained between the h.t. line and chassis. The next thing is to localise the source of the reading. This can be a rather tedious job. Many circuits are taken off from the h.t. line and isolating the offending one can mean unsoldering many leads and remeasuring. As feed wires loop off from one tag panel to the next, one can be led a merry dance around the chassis until the culprit is run to earth.

Voltage readings

This can be minimised, however, by intelligently comparing the readings at various points and following the lowest. For example, a number of wires may be found connected to the smoothing capacitor, often used as an anchor point for the main supply leads. One goes to the smoothing resistor or choke. Measuring the other side of this gives a higher reading, so the short is not here. Another is taken to the sound output transformer and again the reading on the anode of the output valve is higher, so once more we look elsewhere. A further lead we find going to the field timebase section and here a connection is made to the field output transformer primary. A reading on the anode side shows lower than the h.t. side, so the fault is localised. The output valve is first removed to make sure that the trouble is not due to an electrodes short in it, but the reading persists. A capacitor is noticed from the anode to the feedback linearity network. The reading on the other side of this component is the same. Disconnecting one end of the capacitor and measuring across it shows a dead short. It is as well after the fault has been isolated to check for damage that may have occurred as a result of the current. In this case it is possible that the linearity control track may have burnt.

This case illustrates the general principle that if measurements are taken at the other side of inductors or resistors that come directly from the h.t. line they can either be absolved or condemned without any unsoldering and, if all give higher readings, then attention can be concentrated on those components which are connected directly to h.t. without any intervening resistance such as decoupling capacitors and valve screen grids. Remember though that output transformers can develop leaks to core. If this occurs at the h.t. side of the winding a high reading will be obtained at the anode of the valve and the circuit may be considered above blame. If in doubt it is sometimes easier to loosen the screws fixing the transformer rather than unsolder the leads. Moving the transformer will then cause the reading to disappear as contact between the core and chassis is broken.

Don't waste time

When taking the readings do not waste time measuring the other side of high-value resistors as even if a dead short was present there the current would be insufficient to make any appreciable difference to the total h.t. current and certainly not enough to blow a fuse. Carbon resistors will most likely show the overheating signs previously mentioned, so circuits fed by them are not likely to be the faulty ones if the resistor looks fresh and clean. Wire-wound resistors sometimes show the effects of overheating, but not always as they usually run warm normally, so circuits which they feed should be checked.

Capacitors will often be found connected to the h.t. line, but not all are decouplers, not all, in fact, are returned to a point near chassis potential. A resistance reading on the other side will confirm whether there is a low-impedance path to chassis; it should. of course, be equal to or less than the leakage reading from the h.t. line for it to be suspect.

Sometimes what we will call the "intervening resistance" between the h.t. line and the suspected circuit is very low, too low to show any difference on the ohmmeter which the reader may have at his disposal. Such circuits could be in the i.f. amplifier, where the i.f. transformer primary winding may only be a few ohms. In such cases it is difficult to ascertain which side gives the lower reading. If the short is itself of low resistance a better indication may be obtained with a battery and a flashlamp bulb. These should be connected in series with a couple of flying leads. A low-voltage high-current lamp is most suitable such as a 2·5V 0·3A with a 3V cycle lamp battery. The lowest point can now be more readily determined as even a few ohms in the circuit will cause a noticeable drop in the brilliance of a bulb of this rating.

Now we come to the case where the h.t. fuse blows and yet the resistance from the h.t. line to chassis seems normal when measured cold. By examining the fuse as previously described we can discover if the short is a "heavy" one or just a rise in current beyond the fuse rating. If it is the latter and if it blows only occasionally it possibly is due to the surge as described, but if it happens almost everytime the set is used then we must look further for the trouble. There are many possibilities. Valves sometimes develop inter-electrode leaks. These leaks more often than not are present when the valve is hot and clear when it is cold. Anorher cause is in the inter-valve coupling capacitors. One of these may leak or go s/c but because of its position in the circuit will not affect the h.t. to chassis resistance. However, when the set is running the defective component will apply h.t. from the anode of the preceding stage to the grid of the next. This, especially if it is an output valve, will then pass an excessive anode current and blow the h.t. fuse.

Removal of bias

A similar condition can occur if the cathode bypass capacitor of one of the output stages goes s/c. This removes the bias from the valve and as a result the anode current will increase. Yet another cause can be failure of the line oscillator. The line output stage has customarily little or no standing bias, the bias resulting from the negative drive on the grid from the oscillator. It follows then that if this ceases the anode current will rise rapidly.

Fortunately all of these fault conditions will have an effect on the performance of the circuit concerned other than drawing excessive h.t. current from the power supply. As the current

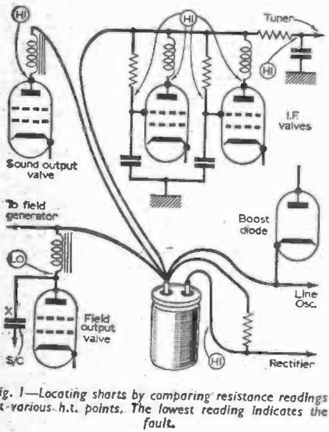


Fig. 1—Locating shorts by comparing resistance readings at various h.t. points. The lowest reading indicates the fault.

will be limited by the saturation current of the valve concerned little damage can be done if the receiver is run for a few minutes in this condition. So it is that some clue can be obtained about the cause by observation of other symptoms.

As constant replacement of fuses can be expensive the fuseholder contacts can be bridged by an ammeter switched to one of its higher ranges. This will afford further clues by indicating when the excess current flows, either immediately, after a few seconds or after several minutes, also the amount of current. It should be noted that if it flows immediately then the above faults could not be responsible as these all depend on valve conduction, hence it is necessary for the valves to be warmed up.

When the meter indicates that the fault is present a quick check can be made of the performance of the various parts of the receiver. Is there a raster present of sufficient width? Is the scan free from fold-over and reasonably linear? Is the sound of sufficient volume and free from distortion? A negative answer to any of these questions will indicate the stage in which the fault is present. Voltage measurements, valve substitutions and other normal fault-finding techniques should then reveal the precise cause.

Low h.t. to chassis

The lack of a low h.t. to chassis reading when cold can be due to components breaking down only when the voltage across them exceeds a certain amount. The voltage of the battery in the ohmmeter is insufficient for this purpose, hence no reading is obtained. This breakdown can range from a dead short to a high-resistance leak and as a result the effects on the fuse will vary. Capacitors are the most likely offenders but there are others. Tracking from the carbon elements of controls that carry h.t. such as the brilliance control to the earthed metal cases is not uncommon. Also tracking over the paxolin terminal boards of transformers is another possibility.

About the only way to tackle this if there are no visual indications and no effects on receiver performance is to isolate individual h.t. circuits. There are two methods that can be followed. Firstly, each circuit can be disconnected by unsoldering the appropriate lead and then switch on. This is repeated until the stage is reached where the fuse does not blow. The last circuit to be disconnected will then be the culprit. The other method is to disconnect as many circuits as practicable at the start, then to reconnect them one at a time until the fuse blows. The advanrage of the former method is that unsoldering will be reduced to a minimum as it is possible that the defective circuit will be among the first few tried. However, we must blow a fuse at each trial unless we are using an ammeter. The second method is more economical as only one fuse will be blown but more unsoldering will be required. If the short is a bad one, as inspection of the fuse will reveal, and it is desired to use an ammeter, it would be prudent to include a series surge limiting resistor while tests are being made. This will not only protect the meter but also the rectifier, which would not take kindly to repeated surges of high current. In fact in such a case it would be best to use the latter method as the heavy current will then only flow at one test. Should the short be only slight then the former method could be safely used.

Use of a "Megger"

As an alternative a " megger " could be used if one is available. This is an insulation tester powered by a small hand generator built into the instrument. While this would save the switching on of the apparatus in the fault condition there are points to watch in its use. Many, in fact most, meggers generate a potential of 500V. To apply this to the h.t. line may actually cause insulation breakdowns, especially among electrolytic capacitors which in most cases will be rated below that figure. The normal rating for the smoothing and reservoir components is 250V with occasionally a 350V rating being found. The individual tubular electrolytics are usually rated higher, but even here 450V is a common limit. If such an instrument is used it should be one of the smaller ones that operate at 250V.

Another point to remember when using a megger on the h.t. line is that as it indicates high values of resistance, values of a few thousand ohms will give an almost full-scale reading. Thus care would be needed to distinguish an h.t. short or leak from the normal reading obtained from the h.t. line through the various electrolytic capacitors and bleeder networks. When connecting the megger, polarity, of course, must be observed.

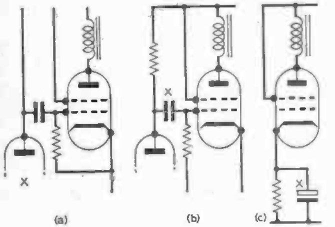


Fig. 2—Common causes of excessive h.t. current which do not affect h.t.-to-chassis resistance reading. (a) failure of line oscillator (b) s/c coupling capacitor to sound on frame output stage (c) s/c cathode bypass capacitor in output stage.

Finally we come to the most difficult and irritating h.t. short—the intermittent. The set may work well for hours. days or even weeks and then the fuse will blow. Immediate examination will reveal no fault and after replacing the fuse the set will carry on for another extended period. The fuse may blow immediately on switching on or after the receiver has been on for some while. If the latter is the case there may occur some symptom immediately prior to the short which might give a clue. If it occurs on switching on and the fuse is not badly blown, switch-on surge may be responsible as previously discussed.

There remain the obstinate cases where no symptoms or other clues are to be found to give a lead as to where to look. The indiscriminate replacement of possible components can be frustrating and expensive unless one is fortunate enough to hit on the right one at the first try.

Final fault location

The final location of such faults calls for some improvisation and patience, but if tackled systematically they can be located and cured. One method is to split up as many of the h.t. supply leads as possible. Then in series with each one is soldered a fuse of suitable rating—100mA would be a good value. These can be prepared in advance by soldering a short length of insulated lead on one end, an inch or two should suffice. This lead can then be connected to the point from which the h.t. lead has been removed, which in turn is soldered to the free end of the fuse. Care must be taken that there is no likelihood of the fuse end caps shorting against other components or the chassis. Having thus been doctored the set is reassembled and used in the ordinary way.

The next time the fault occurs an examination should reveal that one of the added fuses has also blown. It may be that one of these will have blown by itself without affecting the main h.t. fuse, which is likely if it is rated lower. (Actually it should be rated lower as otherwise the main fuse may go and all the additional ones be still intact.) Thus the offending circuit will be identified and all the other extra fuses can be removed. If the defective circuit is itself supplying several sub-circuits it may be necessary to repeat the process by fusing each of these and running the set again.

Transformer leakage

In this manner it will be eventually possible to pinpoint the defective component and replace it. One sometimes baffling source of intermittent h.t. shorts is a leakage between primary and secondary or primary and core of a transformer. If the fuse to this component had blown it could be mistakenly assumed that the fault was in the valve or an associated anode capacitor. If a fault in a transformer seems likely a fuse should be inserted both in the h.t. and anode side of the primary winding. The anode fuse should be rated less than the other: 100mA and 150mA would be suitable. If they both fused or if the anode one did the fault would be in the anode circuit, but if the h.t. side fuse blew and the anode one was unaffected then indeed the transformer would be itself responsible.

So, as with all servicing, by intelligent observation of all symptoms and a systematic approach even the most obscure fault in the h.t. line can be located and rectified. ■

TV TERMS AND D

LETTERS and technical queries from our readers reveal that certain television terms and the parlance adopted by the more knowledgeable are not always fully understood. This applies also the names of certain television faults and circuit conditions. This series of articles, therefore, sets out to correct this state of affairs and to explain in simple terms the meaning of both common and uncommon definitions and phrases used in television practice.

With the rapid progress of television, new terms crop up each year while the old ones remain. This series will thus embrace the old and the new, giving details of any modifications in meaning or expression of the names, terms, techniques and so forth that have occurred over the years.

Aerial

Although we are all perfectly aware of this name, there are one or two things about the modern television aerial that are not so well-known. The basic component is the "dipole" whose length is slightly less than the *half wavelength* of the signal it is to receive. The overall length of the dipole in feet is equal to the wavelength in metres times 1·57 or to 474 divided by the signal frequency in Mc/s.

The half-wave dipole can be connected to the downlead or feeder at its centre, where the impedance is low (about 72Ω) and matches the characteristic impedance of the feeder or at one end where the impedance is high (about 3,500Ω). End feeding to low impedance cable thus demands the use of an impedance matching device.

The bandwidth of a dipole is somewhat governed by the length/diameter ratio of the conductor forming it. The smaller the ratio, the greater the bandwidth.

It is for this reason that a u.h.f. aerial has an intrinsically greater bandwidth than a v.h.f. aerial using a similar diameter conductor. The bandwidth of an aerial is sometimes purposely increased beyond this by the employment of two (or more) dipoles specially dimensioned, spaced, phased and connected to each other.

The basic dipole is sometimes said to have a gain of 1dB (i.e., unity gain). When the dipole is vertically mounted it is "omnidirectional". This means that the gain is constant all round it and that it picks up signals equally from all directions at right-angles to the dipole. When the dipole is mounted horizontally, however, it is "bi-directional". This means that it has two points of maximum pickup and two points of minimum pickup. The bi-directional characteristic is compared with the omnidirectional characteristic in Fig. 1, at (a) and (b) respectively.

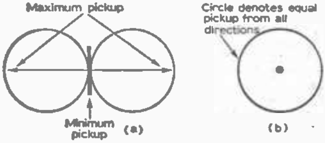


Fig. 1—Polar diagrams of dipole aerial (a) when mounted horizontally to receive a horizontally polarised signal and (b) when mounted vertically to receive a vertically polarised signal.

The dipole is mounted vertically or horizontally to coincide with the polarisation of the signal transmitted. Both polarisations are used with television as a means of discriminating between stations using the same or a shared channel number.

The directivity of the basic dipole is modified when non-electrically connected elements (called "parasitic elements") are set up in conjunction with it. These take the form of rod conductors to match the dipole, but that mounted behind the dipole (the "reflector") is slightly longer and that (or those) mounted in front of the dipole (the "director") is slightly shorter than the dipole.

Aerial, Yagi

When directors and a reflector are used with a dipole the array is called a *Yagi aerial*, after the name of the engineer who discovered it. The Yagi aerial is shown in Fig. 2 and it forms the basis of almost all present day TV aerials.

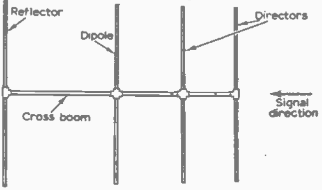


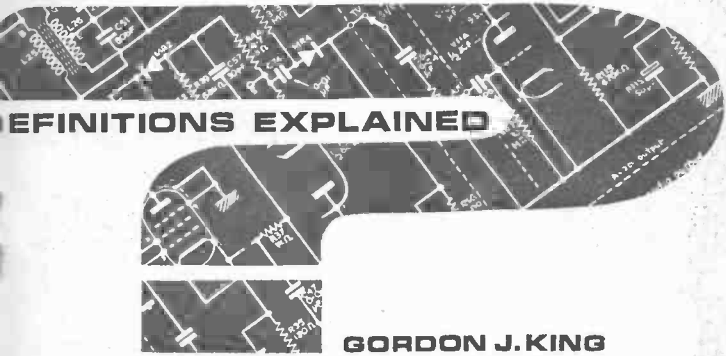
Fig. 2—The basic Yagi aerial. For reasons of matching, the dipole is sometimes "folded", but this does not affect its normal operation.

The basic lengths of the reflector and director(s) in feet are equal to 498 and 450 respectively divided by the signal frequency in Mc/s. With some designs the length of the directors diminishes at the rate of about 2% from the first director when that is calculated in length as above.

The reflector may be spaced by a quarter wavelength of the signal from the dipole and the director (and subsequent directors) by 0·128 wavelength. Specialised designs, however, may differ from these basic dimensions.

The addition of parasitic elements makes the aerial "unidirectional". This means that it has one favoured direction of signal pickup where its effective gain is somewhat above that of the dipole alone, as shown in Fig. 3. This pattern and those in Fig. 1 are called "polar diagrams" and they are very useful for determining the directivity, gain and rejection characteristics of an aerial.

The one aerial has to have a fairly flat response over the TV channel with which it is to be used. The 405-line channels in Bands I and III are 5



EFINITIONS EXPLAINED

GORDON J. KING

Mc/s wide, while the 625-line channels in Bands IV and V are 8Mc/s wide.

The intrinsic bandwidth of an aerial for use in Bands IV and V, however, has to be considerably greater than 8 Mc/s because eventually four channels in these bands will be in simultaneous use in each local area, embracing a bandwidth of at least 88 Mc/s. In some areas the four-channel groups will occupy a spectrum wider than the nominal 88 Mc/s.

Aerials for these ultra high-frequency (u.h.f.) bands are thus designed to cover a local group of four channels. Aerial makers have got together and have divided the u.h.f. channels into three groups "A", "B" and "C", covering channels 21 to 33, 39 to 51 and 53 to 65 respectively, and aerials are now made corresponding to these groups of channels. This, then means that the whole of Bands IV and V can be covered by just three aerials!

U.h.f. aerials, of course, have shorter elements than their very high-frequency counterparts. This permits the use of a larger number of elements, and sometimes fifteen or more directors are used. The reflector may also consist of several rods or a wire mesh of some kind; but no matter how many elements it comprises, the reflector system is considered as just a single element.

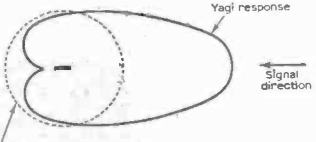


Fig. 3—The polar diagram of a Yagi aerial compared with that of a vertical dipole. Note the zero response to the rear of the aerial.

Aluminised

This term refers to a coating of aluminium that is deposited at the rear of the fluorescent screen of the picture tube. This coating does two things. It increases the effective forward brightness of the picture on the screen due to forward reflection and it minimises the possibility of an ion burn.

The technique has now been so well developed that modern tubes do not incorporate the old-type ion trap assembly and magnet round the neck.

An aluminised tube generally demands a greater e.h.t. (extra high-tension) voltage than a tube that does not incorporate the feature.

Array

This term is often applied to an aerial of the Yagi type when it is composed of a number of elements in addition to the dipole and when two or more complete aerials are coupled together. The description *aerial array* is then favoured.

Aspect Ratio

This describes the width-to-height ratio of the television picture as it appears on the screen and is 4:3. That is, four units of width to three units of height. Modern sets and pictures tube (and tube masks) are designed specifically to accommodate this ratio, corrective adjustment to it being made in conjunction with a test card by the width and height controls of the set. In some sets the width is fixed and the ratio is set by the height control. This may sometimes lead to under- or over-scanning, but this is not usually bothersome unless the set is defective.

The horizontal and vertical linearity (sometimes called " form ") controls are also adjusted at the same time to eliminate top, bottom or side expansion or compression of the picture and to obtain a picture of the most linear geometric proportions.

Asynchronous

This term applies to two or more happenings that are out of step with each other. Synchronous in TV parlance means " in step ". Asynchronous is particularly used to describe the condition which exists when the 50 c/s mains power supply differs very slightly in frequency from the field (frame) repetition frequency of the TV system.

The field repetition frequency of early 405-line transmissions was always " locked " or synchronised to the mains frequency, but there are times now when this is not done. 625-line and colour transmissions cannot be locked at exactly 50 c/s for various technical reasons. These transmissions are thus asynchronous.

Whether or not asynchronous operation affects the picture depends on the efficiency of the set's smoothing. If the hum voltage in the field timebase or the vision stages is above a low residual level it shows on a picture as horizontal bands of shading and an expansion-compression wave occurs vertically on the picture due to hum in the field timebase.

When the field frequency is locked to the hum, the hum band and wave effects are stationary on the screen and cannot normally be discerned. However, when there is a difference between the field and hum frequencies the hum band and wave tends to move up or down the picture at a rate corresponding to the difference between the two frequencies. Often this is less than one cycle, so the effects move slowly vertically on the picture, and can then be extremely disconcerting.

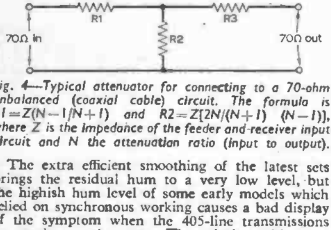


Fig. 4—Typical attenuator for connecting to a 70-ohm unbalanced (coaxial cable) circuit. The formula is $R1=Z(N-1/N+1)$ and $R2=Z[2N/(N+1)\ \ (N-1)]$, where Z is the impedance of the feeder and receiver input circuit and N the attenuation ratio (input to output).

The extra efficient smoothing of the latest sets brings the residual hum to a very low level, but the highish hum level of some early models which relied on synchronous working causes a bad display of the symptom when the 405-line transmissions are made asynchronous. The solution with these old models is to improve the h.t. smoothing either by additional, large value electrolytic capacitors or by the employment of an extra complete stage of filtering.

Attenuator

Television-wise, an attenuator is essentially a resistive network which is designed to be incorporated between the aerial feeder and the aerial socket of the TV set for reducing the strength of the signal fed from the aerial to the set.

In some of the older type sets an aerial signal of too greater strength, causes overloading and sound and vision interference troubles. An attenuator is useful for overcoming these difficulties. Modern sets, however, are less bothered by a very strong signal since their efficient sound and vision automatic gain-control (a.g.c.) systems cut down the sensitivity of the circuits when the signal level is high, thereby automatically reducing the effects of the overload.

Attenuators of the kind mentioned have to be specially designed so that correct impedance matching is retained both at the end of the feeder and at the aerial socket of the set. The circuit and details of a typical TV attenuator are given in Fig. 4.

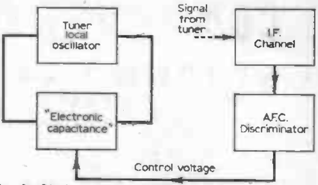


Fig. 5—Block diagram showing the elementary aspects of a.f.c.

Automatic Frequency Control (A.F.C.)

This term describes a system whereby the tuner is automatically adjusted accurately to the selected channel should there be a tendency for the tuning to drift away from the correct point. Normally, of course, the tuning is set manually for the best sound and vision and if there is a drift in the local oscillator this has to be corrected manually by the tuning control. When a set with a.f.c. is once tuned it " holds " to the signal automatically.

The system is not normally used in Great Britain on the 405-line channels, but some 625-line and dual standard models incorporate it on the u.h.f. channels. It is thus in part connected with the u.h.f. tuner. Basically, the system operates as follows:

A device, which varies up or down in capacitance as a control voltage applied to it varies, is connected across the tuner local oscillator. This, then, means that the tuning can be adjusted within the limits by increasing or decreasing the control voltage.

The control voltage is produced by a discriminator, which is something like an f.m. detector. The discriminator works relative to the set's i.f. channel. When the signal in the i.f. channel is of exactly the same frequency as the discriminator tuning no control voltage is produced. However, should the tuner's local oscillator drift up or down in frequency, the frequency of the signal in the i.f. channel will also change. This causes the discriminator to react and produce a plus or minus voltage, and it is this that is applied to the " electronic capacitance " device at the tuner's oscillator. The circuit and polarities are so arranged that the oscillator is brought back to the frequency that produces a signal of the correct frequency in the i.f. channel. A block diagram of the system is given in Fig. 5.

Part 2 follows next month.

COMPONENT-CAUSED ALIGNMENT FAULTS

HOW TO TRACE THOSE FAULTY COMPONENTS THAT CAUSE POOR DEFINITION AND SOUND TROUBLES

by G. R. Wilding

TV receivers very often display symptoms of incorrect alignment such as sound on vision or vice versa, poor definition, weak sound, or incorrect picture/sound balance, but unless the various trimmers and core slugs have definitely been re-adjusted, it is most likely that a faulty component or valve is the cause of the effects.

In practice, core settings drift very little indeed from the optimum positions set by the manufacturers during works alignment and should they move, or should circuit capacitances vary, it would probably have little noticeable effect since TV tuned circuits are so heavily damped and have such a wide response curve.

For instance, that most common and annoying of alignment defects, sound on vision, can be caused by a variety of component faults, as well as by over advancing any pre-set sensitivity control and employing an aerial providing too much gain or which unduly favours the sound channel by unusual siting difficulties.

Receiver defects

Receiver defects can be listed as follows in order of probability:

1. Loose paxolin fine tuner in the older pattern 13 channel tuners, which either completely prevents correct setting or else slowly drifts away from optimum as the set warms up.
2. O/C a.g.c. feed resistors, s/c a.g.c. decoupling capacitors and s/c cathode bypass capacitors to the r.f. or common first i.f. stage which then causes these stages to work at full gain even on a very strong signal, so that the subsequent vision i.f. stage cannot eliminate the sound frequencies.
3. Valves in these stages which develop grid current to dampen the tuning circuits and both widen and change the overall response curve.
4. Reduction in the value of the fixed trimmers shunted across the sound rejector coil in the video amplifiers cathode lead, thus restricting its frequency range or even putting it right out of effective use.

Faults 1, 2 and 3 are almost equally applicable to symptoms of vision on sound, and in fact the effect produced by these defects whether S on V or V on S, depends almost completely on the relative gain and selectivity of the separate vision and sound i.f. strips.

Sound i.f. selectivity

As the selectivity of the sound i.f. stages is so much higher than that of the vision i.f. stages, and because viewers tolerate V on S buzz much more than they will S on V picture shimmering, complaints due to these faults invariably refer to vision effects.

However, the characteristic vision on sound buzz can often be caused by an internal leak or heavy grid current in the sound-only i.f. amplifier, especially if it is of the diode/pentode EBF89 variety, flattening the associated tuned circuits response wide enough to include some of the extreme vision frequencies.

Indeed more than one experienced TV engineer has repeatedly tried to "tune out" the offending vision buzz completely to no avail when replacement of the EBF89 valve completely cleaned up the sound response.

Frame buzz

Some older Sobell and GEC models tended to pick up some "frame (field) buzz" if the wiring or components in the early stages of the a.f. section were displaced, and care must always be taken to ensure that complaints of vision on sound are not 50 cycle pick-up from the frame output transformer getting to the a.f. triode grid or an unearthed volume control case.

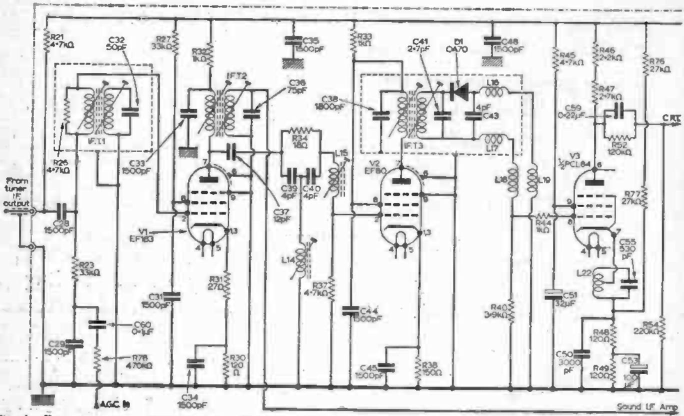


Fig. 1—Typical common-i.f./vision-i.f. and video amplifier stages showing those components whose failure can closely simulate mis-alignment (G.E.C.—Sobell).
S/C in C29, C60 or o/c R23 and R78 will remove a.g.c. bias to V1 and unduly widen response curve by over-running valve on strong inputs.
O/C C32, C36 or C41 fixed i.f. trimmers will widely mis-tune their coils.
O/C C31, C33, C38 or C44 anode and screen decouplers can cause instability 'ringing' and loss of gain.
O/C C39 or C40 sound rejector fixed trimmers will ruin effective sound rejection.
O/C in C50 or C53 V3 cathode decouplers will impair h.f. video response.
O/C C55 3·5 Mc/s rejector fixed trimmer will prevent 'dot' suppression.
O/C C59, c.r.t. video feed capacitor will ruin h.f. and m.f. video response.
S/C in C34 or C45, V1 and V2 cathode by-pass capacitors will remove standing bias from valves, cause degree of mis-tuning and considerable over-loading on strong signals, especially on V2.
O/C or dry-jointed ***R26****, T1 damping resistor will narrow frequency response of common i.f. stage and may cause 'ringing'.*
O/C C43, i.f. filtering capacitor will cause background patterning.

Similarly some complaints of sound on vision are really due to a microphonic vision valve being subject to speaker output. The surest test is to observe if the effect vanishes when volume is reduced to zero, although it has been known for a reduced capacity a.f. decoupling capacitor to simulate this effect very closely, and which, of course, will also reduce as volume is reduced.

In such instances the paralleling of a medium value electrolytic across a suspect will always clear it up.

Volumes can be written on the subject of poor picture definition but the causes of inferior results attributable to component defects simulating faulty alignment can be narrowed down to the following:

1. R.F. and particularly i.f. decoupling capacitors going open circuit or becoming dry-jointed and causing circuit mis-tuning, mild instability and loss of gain with "ringing" producing the most disturbing picture defects.
2. Dry-jointed damping resistors connected across i.f. transformer windings causing peaking at some video frequencies with an overall reduction in the band-width.
3. Open circuit or dry-jointed fixed trimmers across i.f. transformers, causing mis-tuning.
4. Open circuit or dry-jointed i.f. filtering capacitors in the video detector stage. These are always of particularly small value, about 5pF is a common figure, so that the slightest loss is important. Symptoms are background patterning and a slight tendency to instability.
5. Loss of focus. It is impossible to reproduce the 3Mc/s gratings if c.r.t. spot size exceeds or even approaches grating line width, and as focus is directly dependent on e.h.t. this raises the entire line output stage. However, in practice a material reduction in e.h.t. would be accompanied by other symptoms such as reduced picture width and possibly raster cramping.
6. Faulty tube. This could take a much heavier beam current than normal, to pull down e.h.t. and thus indirectly cause de-focussing, or it

could develop a heater/cathode leak to capacatively load the video amplifier and thereby reduce its h.f. response. Internal leaks in the tube, from one electrode to another, possibly inhibiting peak whites, or preventing complete beam cut-off and thereby giving all blacks a "milky" appearance, could not be interrupted as mis-alignment so are not our concern here.

7. Wrongly biased or low emission video amplifier valve. Here again the effect produced on picture quality is not one that can directly be confused with mis-alignment, since it mainly deteriorates tonal quality and gain.
   However, the loss of contrast and poor picture gradation from black to peak white, often induces the viewer to increase contrast and sensitivity control settings to the maximum to restore good reception, but which only succeeds in introducing grain and S on V, worsening results.
8. O/C compensating chokes. Most manufacturers who use miniature chokes in video output stages to resonate with the stray circuit capacitances and thus boost the h.f. video response place the choke in series with the main resistive load, but Philips, for example, place them in parallel. This means that if it goes o/c it will not completely kill the picture, but produce precisely the kind of reception associated with i.f. circuits not correctly staggered.
9. Open circuit, dry-jointed or leaky cathode bypass capacitors to the video amplifier.
10. Component value changes in the sync separator or video amplifier circuits resulting in "pulling on whites" and test card "cogging", in a precisely similar manner to that produced by an inadequate i.f. response curve.

It will be seen then, that there can be very many causes of apparent mis-alignment being produced by faulty components.

Then there are the unusual or freak causes, such as an unearthed or badly earthed outer braid on the short lengths of coaxial linking the tuner to the first i.f. amplifier, the badly earthed screening can or faulty i.f. pentode producing mild instability and ruining good resolution, video anode load resistors with a marked rise in value, the fitting of incorrect valves, i.e., vari-mu EF85 types in place of EF80's and vice versa, and mistakes in replacing burned-out components or mis-reading resistor coding in previous repairs.

Re-alignment

However, if it is pretty obvious that some of the coil slugs have been twirled and that some degree of re-alignment is essential to restore good resolution with complete freedom from side effects, the question arises, "can re-alignment be carried out effectively without a signal generator and maker's instructions, purely on the test card?".

The answer is "Yes, if receiver alignment is not too far out to begin with, and if certain rules are strictly adhered to".

In fact most service workshops very rarely indeed use the naturally rather involved official alignment procedure to restore minor trimming defects, and with care absolutely first class results can be acheived.

In the following issue we will describe in detail this workshop system and the essential rules that must be followed.

But in case you wish to prepare for tackling a re-alignment job now, try and obtain a copy of the relative service manual indicating coil and trimmer function, a plastic or aluminium trimming tool (knitting needle), checked to have a blade width no greater than that of the core slots and really sharp, replacement cores for any with damaged heads, plus one or two needles to remove any hardened locking compound from coil former threads.

Some i.f.t. cores now have a through hexagonal holes for adjustment purposes, in which case the appropriately shaped tool must be obtained or made from plastic or a sliver of hardwood.

These special little tools are extremely hard to find and we unfortunately cannot name any certain source.

It is essential that all tuner and i.f. valves are fully up to standard otherwise their reduced amplification may prevent perfect alignment by giving the impression that wide band-width sacrifices too much contrast.

Further, all valve pins and turret contacts must be clean so that contrast stays constant.

Finally a good aerial is essential. Although window-rod and set-top varieties are quite adequate in good signal strength areas, they are rarely good enough for alignment purposes since they may well have an unbalanced sound/vision sensitivity, Band I/III gain discrepancies or a restricted band-width.

Check these items and next month we shall describe trimming by test card. ■

DX-TV

A MONTHLY FEATURE FOR DX ENTHUSIASTS

by Charles Rafarel

LAST month the news was good, but it seems that I spoke too soon. The "depression" has come back again, and there is nothing remarkable to report. Poor reception has been widespread.

There have been some erratic short duration openings to USSR, and Czechslovakia throughout the past month, but nothing that could really be called an "opening" for Sporadic E.

The Tropospherics in this area have been generally poor on all bands, the best period being early February, with some improvement being noticed after the 17th, particularly on u.h.f.

By the time you read these words in March we should be getting near the usual early Sporadic E openings, and I hope that we will all be well satisfied!

NEWS

As mentioned last month, my wife and I have been over to Paris to hand over the old 30-line TV (circa 1932) for permanent inclusion in O.R.T.F.'s museum of the history of Radio and Television. (See page 307.) The visit was preceded by an interview on BBC South, which you may have seen, during which "the old bacon-slicer" was shown, and I gave a short description of it.

Our O.R.T.F. visit was a tremendous success, and we were treated like V.I.P.'s with conducted tours complete with hostess and luxury transport around all the studios at Quay Kennedy, and Buttes Chaumont. The Radio and TV centre is just out of this world, and the studios at Buttes Chaumont, for TV only, are vast, they were once the old Gaumont film sets!

O.R.T.F. were really delighted with the old Baird TV and it is going to repose in a place of honour alongside its Bélin counterpart of the same era, and these two TV receivers will be the oldest on show.

We are due back again in Paris for the official opening of the museum in early April, with a possible appearance on French TV.

As promised I now have the following French second chain u.h.f. news, and the list below is complete for stations now in operation, but more will be opening this year, the list applies to high power transmitters only:—

Mulhouse	Ch21	Nantes	Ch29
Pic du Midi	Ch21	Rouen	Ch33*
Paris	Ch22	Metz	Ch34
Marseilles	Ch23	Lyon Mt. Pilat	Ch40
Troyes	Ch24	Le Havre	Ch43
Caen	Ch25	Limoges	Ch50
Lille	Ch27	Strasburg	Ch56
Clermont-Ferrand	Ch28		

*Provisional low power to be increased soon.

You will see from the above that Brest Roc Tredudon CH21 is *not* yet in service, and this accounts for some "frustrated" West Country u.h.f. DXers not being able to raise it! Brest and Rennes CH45 will go into service shortly, and these will be "possibles", at least in the South of England. More news, for which we are indebted once again to R. Bunney of Romsey: —

(1) N.R.K. Norway has a new transmitter at at Stiegen on E2.
(2) The Canary Islands are reputed to now have transmitters on E3 and E4 (if so, both are "possibles" here).
(3) N.T.S. Smilde Holland is now operational u.h.f. on Ch43.
(4) Morocco now has a TV station operating at Zerhoun, near Fez, on ChM4, this is E4 channel, and it could be an "exotic" one for us this year under good conditions.

READERS' REPORTS

D. J. Mountjoy of Gloucester, has added to his score with Poland Bydgoszcz on R1, and probably Norway on E2.

K. Rowe of St. Helens, Lancs., has logged Sweden, Portugal, Spain, and Italy, via Sporadic E, and France via Tropospheric reception. He has also had the Telefis Eireann type test card but without words, but as this cannot be Eire I feel that it must be Yugoslavia. Have DX readers any comment to make, as Yugoslavia is probably using this type of card.

P. Hocking, who now lives at Redruth, Cornwall, has started DX in his new location with reception of Cherbourg F12, and he has already got converted to 625 with success via sporadic E.

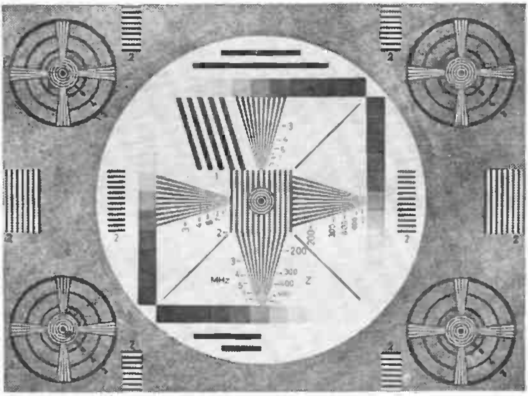
LATE NEWS

Our old friend Ian Beckett married on 19/2/66, and we and two other DXers (Roger Bunney, of Romsey, and Roy Allen of Bristol) were guests at the wedding at Gawcott, near Buckingham. The bride was Miss Jennifer Jones, who is a successful DXer in her own right, with a long list of successes to her credit! Congratulations, and we look forward to news of their combined DX successes in the future!

CONVERSION

Would readers, when requesting information on set conversions, include the appropriate Service Sheet in order that I may advise them with the minimum delay, as suggested in our January 1966 issue.

DATA PANEL-8 **AUSTRIA O.R.F.**



(courtesey M. Alsbery)

Test Card—As above. Note that this is identical to that of West Germany, except that there is no lettering at the bottom.

Channels—Austria operates on two channels in Band I, as follows: **E2a**, Jauerling St. Polten (near Vienna). E2a is the same vision frequency as R1, but the sound is on 55.25 and not 56.25 Mc/s as for R1. E4, Patscherkopfl, near Innsbruck.

The first of these stations is well received here and the other one often comes in well although it is of comparatively low power.

Times—Test card times are 10.00 to 19.00 GMT daily, unless special programmes are being transmitted. Programme times are approximately 19.00 to 21.00 GMT daily.

COLOUR TELEVISION AT THE IDEAL HOME EXHIBITION

YEARS of research by Baird Television Limited at Bradford, culminated in a grand show at Olympia (March 1—26) when continuous daily demonstrations of colour television were given from the Radio Rentals stand No. 225.

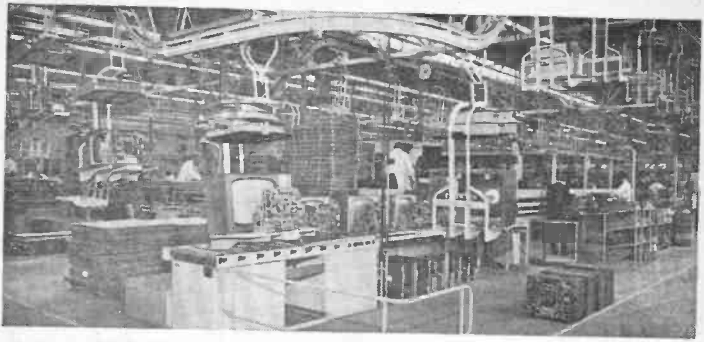
The studio that Baird Ltd. built for Radio Rentals contained the lighting, colour cameras and microphones. Three floors above the studio, a control room for processing the signals from the cameras and microphones was built.

Visitors were able to see for themselves the superiority of colour television over black and white. They saw a scene being televised, and its reproducion on a number of sets at the same time.

In order that such comparisons could be made, a great deal of accurate design work had to be done, as producing an acceptable colour picture is a much more difficult task than producing a black and white picture. This is because in black and white television, only one picture at a time is seen and errors of contrast and brightness are not too important. However, a colour television picture is made up of three superimposed pictures of red, green and blue light and these colours are then mixed to produce any colour desired.

If there is any error in any one of these pictures, the balance of colour in the scene will be disturbed and the more delicate colours, like flesh tones will be reproduced wrongly.

This was the first time that the public were able to see British colour television on sets of the sort which will be available for rental or purchase. Recent estimates have put the probable cost at about 30s. per week rental, or £200 for the purchase of a colour receiver.



MEET THE SETMAKERS

PART 3: DESIGNING A NEW TV

P. WESTLAND

WE have now reached the stage where a complete specification of all our new models of TV receiver has been recorded on paper. In some cases it will exist as a single document, whilst in others it will be incorporated in the minutes of a number of different meetings. True, we didn't have space to list all the details last month, but let us assume that everyone in the design department knows what is required.

The man who is most conscious of this is the chief engineer. He has promised, in effect, to produce a satisfactory design of chassis, and a large number of different styling presentations, by a certain date. If he fails, even by a week or two, the whole sales programme will be thrown completely out of gear because the new receivers will not be in the stores in time to hit the big selling peak in the early autumn. These designs *must* be completed on time—whatever the difficulties.

So far almost everything that we have discussed has had at least some engineering content, although the context of the various matters has been commercial. Now we move on to the realm of almost pure engineering, where the commercial angle merely provides the ever present background.

What is Engineering?

If you tell somebody that you are an electrical engineer they look blank for a moment, then they brighten slightly, and it is obvious that they are thinking of the man around the corner who installed their power point. If you are lucky, you are regarded as the man who mended their telly. Now both of these are valuable and worthwhile occupations, but they are not true engineering in the professional sense.

The engineer has been defined as the man who can turn out for half-a-crown what any fool could only turn out for five bob. True: but there is much more to it than this.

The engineer is a person who can interpret a customer's requirements so that he knows what is wanted better than the customer himself. He then produces a design which does exactly what the customer wants, at the lowest possible production cost; or alternatively strikes the best compromise between performance (in its widest sense) and price. The design of a power station typifies the first approach, whilst designing a TV is an example of the other. All the time the engineer is asking himself "*exactly what does this have to do?*" and having declared this, "*how can it be made at the lowest possible price?*".

Incidentally, it should not be thought that an engineer thinks only in functional terms. If the product has to have a nice appearance, such as a TV set, the engineer will co-operate wit hthe stylist, and make any necessary provision to cater for the stylist's requirements. The two parties work together as a team.

Independent Activities

Our design department has the task of producing a package with a good electrical performance, a sturdy mechanical construction, and clothed with a cabinet of pleasing appearance. All three activities are closely interdependent, and it is a moot point as to which are the chickens and which are the eggs.

Probably the starting point is electrical. The engineers already have a pretty good idea of what they intend to do based on past experience, and the results of the design studies that they have already carried out. Accordingly they are able to give the mechanical designers a list of the major assemblies that will have to be housed in the cabinet, together with dimensions, or samples, and any restrictions on location based on electrical or heat requirements.

For instance, the electrical engineers will specify the area of printed board that will be needed, and will quote preferred shapes based on circuit layout considerations. They will also pass on information about the number of system switch functions, and perhaps the spacing or overall length. They will probably say that the printed board containing the i.f. circuits should be close to the tuners, and that the timebase circuits should be close to the line transformer. They will also describe the size, clearances, contents and screening requirements of the line transformer, and will request that it is placed well clear of the tuners to prevent pick-up of spurious oscillations which could become modulated on to the signal.

Field transformers, h.t. chokes, and speaker transformers must not be placed too close to the deflection coils or the c.r.t., and there are also the problems of heat to be borne in mind. Any electrolytic capacitors not mounted on printed boards should be placed in a cool part of the cabinet—generally near the bottom—in order to prolong their life. Tuners should also be mounted in the lower half of the cabinet in order to avoid any unnecessary frequency drift caused by external heat. Mains droppers provide a problem because they need to be placed in a good cool airstream, and the resulting hot air current must not impinge on any other assemblies susceptible to heat.

Co-ordinating the Design

Armed with all these details, and others too numerous to list here, the mechanical designers begin to dream up a chassis configuration that will not only house all the bits and pieces in the appropriate places, but will also fit into the smallest cabinet of the range that has been specified. Close liaison with the styling department is essential at this stage in order to ensure that all controls, etc., come out in the right places; that provision is made for alternative layouts, and that the proportions of the smallest cabinet contemplated are not spoilt by the chassis being either too tall or too wide.

Whilst all this has been going on the stylists, who are well aware of the outline electrical and mechanical design, have consolidated their ideas in the form of styling sketches and have shown them to the sales manager. Styles which have been approved in principle are then translated into mock-up styling models, based on the mechanical design as it exists at that time. From now on all three activities—electrical, mechanical, and styling—have to converge into a series of completely integrated designs which are in strict accordance with the specification previously agreed. They also have to be completed by certain dates if production is to start on time.

It is clear that all three activities are interwoven, and none can progress independently of the others. However, in order to prevent our story becoming hopelessly complicated we will take a look at each in turn.

The Electrical Design

Since our new design of chassis is going to be used in a number of models which form the basis of the whole sales programme, it does not incorporate fundamentally new techniques such as would be needed for small portable or colour receivers. Instead it will follow a process of evolution whereby it uses the best aspects of the current design, together with improvements and modifications which will bring it into line with the new requirements.

During the specification stage the electrical engineers carried out a number of design studies to establish the feasibility of some of the commercial requirements. They will also have made studies of their own concerning some of the circuit problems that they knew would arise, and have investigated the production implications of any new techniques proposed.

A Typical Design Study

Let us take as an example, the proposal to increase the e.h.t. from, say, the unstabilised 15kV of the current design to a stabilised 18kV. In other words, on a normal picture the actual operating voltage will be increased from 14 to 17½kV with a corresponding improvement in picture brightness, spot size, and deflection defocussing. A brighter, sharper picture. The engineers will start by posing to themselves the following questions:—

1. *How much extra will it cost?*
2. *Will the improvements to the picture be worth while to the customer?*
3. *Can the reliability be made at least as good as in the current design?*
4. *Can the line transformer be made safe from any risk of fire?*
5. *Can it be made small enough to fit into the space available?*
6. *Can the line timebase (interference) radiation be kept small enough to comply with BS905, and is there any likelihood of X-radiation exceeding the limits specified in BS415?*
7. *What new circuitry, core material, winding techniques, potting and impregnating materials will be required?*
8. *What implications will all this have on the design of the rest of the receiver?*
9. *Can the factory make the new line transformer to the high standards needed, despite the requirements of high speed mass production conditions?*

At this stage the engineers are not actually designing the circuitry because they have not got the time. Answers are needed quickly. Instead they carry out a series of calculations, experiments, and discussions with the factory to enable them to assess the situation, with all its problems, and give answers with the knowledge that they are sufficiently accurate to form the basis of a policy decision.

Having discussed matters in detail with his staff, the chief engineer may well tell the sales manager "*No, the present state of the art is not sufficiently advanced, and in our considered opinion we would not be justified in taking this step at present. Both the costs and the risks are too great*"—or words to that effect. Alternatively he may say, "*Yes, we can see our way clear to engineer 18kV properly, but it will cost you X shillings more*".

Whatever the outcome of the design study, and we will assume in this case that it was favourable, a demonstration will probably have been laid on to illustrate the effect of the higher e.h.t. An engineer will have been given the job of choosing two c.r.t.'s of equal phosphor colour and performance and of providing the necessary drive voltage and e.h.t. A group of engineers and top brass will then gather round and discuss the results. Everyone is agreed (for once!). There is no doubt about a worthwhile improvement.

A Typical Design

Meanwhile another engineer has been doing some calculations. Since the required line scan current is proportional to the e.h.t. it is comparatively simple to calculate in outline the increase in drive current that the line output valve and boost diode will have to provide. This will be further increased under limit conditions by the addition of the e.h.t. stabilising circuit.

From this it appears that the existing boost diode of the receiver in current production can be retained, but a larger line output valve will be needed. The drive waveform from the oscillator will need to be altered in size and shape and circuit changes are called for in addition to adding the stabilisation set work. All this information is fed to the estimators.

E.H.T. Inductor

Whilst this has been going on the coil winding experts have come to the conclusion that a core with a larger window is needed and that the overwind will have to be potted in a special resin. They have also drawn up in outline the probable winding details with regard to wire gauges, insulation, taps, sleeving, etc., and all this information, too, has been sent to the estimators.

Yet another engineer has decided that the same field output valve can be used but with a more efficient output transformer to give the bigger scan current needed by the higher e.h.t. More pieces of paper appear on the estimator's desk. Whilst he is busy working out how much more the new circuitry will cost compared with the existing one, taking into account labour costs, tooling costs, preparation costs, test gear and factory overheads, we will return to some of the other problems.

Insulating 18kV

If you ask a power engineer how much clearance to allow for 18kV he will give you an answer in feet. If you ask a TV engineer he will say about an inch. Lucky, isn't it, otherwise you would not have a TV on your table! The answer lies in the amount of power involved, the short distance it has to be conveyed and in the specialised winding and impregnating techniques used.

The TV engineers of our story say yes, they can just find enough space in the cabinet for the higher e.h.t. by using a potted overwind. Discussions with the factory bring out a few points of difficulty but in general the OK is given. The works doctor agrees that there will be no danger to the operators' health in using the new organic resin. (You hadn't thought of that had you?)

Safety and Reliability

These points are taken care of by the continuous background of development that goes on all the time. Experience of present and past designs ensure that mistakes or inadequacies are not repeated and the potted overwind should, in fact, help to make the new design better than the old.

The doubt about X-radiation is removed both by actual test measurements and by reference to the valve manufacturers. There is no danger.

The Circuit Diagram

A typical full-scale design study has been described in detail because it represents true engineering in nearly all its aspects, it illustrates the normal process of design and it forms the basis of some of the new bits of circuitry that will be incorporated in our TV-to-be. Other design studies about such things as power supplies, improved sync separators and noise limiters will also have been carried out and in most cases the individual designs will be complete.

With the results of all these studies to hand and armed with the corporate experience of the whole TV development lab. it is possible to draw up a circuit diagram and parts list of the complete receiver. At later stages the circuit will be modified in detail to introduce improvements but on the whole the changes are only minor ones. A parts list is also drawn up, but here the area of uncertainty is bigger because not all the component values are known accurately yet.

A Parts List

This document lists every electrical component used in the receiver and specifies the part number that identifies it, together with working voltage, power rating, value, tolerance, temperature coefficient, etc., as appropriate. It is largely the careful choice of component to suit each particular application that determines the reliability of the receiver.

In addition it is essential to ensure that the component ratings are never exceeded. We shall see later just how much care is taken in this respect of the design process.

Designing the Printed Boards

By this time the electrical and mechanical designeds have agreed upon the exact size and shape of boards to be used. This enables the design of the printed circuit layout to go ahead. It is really a very sophisticated form of jigsaw puzzle with the following set of rules taking the place of the simple interlocking shapes so well remembered from our childhood.

1. **Electrical clearances.** *Sufficient clearance must be provided between adjacent copper conductors to provide adequate insulation at the voltages concerned. If silk screen printing is used, allowance must be made for stretching of the screen during use. Minimum clearances will usually be 1/16in. thick.*
2. **Mechanical clearances.** *Components such as present potentiometers may have to be located in certain positions to provide access through the back cover. Bulky items such as electrolytics and coil cans are restricted to certain areas because of inadequate clearances overhead.*
3. **Heat.** *Hot components such as valves and wire-wound resistors must be placed where they will not cause overheating of adjacent components. Precautions must also be taken to prevent the board itself from getting too hot. Temperature sensitive circuits such as line oscillators will have to be placed in cool positions to reduce frequency drift.*
4. **Stray couplings.** *The field oscillator must be placed well clear of the line timebase and deflection coils to prevent the pick-up of line pulses which might cause poor interlace. Similarly a.f. circuits must not pick up field pulses because of hum problems.*
5. **Terminations.** *Connecting leads should preferably be terminated near the edge of the board and close to the other circuit concerned.*
6. **Cost.** *Components should be packed close together to save costly board space. In some cases it will pay to specify a more expensive miniature component rather than a cheap bulky one.*

The Circuit Diagram

These and many other considerations have to be borne in mind before the layout can be started. Often the location of major components and complete items of circuitry settle themselves and then challenge you to connect them up. All in all it can be quite a time-consuming struggle between the intractable, inanimate, components and the artist and the contest sways back and forth.

The Mechanical Design

Whilst the printed board layout is being designed the mechanical engineers are busy consolidating the overall structure of the receiver. The basic requirements have long since been made known and a general line of approach has been decided upon.

Obviously there are a number of different ways of packing all the bits and pieces of a television receiver into a cabinet and no particular one can always be said to be the best. What the engineer is trying to achieve is not a unique solution to the problem but a completely integrated design that fulfils all requirements.

He must design a cheap, sturdy structure that will fit into the smallest cabinet of the range; that meets the electrical requirements; that provides good access for serving and yet provides complete freedom of action to the stylists within their agreed brief. He spends most of his time integrating all the detailed build-up of the structure rather than dreaming of grandiose schemes on his drawing board.

In a perfect world the mechanical engineer would complete the internal chassis design and control panel assemblies first and would draw up the moulded back cover and any plastic cabinet mouldings afterwards. In practice, however, the engineer has to finalise these items at an early stage, long before he has completed the whole design, because of the length of time needed to get the moulding tools made and proved.

This is where skill and experience pay off because it enables the engineer to make a big leap ahead in the design and then to retrace his steps without finding numerous pitfalls awaiting him. An added difficulty is that the general shape of the mouldings will have been decided by the stylist, but it is the responsibility of the engineer to ensure that they are practicable and to co-ordinate all the internal details.

When the mechanical design is nearing completion some hand-made models of the chassis will have to be ordered from the departments' model shop so that the electrical engineers can assemble the printed panels into their first prototype receiver, together with all the rest of the circuitry. Whilst we are waiting for the complete prototype to appear we will take the opportunity to consider problems of styling.

Styling a TV

Styling is such a subjective matter, depending upon individual tastes and preferences, that it is difficult for anyone who is not a stylist himself to talk intelligently about it or to analyse the features that make a particular presentation either pleasing or displeasing. Why is it, for example, that most styles popular today will look drab or old-fashioned tomorrow, whilst the occasional exception will still look nice in ten years' time?

Speaking as one with experience of styling but who is not a stylist himself and is therefore open to correction there seem to be certain basic rules that apply to any mass market. Remember that we are styling for thousands of people from all walks of life and not just you or I.

In the first place you must not climb too far out on a limb and produce a style that differs too much from your competitors and is out of context with contemporary taste. People like something a little different but will be scared off by anything too far outside their aesthetic experience. This then is the first clue to use as a starting point. The next point is that most people like a TV to have a harmonious appearance rather than a styling presentation with strong contrasts of tone or colour. In other words, avoid too much black and white or bold, dominant colours such as bright blues or reds. The larger the area the softer the colouring.

Texture and Contrast

Also a large area all one colour is dull, so a pleasing surface texture or subdued pattern must be introduced to relieve the monotony. Subtle changes of colour which are in themselves quite ordinary, allied to pleasant contrasts of texture, form a good basis for a styling presentation. However, these are not enough on their own, in fact they would look too subdued.

Somewhere there must be discreet areas of high contrast to act as a foil to the rest of the colouring and to provide visual impact or styling "lift". Bright metal trim is the easy answer (and therefore nearly always overdone) or the knobs can be silver or gold or the cabinet can be burnished to a high gloss. Sometimes a single bright emblem can be sufficiently eye-catching and at the same time fill an empty space.

Proportion

One of the most basic points of all, of course, is cabinet proportion. It must not be too long or too square. Not quite so obvious is the critical size of the space between the c.r.t. and the edge of the cabinet. This must be very carefully balanced.

Having mentioned the importance of harmonious styling it should be noted that the occasional model with a contrasting appearance of black, white and silver, for example, may well score a hit with a minority of the market who want something different. It is the old business of a love or hate relationship.

The Mechanical Design

To revert to our earlier questions, the manufacturer who suddenly introduces a new colour of trim, such as copper instead of the everlasting silver and gold, or who brings out a rash of glittering knobs, is likely to win an immediate response. Here today but, unfortunately, gone tomorrow, so to speak. On the other hand, styling that depends upon good proportions, simple pleasing shapes, harmonious colours and textures and the discreet use of bright trim may well pass the ten-year test, even if the market response at the time is not quite so impressive.

By now the styling department will have submitted a whole range of styling presentations to the sales manager for his approval, who in turn will discuss them with his staff and probably also with the top management. Consciously or unconsciously the final choice will probably depend quite largely upon matters that we have just been discussing.

The First Prototype

One of the electrical engineers has just finished assembling the first prototype receiver. The great moment has come. Contact! Nothing happens!

An anti-climax, isn't it, but it can be guaranteed every time! It simply serves to show that the design has still to be proved.

PART 4 follows next month

LC PICO METER —*continued from page 298*

COMPONENTS LIST

- A1 + L1: Standard medium-wave transistor radio ferrite rod aerial (approx. 7in. long × ⅜in. diam., with m.w. winding tapped near one end). Size is in no way critical.
- P1 : 4-way tagstrip.
- P2, P3 : Combination screw terminals, insulated.
- R1 : 100kΩ ½w carbon, ±20% (see text).
- S1 : QMB toggle switch, double-pole change-over (dpdt).
- VC1 : Instrument-quality tuning capacitor (high stability) preferably ceramic/air. Single gang, approx. 500pF max, linear.
- Desk-type bakelite or plastic case.
- 5in. slow-motion dial (5:1 or 10:1) with perspex vernier pointer and control knob.

Standard Capacitors:

A set of at least 10, preferably 20, small capacitors, values distributed from 1pF to 500pF (see text).

Any type for r.f. (mica, ceramic, polystyrene, etc.) 500V working.

AS ACCURATE AS POSSIBLE: preferably ±1% (used only for scale calibration; not built into unit).

until the exact resonance point (deepest dip) is found. The unknown capacitance is then disconnected, and without changing the dipper tuning, the picometer dial is turned up until exact resonance is restored. The value of the unknown capacitance can then be read off directly on the capacitance scale.

The principle of the method is obvious. The capacitance loss when C_x is disconnected after establishing resonance is replaced by a corresponding calibrated *change* of VC1 to restore resonance. The reading is exact, in that it is not in any way disturbed by the C_0 components, e.g. by the self-capacitance of the ferrite rod coil or circuit strays. Thus there is no fundamental limitation to the smallest capacitance values which may be measured in this manner. Any value which still gives an observable shift of the dip can be measured, which allows reasonably accurate measurements down to a small fraction of 1pF if proper attention has been given to the absorption factor as already described. Hand capacitance effects sometimes cause aberration below about 0·5pF.

To be continued

TRADE NEWS • TRADE NEWS • TRADE NEWS TRADE NEWS • TRADE NEWS • TRADE NEWS

NEW CCTV SYSTEM

A NEW solid-state closed circuit television system capable of many applications which has been developed by EMI Electronics Ltd., of Hayes, Middlesex, UK can be used with any one of three different cameras, including one of the smallest in the world. These cameras, specially designed for the system, operate with modular power and control units which are considerably smaller than any others with similar functions now available.

E.M.I. Type 9 CCTV camera.

Known as **Type 9**, the system enables combinations to suit individual requirements to be built up and these can be extended at any time to include extra cameras, monitors and accessories for either manual or remote control. High-quality pictures are given in normal room lighting conditions and special or additional lighting is seldom needed. Attachments for the remote control of focus, lens aperture (iris), zoom and lens changing are available as standard accessories. Remotely controlled pan and tilt heads can control camera movement and special camera enclosures have been designed for use in wet, dusty or explosive conditions. With camera selectors and switching units one camera can feed many monitors at once or singly. All operational controls may be switched through to the picture monitor, enabling the entire system to be controlled from a central viewing position. Printed circuit construction is used and all sub-units and printed circuit cards are easily unplugged from the main frames for servicing. Should a failure occur a new sub-unit or circuit card can be inserted in a few seconds.

NEW TV FROM K-B

THE new KV006 19in. model is additional to the successful KV005 and KV105 in KB's low-cost sale or rental range. It has a gold anodised fascia and is fitted with a transistorised u.h.f. tuner.

Prices are 57½ guineas or 65 guineas with u.h.f. tuner.

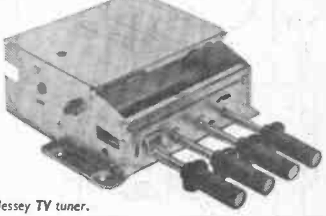
The K-B KV006.

PLESSEY PUSH-BUTTON TV TUNER

THIS new transistorised push-button quarter wave TV tuner from the Plessey Components Group was exhibited for the first time at the 1966 Paris Components Show. Construction is unique, with the push-button mechanism directly operating a 60° tuning capacitor, thus elminating the conventional intermediate mechanism and resulting in an exceptionally compact unit with low button pressure. Each button will tune any channel in the u.h.f. band.

The tuner can be supplied with 300Ω balanced aerial input or with 75Ω unbalanced aerial circuit for UK use.

Frequency range is 470Mc/s to 860Mc/s and supplies are available from the Group's Electromechanical Division, at New Lane, Havant, Hampshire.



Plessey TV tuner.

OSCILLOSCOPE BROCHURE FROM E.M.I.

A NEW brochure describing the E.M.I. solid-state oscilloscope 101 has been issued by E.M.I. Electronics Ltd.

Copies of the brochure can be obtained from Publicity Department, EMI Electronics Limited, Hayes, Middlesex.

Servicing TELEVISION Receivers

No. 123 Defiant 9A30 and associated Pageant models

by L. Lawry-Johns

DEFIANT and Pageant receivers are made by the Co-operative Wholesale Society Ltd., for sale through the various branches of the movement throughout the country. The 9A30 is representative of quite a large range of models and these notes in many respects will be found applicable to quite a few receivers not mentioned in the text including the Defiant 7A21 and Pageant 7P20 provided a little prudence is used in recognising the differences where they occur. The 9A30 uses a 19in. CME 1901 110° tube, and is designed to receive Bands I and III on 405 lines. The design is attractive and makes for easy servicing. There are two vertical chassis, one either side of the tube and

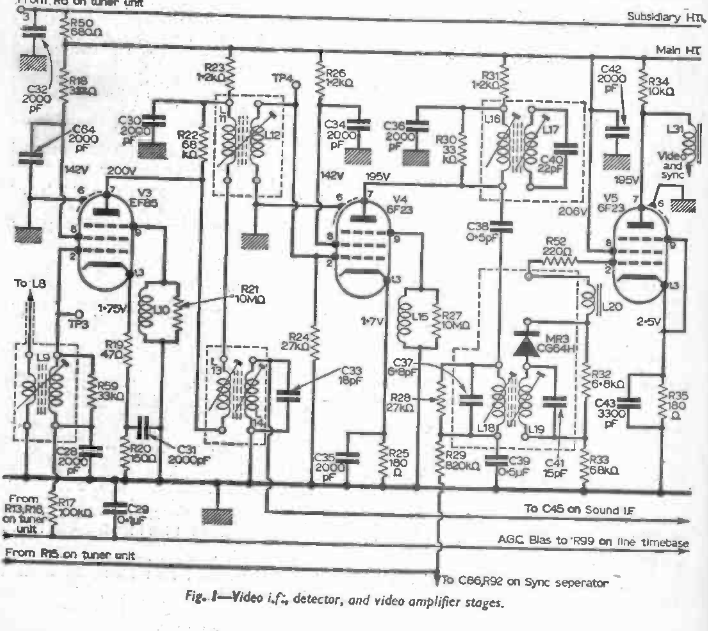


Fig. 1—Video i.f., detector, and video amplifier stages.

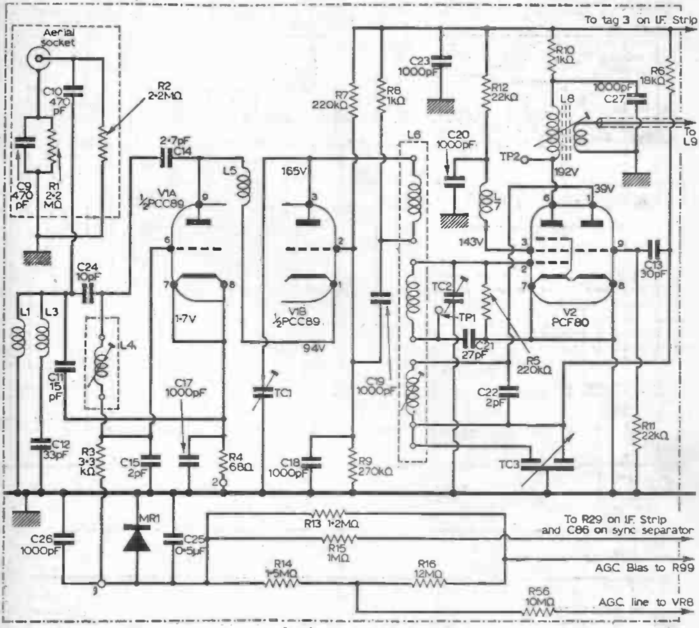


Fig. 2—The tuner unit.

viewing the set from the rear the receiver unit is on the left, this including the tuner unit, i.f. stages, video stage and audio output. The right side unit carries the sync separator and timebases, h.t. smoothing components etc., nicely arranged in logical order. If there is a flaw in the design it is that some of the capacitors used seem prone to leakage and shorts, but this is the opinion of the writer only.

Removal of Chassis and General Handling

If the 7A21—7P20 models are being handled, remove the rear cover, pull off the control knobs and remove the loudspeaker clips from the left-hand side. Remove the bottom left screw from the side of the cabinet which releases the loudspeaker and remove this. Remove the rear bottom screws inside the cabinet, one either side of the baseboard and slide out the baseboard complete with chassis and tube. Re-connect the loudspeaker externally for test purposes. When replacing the tube do not remove or slacken the corner brackets at the base of the tube. The tube retaining strap and the top brackets can be slackened or removed but the bottom one should remain in position in order to correctly position the tube when it is replaced.

These latter remarks apply to the 9A30 and to other models. Removing the 9A30 chassis also follows along similar lines to the 7A21, but there are four base screws, these are underneath the cabinet and this should be placed face downward.

Removing the Front Glass or Implosion Screen

Lay the receiver on its plain or knobless side. Remove he two screws from the strip under the front, remove the strip and slide out the glass.

Tuner Unit

This is mounted in an inverted position and as the cover is simply sprung off, cleaning the coil biscuit studs is an extremely easy operation. This is of course necessary when the studs become tarnished making switching unreliable and giving rise to fading signals, splashes when turning the turret and the other usual symptoms of improper contact.

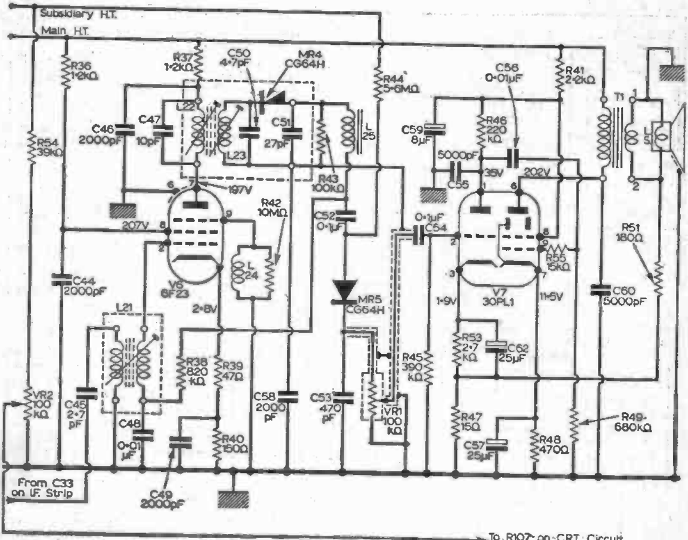


Fig. 3—Audio output stages.

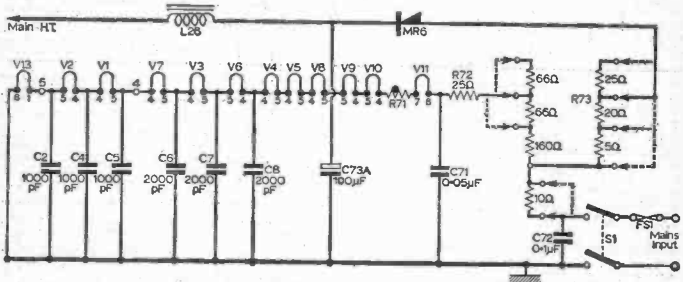


Fig. 4—Mains input, power supplies.

Common Faults

Still on the subject of the tuner unit, weak reception with grainy pictures and noisy sound should first direct attention to the PCC89 r.f. amplifier. If a new valve does not restore normal conditions, check the PCF80 and the 22kΩ resistor R12 which is the screen feed resistor to pin 3 of the PCF80 via a small choke. This resistor sometimes changes value giving rise to poor reception and sometimes no reception at all on one or both channels.

continued next month

LETTERS TO THE EDITOR

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.

THE TIME MACHINE

SIR,—Having been a reader of your excellent magazine for over ten years, I thought you might be interested in the following newspaper cutting from the *Bolton Evening News*, dated 29th November, 1965.

"A Bolton woman bought a new television set from a town centre dealer. A few days after its installation she phoned for an engineer to come and make some adjustments.

"'The sound is perfect, and so is the picture,' she told him, 'but it will only give last week's programmes.'

"The engineer looked at her more in pity than in anger.

"'It's true,' she said, 'last night's "Coronation Street" was exactly the same as I saw last week.'

"The engineer thought he had better humour her, so he twiddled a few knobs and left, assuring her that it would be 'all right now.'

"A few days later she phoned again. 'It's still giving last week's programmes,' she said. 'Last night's "Coronation Street" was a direct follow-on to what I saw last week.'

"Desperately the engineer dived into the set's entrails. Eventually, he found that someone had fitted the wrong coil so that the set was receiving Channel 8 instead of Channel 9. Channel 8 goes to the Midlands—and their 'Coronation Street' programmes are a week behind ours."—H. PATTERSON (Bolton, Lancashire).

SERVICE SHEET OFFER

SIR,—I have to offer the following to any reader who cares to send me a s.a.e. (large envelope—4d. stamp will do) in respect to the following service sheets.

Baird 269, Ferguson 3006 Mk. 2, Ekco CR932 Car Radio, Ferguson 3140, Europhon Eurostar-Lux, G.E.C. G824/Sobell G324, Elizebethan Auto 284, Perdio PR99 Curzon, Bush VHF81, H.M.V. 2128, Ever Ready Sky Baby (transistor), Baird M620/640' TV, Fidelity Playmaster Tape Recorder, Regentone A121/U121/U141/Auto 99, Philips 431G R-Gram, Invicta 8012 Car Radio, Sobell S319, Murphy A815G Rec-Player, Stella ST431T, Ekco PT 438, Ferguson 3324 R-Gram, Alba 777 Swan, S.T.C. GC2 Chassis St. R-Grams, Philips 236 Car Radio, K.B. KRO16/R.G.D. RR214 (International), Pye 31F Mini-TV, K.B. K.B.010/R.G.D. RR210, Philips 338T Car Radio, Baird 294, Master Radio D525, Ekco A455/Ferranti A1149, Creda Debonair New Spin-drier, Walter Metro Mk. IVB (Service Aid Only) and Regentone TR415.

As there is only one of each, first come first served, all returns by return post.—J. G. DAY, (108 Kingsley Crest, Birkinstyle, Stonebroom, Derbyshire).

P.S. Please state full name and model number of sheet required.

STOCK FAULTS

SIR,—I should like to say how helpful the series "Stock Faults" has been to me. It was very well written by Mr. H. W. Hellyer, who excels in technical authorship.

Good luck to PRACTICAL TELEVISION, and may we have many more articles along the "Stock Faults" lines.—M. ROGERS (London, E.10).

[*In response to numerous requests we shall shortly be publishing a further series of "Stock Faults"*]—Editor.

FERRITE WIDEBAND TRANSFORMERS

SIR,—In relation to the above-mentioned article, I find that in Fig. 9, output 2 of the i.f. transformer is out of phase, giving a reduction of 4:1 on this outlet.—G. T. MAUNDRELL (Fife, Scotland).

[*Thank you for pointing out the phase unbalance in the winding details of transformer in Fig. 9. We are very grateful to you for this information.*]—Editor.

'SCOPE FROM A TV CHASSIS

SIR,—It has recently been brought to my notice that one or two errors appeared in my article "'Scope from a TV Chassis" published in the February issue of PRACTICAL TELEVISION. Both errors are in Fig. 5.

Firstly, the EY51 has been shown reversed: the anode and not the cathode, should be shown connected to the e.h.t. overwind; i.e. no change is implied in the original winding.

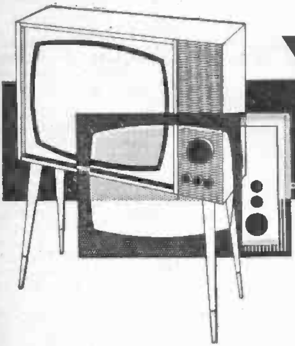
Secondly, C4 has been shown connected between pins 2 and 8 of V2 instead of pins 2 and 6.—C. J. DORAN (London, S.E.20).

[*We are grateful to Mr Doran for bringing these errors to our notice.*]—*Editor.*

TRANSISTOR A.G.C. CIRCUITRY

(March 1966 P.T.V.)

Two drawings (Figs. 1 & 2) appear on page 264. They are, however, shown transposed, i.e., Fig. 1 should be in Fig. 2 position (and vice versa). The captions remain unchanged.



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. 333 must be attached to all Queries, and a stamped and addressed envelope must be enclosed.

K-B MV100

A picture can be obtained but it is out of focus. Without a signal, the raster lines are not visible; just a hazy blue illumination. The c.r.t. voltages check OK. Also, I have replaced the video amplifier, line and e.h.t. valves. When turning down the brilliance and contrast controls, there is sometimes an arcing in the line output transfromer. A new c.r.t. has also been fitted, being a CRM211 and the heater voltage of 12V being correct. The tube quoted is a C21HM 6V. Is this replacement correct?—A. Whittaker (Northolt, Middlesex).

The Mazda tube is not a replacement of the Brimar originally used in the set. The former has a 6V heater and the latter a 12V. Both tubes are tetrodes, however, though it is understood that there may be some difference in the focusing field requirements. This indeed may be the reason for the lack of focus. You should try shifting the focusing unit along the tube neck for the best results. The arcing in the LOPT may indicate poor insulation between the windings.

STELLA ST6417U

The contrast control is nearly at the end of its range. Turning the contrast or brightness controls full on sometimes results in temporary loss of picture.

After the set has been on for some time, the picture flickers and jerks. The picture also over small areas periodically breaks up with "wavy" lines or bands or ripples horizontally.

On BBC-1 the sound hisses and splutters in the background. Renewal recently of the PY81 resulted in the picture not disappearing for periods after the set had been on for some time. The other symptoms remained unchanged.—F. S. Wilkins (Hornchurch, Essex).

You should check the tuner unit valves and clean the turret contacts thoroughly. Improve the directivity of the aerial to differentiate against reflected signals.

Check the setting of the sensitivity controls and renew the line timebase valves if necessary.

BUSH TV

At first there was a wedge-shaped raster, tapering towards the top. The sound remained normal. The wiring on the scancoils looked in bad condition. On putting in another set that was supposed to be in order, a brilliant white line was obtained across the screen. I changed the ECL80 but the fault still persisted.—A. Causill (Lancashire).

You should carefully check the fine lead-out wires of the coils and ensure that they connect properly to their correct soldering posts. They are easily broken and this no doubt is what has happened.

Also check the $8\mu F$ boost line capacitor if necessary.

BUSH TV195

When this set is switched on, there is a good picture for a couple of minutes then it becomes blurred and distorted and flickers. The picture looks as though someone were pouring water down in front of it.—T. Holehouse (London, W.5).

You should check the PCF80 video amplifier valve by replacement. Check the right side ECC82 and PL81 valves by replacement if necessary. Check the electrolytic capacitors if necessary.

ALBA T866

Two white lines appear towards the top of the BBC picture but not the ITA. The picture is linear and otherwise quite good. I have changed the ECL80 sync separator and PCL85 frame output valves, and changed the complete timebase panel but the fault still persists. Are there any possible modifications that could be made?—G. Huxley (London, N.19).

We know of no "official" modification that would increase the field retrace time. The display of the test pulses means that the field retrace does not finish before the pulses occur. Thus they are visible at the top of the picture. You could try altering the anode resistor of the line oscillator, but it is likely that the slow-down is inherent to the design of the field output transformer.

EKCO TC209

There is no picture but there is a good raster. The sound is faint and severely distorted. All valves seem OK; the PCC84 and PCF80 being new. Is it possible to bring the preamplifier into operation? There are four small sockets next to the vision interference limiter selector.—R. Huntington (Penrith, Cumberland).

Your symptoms could be due to defective decoupling capacitors, particularly the 0·003μF screen grid decouplers on the various i.f. stages.

It is possible to bring into operation the preamplifier, and when it is plugged into the four pin socket it is necessary to disconnect the shorting lead across the two heater pins behind the socket.

PHILIPS 1768U

My own 1768U gives a good picture and sound on channel 4 and good sound on channel 8, but with a poor picture—on my aerials!

The quite good sound on channel 8 gives me the idea that one of the trimmers in the tuner unit needs adjustment.

I have checked the PCC84 and PCF80 by substitution and set the oscillator core for maximum sound as my circuit diagram specifies.

The only difference between my 1768U and my neighbour's is that my set uses an ECL80 in the line stage, and his uses a PCF80. It therefore occurs to me that the two tuner unit valves mentioned may not be the correct ones.—E. Brydges (Stourbridge, Worcestershire).

Lack of balance in the i.f. alignment or in the tuner could account for the difference in characteristics between the two sets. It is impossible to be certain, however, without performing alignment tests. The difference in line timebase valves would not be the cause of the condition.

TV STATIONS

Could you please tell me whether there is any information available regarding the whereabouts of all TV transmitting stations in this country.

I have a portable TV set and hope to tour the North East Coast and probably Scotland, and would like to see maps showing the areas covered and the relative channel numbers.—H. Farrant (Chelmsford, Essex).

These maps are obtainable from the ITV and BBC publications departments. We know of no other source from where they can be obtained. The "Trader" Year Book, however, contains maps, powers, signal contours etc. but this is available only to the trade.

REGENTONE TT7

The picture is over-contrasted and the control is inoperative. I have tested V5, V6, V8 and V13 by substitution but with no success. I have also checked V3, V4, C80 and R94. The voltage at C80 is 200V with control fully clockwise and drops down to 150V when the control is turned anticlockwise.—R. S. Hale (Battersea, London, S.W.11).

Check R29 by bridging it with a known good resistor, also R101 and C84. Check other a.g.c. line capacitors for shorts (C83, etc.). There is no way that we can pinpoint the fault for you with any degree of certainty.

EMERSON

This set has lost vertical hold, picture rolls continuously with no adjustment possible. The set is fitted with a 'fireball' tuner.—J. Poole (London, S.W.18).

Lack of vertical hold means that the field sync signals from the sync separator are failing to arrive at the field timebase oscillator. A number of components and circuit elements could, if faulty, cause this trouble. You should carefully check the components and circuit between the sync separator stage and the field generator, if necessary by substitution.

BUSH TV85

This set has lost its picture. The sound is quite OK and the screen is still all right for brightness. All the controls seem to function OK.—S. McGee (Leith).

You should check the PCF80 video amplifier on the upper left side (not extreme left) and the associated components, including the detector 0A70 crystal diode if necessary.

BUSH TV76

Usually during a voltage drop between 6 p.m. and 7 p.m. the picture breaks up into horizontal lines. The line hold control then has to be adjusted every few seconds.

The picture gets smaller and smaller and eventually is lost, followed by loss of sound. I then have to await the increase in voltage before I can get the picture back and the sound returning to normal.—A. G. Bearne (Portsmouth, Hampshire).

We would advise you to replace the ECC82 line oscillator valve just above the screened section on the right side of the PL81 inside this section. Check the output of the metal rectifier and, if necessary, replace this.

BUSH TV24C

The sound on this set is OK but the tube does not light up. How can I test the tube to see if it is OK?—S. J. Collins (Cirencester, Gloucestershire).

Check the left side e.h.t. section to see if the EY51 lights up and if the line timebase whistle is audible. If the line whistle is present and the EY51 lights up the e.h.t. is in order and the tube is probably at fault.

Check the tube base voltages and also the position of the ion trap magnet.

PYE CTM17S

The picture is very dark, even when brightness is turned to maximum; by turning contrast up I can get a reasonable picture but lose about 2in. at bottom of picture and about 1in. off the top. I have renewed valve PCL82 rectifier and PY81 and EY86 but without result. I have a new 43-64 tube. Would this replace the 43-80 tube now in the set?—H. E. Collins (London, S.W.6.).

Your symptoms suggest an A1 leak on the tube, giving low boost volts, which in turn reduce the frame scan generator h.t. A possible cure is to feed the A1 electrode of the c.r.t. from h.t., having previously disconnected the existing boost rail feed. An MW43/69 will work in your set but it may overscan and be rather large for the cabinet.

PHILIPS 1758U

This set has no picture and no sound. On checking the rectifier circuit I found the voltage at the anodes of the PY32 had dropped from the usual 180V to 130V, and the cathode from 190V to 110V d.c. I have checked the mains droppers, replaced PY32 and replaced the 60μF capacitor in the smoothing circuit. I have also checked associated components.—E. Block (Manchester, 9).

If the voltages are as low as you say they are, although the droppers and 60μF capacitor are good, we would have thought that the PY32 would have shown signs of overheating as the fault can only be due to excessive current passing.

Remove h.t. leads in turn to locate source of short or heavy leakage. Start by removing the top cap of the PY81.

FERRANTI T1097

The trouble on this set is on u.h.f. only. The picture waves from bottom to top very slowly.

I am using an attic aerial and the picture is received from Winter Hill, about five miles from where I live.—W. Cole (Bolton, Lancashire).

The field timebase is rather susceptible to hum, particularly on the 625-line standard. Check the PCL85 by replacement and try adding extra smoothing capacity across the existing electrolytics.

QUERIES COUPON

This coupon is available until APRIL 21st, 1966, and must accompany all Queries sent in accordance with the notice on page 331.

PRACTICAL TELEVISION, APRIL, 1966

BUSH TV52

I have converted this set to receive 625-line vision and f.m. sound.

The set operates well except that when the transmitted signal changes from all black to white, loss of line hold is experienced and the picture breaks up for a second.

The dipole and lead-in is 300Ω and they are matched to the set impedance by a "bazooka". As the TV transmitter is situated only seven miles away and has an output of 20kW, I wonder if you could offer me an explanation of this effect. —J. Hope (Dunedin, New Zealand).

This trouble appears to be too much bias on the video amplifier. Reduce the value of the bias resistor and/or remove the h.t. to cathode loading resistor.

TEST CASE -41

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 a poor BBC-2 signal strength area an enthusiast endeavoured to secure an improved picture by connecting two u.h.f. transistor boosters in series at the set end of the downlead. Expecting to eliminate most of the picture grain, the enthusiast was very much surprised to find the picture worse than before.*

Moreover it was found that the u.h.f. tuning on the set behaved very much like a short-wave receiver, picking up stations of a kind almost all over the dial!

Removing one of the boosters, the short-wave effect was mostly removed, but it was noticed to return when the coaxial cable from the booster to the set was orientated to a critical position at the back of the set. There was an improvement in signal/noise ratio on the BBC-2 picture but not so great as was originally expected by the enthusiast. However, after a good deal of experimenting the enthusiast discovered that the signal/noise ratio could be altered considerably by changing the length of the booster-to-set connecting coaxial cable and the aerial downlead from the u.h.f. aerial.

The reasons for these apparently curious effects will be detailed next month and next month's PRACTICAL TELEVISION will also give a further item in the Test Case series.

SOLUTION TO TEST CASE 40
Page 285 (last month)

Although the resistor to h.t. plus at the top of the brightness control was found to be up in value the positive voltage with respect to chassis at the grid of the picture tube was still little more than about 40V at maximum brightness control setting.

Further investigation showed that the vision interference limiter is part of the brightness control circuit in the Philips model 1757U. Subsequent tests proved that the trouble was in fact in the limiter circuit. The control itself was open-circuit and the limiter was biased well away from its conducting condition.

Replacement of the limiter control restored normal brightness control and limiter operation.

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Practical Television

APRIL 1966
VOL. 16 No. 187

CLIFF-HANGER

SINCE the halcyon days of the 1950's, when they literally "never had it so good", television manufacturers have been fighting an ever-stiffening battle against commercial difficulties often not of their own making. Apart from seasonal and transient setbacks, which are expected and can be catered for in planning, the industry has been faced with diminishing sales, more intense competition, higher manufacturing costs and—worst of all—the eroding effects of unhelpful Governmental decisions.

The perpetual vacillations and evasions surrounding major issues on broadcasting have resulted in a highly depressant effect on what should be, and could be, a very buoyant industry. Indecision on line standards, colour TV and the future of u.h.f., coupled with restrictive economic measures, has reduced a lively industry to one fighting for survival.

Retail shops are hard pressed and continue to close the shutters. Manufacturers are under pressure and continue to lay off workers. Development engineers and technicians are frustrated. Rental companies have been hit by Government economic policies. In the dark regarding vital issues, the industry cannot plan production programmes or finance development in the best possible way; designers leave the country and manufacturers lose out on export orders.

As if the cumulative effects of these factors were not enough, we now hear that the long awaited White Paper on the future of broadcasting (now postponed until *after* the General Election) contains further gloomy prospects for the future of the television industry as well as for viewers.

It now seems that the prospect of a fourth channel (ITV-2) is indefinitely shelved. And, although, at last something has been said on colour it is all very half-hearted and unsatisfactory. Four hours a week of colour on BBC-2 only at the end of 1967 is not news likely to set the crowds cheering and get the banners waving. And the PMG, despite stating that his committee has recommended PAL, has adroitly left the door open on this vital issue.

So, despite many words, the Cliff-hanger serial continues. The television industry will no doubt survive, but will it flourish?

THIS MONTH

Teletopics	292
LC Picometer *by M. L. Michaelis, M.A.*	294
A.F.C. Part 2 *by S. George*	299
Underneath the Dipole *by Iconos*	302
Faulty Inductors *by F. A. Grindthorpe*	304
Old Time DX-TV	307
High Tension Shorts *by V. D. Capel*	308
TV Terms and Definitions *by Gordon J. King*	312
Component-Caused Alignment Faults *by G. R. Wilding*	315
DX-TV *by Charles Rafarel*	318
Meet the Setmakers Part 3 *by P. Westland*	320
Trade News	325
Servicing TV Receivers—Defiant 9A30 and associated Pageant models *by L. Lawry-Johns*	326
Letters to the Editor	329
Your Problems Solved	331
Test Case—41	333

OUR NEXT ISSUE DATED MAY WILL BE PUBLISHED ON APRIL 21st

All correspondence intended for the Editor should be addressed to- The Editor, "Practical Television", George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Phone: TEMple Bar 4363. Telegrams: Newnes Rand London. Subscription rates, including postage: 29s. per year to any part of the world.

TELETOPICS

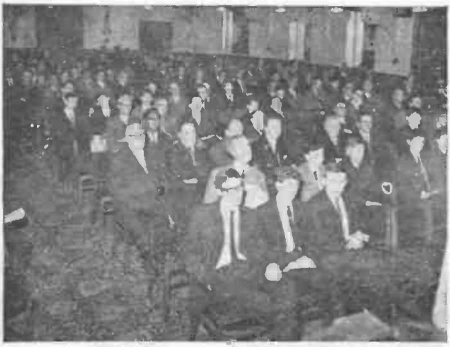
EXPERIMENTAL COLOUR TELEVISION TRANSMISSIONS

THE introduction of the modified sub-carrier frequency for the experimental PAL colour transmissions had to be postponed until Tuesday, March 8th.

The new sub-carrier frequency accords with a recommendation agreed at a meeting in January of representatives of the European Broadcasting Union; it will be 4·43361875Mc/s, giving a line period of 64·00μS and a field frequency of 50c/s.

The characteristics of PAL Colour Television System used are: Line Standard, 625-line standard "I"; Luminance Bandwidth, 5·5Mc/s; Subcarrier Frequency, 4·43361875Mc/s; Line Period, 64·00μS; R-Y Bandwidth, 1·6Mc/s; B-Y Bandwidth, 1·6Mc/s; Burst Amplitude, 0·3V peak-to-peak; Burst Phase, 45° clockwise from the −(B-Y) axis for +(R-Y). 45° anticlockwise from the −(B-Y) axis for −(R-Y); Burst Position. as for NTSC (back porch); Field Frequency, 50c/s; Switched phase line-by-line, R-Y axis.

P.W. AND P.TV. FILMSHOW



FRIDAY, February 4th, was the date of the P.W. Filmshow. Once again this year, the meeting was well attended by readers from all parts of the country.

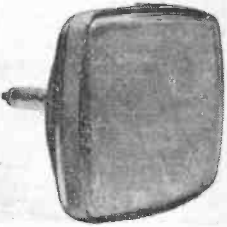
In the absence of Mr. Stevens, the Editor, Mr. A. T. Collins, the Managing Editor of the Practical Group took the chair. After his opening speech. Mr. Collins introduced Mr. Ian Nicholson, of Mullard Ltd., the speaker of the evening.

Mr. Nicholson then introduced the first film, entitled "Electromagnetic Waves—Part 2". After this film there was an interval of 25 minutes during which refreshments were served.

During the second half of the programme Mr. Nicholson gave a talk on Servicing Transistor Receivers. After this, there followed a film entitled "Thin-Film Microcircuits". The evening ended with a question and answer session during which Mr. Nicholson answered questions put to him by members of the audience.

The photograph depicts a small cross-section of the audience.

Mazda Picture Tube Reinforcement



MAZDA have introduced CME1201, the second "Gold Star" c.r.t., for the mains transportable TV market. With a standard 29mm neck, 110° deflection and 6·3V heater, the new 12in. tube is the first British made tube to use a new simplified form of bulb reinforcement which dispenses with the need of an additional implosion protection in front of the tube face. This method of bulb reinforcement is called Mazda Rimband.

Transformers and Chokes from Parmeko

A STANDARD range of transformers and chokes has just been designed by Parmeko Ltd., of Leicester. in conjunction with leading semiconductor manufacturers in an effort to speed up development projects and to minimise costs of small quantity production runs. It is anticipated that many designers and engineers will now be in a position to select from a standardised range, with consequent saving in time and money. For projects requiring components out of this range, Parmeko can offer design and manufacturing facilities covering sub-miniature to 15kVA designs.

All units are fully vacuum impregnated to give adequate protection in varying humidity conditions.

TV SOCIETY DINNER - BAIRD 40th ANNIVERSARY

ON the site where John Logie Baird gave his first public demonstration of television on January 26th, 1926, the Television Society recently held a dinner to mark the 40th anniversary of this great achievement.

The site, at 21a, Frith Street, where in Baird's crude laboratory, members of the Royal Institute and the press first saw flickerings of what was to become the world's most popular entertainment medium, is now a restaurant.

Picture shows some of those who re-lived that early experience: (Left to right) Mr. W. C. Fox, a *Times* reporter in 1926 who covered the original Baird television demonstration; Mr. J. Ware, a member of the Television Society Council; Mr. T. Kilvington, Chairman of the Television Society Council; Mr. G. Cole; Mr. J. C. O'Regan, Managing Director of Radio Rentals (U.K.) Limited and Mr. W. Taynton, first man to be televised.

MINIBOOKS FROM MULLARD

"PRINCIPLES OF ELECTROSTATICS" is the title of the first in a new series of "minibooks" announced by the Mullard Educational Service.

Based on the successful series filmstrips and slides produced by the service, the new books are expected to become popular with both student and teacher.

"Principles of Electrostatics" is a 32-page book measuring 15cm. x 21cm. Its 13 sections each cover a particular aspect of electrostatics. Typical headings are: insulators and conductors; the electrification theory; the gold leaf electroscope; capacitance and capacitors.

Minibooks are available from The Mullard Educational Service, Mullard Ltd., Mullard House, Torrington Place, London, W.C.1., price 2s. 6d. (including postage), cash with order.

M.P. SWITCHES ON PIPED BBC-2 TV

THE first BBC-2 television programme to be seen in Swindon was switched on by Mr. Francis Noel-Baker M.P. for Swindon, over the local Television relay system this week. Until now, Swindon has been out of range of BBC-2. The programme is being received by a temporary 80ft. aerial erected by Swindon Radio and Television Relay Service Limited, but it is anticipated that shortly it will be received at Wanborough, where the Company has a receiving station three miles from the centre of the town. This location is about 900ft above sea level and reception from there should be extremely good. The programme will then be beamed into the town by a microwave link to the central control station. Mr. Noel-Baker visited the receiving site at Wanborough and also toured the various television relay installations and other premises.

The switch-on took place in the new studio which has been set up by the Company's Wired Services Division for demonstrating educational television and closed circuit television systems of all kinds.

The photograph shows Mr. Noel-Baker watching a video tape recording of his opening address.

LC PICO METER

Designed and Described by

Martin L. Michaelis M.A.

THE measurement of small capacitance and inductance values is a vital requirement for efficient and systematic design work on v.h.f. circuitry, video equipment, wide-band oscilloscope amplifiers, pulse circuits and a host of other modern devices. An electronics design bench which is not equipped with capacitance/inductance measuring equipment reaching down to a small fraction of 1pF or of 1μH, tends to limit its operator to time-consuming hit-and-miss methods when engaged on more critical circuits. Q-meters and similar devices used for making measurements on r.f. tuned circuits commonly get down to about 1μH or 100pF respectively. A.C. bridges, if carefully designed, get down to about 10pF on the capacitance ranges without particular difficulty.

The most important range of stray capacitances which requires measurement in the design of a wide variety of modern equipment, is between approx. 0·5 and 10pF. Simple a.c. br dges cease to function in this range, for they can only operate correctly, as long as stray capacitances are not confusing the issue. It is the purpose of this article to show how a conventional *grid dip oscillator* may, with the help of the "*LC Picometer*", be extended for adequate coverage of the required low C and L ranges. A g.d.o. with an overall frequency range of 150kc/s to 22·5Mc/s (standard long-medium-short waveband coverage) is required. However, a g.d.o. with v.h.f. range coils up to 250Mc/s will be useful for other measurements, and can be utilised as long as its lowest range goes to 150kc/s.

The Principle of the G.D.O.

We will commence with a brief description of the essential points concerning g.d.o.'s, so that those readers who may not have handled a g.d.o. (or g.d.m.) may familiarise themselves with its operation.

Fig. 1 shows the essential features of the construction of a typical g.d.o. The circuit shown in (a) is not necessarily meant to be a final design, but rather illustrative of the principle. It is seen that the arrangement is a conventional triode oscillator circuit in the same form as used for a leaky-grid detector stage with reaction. Here L2 is the grid coil, tuned by TC2, and L3 is the reaction coil, fed via the reaction capacitor C1 from the anode circuit. C1 is large and the coupling between L3 and L2 tight, so that oscillation is sustained at all tuning settings. C2 and R3 constitute the grid capacitor and grid leak of the oscillator valve V1. C2 and R3 act as negative d.c. restorer for the grid waveform in conjunction with the grid to cathode section of the valve functioning as diode. As soon as oscillation commences, C2 draws electrons from cathode to grid on positive peaks, until it is charged up to virtually the peak-to-peak amplitude of the grid waveform. This is normally a large percentage of the h.t. voltage, i.e. in the region of 100 volts. C2 thus charges to about 100 volts d.c., or whatever the exact value of the peak-to-peak oscillation amplitude at the grid. The right-hand plate of C2 is negative. C2 discharges so that the d.c. voltage is developed across R3 and VR1 in series. As the grid waveform reaches each

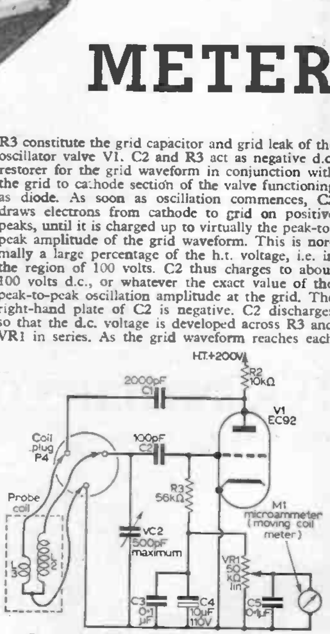


Fig. 1—Circuit of a typical grid dip oscillator.

positive peak, a brief pulse of electron current from cathode to grid of the valve replaces the slight charge which has leaked away from C2 during the rest of the cycle, so that the mean d.c. current through and voltage across R3 and VR1 correspond to the peak-to-peak oscillation amplitude. C3 and C4 provide smoothing across the lower section, VR1 track, so that a large (approx. 50 volts) steady d.c. voltage appears across the track of VR1. A proportion is taken from the slider of VR1 to a sensitive moving coil meter M1.

If the oscillator coil L2/L3 is coupled to any other external tuned circuit simply by being brought into proximity thereto, then some of the oscillation energy will be transferred to the external circuit *if and only if* the external circuit is tuned to resonate at the oscillator frequency. The transfer of energy at resonance means a corresponding reduction of amplitude of oscillation, so that the meter M1 will show a sharp dip to a much lower deflection at the resonance point. Hence the name of the instrument "grid dip oscillator".

In use, the g.d.o. is held in the hand after inserting the coil for the frequency range including the expected resonant frequency of a tuned circuit which is to be measured. With the plug-in coil well clear of any other objects, VR1 is adjusted to give a convenient meter deflection, say about two-thirds full scale. The probe coil is then brought near to the tuned circuit on test, and VC2 slowly turned through the range. At some point, the meter needle will suddenly dip indicating the resonant frequency of the tuned circuit being tested.

A common refinement is to use a positive backing voltage for the negative signal voltage across VR1 in conjunction with a much more sensitive meter. The sensitivity is then enormous, even for very slight energy transfer. The probe coil may then be moved much further away from the tuned circuit on test whilst still obtaining an observable meter dip at resonance. This leads to maximum accuracy.

Disadvantages

A disadvantage of the conventional g.d.o. in the form just described, as far as certain applications are concerned, is its high output amplitude of the order of 100 volts peak-to-peak. The r.f. field in the immediate vicinity of the probe coil is intense and appreciable voltages must be induced in the tuned circuit on test before they represent a significant percentage energy transfer for a positive dip in the meter reading. Induced test voltages of this order of magnitude were not objectionable in the days when valve-operated equipment was being designed and used.

The question has become more problematic in these days with widespread use of transistorised equipment. This does not mean that a conventional valve-operated g.d.o. will necessarily inject destructive voltages into transistorised equipment. That is seldom the case if one avoids poking the probe coil indiscriminately into a transistorised circuit. At a distance of about an inch or slightly more, very good resonance readings are possible, and induced voltages are normally kept down to 10 volts or less thereby. Since transistors are often coupled to a low tap on associated tuned circuits, the actual voltages reaching them will be harmless under these conditions.

Tunnel Dippers

Hand in hand with the advent of semiconductor circuits, other forms of resonance indicators operating on the principle of the g.d.o. have been devised. The first types employed transistorised oscillators to excite the probe coil at correspondingly lower amplitude, so that a much smaller injected voltage in the circuit on test corresponds to the necessary percentage energy transfer for a positive meter dip. Still better are the modern dip-resonance indicators using tunnel diodes as active elements to excite the probe coil. These are much more suitable for measurements on tuned circuits containing voltage-dependent capacitive components—or, for that matter, for measuring the barrier layer capacitances of semiconductors in general.

As far as the LC-Picometer to be described in this article is concerned, it is immaterial whether a conventional g.d.o., a transistor dipper or a tunnel dipper is used. If building or procuring a suitable dipper at the same time as constructing the picometer, it is advisable to choose a tunnel dipper if desiring to make measurements of barrier layer capacitances directly on semiconductors as well as on normal and stray capacitances and inductances of a non-voltage-dependent nature.

It may be of considerable importance in general electronics design work to be able to determine the barrier layer capacitances between any pair of electrodes of a given semiconductor. This is, as far as the LC-Picometer is concerned, readily possible by connecting the two electrodes (in series with a battery giving the reverse polarising voltage for the operating point in question) across the "X" terminals of the picometer and taking a capacitance reading in the normal manner described below. When a grid dip oscillator meter is used to excite the picometer, no readings will be obtainable for reverse voltage operating points which are much less than the induced amplitude. Only at high inverse operating points of high-voltage diodes is the signal swing from the g.d.o. negligible in comparison thereto and some form of indication appears. This may still be useless, however. The voltage dependance of the barrier layer capacitance of all semiconductors may give "dragging" effects which cause the g.d.o. reading to drop progressively over a wide frequency range and then to jump back abruptly to a ligher value at some frequency where capture is lost. This jump point will be nowhere near the true resonance point, since it represents the maximum possible displacement due to dragging, before capture is lost and the circuit returns to its normal operating point which the g.d.o. is well past at this stage. Reduction of coupling reduces the "dragging" range and the extent of the jump, both approximating closer to the true static value. But a clear reading may still not be obtainable before the coupling is so weak that all definite effects have ceased. Tests were made with an S36 high voltage diode at the 120 volt reverse bias point, and after a lot of observations and judicious extrapolation, a reading of about 5pF was obtained, which is about correct for the named operating point according to the maker's curves for this diode. For lower voltages, no readings at all were obtainable with the g.d.o. for this or any other diode.

This is no shortcoming of the picometer method as such, but rather a demand for a low amplitude dipper, such as the tunnel dipper, to excite the picometer when intending to measure voltage-dependent capacitances at low voltage operating points.

Now there is of course another simple way round the difficulty. As long as no voltage-dependent capacitors are involved, the picometer method to be presented in this article gives very clear readings with *any* type of dipper. The only voltage-dependent capacitors normally met with in most electronics design work are the barrier layer capacitances of semiconductors. It is thus usually possible to disconnect the semiconductors in order to measure the