The Sun
Television Data Sheets

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OSCILLATOR DRIFT

A frequent trouble experienced in television receivers is caused by frequency drift in the oscillator section of the receiver. It generally manifests itself as a lost sound program, or in extreme conditions as a great loss in the picture fidelity.

The oscillator frequency in a receiver can drift from a number of reasons:

1. Temperature changes in the coil and condenser in the tuning circuit.
2. Changing tubes.
3. Changes in filament and plate voltages.
4. Mechanical shifting of parts of the coil or condenser parts of the tuning circuit. It is customary to provide separate trimmers in the oscillator tuning circuit which can be used to reset the frequency but this control should not be used indiscriminately.

Receivers comprise a variety of local oscillator circuits, although most of them use a separate oscillator tube of the triode type, such as a 6J5. If ordinary radio parts of commerce are used, the temperature drift in a television oscillator circuit might be of the order of 0.01 per cent per degree Centigrade. In this case the oscillator may drift about 6,000 cycles per degree, or 150,000 cycles for a 25 degree Centigrade (45 degrees Fahrenheit) shift in the operating temperature.

In the more elaborate receiver designs a separate tuning circuit is provided for each television band, in which case each (LC) combination may require adjustment.

In practically all receivers the oscillator frequencies are higher than the respective radio frequency carriers. Should occasion arise where it is believed that the oscillator frequency has shifted, as by a loss of the sound program the circuit should be examined to see if any manual adjustment controls are provided. After taking note of the present position of the knob it can be slowly turned while tuned to a station known to be on the air.

A carrier frequency test oscillator has great utility in such tests if it has a fairly accurate calibration curve.

Few of the signal generators that are used in radio and service laboratories are arranged to cover the television ranges. While in making design tests and in research matters a calibrated output having a range of 10 to 10,000 microvolts would be necessary, in most servicing work a simple modulated oscillator proves satisfactory. The details of a signal generator having characteristics suitable for television servicing will appear soon in this space.

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INTER-CIRCUIT COUPLING

In the majority of television receivers now available, a single low-voltage power unit supplies the plate potentials to all circuits of the set except the cathode-ray tube. It is natural that interference might take place, in some instances, should coupling occur by the way of the impedance in the common power supply.

The circuits which might be affected by this condition are, for example: Sound channel, Video channel, Synchronizing pulse separators, Vertical scanning oscillator, and the Horizontal scanning oscillator.

For instance, the sound signal might get into any of the other circuits listed above. The effect on the video channel might be to add "rain" effects or rapidly moving "clouds" across the picture. Unless the sound signal is quite strong, however, it is doubtful if that program would upset the synchronizing system, or the scanning oscillators following it. The loss of synchronization would cause frequent shifts in the framing rate, the picture acting as if it were projected onto a page of a book with a fresh page being lowered vertically into place from time to time.

The pulses introduced when the scanning oscillators are discharging will not affect the video signal circuits, in most cases, since the strong blanking signal that is taking place in the latter at the same time, will ordinarily blanket out these surges. However, should these surges have a reversed polarity with respect to the blanking pulses, zig-zag streaks might appear that are caused by the fluorescent spot following-up the return sweep of the vertical scanning oscillator, to appear in the picture.

The most usual trouble seems to be found due to the discharge pulses from one scanning oscillator affecting the other or else the interlocking pulse separation circuits. This has the general effect of distorting the field, such as stretching one or more of the corners or the vertical edges of the picture. A scanning oscillator will operate reliably, even without synchronization, even though the operating frequency might drift quite badly, so each sweep of the spot should fall directly below the one immediately preceding it. Any false signal impressed upon the horizontal sweep circuit, or upon the voltage divider circuit that supplies potentials to the positioning controls, will cause an uneven and distorted picture. The appearance of false jiggles anywhere should be checked with the incoming signal off. An irregular, poorly filtered power unit will sometimes add an irregularity which shows up in many ways in the picture. A temporary check by adding an additional condenser to the filter would show whether this power unit is the cause of the trouble.

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TELEVISION SERVICING PROBLEMS

A check-up on some of the television receivers which have been built from kits or assembled from components, shows that a surprising number have distortion due to non-linearity of the scanning oscillator potentials. A few tests will show the probable causes and suggest remedies.

First take note of the appearance of the frame when no incoming signal is present. It will be well to disconnect the antenna entirely to insure that interference does not affect the test. The appearance of the illuminated field on the screen should be rectangular, with the scanning lines visible upon close inspection and proper focusing. These scanning lines should have equal spacing at both top and bottom edges. It will be noticed that certain diagonal streaks also appear superimposed on the field, but these can be disregarded since they should disappear when a television carrier is received.

The vertical edges of the picture may appear wavy. A small amount of curvature can be tolerated, but if the edge variations are greater than about an eighth of an inch some means should be taken to improve the power supply filtering to the scanning oscillators. It is desirable to adjust the vertical oscillator frequency until the wavy edges of the picture appear to stand still.

If the field appears substantially rectangular the same test can then be repeated with a television signal tuned in. The shape of the picture should not change if synchronizing pulses are properly applied, but it seems that a condition frequently appears with a part of the picture offset from the rest, the vertical edges having either an abrupt or a curved contour. This is evidence that a false synchronizing signal is getting into one or both of the scanning oscillators.

At times the fault may be due to a strong 60 cycle interference signal being picked up by the antenna. In this case, however, horizontal bands of high or low intensity illumination would also make their appearance.

Trouble should be looked for in the synchronizing pulse separation network or in the synchronization pulse amplifier. The latter circuit should be checked thoroughly to see where the vertical pulses introduce false surges in the horizontal synchronizing leads. The gain of the synchronizing pulse amplifier should also be checked.

The above checks and tests have been based primarily on the appearance of the edges of the picture. When any troubles so found have been corrected other checks can then be made which are based on distortion appearing in the picture itself.

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TELEVISION SERVICING PROBLEMS

On the preceding data sheet, checks applying to the synchronizing pulse circuit were recommended if the vertical edges of the picture appears distorted when a television signal is present. Distorted or curved edges when no signal is present is likely to be due to excessive hum in the scanning oscillator power supply, the remedy for which is obvious.

The next thing to note is the horizontal scanning wave distortion, which, as shown on Data Sheet 390.3, is easily noted by examining the circular test chart that is received at frequent intervals.

Having determined that trouble occurs in the scanning oscillators, the next thing is to correct it. It is recommended here that the tubes in the scanning circuits be checked. A simple tube test is to interchange each tube in these circuits with another of the same type: that is, use the horizontal circuit tubes for vertical scanning and vice versa. Generally the same tube types are used in both places.

When this is done, the same picture conditions and the same type of distortion should appear. However, if the conditions are either improved or made worse it is evident that at least one of the tubes is not up to par. It is a waste of time to try to apply circuit corrections when tubes are known to be inferior.

When the circuit itself is suspected it is necessary to determine whether the scanning oscillator is at fault or the scanning wave amplifier. The best test is to apply an oscillograph to the output of the oscillator and thus check the saw-tooth wave directly. Then apply the same test to the output of the amplifier, and again take note of the waveform. An oscillograph so used shows immediately the value of any circuit changes that may be applied. It should be realized here that scanning oscillators designed for use with magnetically deflected cathode ray tubes do not have a true saw-tooth wave output but the correct wave shape is generally described in the manufacturer's literature.

A frequent source of trouble is mismatching in the scanning wave amplifier circuit, which is usually of the "inverter" type, wherein one section of the push pull stage amplifies differently from the other. An oscillograph will permit accurate checks in this case also.

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SQUARE WAVE GENERATORS

In the single sideband system of modulation now in use it is necessary to treat the lower frequencies in the range as if double sideband operation were in effect. The two sidebands are supposed to add up to give a voltage output (after rectification) equal to the output at the higher frequencies. To do this, each frequency in the lower range must be in phase with its equivalent frequency in the other sideband.

There is no particular reason why low frequencies should be lost in the r—f or i—f stages any more than any other frequencies. It is in the video amplifier stages (those after the second detector) where phase shifts and amplitude reduction might occur. Such effects are often tested with a square wave generator.

Such a study is quite all right for television research or classroom problems in schools, but it is believed that few service laboratories will need such apparatus in routine work, as too much time will be needed to make the necessary connections, and to interpret the results.

In servicing receivers, it will probably suffice to investigate the effects of poor low-frequency response from a study of the resulting picture resolution. However, the experimentally inclined might desire to setup a square-wave modulated oscillator. The details of one method of operation will be given here, followed on the next sheet by suggestions as to simple methods for securing this wave form.

In order effectively to measure the phase and amplitude distortion at low video frequencies, it is necessary to use either an oscillograph or else to convert the receiver itself to an oscillograph (assuming that it incorporates a cathode-ray tube of the electrostatic deflection type). It is not recommended that a television receiver with an electromagnetic deflection system, be converted to an oscillograph for temporary testing uses. The conversion can be made by first removing the horizontal scanning potential from the deflection plates, and the video signal from the modulation grid. After doing the latter, it is necessary to apply a proper bias voltage to the modulation grid. Just how this is done depends on the particular circuit found in the receiver but in most cases it is probably easier to disconnect the wire from the modulation grid and to connect a 4½ to 9 volt C battery between this grid and its cathode, putting the negative terminal on the grid. Otherwise, it would be necessary to figure out and change the biasing resistors to new values. The output of the video amplifier is connected (through a large blocking condenser to the horizontal plates. The video amplifier response therefore appears on the screen in the form of an oscillogram. The circuit constants in each video stage can then be varied while noting the effect on the square wave distortion.

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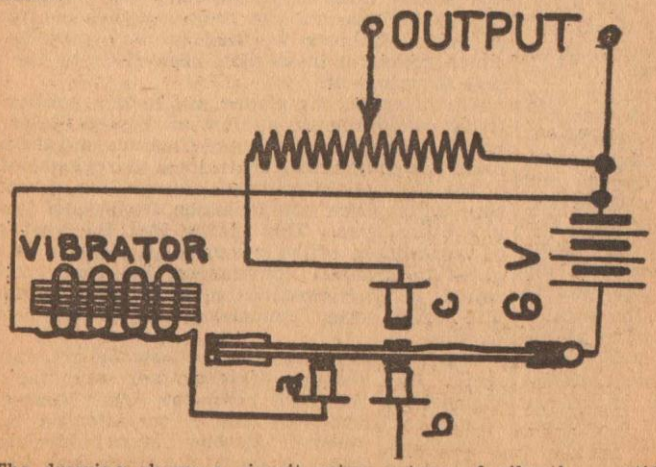
SQUARE WAVE GENERATORS

The low frequency response of a video frequency amplifier, (as distinguished from the video i. f. amplifier or the video r. f. amplifier) must extend down to zero frequency, theoretically. In many parts of the televised picture a flat unvarying background can be effectively transmitted only by a d—c component in the frequency range. It is quite easy to test such an amplifier with a low frequency potential, such as a 60 cycles sine wave but it has been shown that this type of wave will not give the correct answers. An amplifier may handle a low frequency sine wave perfectly and still perform poorly when a "square wave" is tested.

There are numerous ways of generating square waves and applying them to the amplifier under test. One way frequently used is to utilize the output of one of the signal generating tubes, such as Monotron, Monoscope, or Phasemajector &c. The black and white line drawings in these tubes produce an execellent square-wave output. There are numerous circuits whereby such frequencies can be generated directly by special oscillator circuits (and there are numerous circuits available such as the multivibrator circuit, than can be used). In fact it is quite possible to produce low frequency square-waves using a mechanical vibrator or buzzer. Even an autoradio vibrator rectifier can be used.

While the square wave signal can be applied to the input circuit of the amplifier under test, the better method is to modulate an r—f signal generator or an i—f signal generator with this wave so that the signal is applied to the amplifier under test in a normal manner.



The drawing shows a circuit using a type of vibrating rectifier and a 6 volt battery. Here a vibrator of the "series-driver" type is shown, wherein current from the battery flows through the normally closed contact (a) and magnetizes the coil. Contact (a) thereby opens and current momentarily flows through the contact (c) and resistor R. The latter is adjustable to permit the output to be obtained by an adjustment. If a 6 volt d—c source of voltage is available this system is exceedingly simple.

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TELEVISION RECEIVER PROBLEMS

A survey into what are the most prevalent types of television set difficulties from a servicing standpoint shows that the following are quite regularly reported:

1. Poor contrast and irregular framing synchronization.
2. No sound program, or sound but no pictures.
3. False shadows and poor picture detail.
4. Irregular streaks and spotted effects on pictures.

1—The first trouble may in all likelihood be due to insufficient signal strength. Remedy may be effected by improving the antenna, either by its relocation or by using low-loss lead-in, such as by avoiding the ordinary twisted pair line. A less strenuous job might be the improvement of the amplifier stages. It happens that the usual high-transconductance tubes vary quite a bit as to their characteristics and frequently the substitution of a new tube in a particular stage will do wonders. Spare tubes of the 1852 or 1853 types prove a good investment in these cases. The set may need retrimming in some of the tuned circuits for greater efficiency, but this job should not be tackled without full knowledge of the circuit, and using proper test equipment.

2—A missing sound program will probably be found to be caused by oscillator drift, assuming that the circuits associated with the sound channel are functioning. An ordinary service test oscillator set at a frequency 8.25 megacycles higher than the sound carrier of the station desired, should be easily heard. If the test oscillator does not reach this frequency it may be set at a frequency one-half or one-third of the desired value, and it should be heard through the speaker in the set.

3—False shadows and poor picture detail are in all probability due to irregularities in the video-i-f channel or even in the video amplifier after the final detector. If good contrast is obtained in the picture with the volume control set at a position considerably less than maximum, the video i-f channel should be studied. However, if the volume control has to be kept at maximum position, the signal level should be increased first, as explained above in (1).

4—Irregular streaks and spots on the picture generally come and go, disappearing completely at times. This is a sign of interference of some sort. If the streaks appear continuously and are of the same type at all times, a faulty tube, resistor or condenser may be adding noise to the circuit.

(To be continued.)

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TELEVISION RECEIVER PROBLEMS

Probably the one most exasperating trouble found with television reception is that due to the last item mentioned on sheet 430.7, viz., irregularities due to interference. The effect of automobile ignition systems is most prevalent, especially when the antenna is not far above a busy street. However, on the other hand, receivers are also troubled by aircraft ignition systems when planes are flying overhead.

It is quite probable that means can be found for eliminating or reducing this trouble, because the surges that cause radio interference are not those that are needed to produce a spark in a cylinder and by proper design of the coils and with adequate shielding installed on the connecting wires the effect can be reduced to a value that will cause little disturbance. Not all cars cause the same amount of trouble so that before long, manufacturers will try to eliminate unnecessary radiations, if only as a good-will gesture.

There are other types of disturbances however, which most people regard as "diathermy interference." Many electrical devices radiate high-frequency waves, which are modulated at the 60 cycle line voltage. Several types of medical equipment, such as the above mentioned diathermy equipment, are actually high-frequency oscillators which may have been tuned to frequencies in the television band, or to harmonics of those frequencies. Since this type of interference sounds the same as other disturbances which have a 60 cycle tone, practically all 60 cycle interference is considered to be caused by medical devices.

A great deal of this apparatus is characterized by a raw a-c power supply so that the interference is radiated on alternate half cycles only. If the vertical scanning oscillator in a television receiver can be temporarily adjusted for a 30 cycle instead of a 60 cycle rate, two television pictures will be received, one above the other. In this case the interference from diathermy equipment of the usual type will be noticeable over only part (less than one-half) of the picture screen area. Most of the other sources of interference will cause a disturbance over the whole screen area, under these circumstances. Ordinarily there is little that can be done, when interference is found, except to try different antenna arrangements, either in an attempt to increase the signal pickup in the desired direction (toward the transmitter), or to avoid signals from other sources. The rules relating to the matter of directive reception to avoid interference are as yet not fully established, although data is being collected by many organizations that are endeavoring to improve reception conditions.

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SERVICING CATHODE RAY TUBE RECEIVERS

In servicing television receivers it will be found that many troubles advertise their presence by telltale effects in the picture. In fact, the receiver itself generally proves to be its own best servicing instrument. You either get a picture or you don't, also, you get the sound program or you don't.

If a sound program is heard, the adjustments can be made on the r-f stages, converter and oscillator until best signals are heard. The antenna can be also checked up if its characteristics are in doubt.

If the pictures are missing when a sound accompaniment is heard, take note if the scanning frame (the rectangular illuminated area) appears on the screen, or if not—whether a spot of light is apparent. The procedure can be listed as follows:

1. No spot of light on the screen. This condition must first be corrected before proceeding with other conditions.

First check, by looking at the tube, for filament lighting. If the filament lights, proceed with caution, because the voltages to be dealt with are dangerous, and are capable of jumping through ordinary insulation on test cords, &c. The only safe plan is to pull the power plug and check all condensers and resistors in the high voltage unit individually, using ordinary servicing routine. Never attempt to work with a circuit unless a wiring diagram is at hand. It is not safe to remove the high voltage rectifier tube and to leave the rest of the circuit alive, because the secondary of the transformer is the source of the high voltage and may be connected so as to leave a number of circuit elements alive, even though the rectifier tube is out. Also, before starting tests make sure that all condensers are short-circuited, using an insulated screw driver to discharge them, since the normal bleeder circuit may be open. In making resistance checks investigate the possibility that the leakage resistors across the terminals of the deflection plates (in tubes that have such plates) are intact. The lack of such leaks will cause the spot to drift off the screen when the tube is first turned on. If the power unit seems correct, replace tubes and reconnect power. If a high voltage voltmeter is not available for an actual check of the potentials, a small neon lamp taped to the end of a wooden rod can be used to indicate that a voltage is present.

If a cathode ray tube lights normally there is probably very little that can happen to it internally to prevent a spot from appearing, although a loss of vacuum, magnetized elements or displaced electrodes have been found. It is well to check the bias control circuit of the cathode ray tube, with an ohmmeter before restoring the high voltage. In most cases these troubles will be found to be defective resistors or condensers.

(To be continued.)

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Servicing Problems.

Manufacturers of television receivers have, for the most part, undertaken the job of attending to servicing problems by sending out their own trained men to handle complaints. In this way they have been able to learn immediately if any weak and troublesome items are present and to take steps to improve conditions. Most difficulties have been analyzed broadly as irregular reception, due in some manner to insufficient signal. However, the causes may vary, possibly a poor tube in most cases, or sometimes a poor antenna. In the latter case the trouble many times is due to the proximity of newly erected antennas near the television dipole.

Even if sufficient signal is present to give a picture, it may not be strong enough to override the major part of the interference level existing at the place. A great deal can be done if a good signal is picked up. Results depend largely upon the tubes, not only because a lowered amplification factor will reduce the signal level, but tubes with unusual capacitance values will cause mistuning. It happens that the capacitance of the tubes will often be the predominating capacitance in the circuit, and mistuning in many circuits will greatly reduce the signal level. This is especially true in the case of the r-f oscillator used in conjunction with the converter tube circuit.

If the oscillator is working only fair, as the higher frequency carrier bands assigned to television are opened up, the adjustment of the oscillator frequency in the converter section of the receiver becomes much more critical. One of the factors which requires rather accurate setting of this oscillator is the presence of tuned traps in the i-f sections of the receiver which trap the sound programs of the same and adjacent stations out of the video signal. They are tuned to the exact carrier frequencies used by the transmitter.

Some of the factors affecting oscillator stability have been listed on Sheet 430.1. Oscillator circuit parts receive critical inspection in all manufacturing plants. In setting up home constructed receivers attention should be paid to this problem as well.

Tuning condensers should preferably have ceramic insulation and have air dielectric instead of mica. Sometimes the sound program will drift in or out of tune after the set has warmed up, generally due to the tuning elements being located in a position where they get too hot after the tubes have been in operation for a while. The oscillator stability is improved when the capacitance of the circuit is relatively larger than the capacitance used in a radio-frequency amplifier stage. Other conditions dealing with oscillator stability will be taken up in later sheets.

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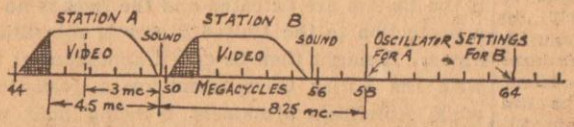
Oscillator Drift.

As more stations transmit television signals, many set owners will be confronted with the problem of adding new tuning ranges to the receiver or readjusting present ones for more efficient reception. In actual servicing practice a condition is sometimes encountered where all indications point to a wrong oscillator setting—where the frequency has slipped for some reason. The problem, in most instances, reduces to the checking of the oscillator tube to see if it is in good shape, and resetting the frequency until the sound program is coming in best. Then, if the i-f stages in both sound and video channels are in order, the video signal should also come in. However it is sometimes found that the oscillator frequency control can be set so that either the sound program can be received or the video program, but not both at the same time.



In such cases the situation should be carefully analyzed before any further adjustments are attempted. In the present system manufacturers have established a practice of using an 8.25 megacycle i-f for the sound channel. The picture i-f would therefore become 12.75 m.c. (theoretically) since the two carriers are 4.5 megacycles apart. However, in the ordinary case, a 12.75 m.c. frequency is not the best value when receiving single sideband modulated signals for the reason illustrated here. A somewhat lower frequency is favored, for example 11.25 m.c

However the exact oscillator frequency selected by the manufacturers should be strictly adhered to, especially if the i-f coupling is in the form of band-pass filter networks. A 11.25 m.c. setting centers the tuning with respect to the incoming signal, but places the vestigial side-band (shaded part of the figure) in difficulties, if phase distortion in the video i-f channel should occur.

From the figure it will be seen that the oscillator frequency should always be 8.25 m.c. higher than the sound carrier signal to be received. In the case where sound and picture signals appear best at different points on the oscillator trimmer control, it is possible that the oscillator has slipped to a frequency below the incoming carriers. If a given sound program can be heard at two separate points on the oscillator tuning range, the one that requires the least tuning capacitance will be the right one.

(To be continued.)

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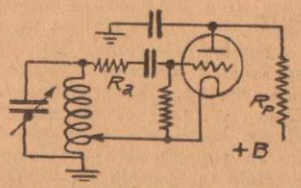
OSCILLATOR DRIFT

(Continued.)

It requires extremely stable oscillator tuning elements to cope with the many factors that contribute to this effect:

1. Changes in the operating voltages in the r-f section.
2. Changes in the oscillator tube characteristics with aging or replacement.
3. Temperature changes which affect the capacitance of the condensers and the inductance of the coils by changing the dimensions by expansion.
4. Humidity effects.
5. Mechanical stability or the capability of maintaining initial dimensions precisely with normal handling.

Different designs take care of these factors to different degrees. It is not the intention to imply that various commercial designs all shift, but the problem is not unknown. The following information may be useful in arranging a home-constructed receiver. Certainly the oscillator in a commercial receiver should not be altered, in ordinary cases, because if the oscillator has slipped the advice of the manufacturer should be sought first, as he has probably prepared service notes on this possibility.



An open-spaced coil of wire, wound without a retaining form, must be handled rather carefully and is subject to dimensional changes. Coils wound on bakelite or fiber forms are likewise subject to abnormal expansion factors. A coil wound on a grooved ceramic form is capable of maintaining its dimensions accurately under all normal temperature and humidity effects. The wire used in the winding need not be large—No. 26 copper being as effective as No. 14 bus wire on these coils. A single tapped coil used in the circuit, Fig. 2, provides an easily designed and assembled oscillator, but for greatest stability in the matter of operating voltage variations the cathode tap must be accurately established. This may seem futile in the case of a coil with a total of only two or three turns anyway, but some attempt should be made when designing these coils to establish the correct contact point.

If an oscillator using this (or other circuits) is sometimes found to have erratic action and weak output, some consideration can be given to the possibility of parasitic oscillations. A resistor Ra, shown in Fig. 2, placed in the grid lead, quite close to the coil, will ordinarily stop operation at false frequencies, however. It need not have a value of more than 50 ohms and must be quite small physically.

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CIRCUIT LAYOUT AND WIRING

It is good policy in setting up and adjusting the component parts of a television receiver to follow the same general principles that are used in short wave radio circuits. A few rules, however, might be stressed.

First, consider the dangerous nature of voltages that must be used. The insulation between various condensers, &c., and the chassis, is just as important as the breakdown capability of the item itself. In addition condensers should have a leakage shunt if there is any chance of their remaining charged after the power is off. The use of panel indicator lamps to indicate when each power unit is "on" is desirable.

Ordinary push-back wire is not safe for potentials over 600 volts, so that higher insulation values must be used. Ignition cable is recommended for voltages greater than around 2 kilovolts.

Second, in the matter of intercircuit shielding many problems must be studied. One of the most important is the surges that appear during the discharge intervals of the scanning oscillators. Considerable energy is present in the high current discharges which finds its way into other circuits unless precautions are taken. In particular, the surges from the line scanning circuit should not prematurely trigger off the framing oscillator.

The effect of surges of this nature on the video and the sound portion of the receiver must be eliminated. Toward this end, separate power units for the receivers and the scanning oscillators is the first step.

In wiring the scanning oscillators, keep the wiring of each discharge path short and direct, and avoid using any common leads to carry currents to other parts of the circuit. The scanning wave potentials can also induce surges in neighboring circuits, so it is a good policy to mount the scanning oscillator circuits on a separate section of the chassis, whereby most of these troubles can be avoided.

In the case of scanning oscillators for magnetic deflection coils, the power unit should have good regulation, i. e.—a large power handling capability. All choke coils, and other coils carrying the sawtooth currents have fields whose effects on other circuits must be minimized.

In the radio frequency and video frequency amplifiers the wiring should be in accordance with the best short wave practice. Particular emphasis will be given to this problem on another sheet.

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CIRCUIT LAYOUT AND WIRING (Continued)

Those experimenters who are addicted to breadboard layouts in radio broadcast receiver, amateur transmitter and receiver layouts, soon find that those methods are unworkable where television circuits are concerned.

All component parts of the circuit must be properly positioned to permit short leads. Although neat and compact arrangements are in order, still this policy can be carried out to excess. Mounting all resistors and condensers on a common resistance panel makes for neat and orderly wiring but in many cases such a procedure would cause excessive lead length and much inter-circuit modulation or cross interference.

In the same way, apparatus that is piled up, layer on layer in the interest of the shortest possible leads, also has excessive losses and has been rendered less efficient thereby, due to the excessive capacity between various components. The wiring of the circuit introduces two important factors in its operation, since wires have both inductance and capacitance.

If these factors are in excess it is necessary to reduce greatly the size of the tuning elements themselves so as to include the distributed constants of the wiring. This reduction introduces lowered efficiency and in some cases makes the circuit inoperative.

It would therefore appear as a fundamental rule to keep leads short, unless this practice brings the circuit components excessively close together so that their inter-capacity values are greater than the values that would result with slightly longer wires and greater spacing.

The optimum circuit layout plan for each circuit cannot be defined by hard and fast rules, however.

The effect of longer leads can sometimes be reduced by using smaller sizes of connection wire, and by taking care that they are spaced away from both the chassis and the neighboring apparatus as far as possible.

Except for the cathode ray tube and, where used, magnetic deflection coils, the equipment associated with a television receiver is not greatly different from that embodied in other apparatus, so that the use of items with unknown characteristics is not necessary. Most of the items are inexpensive but an intelligent use must be made of them with due regard to their own breakdown characteristics. The best grade of condensers, voltage dividers, &c., will doubtless save much time in getting the circuit operating satisfactorily.

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PERSONALIZED TELEVISION

As with many other scientific subjects, the principles of television furnish the basis of numerous technical setups which make interesting and instructive hobbies for the experimenter. For example, it is quite possible, with two cathode-ray oscillographs and a photocell, to transmit a photograph over wires, so that it appears on the fluorescent screen of one of them the same as a television picture. The photograph can be an advertising slogan, trademark or pictures, so that an interesting counter or window display is afforded. A short-distance facsimile message transmitting system can also be worked. In fact, the number of ingenious applications for localized wire television are countless.

Since a cheaper form of Iconoscope (the 1847) is now available, moving scenes are entirely practicable without the usual elaborate and expensive setups. This makes feasible the design of simple demonstration setups of television principles for schools and projects for boys' clubs.

If a television receiver or even a cathode-ray oscillograph is available the main difficulties of the apparatus problem are eliminated. It is always well to utilize any available equipment at the start, if possible. The following applications of television principles should be considered in the light of educational hobbies or an interesting display feature for a television and radio salesroom, &c. In the latter case it gives any television receivers on display a full-time schedule instead of only a part-time (at present) operating interval.

If a television receiver and a cathode-ray oscillograph can be used, the easiest plan suggested is the reception of scanned snapshots or other diagrams of a fixed nature, or pictures changed manually at intervals. In addition to the above, the main items are a photocell, lens and an amplifier. The transition to full scanned moving scenes with an Iconoscope camera is a step that can follow.

While the following arranged projects are not difficult for a technically inclined (and the word is "inclined," not "trained") experimenter, it is certainly not feasible for an uninformed television set owner "to mess" around in that receiver trying them out. That is an expensive and dangerous procedure, on account of the high voltages found at certain points in the receiver. These points will be covered in this series.