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Editor
John E. Remich

Managing Editor
Robert L. Gish

Technical Editors
Frederick S. Mohr
Francis R. Sherman
Gail W. Woodward

EDITORIAL OFFICE:
PHILCO CORPORATION
TECHREP DIVISION
22nd and LEHIGH AVENUE
PHILADELPHIA 32, PA.

Editorial

PATENTABLE IDEAS FROM FIELD PERSONNEL

By John E. Remich, Manager, Technical Department

In the past few months, there has been a considerable increase in the number of patentable ideas submitted to Headquarters by Philco Field Engineers. This, of course, is most gratifying, and everyone involved has benefited.

First, considerable credit accrues to the field engineer whose originality, engineering know-how, and alertness are such that he recognizes the need for a new circuit, device, or process; develops an effective answer to the problem; and then communicates the information to Headquarters so that the necessary legal action can be taken.

Second, the vast scope of Philco's activities in the electronics and allied industries, combined with our worldwide Armed Forces field-engineering program, insures that optimum use will be made of new ideas. Many inventions which would otherwise find only limited application, and in some cases be lost entirely, can thus be recorded, developed, and made widely available to industry and the Armed Forces through Philco's research, development, and technical-information facilities.

Finally, the individual field engineer who submits an idea which proves to be patentable is paid a bonus at the time a patent application is filed, and another bonus at the time the patent is issued, provided, of course, that the inventor is still a Philco employee. In those cases where two or more inventors are involved in a single invention, appropriate arrangements are made to compensate each one.

In view of all these facts, we strongly urge that each field engineer submit a descriptive letter on any new circuit, device, or process he develops. Some of the simplest circuits and devices imaginable have, in the past, proved to be patentable inventions, so don't hesitate to submit a disclosure merely because your solution to a problem looks obvious to you. Your idea may be entirely new. One circuit for which a patent application was recently submitted consisted of exactly three resistors connected in a particular manner in an otherwise conventional circuit. (See "Voltage Regulators, Vest-Pocket Style," July, 1951 BULLETIN, page 25.)

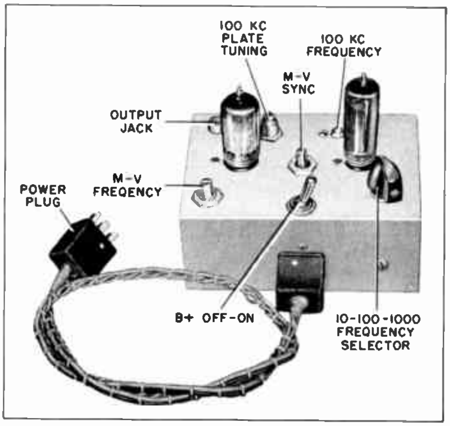
Any technical data intended as an invention disclosure should be prepared as completely as possible, signed, dated, witnessed, and sent to the Technical Information Section, Technical Department, for handling. All security regulations pertaining to transmittal of classified information should, of course, be fully complied with.

A SECONDARY FREQUENCY STANDARD

By John Servetnick
Philco Field Engineer

A simple, easily constructed, secondary frequency standard for use in any application where high accuracy is required for a large number of frequency measurements.

A SECONDARY frequency standard is a device used to measure frequency. The use of the secondary standard alone usually guarantees a fair degree of accuracy in the frequency measurements, but if checked frequently against some primary standard, such as Radio Station WWV,* precision frequency measurement is possible. For example, the device described in this article is capable of making measurements with an accuracy of five parts in ten million.



Top View of Secondary Frequency Standard, Showing Location of Adjustments and Controls

CONSTRUCTION

The secondary standard described in this article is of the signal-generation type, and is shown in figure 1 in block form. Three basic signal generators are

*See the August-September (1951) issue of the BULLETIN.

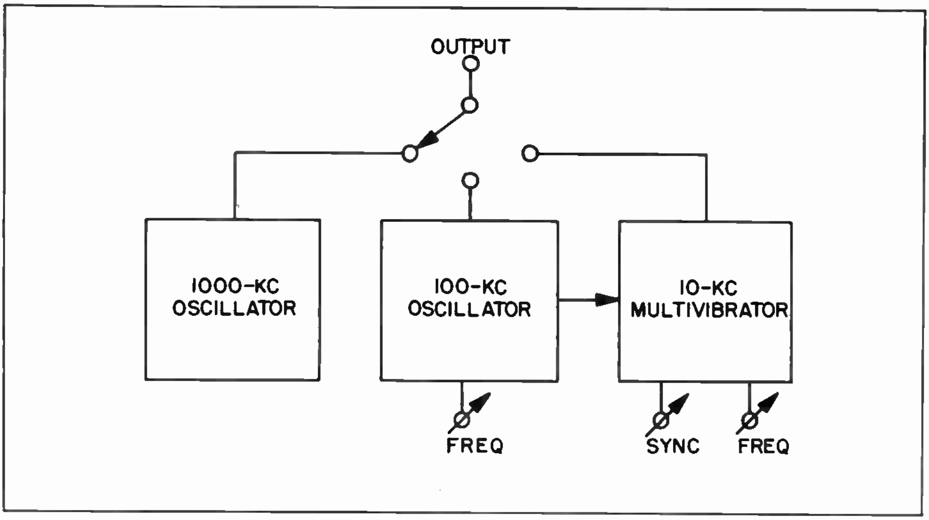
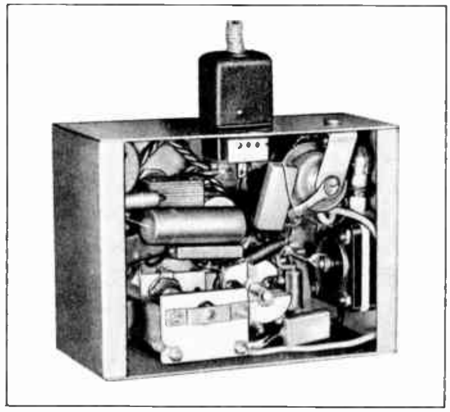


Figure 1. Block Diagram of Secondary Frequency Standard

used: one produces a 1000-kc. fundamental, another produces a 100-kc. fundamental, and third produces a 10-kc. fundamental. Each circuit is designed to produce a highly distorted output which contains a great number of harmonics. If the 10-kc. output is considered, with its harmonics, it can be seen that no frequency exists (within the usable harmonic limits) which differs by more than 5 kc. from one of the harmonics. Therefore, if the frequency difference between the signal to be measured and the nearest 10-kc. harmonic is found, and the harmonic number is determined, the signal frequency itself can be known.

Figure 2 shows the complete schematic diagram of an easily constructed secondary standard. The signal source is stabilized by the use of a dual-mode crystal which can be made to oscillate at either



Bottom View of Secondary Frequency Standard, Showing Location of Parts

100 kc. or 1000 kc. by tuning the oscillator tank circuit to the appropriate frequency. Since the 1000-kc. circuit is to

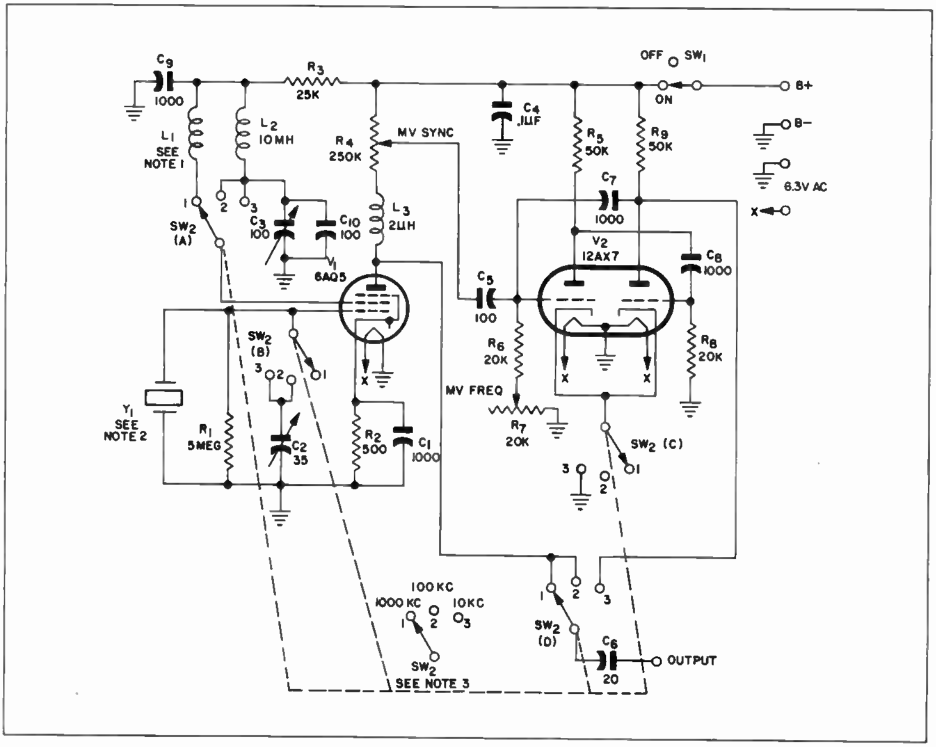


Figure 2. Schematic Diagram of Secondary Frequency Standard

Notes: 1. L_1 is one section of a 4-section, 2.5-MH., r-f choke.
2. Y_1 is dual-mode crystal—100 kc. and 1000 kc. (Bliley SMC-100).
3. SW_2 is a 4-pole, 3-position, rotary switch (Mallory 3243 J).

be used only as a rough check, extreme accuracy is not important, and no special provisions for its adjustment are included. The 100-kc. circuit is provided with a crystal-trimmer capacitor as well as an adjustable tank capacitor to allow a precise adjustment of the 100-kc. signal. (The dual-mode crystal is built to oscillate slightly above 100 kc., and the trimmer provides sufficient range of operation to obtain frequencies either slightly above or slightly below 100 kc.)

For the 10-kc. position, a 10-kc. multivibrator is provided, with its tenth harmonic synchronized by the 100-kc. oscillator. Thus the crystal not only provides 1000-kc. and 100-kc. signals, but it also controls the accuracy of the 10-kc. multivibrator. In practice, the multivibrator is adjusted without sync to a frequency below 10 kc., and then the sync level is raised until the multivibrator "locks in" at exactly 10 kc.

The circuits used are conventional, and power can be obtained from a small, separate power supply, or from a communications receiver. Switch S_1 removes B+ from the circuit when no signal is required. It is a good practice to allow the heaters to operate continuously as a means of maintaining operating temperature. This practice will minimize frequency drift during warm-up.

CALIBRATION OF STANDARD

Before the secondary standard is placed in service, it must be given an extended warm-up (several hours), to allow proper "aging" of components. (This must also be done after the replacement of any component, but for a normal use, only a 15-minute warm-up is required.) Before each series of critical frequency measurements, the standard must be calibrated in accordance with the following step-by-step procedure.

After a sufficient warm-up, the standard should be loosely coupled to a communications receiver which has been tuned to Station WWV. Then proceed as follows:

1. Switch standard to 1000 kc., and observe beat note. On WWV's 5-mc. channel, the 1000-kc. crystal tolerance of 0.05% should result in a beat frequency of less than 2500 c.p.s.
2. Switch standard to 100 kc.
3. Adjust C_2 for zero beat. (It may be necessary to adjust C_3 for proper oscillation of the 100-kc. crystal. This can easily be established by turning the B+ switch, SW_1, off and on—when C_3 is properly adjusted, the oscillator will start readily.)
4. Switch standard to 10 kc.
5. Couple output of standard to oscilloscope vertical input, and connect an ac-

JOHN SERVETNICK, a native of Haverhill, Mass.,

received his first electronics training at Fort Monmouth, New Jersey, in 1946, after which he spent 10 months in Japan, maintaining communications equipment. Upon his discharge from the Service, he continued his training in electronics by successfully completing the course at Valparaiso Technical Institute, Valparaiso, Ind. Additional maintenance experience was gained at Kelly Field, where he was employed as a repairman of airborne radar test equipment for the Air Force. John is a recent addition to the TechRep Division, having joined Philco in August, 1951, and is currently working with the Strategic Air Command, in Louisiana.

curately calibrated audio oscillator to oscilloscope horizontal input.

6. Adjust MV FREQ (R_7) to center position.

7. Adjust MV SYNC (R_4) for a 10-kc. output, as indicated by scope and audio oscillator. (It should be possible to obtain several stable multivibrator frequencies. For example, 11.111 kc. and 9.111 kc. represent sync on the ninth and eleventh harmonics, respectively—the tenth harmonic is the correct one.)

8. Rotate MV FREQ (R_7), and observe the two extreme points where the frequency suddenly shifts away from 10 kc. Position the adjustment midway between the two observed extremes.

9. Switch standard to 1000 kc., 100 kc., and back to 10 kc. The circuit should rapidly stabilize at 10 kc.

10. Recheck step 8.

The secondary standard is now ready for precision frequency measurement.

CALIBRATION OF AUDIO OSCILLATOR

Since the final measurement accuracy will depend upon an accurately calibrated audio oscillator, and since step 5 of the above-given "Calibration of Standard" procedure requires this also, the following calibration procedure is given:

1. Tune a communications receiver to the most stable WWV frequency.

2. Connect receiver output to vertical input of oscilloscope.

3. Connect audio oscillator to horizontal input of oscilloscope.

4. Wait for 600-c.p.s. WWV transmission (see schedule), and calibrate audio oscillator in multiples and submultiples of 600 c.p.s., using Lissajous oscilloscope patterns. (By using patterns up to a 10-to-1 ratio, the audio oscillator can be accurately calibrated from 60 c.p.s. to 6000 c.p.s.)

OPERATION

Figure 3 shows the setup most suitable for use of the secondary standard. The communications receiver serves as a detector, and as a means of identifying the signal to be measured.

When it is desired to measure the frequency of a received signal, proceed as follows:

1. Tune receiver for maximum received signal, and note approximate frequency.

2. Turn on standard, and set for 1000-kc. output.

3. Tune receiver to nearest 1000-kc. harmonic.

4. Switch standard to 100-kc. output.

5. Tune receiver back toward signal frequency, noting how many 100-kc. check points are passed, until 100-kc. point nearest signal frequency is found.

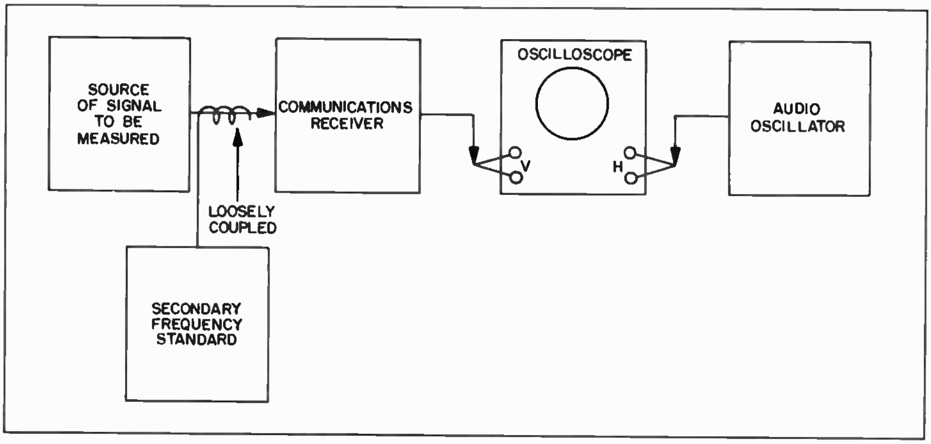


Figure 3. Block Diagram of Frequency-Measurement Setup

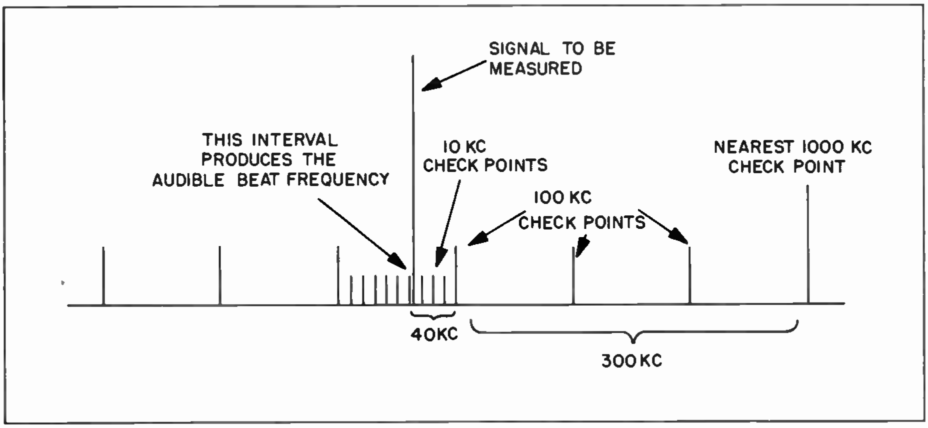


Figure 4. Frequency Relationship of Output Signals of Secondary Frequency Standard

6. Switch standard to 10-kc. output.

7. Continue tuning receiver toward signal frequency until 10-kc. check point nearest signal frequency is found, noting how many 10-kc. check points are passed (this will result in an audible beat frequency of 5 kc. or less—two beats may be heard, but one will be higher in frequency than 5 kc.).

8. Observe beat frequency as vertical deflection on oscilloscope, and tune audio oscillator until a pattern as nearly circular as possible is obtained.

9. Read audio-oscillator dial, and compute frequency of unknown signal as follows:

a. Add total number of 100-kc. check points found in step 5, and multiply this number by 100 kc.

b. Add total number of 10-kc. check points found in step 7, and multiply this number by 10 kc.

c. Combine frequencies in above-given steps 9a and 9b.

d. If signal frequency is above the 1000-kc. check point of step 3, *add* the figure obtained in step 9c to the frequency of the step-3 check point. If signal frequency is below, *subtract*.

e. If loudest beat obtained in step 7 is found at a receiver dial setting above that of step 1, *add* audio-oscillator reading to frequency obtained in step 9d. If loudest beat obtained in step 7 is found at a dial setting below that of step 1, *subtract* audio-oscillator reading from frequency obtained in step 9d.

The above-given procedure can be visualized with the aid of figure 4. The horizontal axis can be thought of as a receiver dial, with the signal to be measured indicated by the long vertical line in the center of the drawing. Actually the 10-kc. check points would exist all along the diagram, but, for simplicity, only the ones in the region of the signal are shown. The long marker at the right represents the nearest 1000-kc. check point, and we will assume that it is the 3-mc. point on the receiver dial.

As the receiver is tuned from right to left, three 100-kc. check points are passed, after which three 10-kc. check points are passed and a fourth one contacted in order to obtain the strongest beat note. This beat note now represents the difference in frequency between the signal and the nearest 10-kc. check point. We will assume that in the example shown in figure 4 the audio beat frequency has been found to be 3300 c.p.s. To find the exact signal frequency, it is necessary to add the 300-kc. interval to the 40-kc. interval, and then to subtract the 340 kc.

from 3 mc. This results in a frequency of 2660 kc. Since the audio beat was more pronounced when the receiver was tuned to the 10-kc. check point below the signal frequency, it is apparent that the beat interval (3300 c.p.s.) must be added to 2660 kc., thus giving an exact frequency of 2663.3 kc. as the signal frequency.

AURAL INDICATION

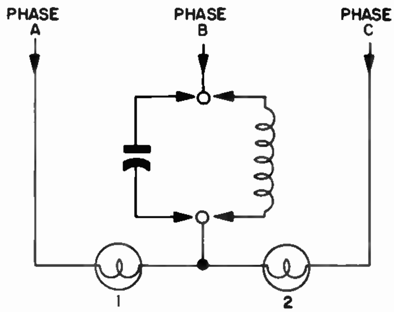
The foregoing procedures indicated the use of an oscilloscope for accurate measurement, but, while this is the best method, a simpler system has been used with great success. This simpler system consists of listening to the beat-note output while simultaneously listening to the audio oscillator. The ear can be used to detect zero beat, instead of using an oscilloscope for this purpose.

The easiest way to use the aural method is to connect one earphone of a conventional headset to the communications-receiver output and the other earphone to the audio-oscillator output. The beat frequency (difference) can easily be heard, and is most pronounced when the two earphones operate at the same sound level.

• • •

PHASE-SEQUENCE TESTER

The phase sequence in a three-phase circuit may easily be determined by means of the circuit shown. In the line connected to phase B, either a capacitor or an inductor is used. The reactance



should equal the resistance of one of the lamps.

For example, on a 400-cycle circuit, using 25-watt lamps, a 0.7-*uf.* capacitor should be used. If a 50-watt lamp is used, a 1.4-*uf.* capacitor is required. The phase rotation will be indicated by one lamp's burning more brightly than the other.

When a capacitor is used in the circuit, lamp 1 will be more brilliant for phase sequence A-C-B, and lamp 2 will be more brilliant for phase sequence A-B-C. If an inductor is used instead of a capacitor, lamp 2 will be more brilliant for phase sequence A-C-B, and lamp 1 for phase sequence A-B-C.

Robert E. Miller
Philco Field Engineer ComAirPac

GYRO PRECESSION and AUTOMATIC GYRO ERECTION

(Editor's Note: This article is appearing in the BULLETIN because of a number of requests from the field for data on the basic theory of gyro action. We feel that the problem is of interest to a great many of our readers, and in keeping with our policy of publishing information of greatest interest to the greatest number of readers, here is another answer to "Letters from the Field.")

ASSUME that the gyro is rotating as shown by the curved arrows in figure 1. As soon as the pressure is applied as shown, a slight tilting motion to the right will result. As soon as there is any tilt at all, that part of the periphery of the wheel that is toward the observer would be traveling downhill. Point A represents a point on the periphery of the wheel, and F_1 indicates the normal direction this point would take. However, if the wheel becomes tilted, point A assumes a new, or altered, direction, which tends downward; thus all points on the exposed periphery of the wheel tend downward. This represents a departure from the original motion—hence the force of inertia comes into play.

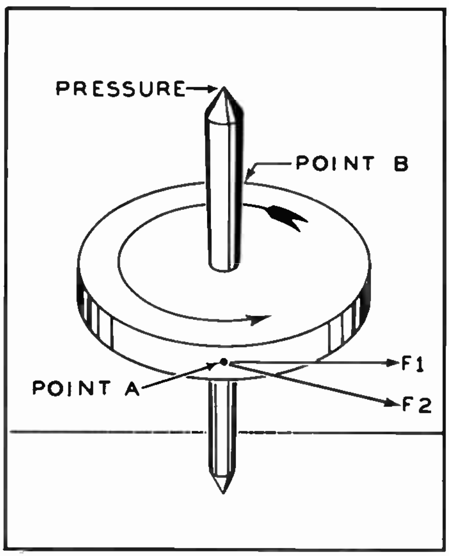


Figure 1. Simple Gyro Rotor, Showing Precession Forces

Anyone who has ridden in a car while it was traveling at high speed over a slight depression in the road has noticed that the downward motion of the car results in an effective upward thrust, or a lessening of weight, and as the car is subsequently thrust upward, a resultant downward force, or increase in weight, results. The gyro acts upon this principle.

When point A tends downward (F_2 vector), it will receive an upward thrust because of the inertia of the wheel. The value of this thrust depends upon three things: the rotational velocity, the moment of inertia, and the pressure applied. If attention is directed to point B, it will be found that so far as the observer is concerned, the direction of travel is reversed, and the wheel tilt shown will result in a downward thrust at point B when the pressure is applied as before.

Since point A is thrust upward and point B downward, the resulting motion will tend to push the upper pivot away from the observer, or at right angles to the applied pressure. This is precession.

If a toy top is allowed to spin, it will develop a circular, or more accurately, a spiral, wobble. This is due to the fact that as the top slows down, a point is reached where it starts to tilt under the influence of gravity. The tilt causes a motion (precession) at right angles to the tilt, which causes motion again at right angles. The action is relatively slow, and becomes more and more pronounced as the top slows. The increasing degree of wobble is due to the fact that the reduction of inertia caused by slower speed requires that the top achieve greater tilt for the same degree of precession; as mentioned previously, precession force is a function of rotational velocity.

AUTOMATIC GYRO ERECTION

This discussion brings the action of automatic gyro erection into the foreground. One common form of automatic erection is produced by the action of a ball bearing which is driven around a raceway attached to the gyro assembly. Figure 2 shows a rough sketch of this device.

The ball bearing is caused to move around the raceway by the same drive force used to rotate the gyro, and an escapement mechànism establishes the period of revolution at a relatively low value (much slower than gyro rotation).

To show the erection action, assume that the entire assembly is tilted toward the observer. This means that as the ball bearing moves past point A, it is moving downward, thus causing a lessened downward (or an effective upward) force to appear at point A. This tends to cause the entire assembly to tilt to the right. Of course, as the ball moves past point C, it is going upward, thus exerting a downward force which also aids the tilt of the entire assembly. The tilt resulting from the action of the ball bearing causes point B on the gyro to move downward (in comparison to its normal motion), and the resultant upward force (precession) at B tends to tilt the entire assembly away from the observer and to restore it to a vertical position. This action can be extended and applied to gyro tilt in any direction—the resultant force produced by the erection mechanism is always opposite to the direction of the causative tilt.

As long as a true vertical position is maintained, no tilting is present; hence, no corrective action is produced by the

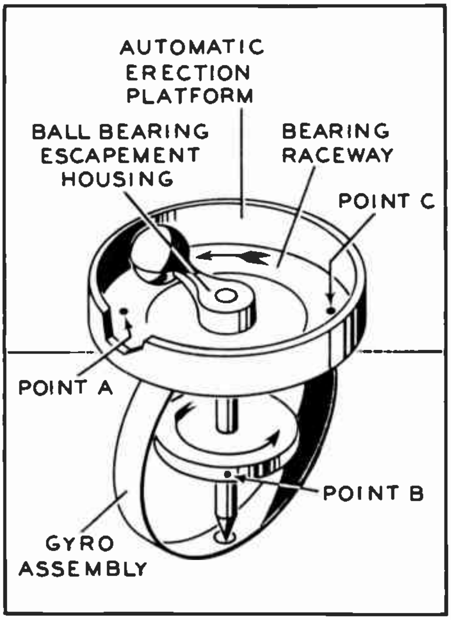


Figure 2. Gyro Assembly with Automatic Erection Mechanism

ball bearing. Any departure from vertical, with respect to the earth's center, is automatically corrected.

Another similar form of automatic erection has been used in connection with the gyro which furnishes artificial-horizon data for airborne antenna tilt stabilization. This gyro assembly is mounted upon a rotating antenna system, and the antenna rotation is used to impart motion to the ball bearing (a ratchet device is often included to prevent the ball from moving in the wrong direction). In this case, if the gyro is not erect, the ball will be moving uphill on one half of the track, and downhill on the other half. Of course, with no speed regulation, the ball will roll more slowly uphill and more rapidly downhill. Therefore, the weight of the ball acts *longer* on the uphill path than on the downhill path, and thus causes an effective force at right angles to the direction of tilt. The rest of the erection process occurs as described above.

GAIL W. WOODWARD,
Technical Information Section

A TESTER FOR VB-16 VIBRATORS

By W. E. DuVall
Philco Field Engineer

Proper adjustment of vibrator VB-16, as accomplished with this tester, corrects difficulties encountered when PE-237 is used on 24 volts.

RADIO SETS SCR-694 and AN/GRC-9 have developed considerable trouble recently when installed in vehicles with the new 24-volt system. These equipments are designed to operate on 6, 12, or 24 volts, and although they have operated successfully on the lower voltages, power supply PE-237 would fail when used in vehicles with the 24-volt system.

To find out what was causing these failures, one of the SCR-694 sets was taken into the local maintenance shop, where extensive tests were made. The trouble was found to be misadjustment of vibrator VB-16, which is located in the transmitter section of the power supply. In addition, a large number of new, stock vibrators were checked, and these also were found to be out of adjustment.

This condition presented a definite need for a vibrator tester that could be used to adjust and test VB-16. Since there was no unit available, the simple vibrator tester described here was built. The base and case of an old vibrator was used in the construction of this new tester. The unit was designed so that the vibrator and the power supply could be tested without the necessity for removing the power supply from its case. In addition to the tester, an oscilloscope, and a voltmeter capable of reading up to 1000 volts d.c. are required in the test procedure.

CONSTRUCTION OF THE TESTER

The case and plug from an old vibrator, VB-16, are the major components of the tester. To remove the case from the vibrator, the two screws on the bottom, and pins 13 and 14 (see figure 2) are removed, permitting the vibrator to slide out of the case. Next, the vibrator and base plug are separated by cutting, with a saw, the leads to the pins.

The case is now ready for further modification. First, cut a hole large enough to clear all the connections to the 732 socket. This can be done either by using a circle cutter, or by drilling closely spaced holes to form the desired circle. Holes are also drilled in the side of the case for the selector switch and the two pin jacks. The switch and jacks that are locally available will determine the sizes of the holes. It is desirable that these jacks and switch be mounted as close to the top of the case as the parts will allow. Figures 3, 4, and 6 indicate the location of the parts.

Assembly of the tester begins with the mounting of the pin jacks and the switch. The tester is then wired according to the schematic diagram shown in figure 2.

Figure 1. Bottom View of Vibrator VB-16, Showing Pin Arrangement

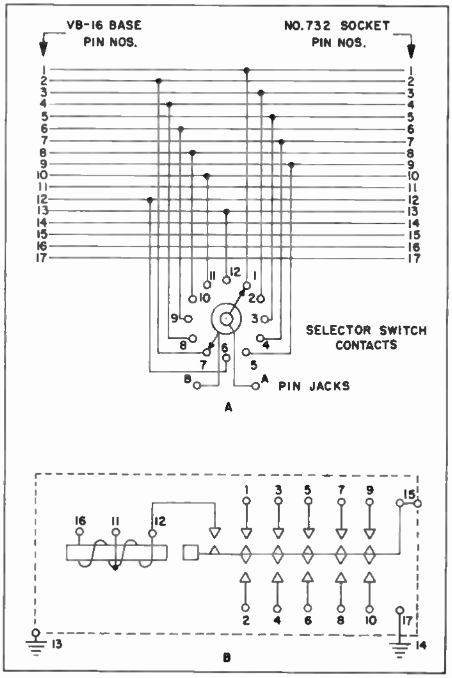


Figure 2. Schematic Diagrams of (A) Vibrator Tester (B) Vibrator VB-16

When the wiring is completed, the base plug is mounted by replacing pins 13 and 14 and the two screws; the 732 socket is mounted by means of self-tapping metal screws.

TEST SETUP

To test vibrators VB-16 with the tester, a PE-237 power supply which is known to be in good condition is placed on the test bench. This power supply is then connected to an SCR-694 or to an AN/GRC-9 by means of the regular power cable. Push the OFF button on the PE-237, and connect the power leads to a 12-volt, d-c power source. Caution: *Never perform any preliminary adjustments with the equipment connected to 24 volts.*

Remove the cover of the power supply and take out the VB-16 vibrator. Insert the tester in the vibrator socket, and plug the vibrator to be tested into the socket on top of the tester. Make connections from the tester to an oscilloscope, as shown in figures 5 and 6. The voltmeter is connected to pins 21 and 32 of the power-output plug. There is a terminal strip, with corresponding pin markings, connected in parallel with the power-output plug, and located directly above the plug. This provides a readily accessible point to connect the voltmeter test leads. Everything is now ready for testing and adjusting the vibrator.

TEST PROCEDURE

Turn the oscilloscope on, and allow it to warm up. While the oscilloscope is warming up, turn on the power-supply unit by pushing the ON button, turn the PHONE-MCW-CW switch on the transmitter to the CW position, and turn the OFF-SEND-STANDBY control to the SEND position.

When the oscilloscope has warmed up, adjust the sweep frequency until a stationary pattern is obtained. (It is usually necessary to apply internal synchronization.) Adjust the vertical amplitude so

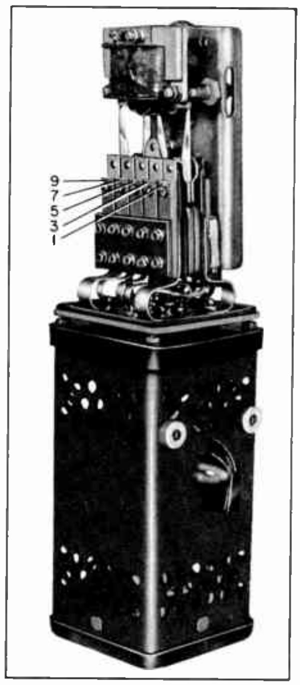


Figure 3. Left-Side View of Vibrator, Showing Contact Adjustments

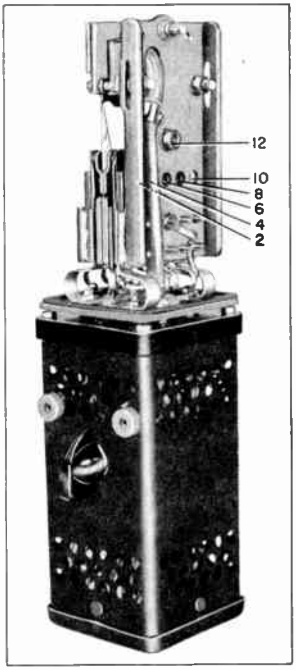


Figure 4. Right-Side View of Vibrator, Showing Contact Adjustments

that the trace is approximately 1 inch high.

Next, set the selector switch on the vibrator tester to position 1, and adjust contact 1 (figure 3) and contact 2 (figure 4) until a waveform similar to that shown in figure 7A is obtained.

Similar adjustments are performed on each pair of contacts, for each position of the selector switch through position 5. Waveforms observed on each position should be similar to figure 7A. Next, the switch is turned to position 6, and the observed waveform should be similar to figure 7B.

It is quite possible that the waveforms will appear inverted rather than as shown in figures 7A and 7B. If this happens, the waveforms may be reinverted by reversing the leads to the tester, or by changing the polarity of the sync signal in the oscilloscope.

With the vibrator correctly adjusted on 12 volts, turn off the power supply, and change the voltage-selector switch to

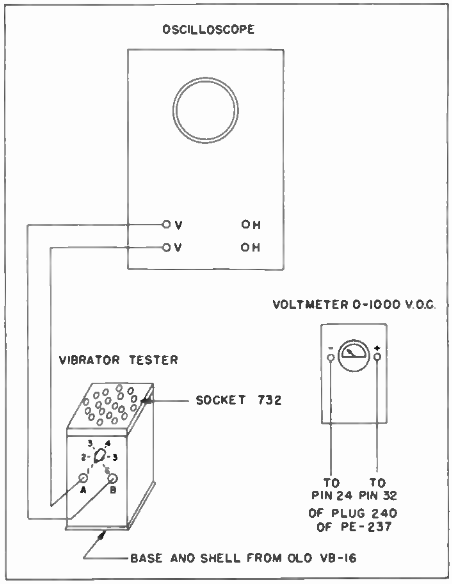
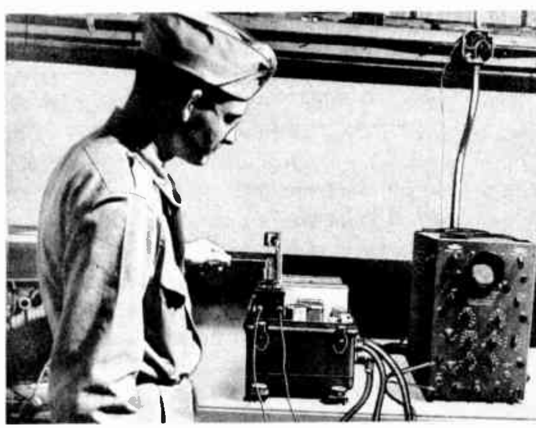


Figure 5. Wiring Diagram of Test Setup

the 24-volt position. Disconnect the power leads from the 12-volt source, and connect them to the 24-volt source. Then turn on the set, and observe the waveforms and the voltage output for each position of the selector switch. The waveforms should be the same as those observed on 12-volt operation, and the voltmeter should read 550 volts. Some adjustments may be necessary in order

Figure 6. Tester Being Used in Adjustment of VB-16 Vibrator



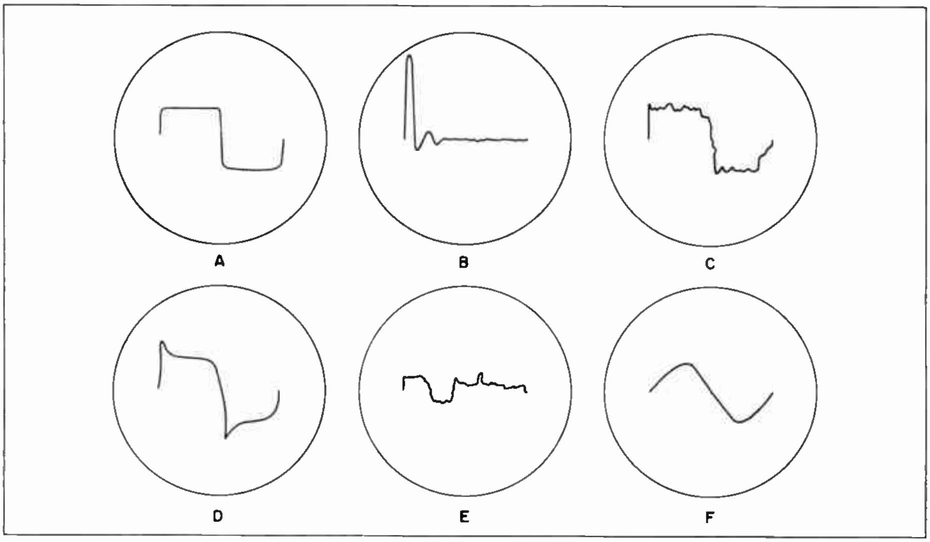


Figure 7. Waveforms Seen During Adjustment of Vibrator or Trouble-Shooting of Power Supply

A. Proper Adjustment for Switch Positions 1 through 5
B. Proper Adjustment for Switch Position 6
C. Sparking at the Contacts, Caused by Bouncing or Dirty Contacts
D. Bad Buffer Capacitor
E. Short Circuit in Power Supply
F. Open Contacts or Open Winding

to get either the correct waveform or the 550-volt output. When these are obtained, the vibrator can be put back in its case, and is then ready for 24-volt operation.

TESTING POWER SUPPLY

While the tester was designed primarily to facilitate the adjustment of vibrator VB-16, it can also be used for locating trouble in the power supply. This requires use of a vibrator that is known to be properly adjusted. Then, by observing the waveforms on various positions of the tester, individual troubles will be indicated by characteristic waveforms. The waveforms shown in figures 7C, 7D, 7E, and 7F indicate some of the more common troubles. It should be realized that there are a great number of variations in waveforms from those shown in figure 7. With practice, the engineer will find it a simple matter to diagnose trouble in the power supply by this method.

TABLE I PARTS LIST FOR VIBRATOR TESTER

Quantity	Item	Signal Corps Stock No.
1 ea.	Socket, vibrator, No. 732	2Z8687-3
1 ea.	Switch, rotary, 6-position	
2 ea.	Jack, phone	
1 ea.	Vibrator, VB-16 (case and base)	346694-11
As req.	Miscellaneous screws, wire, and solder	

A Field Fabricated TWO-PATH-POLAR LINE UNIT

By *Edward H. Dingman*
Philco Field Engineer

A field substitute for the TG-30 or OA-6 FC telegraph repeaters.

European teletype circuits, particularly those of the French P.T.T., provide a half-duplex, two-path-polar termination to the subscriber. This consists of metallic send and receive lines, with common earth return. A current of 18 to 20 ma. is required for these circuits. Contrary to American-British standards, the French use positive marking signals and negative spacing signals. The line voltage should not exceed 48 volts to ground, or 96 volts between send and receive lines, on reversals. The subscriber furnishes the send current and the telegraph company furnishes the receive current, but there is no certainty that the subscriber will be furnished an 18 to 20 ma. signal, and, in practice, the value of the signal current proves sometimes to be much less. Therefore, it is necessary to keep the receive relay of the line unit adjusted for maximum sensitivity.

The most common types of repeaters used on European, two-path-polar systems are the type TG-30 and type OA-6 line units, both of which must be modified to operate on reversed polarity and reduced receive current. In the event that it becomes necessary to activate a circuit and no suitable line unit or repeater is available, a substitute can be easily constructed from four vacuum tubes, a pair of jacks for the teletype send and receive cords, a few resistors,

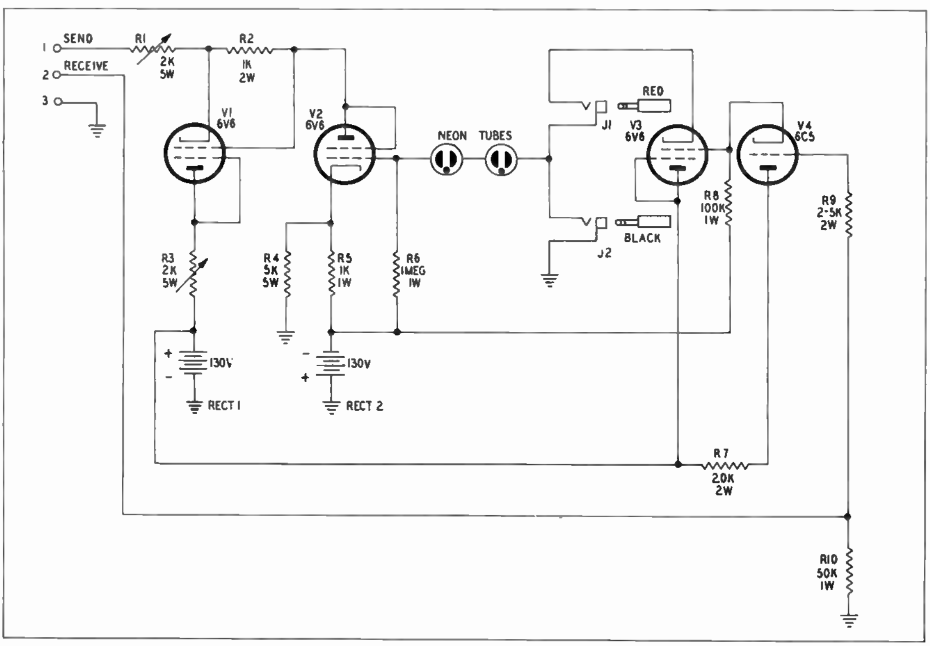


Figure 1. Schematic Diagram of Two-Path-Polar Line Unit

EDWARD H. DINGMAN, who was born May 13, 1917, in Salem, Oregon, first entered electronics while still in high school. As a Signal Corps reservist, he received training in radio and radar theory and design.

Entering the Air Force in 1943, he received further training at Boca Raton, Fla., and Scott Field, Ill.; he served as an instructor at Boca Raton, and at Truax Field, Wis. Later he was attached to the Manhattan Project, first at Purdue University, and then at Albuquerque, N. Mex.

Upon his release from the Air Force, in 1946, he attended Oregon State University, where he majored in physics. In 1948 he joined Philco, and was sent to the Far East on a 21-month AACS assignment which involved the planning and engineering of AACS communication sites. On his second assignment, from which he has just returned, he spent 18 months in Germany and France, again with AACS. He is currently at Philadelphia, awaiting new orders.

and a pair of RA-87's, or similar type of teletype power supplies. In one test, the pilot model of this device operated steadily for three months, and no tube weakening was observed. It is likely that a full year's life could be expected.

THEORY OF OPERATION

The receive circuit is quite simple. The positive marking voltage causes V_4 to conduct, which places the control grid of V_3 at a positive potential. This ensures the providing of the necessary holding current on a marking signal. On a spacing signal, V_4 is cut off, and the control grid of V_3 is swung negative because it is connected, through R_8, to the negative side of rectifier 2. This improves the waveshape on interruptions (spacing) of the holding current. If a suitable signal voltage is provided, V_4 can often be eliminated, and the input signal applied directly to the control grid of V_3. It is necessary, however, to prevent excessive grid current from being drawn, as otherwise control of the tube may be lost. A limiting resistor (R_9) can be used for this purpose.

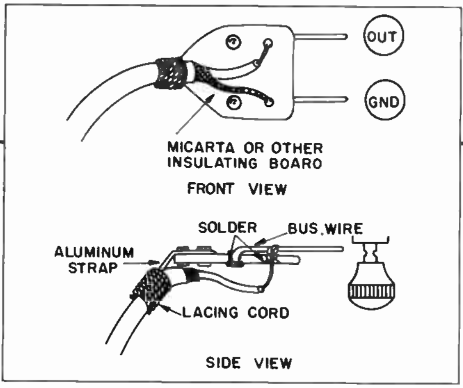
The send circuit is equally simple. V_1 and V_2 are connected as gate tubes which are arranged to provide to the send circuit a positive marking voltage and a negative spacing voltage. V_1 normally conducts, and is held to 20 ma. by R_1. R_3 is used to balance V_1 and V_2. During a "spacing" condition, V_2 conducts, and biases V_1 to cutoff by applying the voltage drop across R_2 to the control grid of V_1. During a "marking" condition, V_2 is held at cutoff by the bias developed across R_5. This resistor is shunted to ground by R_4. The control grid of V_2 is returned through R_6, to a point between R_5 and the negative voltage source. Two ¼-watt neon tubes are used to remove this negative voltage from V_2 by applying a positive voltage from the positive-voltage source to the control grid. This operates as follows: As long as the neon tubes are terminated to ground through the keyboard of a teletype, or a transmitter distributer, the neon bulbs only have about 130 volts applied across them. This is not sufficient to cause ionization. When the teletype is keyed, however, the connection to ground is removed from these bulbs, and about 200 volts are applied from rectifier 1 through V_3 and the selector magnet of the printer. This causes breakdown, and the bulbs remain ionized for as long as the circuit between the bulbs and ground is held open. The conduction of the bulbs results in swinging the control grid of V_2 positive, cutting off plate current through V_1, and sending a spacing signal to the line. The power supplies must be sufficiently well regulated to prevent the voltage from going high enough to cause the neon tubes to remain ionized on a marking condition.

When this system is used with an M19 machine, the tip and sleeve connections of the red and black jacks must be correct, or the polar relay will, when receiving a marking signal, be held in the spacing position because of reversed current in the line winding.

If this line unit is used for sending only, it is necessary to apply a positive holding voltage to the grid of V_3. This is easily accomplished by putting a jumper between the cathode and plate of V_4.

A number of variations of this device are, of course, possible, and several of them have occurred to the author, but have not been developed because the operation of the circuit described in this article has been completely satisfactory.

CABLE CONNECTOR



Cable Connector (Front and Side Views)

The connector shown in the illustration is designed for use on test-equipment cables that require a signal lead and a ground connection. The design permits rapid connection of these leads to the test equipment, and eliminates all flexing of the cable from the soldered connections, thus lengthening the useful life of the connector.

The construction of the connector is very simple. A piece of micarta or other insulating board forms the main part. Two pieces of bus wire form the connector prongs, whose spacing is determined by the spacing between the binding posts on the test equipment to be used. The holes where the bus wires pass through the micarta are countersunk and filled with solder, to secure the wires to the strip. An aluminum strap is bolted to the connector, and the cable is laced to it, as shown. This removes all strain from the soldered connections.

Harold Newman
Philco Field Engineer

THE MODEL 623B MICROWAVE TEST SET

By Lloyd S. Freeman
Hq. Technical Staff

A description of the technical characteristics of the new Philco Model 623B Microwave Test Set.

(Editor's Note: Since Philco Microwave Radio Relay Equipments are now reaching the field in large numbers, we are receiving an increasing number of requests for information pertaining to field maintenance of this equipment. We intend to print as much practical information on this subject as space permits.)

FOR PROPER ALIGNMENT of the Philco CLR-6 microwave relay equipment, certain tools are essential, and the Model 623B Microwave Test Set (figure 1) is probably the most valuable of these. It has been designed specifically for testing microwave relay equipment.

This instrument is actually three basic test equipments in a single package—it may be used as a power meter, as a frequency meter, and as a microwave signal generator. The test set requires 150 watts of power, from a 115-volt, 50/60-cycle source, and weighs about 52 pounds. It may be supplied for use on any one of six frequency ranges, as follows:

5925-6225 mc.	6850-7150 mc.
6125-6425 mc.	7125-7425 mc.
6575-6875 mc.	7425-7725 mc.

Figure 2 is a block diagram of the test set, showing the major components. The oscillator tube is a Varian, X-26 series, reflex klystron, with the cavity-tuning and repeller-voltage controls on the front panel. Each klystron of this series covers a 300-mc. band of frequencies.

The output of the klystron is waveguide-coupled to a coaxial switch, through a fixed pad and a variable attenuator. In the CALIBRATE position the coaxial switch connects the klystron output to the frequency meter (cavity type) and power meter, and in the OPERATE position, to the front-panel OUTPUT jack. The fixed pad provides a 30-db attenuation, while the variable attenuator can be adjusted from 0 db to 70 db (the 0-db level is 1 milliwatt).

Figure 1. Philco Model 623B Microwave Test Set

With the coaxial switch in the CALIBRATE position, the power output of the oscillator can be accurately adjusted to the 1-milliwatt level by means of the power meter, and the oscillator frequency can be adjusted with the aid of the frequency meter. A 1000-cycle audio oscillator (phase-shift type) is included so that the klystron may be frequency-modulated to a maximum of at least ± 15 mc. Deviation is adjusted by means of a front-panel deviation control. A phasing control, also located on the front panel, allows adjustment for a single-trace mode pattern during the sweeping of the klystron.

With the coaxial switch in the OPERATE position, the output of the klystron is available at the OUTPUT jack through the fixed pad and the calibrated variable

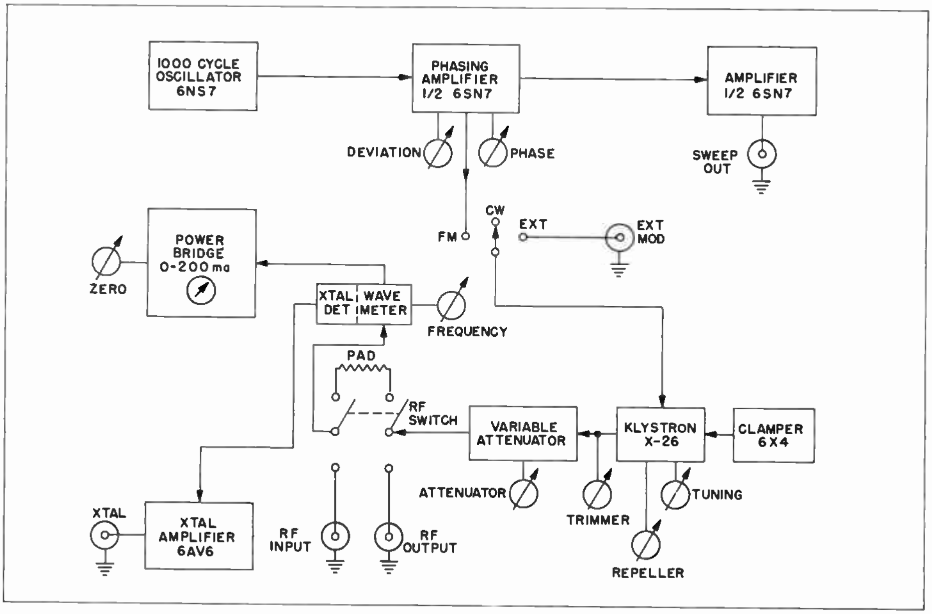


Figure 2. Block Diagram of Test Set

attenuator. Also, an external microwave signal may be fed into the test-set power meter and the frequency meter through the OUTPUT jack. In each case, the INPUT and OUTPUT cables provided with the test set must be used, because the calibration includes specific cable-loss values. A wave-guide-to-coaxial transition is furnished with each cable.

The bridge-type power meter, which has an accuracy of ± 1 db, incorporates three thermistors, two used to compensate for temperature and sensitivity drift, and one used as an r-f power absorbing device. Power levels up to a maximum of 2 milliwatts (3 db above the reference level of 1 milliwatt), can be measured directly.

The frequency meter is of the cavity absorption type, with micrometer drive. It is calibrated for the entire range from 5825 mc. to 7725 mc. This calibration is accurate within 0.03% at an ambient temperature of 25°C. The cavity coupling is adjusted so that a minimum dip of 2 db is obtained at the resonant frequency of the frequency meter.

The test set includes a crystal detector, followed by a stage of amplification, the output of which is available at a front-panel jack. This design allows presentation of a klystron power mode on an oscilloscope, and permits accurate frequency adjustment by means of the frequency-meter absorption pip.

TELEVISION INTERFERENCE ELIMINATION

By *Gail W. Woodward*
Hq. Technical Staff

A discussion of some of the more common causes and cures of TVI.

(Editor's Note: As we indicated in "In Coming Issues" last month, this article grew out of an answer to a field inquiry on the subject, and was not strictly a part of our scheduled series of TV articles which began in the last issue. However, since so many of our readers are located in television reception areas, and since TVI is a considerable problem in many of these areas, we think the article is appropriate.)

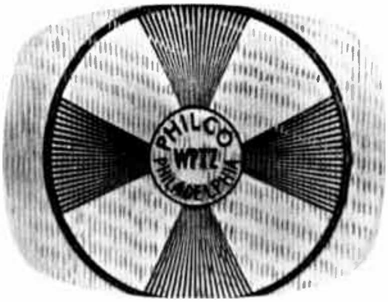


Figure 1. Beat-Interference Pattern

TELEVISION INTERFERENCE has proved to be one of the most difficult problems encountered in the field, and the elimination of this problem is one case where the technician's ability to think is of paramount importance.

Curing TVI requires three definite steps, as follows:

1. **Identify the interference as completely as possible.**
2. **Locate the pickup point, and the source of the interference.**
3. **Decide upon the nature of the cure, and apply it at the expedient point.**

IDENTIFYING THE INTERFERENCE

Step 1 requires general experience in TVI — for example, a c-w signal can cause a bar pattern (either horizontal, slanting, or vertical) to appear upon the picture (see figure 1); auto ignition causes a series of random black streaks (sometimes followed by white overshoot) over the entire picture; diathermy causes a herringbone pattern to appear in a horizontal bar-segment across the picture, as shown in figure 2 (the segment sometimes rides up or down if the TV program emanates from a remote source);* and FM interference produces a pattern of wavy lines which may change configuration during modulation.

During this step, the technician must determine whether the TV receiver itself is the source of the trouble. Simply assuming that the receiver is OK is an error that is often committed, inasmuch as oscillation, signal-lead radiation or pickup, or h-v corona can cause symptoms similar to those produced by external interference. The writer, for instance, has encountered several cases where an oscillating r-f amplifier pro-

**(Editor's Note: This results from the fact that the vertical sweep circuits are synchronized to the power-line frequency, both in the pickup camera and in the receiver. If the pickup camera is not connected to the same power source as the receiver, it is highly probable that a slight difference in frequency may exist between the two sweep rates. Such a difference will cause the bar-segment to traverse the picture at a rate determined by the frequency difference. For example, if the two frequencies are 60 c.p.s. and 60.1 c.p.s., respectively, then the segment will traverse the picture once every 10 seconds.)*

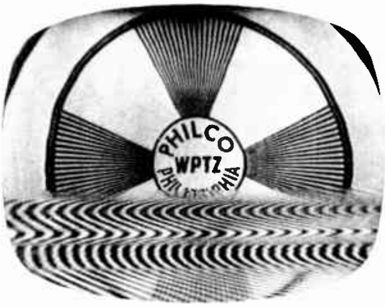


Figure 2. Diathermy-Interference Pattern

duced interference which looked very much like the external c-w interference shown in figure 1.

Of course, the interference can appear in either the sound or picture section, or in both, but it has been noted that the sound section of a well-designed receiver is relatively immune to interference, because of the characteristics of FM transmission.

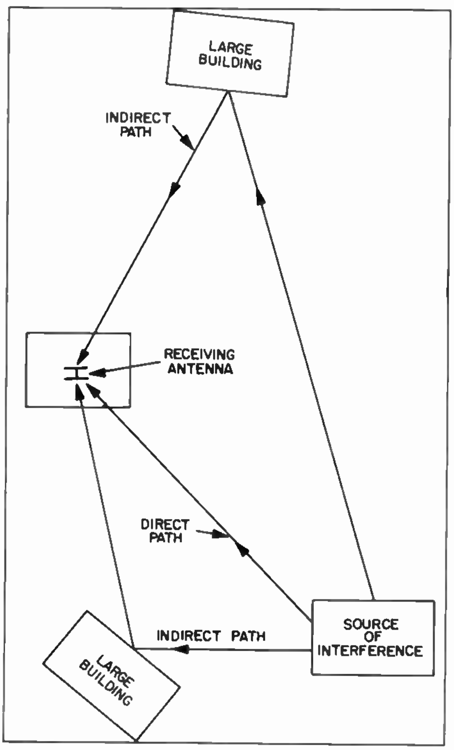


Figure 3. Block Diagram, Showing Multipath Interference

LOCATING THE PICKUP POINT

Once the interference is identified, it is desirable to locate the pickup point. This can most easily be done by removing the antenna lead-in from the receiver; if the interfering signal persists, the pickup is occurring in the receiver proper. (The writer once found standard-broadcast pickup occurring in the video-amplifier section of a TV receiver.) Such pickup may be entering the set by way of the power line, or by way of exposed wiring. (A chassis with an open underside may be susceptible to the latter form of pickup.) The correction of the trouble is most likely to be effected by the installation of power-line filters, and by shielding the receiver. As a shield, copper screen is very effective, and it can be fastened to the inside of the cabinet with very little difficulty. It is important that any added shielding be placed so that it does not alter the capacitances in critical circuits. Above all, do not attempt to redress the wiring of the set unless the manufacturer recommends that this be done, or unless suitable alignment equipment is available.

If the removal of the antenna lead-in removes the interfering signal, it can be assumed that either the antenna itself or the lead-in is acting as the pickup source. To determine which is the source of the pickup, the lead-in should be reconnected to the receiver and then disconnected *at the antenna*. If the interfering signal persists, the lead-in is the pickup source, but if the interfering signal is removed, the antenna is the pickup source.

DETERMINING DIRECTION OF INTERFERENCE SOURCE

When it is determined that the antenna is the source of the pickup, it is wise to locate the approximate direction of the source of the interference. This can be done by orienting the antenna for maximum interference, and then noting its position. (A highly directive array can be used to advantage as a direction-finding array.) It should, however, be borne in mind that the interference-source direction as determined by this method may be inaccurate because of the existence of multipath signals (see figure 3). The writer found one case where the actual source of interference was located on the side of town opposite to the location of the apparent source, owing to reflection from a large building. Once the direction of the interference source is established, it should then be determined whether or not the TV signal is arriving along the same azimuthal bearing. If the two signal paths (TV signal and interfering signal) do coincide, the actual interfering source must be found and the cause of the interference eliminated, if possible, at the source. However, if the angle of the TV signal path differs from that of the interference signal, it may be possible to eliminate the interference by one or more of the following methods:

1. **Shield the antenna from the interference source.**
2. **Orient the antenna until it presents a null point in that direction.**
3. **Relocate the antenna.**
4. **Use a more directive antenna.**

USE OF OPEN-WIRE LINE

Transmission-line pickup, one type of which is shown in figure 4, is very common, and can often be corrected by proper reinstallation. Ribbon (open-wire) line will be very resistant to signal pickup if properly balanced. Figure 5 shows the action of a balanced system. The unwanted signal induces a current into each half of the line, and, since both wires are affected equally, the induced currents will be equal, and in the same direction. When the line-induced currents flow through the receiver input transformer (to ground), each current sets up a field which opposes the field set up by the other current, and the fields thereby cancel. However, if the line becomes unbalanced from any cause, the two currents will not be equal and will

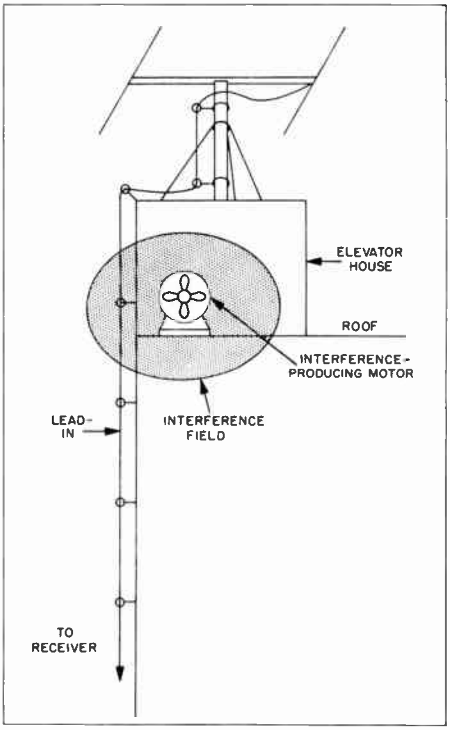


Figure 4. Transmission-Line Pickup Caused by Local Interference Field

not cancel. Of course, balance must be maintained all along the line from antenna to receiver, because unbalance at any point along the line will produce unequal currents at the two receiver input terminals. (Some receiver input circuits are not properly balanced, especially in older-model sets.)

When installing ribbon line, it must not be run near metallic objects—maintain at least a 3-inch clearance, twist the line so as to produce a transposition of the wires about every foot or so, and use the proper type of standoff insulators at intervals which will give the line proper support, thus preventing excessive motion. No standoff interval can be specified, since in protected locations the line does not require the support found necessary in windy locations.

USE OF COAXIAL LINE

Replacing a ribbon line with coax will not necessarily reduce interference pick-

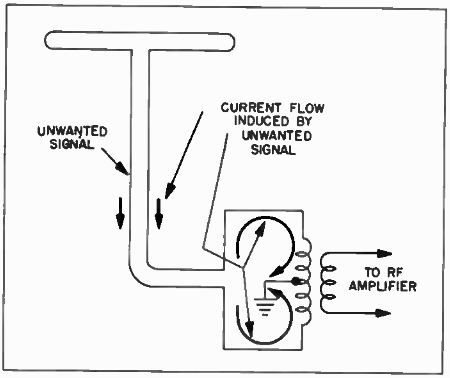


Figure 5. Action of Line-Induced Currents in Receiver Input Circuit

up. Most coax presents more loss than ribbon line, and it can pick up just as much interference unless certain precautions are observed. It is safe to say that a *properly installed* coaxial line will be *superior* to a properly installed ribbon line, in terms of signal loss versus interference pickup. In addition, coax can be run anywhere without fear of unbalance, it is more rugged, and it does not require careful support.

Some TV receivers are designed for a 75-ohm coaxial input, but most receivers are designed with a balanced 300-ohm input with a grounded mid-point, as shown in figure 6. It is interesting to consider that a 300-ohm balanced input will present an impedance of 75 ohms from either input terminal to the grounded center tap. Thus if 75-ohm coax is used, it is merely necessary to ground the outer conductor at a point near the input

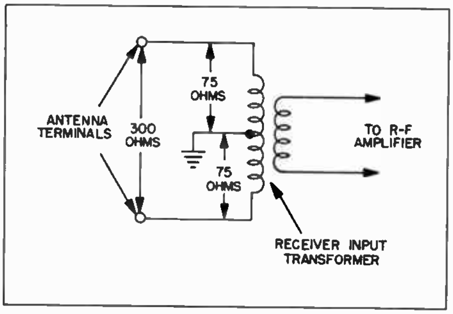


Figure 6. Receiver Input Circuit, Showing Impedance Values

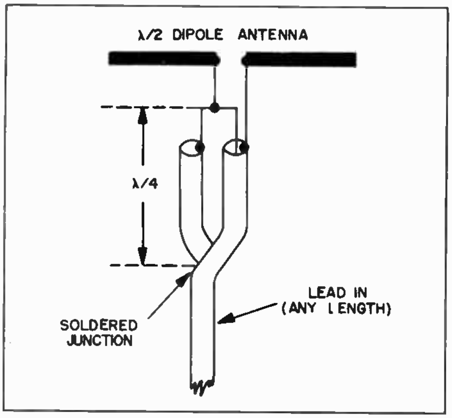


Figure 7. Dipole with Quarter-Wavelength "Balance To Unbalance" Section (Bazooka)

common ground (on the tuner) and to connect the center conductor to either input terminal. When this is done, the coax should be run directly to the tuner, and the ribbon line which joins the tuner to the antenna terminal strip should be removed.

The most important feature of coaxial lines (low noise pickup) is lost unless antenna balance is established. Coaxial lines are unbalanced, whereas most antennas are balanced — it is necessary, therefore, to convert from balance to unbalance at the junction of the antenna and the line. This can be done with the aid of a device commonly called a "Balun" or "Bazooka." This device can most easily be constructed as shown in figure 7, in which a quarter-wave section of coax is used as a bazooka. The center conductor is not used in the quarter-wave section, and the lower end of the braid is joined to the outer conductor of the lead-in. When connected as shown, the coaxial lead-in is very effective in noise reduction.

Figure 8 shows the conventional method of connecting a dipole to a coaxial lead-in. Assume an interfering signal impinging somewhere along the lead-in. The interfering signal will induce a current which flows along the outside of the outer conductor. Part of the in-

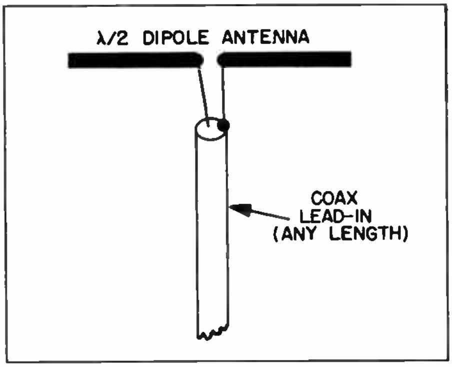


Figure 8. Dipole with Unbalanced Characteristics

duced current will be conducted to ground at the receiver input, and part will flow up toward the antenna. Since this action occurs upon the outside of the outer conductor, the current must flow in the right-hand half of the dipole. The right-hand half of the dipole is mutually coupled to the left-hand half, and the interfering signal is therefore applied to the center conductor, which carries the signal directly to the receiver input. In this case, the use of coax has defeated its purpose, in that it may have achieved only a slight reduction of noise pickup. When the device shown in figure 7 is used, the noise signal which moves up toward the antenna is split at the junction of the quarter-wave section and the lead-in. Assuming an equal split, the two halves of the noise signal will be applied simultaneously to each half of the dipole. Thus, there is no noise voltage developed *across* the dipole. In terms of normal signal pickup, the dipole in figure 7 sees the quarter-wave section as a high impedance, and is therefore unaffected.

USE OF WAVE TRAPS

When the interference cannot be eliminated by the foregoing method, there is another possible solution which can be applied at the receiver. This solution is based upon the fact that quite often the interfering signal is not at the frequency of the TV signal, but affects reception because of the many spurious responses possible in a superheterodyne receiver. Furthermore, the low r-f selectivity, inherent in TV design, makes these spurious responses more pronounced. For example, direct i-f pickup is possible through the antenna circuit, image rejection is often not adequate, and local oscillator harmonics can beat with higher-frequency interfering signals, with the resultant production of i-f energy.

Provided that the interfering signal is not at the frequency of the desired signal, a wave trap (such as the one shown in figure 9) can be placed in the lead-in, and tuned to the frequency of the interference. Such traps prove very effective. A wave trap may be easily constructed from an open-ended section of lead-in, cut to one-quarter wavelength at the frequency of the unwanted signal. This section is connected across the antenna terminals of the receiver, making it act as a series acceptor trap. An old trick is to use a section of line which is too long, and then to trim off small pieces until the interference is minimized. It is very easy to cut off too much line, so great care must be exercised as resonance is approached. This trial-and-error method can be greatly simplified if the frequency of the interfering signal is determined to

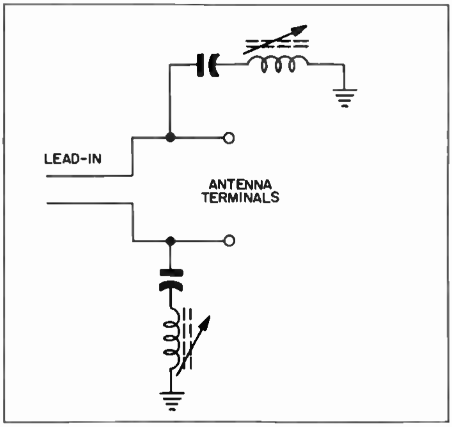


Figure 9. Series-Accepter Wave Trap for Balanced Input

a reasonable degree of accuracy before any corrective action is taken.

DETERMINING FREQUENCY OF INTERFERENCE

One method of determining the frequency of the interference is to couple an absorption wavemeter into the r-f section of the TV receiver, and tune the wavemeter for minimum interference. In practice, switching from one channel to the next (starting with channel 2 and progressing higher) will provide a great deal of information regarding the interfering frequency. For example, if the interference appears upon all channels (to a greater or lesser degree) and is removed by disconnecting the antenna lead-in, the frequency is most likely at the i.f. of the receiver. If the interference appears only upon certain channels, the channel numbers should be noted, and by comparing channel frequencies, a harmonic relationship can be established. For example, video interference on channels 2, 6, and 10 could be caused by harmonics of a frequency of 27.625 mc. Of course, this analysis applies only to signals received by normal superheterodyne action —if variation of the fine-tuning control tends to tune the interference in or out more effectively than it tunes the picture signal, the technician can assume that the interference is not beating directly against the received signal. It is more likely, in such a case, that the interfering signal is beating against an oscillator harmonic, or that it is being received by way of an image response.

The most reliable method of frequency determination is the use of a signal generator. The generator is loosely coupled into the receiver, and is adjusted to a point which produces zero beat with the interfering signal (as seen in the TV picture) at the lowest possible output setting. To make sure the oscillator is producing the beat at its fundamental frequency, tune the generator to twice its dial setting—an increased beat-frequency amplitude means that the first setting was incorrect, and must be increased in integral multiples of the original setting (3f, 4f, 5f, etc.) until an increase in frequency no longer causes a beat note to appear.

If the interference is at the i.f. of the receiver, and occurs as a result of direct pickup through the tuner,* it is a simple matter to insert a high-pass filter at the receiver input. If the cutoff frequency of the filter is just below the lowest channel (channel 2), the i-f rejection is easily made sufficient to suppress this form of interference. A simple form of this type of filter is often incorporated into receiver-input design, as shown in figure 10A. Here, a single-section filter is produced by the action of L_1 in conjunction with C_1 and C_2. If more rejection is re-

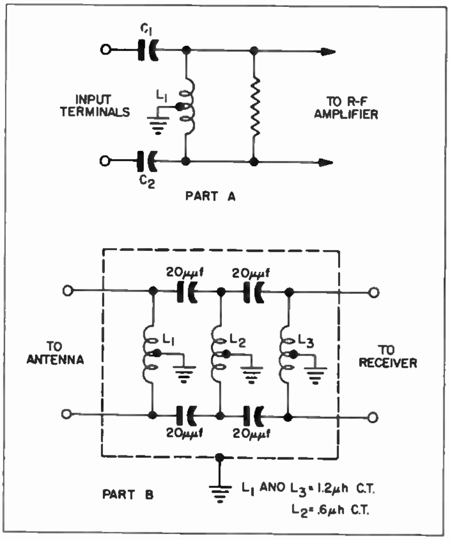


Figure 10. High-Pass Filters for Balanced Input (A) Simple (B) Two-Section

****(Editor's Note: This is easily determined by disabling the local oscillator while the interference is present. If the interference persists, it is at the intermediate frequency. A point to keep in mind is that the local oscillator and the mixer are frequently in the same envelope, in which case the oscillator must be disabled by some method other than pulling out the tube.)***

quired, the filter shown in figure 10B can be used. It is a two-section filter, and is designed to give a cutoff frequency just under the lowest desired channel.

LOCATION OF TVI SOURCE

The last step in TVI suppression is the most difficult, but the most effective. This requires the locating of the source of the interfering signal, and eliminating the signal at its origin. Where one source is causing TVI in a large number of sets, this method is most desirable, of course. If a DF bearing is obtained upon the interference source, the next step is to canvass the indicated area. This canvass of the "area of probability" can be greatly simplified if the form of interference, frequency, and time of occurrence can be accurately tabulated. Of course, the first canvass prospects could be fairly well evaluated. For example, diathermy usually originates from doctors' offices, hospitals, clinics, etc., and looking into each dwelling would be a waste of time. Dielectric- and induction-heating equipment can also cause interference (the effect is often very similar to diathermy, but the duty cycle is more regular, and such interference occurs only during working hours). This phase of TVI suppression is without doubt the most difficult, and we could cite examples that would fill volumes. Each case, however, is distinct, and can be resolved by skill and common sense. It is encouraging to know that your local FCC agency will cooperate to the fullest extent, particularly if the TVI is experienced by many people in one area.

Once the TVI source has been determined, it is necessary to effect a correction of the situation. Here again, knowledge of the equipment is essential. A problem often arises in dealing with the owner of the offending equipment. If spurious radiation exists in excess of values established by the FCC, some legal control over the case can be obtained, but diplomacy is usually the best approach.

The most common causes of TVI seem to arise from the lack of shielding and from harmonic radiation from transmitters or other r-f equipments. Both of these problems have been exhaustively examined by amateur radio operators, and a discussion here of specific techniques would become a volume in itself. If the reader desires more information on this subject, it is suggested that the references which are listed at the end of this article be obtained.

LOCAL-OSCILLATOR RADIATION

Radiation of local-oscillator signal is a subject worthy of special consideration, in view of the close proximity of large numbers of TV sets (in some of the larger cities, fifty percent or more of the homes have TV receivers). For example, a set tuned to channel 3 can cause a beat signal to appear on nearby sets tuned to channel 6. Reputable manufacturers have made every effort to reduce local-oscillator radiation to a minimum by shielding and by careful designing, but there are still a great many receivers which cause this trouble. The local-oscillator signal can be radiated directly from the TV chassis, or the signal can be coupled through the grid-to-plate capacitance of the r-f amplifier, and thus appear at the antenna. To determine which method of local-oscillator radiation is present, disconnect the lead-in from the radiating receiver—if the interference persists, direct chassis radiation is indicated.

Chassis radiation is most often cured by careful shielding of the TV chassis. It is best to surround the tuner circuits (local oscillator, in particular) with a good shield. A second shield, consisting of the chassis and additional shielding over the open portions of the chassis, will further aid in complete suppression. In extreme cases, it may be necessary to rewire the local-oscillator circuit to eliminate r-f chassis currents; providing a single, common ground point for the

(Continued on page 28)

Increasing the Accuracy of Measurements Made with Low-Sensitivity Voltmeters

A method of obtaining highly accurate voltage measurements, using low-sensitivity instruments.

(Editor's Note: The original material on which this article is based was submitted by Philco Field Engineer Robert E. Miller, ComAirPac.)

SINCE the introduction of the VTVM, there has been a tendency to abandon low-sensitivity meters because they quite often load the circuit that is under test, and produce conditions which do not normally exist within the circuit, thus affecting the accuracy of voltage measurements. If it is known that such a condition exists, it is possible to compensate the readings obtained to account for the loading effect.

Before going into an involved compensation, it is advisable to determine if the meter is loading the circuit. This can be done by taking readings on two different voltage ranges. If the two readings are the same, no loading exists, and the reading is as accurate as the calibration of the meter permits. However, if the readings are different, it is advisable to apply the correction described in this article.

It will sometimes be found that the only possible reading must be taken on the highest available scale, thus preventing the use of two scales to determine whether or not loading exists. This problem can be avoided by taking both readings on the highest scale, but with the second such reading taken with a resistor inserted in series with the test leads. (This resistor should have a value equal to the internal resistance of the meter. For example, if the meter sensitivity is 5000 ohms per volt, and the meter is set on the 300-volt scale, the resistor value should be 1.5 megohms.) In the second reading, the meter indication should drop to one-half of its previous value; if it does not, loading exists.

PROCEDURE

If loading is present, read the voltage on two different ranges, and apply the following formula:

$$E = \frac{E_H - E_L}{\dfrac{E_L K}{E_H} - 1} + E_H$$

where E is the voltage which would be present in the absence of the voltmeter, E_H is the higher of the two readings, E_L is the lower of the two readings, and K is the ratio of the higher-voltage scale to the lower-voltage scale.

To illustrate the above formula, assume that a certain voltage reads 50 volts on the 100-volt range, but only 30 volts on the 50-volt range.

It follows that

$$E_H = 50$$
$$E_L = 30$$
$$K = \frac{100}{50} = 2$$

Substituting in the formula, we obtain

$$E = \frac{50 - 30}{\dfrac{30 \times 2}{50} - 1} + 50$$

$$E = \frac{20}{\dfrac{60}{50} - 1} + 50$$

$$E = \frac{20}{1.2 - 1} + 50$$

$E = \dfrac{20}{.2} + 50 = 150$ volts, or the circuit voltage when the meter is removed.

In case the voltage is too high to allow readings on two meter ranges, obtain E_L

on the highest range, and then proceed as follows:

1. Insert a series resistor which has a value equal to the internal resistance of the meter (this has been previously covered).

2. Read the meter as indicated by the setting of the range switch.

3. Multiply this reading by 2 (this will give the E_H value).

4. Solve the formula for E, using the values just obtained for E_L and E_H. (K equals 2 in this case.)

LIMITATIONS OF METHOD

There are two notable exceptions to the use of the system described in this article. The first exception applies to the use of the VTVM, which normally has a constant internal resistance, regardless of the range used. However, the method used in the case of too high voltage is valid, and can be used if it is suspected that the VTVM is loading the circuit. The second exception is found when applying the method to systems that use feedback. Examples of such systems would include the measuring of AVC voltage, and of oscillator bias voltage. The method described in this article cannot be made to apply in such cases.

Television Interference

(Continued from page 26)

entire oscillator-mixer circuit will be effective, in such an instance.

If local-oscillator radiation persists, relocation of the receivers to provide the greatest possible separation is advisable. Grounding the chassis is not recommended because the ground wire is more likely to act as an antenna; it has been found that attempts at grounding have increased interference more frequently than they have reduced it.

In the case where the local-oscillator signal is being coupled back through the r-f amplifier to the antenna, the most effective remedy is the installation of a booster at the offending receiver. The booster provides isolation between the antenna and the receiver, thus preventing reverse-direction transmission. So far as the receiver itself is concerned, this form of radiation can be cured by careful redesign of the r-f amplifier section, but this course of action is usually outside the scope of the field technician. In lieu of the booster remedy, it is often possible to minimize a simple case of this type of interference by reorienting or relocating (or both) the antenna of the offending receiver. Separating the lead-in wires may also reduce coupling between sets.

The tragic aspect of this type of TVI elimination is the fact that the offending receiver may be functioning to the complete satisfaction of the owner, and he may flatly refuse to allow the set to be serviced. In this case, the easiest solution is relocation of the affected sets and application of some of the aforementioned remedies.

The writer is greatly indebted to Mr. John Krawczyk, of the Headquarters Instructor Staff, for his very capable assistance in the preparation of this article.

REFERENCES:

1. ***Television Interference*** **(Second Edition) edited by Lawrence LeKashman, W2IOP; Radio Magazines, Inc., New York, N. Y.**

2. **"Bibliography of QST Articles on TVI,"** ***QST*** **(December 1951), 67.**

3. ***Service Bulletin 50T4,*** **Philco Corporation.**

WHAT'S YOUR ANSWER?

The problem this month was suggested by Philco Field Engineer Hal Gullstad, who says that the problem was an old favorite of Thomas Edison's.

Assume two steel bars of identical size and shape. One is completely magnetized and the other is completely demagnetized. The problem is how to determine which bar is magnetized without using *anything* other than the two bars.

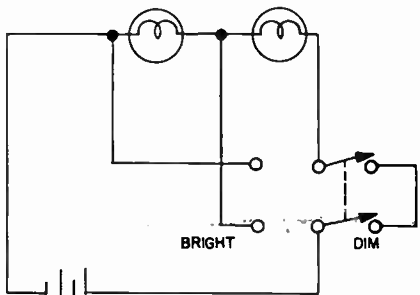
(Solution next month)

★ ★ ★

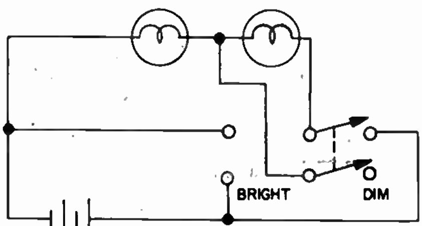
Solution to . . .

Last Month's "What's Your Answer?"

There are at least two correct solutions to the problem presented last month, as illustrated in figures A and B. Perhaps you can devise others.



A



B

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