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A Wide Range Impedance Bridge
Tone Controls
A New Aid To Rapid Servicing
High Quality Analysis Series
Ladders, Their Care and Use

NOVEMBER, 1949

AM-FM-TV-SOUND

The Professional Radioman's Magazine
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and now... THE HANDY G-E TUBE PULLER!

Latest of a series of helps that speed your work, increase your sales, and upgrade your profits, the new G-E tube puller cuts time on the job materially. Now you'll find it quick and easy to remove tubes without the risk of burns, shock, or cuts from fractured glass.

Regular glass types, metal tubes, 7- and 9-pin miniatures—all yield to this universal device, which smoothly extracts tubes no matter how firmly wedged in their sockets. The puller is made of heavy rubber—your fingers are fully protected and insulated. It's simple to use; long-lived.

Ask your G-E tube distributor about this ingenious tube puller—how to obtain one... fast! Inquire, if you haven't before, about the other aids to sales mentioned on this page; also, about the folder describing the many G-E advertising helps that are ready to go to work for you. Stock the tubes that are easy to sell because you get more practical help in selling them... G-E tubes! Electronics Department, General Electric Company, Schenectady 5, N. Y.

You can put your confidence in---

GENERAL ELECTRIC

RADIO SERVICE DEALER • NOVEMBER, 1949
EDITORIAL

by S. R. COWAN

Color Television -- Forget It
Between October 5th and 20th we spoke to the top management and policy-making men associated with 19 of the largest and most important firms engaged in manufacturing television receivers. Each of these executives were asked these questions: "What is your firm planning to do about color television?" and "How soon do you expect to make color TV sets available to the set-buying public?"

Without exception the answers were identical. Every executive stated that "Commercial color television is still only in the earliest experimental stages of development. When it becomes practical we'll have it. Unless some absolutely unforeseeable event occurs color TV sets will not be put into mass production for some years to come." The average estimate in this regard was from 3 to 5 years, or around 1953 at the earliest. But most seem to feel that color TV is still so far away from commercial practicability it should be scoffed at now.

So, if any potential TV set buyer approaches you about the imminence of color TV, tell him to forget it as none will be available for an indefinite time to come.

Built-in TV Antennas

Many major TV set makers are producing sets having built-in antennas. Others will eventually do so too, purely as a competitive defensive measure. But the fact remains indisputable that TV sets operating with built-in antennas do not, will not, and can not give as good results as TV sets having a properly installed external antenna. This will be true until TV transmitters increase their signal output at least ten or more times greater than what is now being telecast.

The TV set buying public must be educated to this fact by the servicing trade, for TV set makers and radio retailers will not do the job as it is not to their best interests to do so. Thus, a condition exists that makes it necessary for technicians to become sales minded. TV installers must learn how to educate and sell their customers on having the proper type of external antenna installed, even if at considerable expense, if that TV set owner wants to obtain maximum results and benefits from his TV investment, and even if he owns a TV set having a so-called built-in antenna.

Time and cost-study records indicate that to date the servicing trade has not made any appreciable profits from the TV antenna installation jobs they have obtained. A technician's prime stock in trade is his know-how and ability to do a job quickly. Installing TV antennas is a dangerous and time-consuming occupation. Doing an installation quickly and correctly the first time is an art that only a few technicians have mastered so far.

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**Field Findings**

**A resume of Industry happenings here, there and everywhere**

This past month yours truly has traveled almost 5,000 miles, making a complete swing around the East and Midwest, contacting receiver and parts and equipment manufacturers, to ascertain their plans for 1950, especially taking into consideration the current hearings by FCC on UHF and color TV. The facts about color TV, and how far away it still is, are reported in this issue's editorial. Don't miss it! You will want to paste this up and show it to potential TV set buyers for many months to come.

**Winchell Errs On 45 RPM**

In his syndicated column published in many newspapers on October 20th, Walter Winchell opined that R.C.A. would soon abandon its 45-rpm record player and line of 45-rpm records in favor of 33 1/3. On the next day, Oct. 21st, the reliable New York Times carried an item stating that “Sales of RCA Victor 45-rpm phonograph records have increased 260% within the past 90 days according to Frank M. Folsom, president of the Radio Corporation of America.” Further checking with top-brass executives of RCA brings forth a categorical denial of Winchell’s claim. They very emphatically say RCA is going to stick with 45-rpm records and playing equipment. Thought this worth reporting.

**Call in the BBB**

A large display advertisement which appeared in the Buffalo (N.Y.) Evening News on October 5th, in my opinion typifies the very worst kind of TV advertising possible, and further, should be scrutinized most carefully by Buffalo’s Better Business Bureau.

The advertisement in question, by a radio retail store, offers immediate delivery on several types of TV sets, and boldly proclaims: “Walk in tonight, walk out in 15 minutes with a TV set for tomorrow’s (World Series) game. No money down ..., meter plan ..., as little as $15 a day ..., the 36-Month Way.” Then the advertisement continues: “Five Years’ Service Without Charge.” Yes, let me repeat, as does the advertisement in another part of it... the advertiser claims to offer “5 years service on TV with Absolutely NO CHARGE.”

Being an advertising man, I am of the opinion that this display advertisement violates several fundamental legal requirements regarding fair trade practices and honesty of advertising claims; and I believe the BBB of Buffalo should take necessary steps to prevent its repetition. For example, if this retail radio firm is absolutely reliable and financially sound, as we must assume it is, what is their method of guaranteeing to TV set buyers that five years of service will be given absolutely without charge? None whatever! To be permitted to make such blatant claims a retailer is by law required to furnish bond or some similar guaranteed collateral that is held in escrow until the contract is consumated.

But, I don’t want to base my case purely upon technicalities. My real object in calling this matter to attention is the fact that it is basically bad to misrepresent or mislead customers because you simply can’t get away with it.

**The Slump Has Ended**

The radio-TV business was in a bad way during the summer months. TV reasons were given by various phases set sales dropped alarmingly. Many of the industry. But, the fact is, TV is a 10-months a year business. Television will always drop off during the summer because as more auto radios and portables go into use they offset to some extent the drop in home listening. From a Service Dealer’s point of view, this information should prove helpful. Hereafter Service Dealers can be prepared to take the line of least resistance during the summer periods. They should start their efforts to sell battery portables, and to get customers to repair their old portable and auto radio sets early in the Spring of the year and take it for granted that less effort need be expended on TV, as a drop off in TV transactions is to be a normal and seasonal expectancy.

Having the correct mental and merchandising slant will eliminate much price-cutting and frenzied summer slack “dumping” in the future. Meanwhile, all present business indices point to a boom period ahead. What with new TV stations going into operation, opening new markets constantly, and with prices stabilized and now close to where they will remain for many moons to come, the outlook is exceedingly bright.

**Retailers Abandoning Service**

Just as they did during the lush prewar period, a great many retail radio stores are giving up their own service departments, preferring instead, to farm out their installation and service work to non-competitive radio service organizations.

Records and history show that unless a firm is willing to specialize in radio and TV service work it cannot make profits from its own service department. Service is too competitive and complex. Be that as it may, from Coast to Coast the service profession is in the main having a pros...
Here is the for-sure answer to your concentric dual problems. The new IRC CONCENTRIKIT is a set of specially designed parts with which you can assemble a great variety of concentric dual controls. With CONCENTRIKIT on the job you entirely eliminate long searches and waits for exact duplicates. Instead, you quickly and easily assemble the exact concentric dual replacement you need... saving time and inventory investment.

**USE WITH NEW IRC BASE-ELEMENT**
Each CONCENTRIKIT contains 11 IRC universal parts. These combined with a wide selection of Shaft Ends and Base-Elements—purchased separately—afford a full range of concentric duals. Thus you save by buying only what you need. IRC Base-Elements are a revolutionary advance in concentric dual replacement. Each unit is a complete blue molded base with element, terminals and collector ring installed—no loose parts.

**NEW IRC CONCENTRIC DUAL REPLACEMENT MANUAL**
With CONCENTRIKIT you'll build concentric duals quickly and easily. Step-by-step instructions are included with each kit. New comprehensive Concentric Dual Manual gives you full replacement data on concentrics for every-thing from earliest home and auto radio to TV. Available shortly from your IRC Distributor.

**YOU MUST SEE CONCENTRIKIT**
See CONCENTRIKIT now, at your IRC Distributor! Take advantage of the most sensational control development that ever hit the industry. It's a money-maker!

**FOR STANDARD DUALS—IRC'S NEW MULTISECTIONS**
Duals, triples, even quadruples—assembly of ganged controls is easy now with IRC's new MULTISECTIONS. These are complete control sections that can be added like a switch to any IRC type Q, PQ or RQ control. A full range of 17 MULTISECTIONS gives you a selection of values from 1000 ohms to 10 megohms. All IRC MULTISECTIONS accommodate Type 76 Switches.

See both CONCENTRIKIT and MULTISECTIONS at your IRC Distributor, or write for new Catalog DC-1A.
Television requires the most durable, heat-and-moisture-resistant components you can get. In capacitors, that means Sprague. You'll have no profitless callbacks with extra-dependable Sprague TV capacitors.

**SPRAGUE TELECAP® MOLDED TUBULARS**

Only Telecaps are molded in heat-resistant Bakelite phenolic, oil-impregnated, and then solder-sealed—just like metal-encased oil-paper capacitors. No other manufacturer can make this claim! Ratings from 600 to 10,000 volts.

**SPRAGUE ATOM® and TWIST-LOK® DRY ELECTROLYTICS**

The most complete line of television electrolytics. Engineered especially for tough TV replacement applications, Sprague's new Type TVA Atom and Type TVL Twist-Lok electrolytics stand up under the extremely high temperatures, high ripple currents and high surge voltages encountered in TV receivers.

Write for Sprague Bulletin M-429

**SPRAGUE PRODUCTS CO.**
(Distributors' Division of the Sprague Electric Co.)
NORTH ADAMS, MASS.

**Alliance Sells With TV**

Sales and Advertising Executives Plan Fall Campaign for Alliance Tenna-Rotor consisting of Spot Demonstrations with sound film in more than 25 key television cities.

Standing, from left to right, Miles C. McKearnen, Account Executive, Foster & Davies, Inc., Advertising Agency, Cleveland, Ohio; “Jack” Treacy, N.B.C. Division Manager of Spot Sales. Sitting, from left to right: John Bentia, Sales Manager, Alliance Manufacturing Company; Harold Gallagher, Sales Manager, WNBK, Cleveland, Ohio; Hal Sweetzer, Sales Department, Alliance Manufacturing Co.

Using television to sell their Alliance Tenna-Rotor—a television antenna rotating device—the Alliance Manufacturing Company is appearing with a regularly scheduled series of six television sound films over most of the major television stations. Each film is an actual demonstration of the product. The opener starts right out with a typical action of an Alliance Tenna-Rotor, turning a television antenna on a house top. Then the scene shifts to the living room where a close-up of a television screen, together with a viewer who is operating the Tenna-Rotor is shown. The demonstration is clear and convincing—it shows fuzzy reproduction of a television picture and how the image comes up sharp and clear with the simple flick of a lever located at the set.

**New Short 16-inch Tube Announced by RCA**

A new 16-inch metal television picture tube, five and a half inches shorter than present kinescopes for 16-inch television sets, was announced recently by the Tube Department of the Radio Corporation of America.

The new kinescope, which will for the first time utilize an RCA “Filter-glass” face plate for greater picture contrast, is expected to make possible more compact chassis and more flexible cabinet design in future television receivers that will be available next year.

The new picture tube, designated the RCA-16GP4, will be supplied in very limited quantities to makers of television receivers in December. Appreciable quantities will be available early next year, company officials revealed.

Like its predecessor—the 16AP4, first 16-inch metal kinescope—the new television receivers in December. Appreciable quantities will be available early next year, company officials revealed.

[Continued on page 25]
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*TEAR OUT — MAIL TODAY!*
The new Du Mont Types 12RP4 and 15DP4 (replacing respectively Types 12JP4 and 15AP4) feature the exclusive Du Mont bent-gun. This ion-trap design eliminates ion-spot blemishes while maintaining an undistorted spot for maximum pictorial resolution. Meanwhile, lead-free glass reduces tube weight considerably. Five-pin duodecal base permits using the new half-socket for a significant saving, although old-type full-socket also accommodates these new tubes without modification.

Definitely "Your best buy!" For initial-equipment or replacement purposes — for superlative performance and longest service — insist on Du Mont Teletrons!

Write for latest literature.
SINCE the advent of television the oscilloscope has taken its rightful place on the service bench as a useful and informative instrument for wide-band i-f alignment, signal tracing, trouble-shooting and as a means for getting visual indications of circuit signals. The technician who is familiar with its application and operation is enabled to save hours in servicing television and frequency modulation receivers.

To get the most from an oscilloscope, however, the serviceman must be thoroughly familiar with the controls and have a reasonable knowledge of the meaning of patterns which appear on the screen. This first article, therefore, will deal with the makeup of the scope and the manner in which it functions. In the next article the practical applications of the scope in servicing will be treated, so that the technician will better understand where and when to connect it into circuits under test.

It is only when the repairman is fortified with such know-how that the scope becomes a tool that gives him enviable facility over his competitors in terms of time saved and in the turning out of superior work.

**How the 'Scope Functions**

Details of the internal construction of a cathode-ray tube such as used in an oscilloscope are shown in Fig. 1. The filament heats the cathode, which in turn emits electrons. The control grid regulates the intensity of the electron stream in the same way that the control grid of an ordinary vacuum tube regulates current flow. Anode #1 and #2 have plus voltages impressed on them and have the dual function of accelerating electron flow and forming the stream into a beam.

A variable means of controlling the voltage applied to anode #1 permits focusing of the beam into a sharp pin-point of light. Actually the two anodes can be considered comparable to a regular lens, because they bring the electron stream to a sharp focus at the face of the tube. The second anode has a high voltage on it because this gives great velocity to the electron stream, thus permitting sharper focusing. Additional acceleration of the electron stream is sometimes accomplished by use of an extra grid after the control grid. The assembly that forms the electrons into a fast moving beam is called an “electron gun.”

After the electron stream leaves the “gun” it enters between two sets of plates. The first set of plates is for moving the electron stream horizontally, and for this reason are called horizontal deflecting plates. The next set, for vertical deflection, have a relative position as indicated in Fig. 1. A potential applied to these plates will set up an electrostatic field and this will influence the electron stream in proportion to the potential and characteristic of the voltage applied to the plates. This is the type of deflection commonly encountered with the smaller tubes, both in oscilloscopes and television receivers.

Larger cathode-ray tubes (10" or larger television tubes included) usually employ magnetic deflection. This consists of a coil placed around the
by focusing as well adjust the visual information secured panel of the 'scope be controlled by the knobs ing plates. These various voltages for the tube elements and deflect-internal power supply furnishes volt-

The Controls

regular 3P1 tubes.

Letters between the first number and the last letter and the number follow-

number relates persistence

This in turn produces light and makes the action of the stream visible. The
chemical coating can be of a composition so that the light trace persists for a fairly long time or a comparatively short time. For oscilloscope use, the
time duration must be sufficient so that the rapidly moving beam will leave a complete trace of the wave-
form under observation.

The RMA designation of cathode-ray tubes screen materials gives useful information for those who need to replace a tube, or want to substitute one which will give different results. Cathode-ray tubes have a standard numbering system which is used by almost all manufacturers. For instance, the 3AP1 tube (used in the DuMont Type 164E and other scopes) may be analyzed as follows from its numerical designation: The "3" stands for a three inch tube and the P1 means it has a green, medium-persistence screen. Thus, the first number relates to screen size, and the last letter and the number following it, indicates the type screen. Letters between the first number and the last letter (P) refer to manu-

Table 1—RMA designation of cathode ray tube screen materials.

neck of the tube. When current flows through the coil it sets up magnetic fields which are also capable of influencing the movement of the electron stream.

Chemical Coating

The inner side of the face of the tube has a chemical coating which "fluoresces" when struck by electrons. This in turn produces light and makes the action of the stream visible. The chemical coating can be of a composition so that the light trace persists for a fairly long time or a comparatively short time. For oscilloscope use, the time duration must be sufficient so that the rapidly moving beam will leave a complete trace of the wave-
form under observation.

The RMA designation of cathode-ray tubes screen materials gives useful information for those who need to replace a tube, or want to substitute one which will give different results. Cathode-ray tubes have a standard numbering system which is used by almost all manufacturers. For instance, the 3AP1 tube (used in the DuMont Type 164E and other scopes) may be analyzed as follows from its numerical designation: The "3" stands for a three inch tube and the P1 means it has a green, medium-persistence screen. Thus, the first number relates to screen size, and the last letter and the number following it, indicates the type screen. Letters between the first number and the last letter (P) refer to manu-

The Controls

When the 'scope is turned on, its internal power supply furnishes volt-

ages for the tube elements and deflecting plates. These various voltages can be controlled by the knobs on the panel of the 'scope so that we can adjust the visual information secured by focusing as well as positioning it.

Figure 2 shows a typical front panel layout of an ordinary oscilloscope. Some manufacturers may change the position of the various control knob, but all the representative ones will be on the front panel of any 'scope, and the usual arrangement is about as shown.

The intensity control permits regulation of the voltage on the grid 1 of the cathode-ray tubes and gives us a dimmer or brighter trace. The focus control, by regulating first anode potential, brings the beam to a sharp point on the screen. The horizontal positioning control regulates the d-c voltage on the horizontal plates, and allows us to move the image on the screen either to the left or right, as may be desired.

The vertical position control permits voltage adjustment on the vertical plates and thus enables the operator to move the image up or down. The horizontal and vertical position controls, therefore, can be used to correctly position the image on the screen for proper observation.

Before undertaking a description of the other controls, it would be well to find out how the electron beam is made to trace out the information on the screen. In Fig. 3a is shown the screen face, with the vertical and horizontal deflecting plates. The electron stream has been properly focused and it shows up as a pin-point of light at the center of the screen. If d-c volt-

If the polarity is reversed, making the top minus and the bottom plus, the beam will move upward, because it will repel the negative electrons comprising the beam (alike poles repel).
cause the beam to move to the right. Reversing the polarity, as at Fig. 3e, will move the beam to the left. By applying voltages to both sets of plates as shown in Fig. 3f, the beam will move at an angle. Thus, it can readily be seen that the beam can be moved around anywhere on the screen, depending on the voltages applied to the plates. Increasing the voltage moves the beam to a greater extent—in fact too large a voltage on the plates can move the beam so far over that it will no longer be visible on the screen.

Going back to Fig. 3a, if we apply an a-c voltage to the vertical plates it will alternately pull the beam up during the first half of the cycle, then pull it down during the second half, as shown in Fig. 4. If this is a 60 cycle a-c, or an audio voltage (also a-c) of any frequency up to the limits of the audible range, the rapid rate of change will cause the spot to move up and down so quickly that a trace of change will cause the spot to move on the screen. This vertical line represents the peak to peak a-c signal.

Saw-Tooth Voltage

The voltage on the horizontal plates, however, must be gradually increased until the waveform is almost traced out; then it must drop rapidly to zero so that the beam will return to the left and start the trace all over again. The type of voltage which will do this looks like a saw-tooth as shown in Fig. 5.

This saw-tooth voltage is generated within the oscilloscope by a special oscillator (saw-tooth oscillator) the frequency of which can be controlled from the front of the scope. By properly adjusting the frequency we can keep this saw-tooth oscillator in step with the frequency we want to observe (the frequency we put on the vertical plates). If the saw-tooth oscillator is not keeping time with the a-c voltage on the vertical plates, then the beam will not return to trace over the same pattern at the proper time, giving false images difficult to interpret.

Frequency Considerations

If the frequency of the saw-tooth horizontal sweep is the same as the frequency of the wave being put on the vertical plates, one pattern (or cycle) will appear on the screen. If the a-c wave on the vertical plates is twice the frequency of the saw-tooth, two cycles will appear on the screen. This means that the number of cycles on the screen will depend on the ratio of the two frequencies on vertical and horizontal plates—regardless of respective voltages. This can be more clearly understood by a study of Fig. 6.

If the horizontal sweep is calibrated, then the frequency of the waveform under observation can be found.
EVERY piece of electronic equipment, whether it is as simple as a 1-tube radio receiver or as complicated as a 16-inch television console, has capacitors, coils, and resistors as basic components. Much of our trouble shooting is aimed toward finding out whether these components are functioning properly. Also, when the radio service dealer has before him a collection of unlabelled parts, he often must determine which are coils, capacitors, or resistors, and the value of each. Resistance, capacitance, and inductance measurements are at the foundation of electronic testing. A single, direct-reading instrument, the impedance bridge, permits rapid measurement of R, C, and L values. This piece of equipment is to be found in all professional electronic laboratories. The measurement-conscious radio technician never has questioned the utility of such an instrument for his own shop, but the high price of accurate impedance bridges has placed these testers out of his reach. His attempts to build a satisfactory bridge often have been fouled up by disheartening stray reactances within the completed instrument and by the lack of satisfactory calibration sources.

The impedance bridge described in this article is a professional instrument which, in spite of superior design and precision of operation, is relatively inexpensive. Available in kit form, it may be assembled within a few hours with ordinary tools. No hard-to-get calibration equipment is required.

**Ranges**

This bridge measures inductance (L) from 10 microhenries to 100 henries, capacitance (C) from 10 microfarads to 100 microfarads, resistance (R) from 1/100 ohm to 10 megohms, dissipation factor (D) from 0.001 to 1, and Q from 1 to 1000. Resistance, capacitance, and inductance units all are read directly on the same dial, graduated 0 to 10, and are multiplied by settings of a multiplier switch.

Six inductance ranges are provided: (A) 10 to 100 microhenries, (B) 50 microhenries to 10 millihenries, (C) 0.5 to 100 millihenries, (D) 5 millihenries to 1 henry, (E) 50 millihenries to 10 henries, (F) 0.5 to 100 henries, (G) 50,000 ohms to 10 megohms, (H) 0.05 to 10 ohms, (I) 0.001 to 1 ohm.

Eight resistance ranges are provided: (A) 0.01 to 1 ohm, (B) 0.05 to 10 ohms, (C) 0.5 to 100 ohms, (D) 5 to 1000 ohms, (E) 50 to 10,000 ohms, (F) 500 to 100,000 ohms, (G) 5000 ohms to 1 megohm, and (H) 50,000 ohms to 10 megohms. These resistance ranges include all common values of fixed and variable resistors, rheostats, potentiometers, etc. Resistance values higher than 10 megohms can be checked by connecting the unknown resistor in series with a resistor of accurately-known value, measuring the total, and subtracting the value of the known resistor. The resistance of coils, transformer windings, choke windings, and some switches also may be measured by means of the bridge. Circuit continuity can be checked, as well.

Six capacitance ranges are provided: (A) 0.5 to 100 microfarads, (B) 0.05 to 1 microfarad, (C) 0.005 to 0.1 microfarad, (D) 0.0005 to 0.01 microfarad, (E) 50 microfarads to 0.01 microfarad, (F) 5 millimicrofarads to 1 microfarad, and (G) 0.05 to 10 microfarads. These ranges include all common fixed and audio chokes, and audio transformers. All types of coils may be checked, included air-core, powdered iron core, and iron core varieties.

Eight resistance ranges are provided: (A) 0.01 to 1 ohm, (B) 0.05 to 10 ohms, (C) 0.5 to 100 ohms, (D) 5 to 1000 ohms, (E) 50 to 10,000 ohms, (F) 500 to 100,000 ohms, (G) 5000 ohms to 1 megohm, and (H) 50,000 ohms to 10 megohms. These resistance ranges include all common values of fixed and variable resistors, rheostats, potentiometers, etc. Resistance values higher than 10 megohms can be checked by connecting the unknown resistor in series with a resistor of accurately-known value, measuring the total, and subtracting the value of the known resistor. The resistance of coils, transformer windings, choke windings, and some switches also may be measured by means of the bridge. Circuit continuity can be checked, as well.

Six capacitance ranges are provided: (A) 0.5 to 100 microfarads, (B) 0.05 to 1 microfarad, (C) 0.005 to 0.1 microfarad, (D) 0.0005 to 0.01 microfarad, (E) 50 microfarads to 0.01 microfarad, (F) 5 millimicrofarads to 1 microfarad, and (G) 0.05 to 10 microfarads. These ranges include all common fixed and audio chokes, and audio transformers. All types of coils may be checked, included air-core, powdered iron core, and iron core varieties.
variable air, mica, ceramic, and electrolytic capacitors of all types. Some large-capacitance units, such as motor starter capacitors, also may be measured. Capacitances higher than 100 microfarads may be measured in series with an accurately known capacitor and the unknown determined by means of the familiar series-capacitance formula.

The letter symbols in parentheses in the preceding three paragraphs correspond to the similarly lettered positions of the MULTIPLIER SWITCH in the circuit diagram, Fig. 2. The complete circuit diagram of the impedance bridge is given in Fig. 2.

**Circuit Diagram**

The complete circuit diagram of the impedance bridge is given in Fig. 2.

The 2-pole, 8-position MULTIPLIER SWITCH sets the bridge to the desired R, C, or L range. This switch cuts in or out of the circuit the various precision resistors R1 to R9. The dial settings of the MULTIPLIER SWITCH show the various R, C, and L factors by which the respective precision resistors Ri to R9 set the bridge. When the MAIN CONTROL is set to 9 for bridge balance and the MULTIPLIER SWITCH is set to position F (0.0001 uf) for capacitance, the value of the unknown component is equal to 0.0001 times 9, or 0.0009 uf.

The function of the DETECTOR SWITCH is to connect an appropriate null detector across the bridge circuit output points. When this switch is thrown to its EXTERNAL position, the two terminals labelled EXTERNAL DETECTOR are connected across the bridge output and an external null detector may be connected to the EXTERNAL DETECTOR terminals. Satisfactory external detectors are high-impedance headphones, oscilloscope, magic-eye tube, a-c vacuum tube voltmeter, or a sensitive zero-center d-c galvanometer. The galvanometer is used only in resistance measurements when the internal 6-volt battery (or a higher-voltage external battery) is used to power the bridge. When the DETECTOR SWITCH is thrown to its GALVANOMETER position, the self-contained zero-center (100-0-100) d-c microammeter is connected, as a null detector, across the bridge output points for d-c resistance measurements. When the DETECTOR SWITCH is thrown to its SHUNTED GALVANOMETER position, the microammeter is connected across the bridge output, but in parallel with the 100-ohm resistor, R90. This resistor decreases the microammeter sensitivity and acts to prevent meter damage when first checking an unknown resistance.

Two self-contained bridge power (signal) sources are employed. One is a General Radio 1000-cycle hummer (an electromechanical type of oscillator) which supplies a 1000-cycle signal voltage for inductance or capacitance measurements. When the 1000-cycle signal is used, the null detector must be of the a-c type, that is high-impedance headphones, oscilloscope, magic-eye tube, or a-c vacuum tube voltmeter. The second source is a 6-volt dry battery, used only for direct powering of the bridge. When d-c resistance measurements are to be made with the microammeter (or external d-c galvanometer) as a null detector. This battery is a small-sized unit (Burgess F4BP), being no larger.

[Continued on page 34]
DAILY service work includes the repair, alteration, planning and construction of the effective tone controls for p.a. systems and high fidelity radios. Separate bass and treble tone controls are becoming more and more popular with both professional sound equipment operators and the average listener. Separate bass and treble tone controls can be used to offset bad hall acoustic conditions requiring either accentuation of bass or treble frequencies. Separate bass and treble controls can also do much to make a bad recording sound more listenable by accentuating the band of frequencies containing the greatest sound energy; or, by supplying some of the higher frequencies missing in the recording; boosting the bass as well. A knowledge of bass and treble tone control circuits is a definite asset to the service man. Some typical circuits and an explanation of the principles involved are given here.

Discussion of Circuits

Expense of components, physical size, dangers of hum pickup and other factors often make the inductance-capacitor type of tone control impractical. The control circuits discussed in this article are compact, use standard and inexpensive components, and are completely non-critical with respect to part values.

The author describes many types of tone control circuits which may be used to advantage in amplifiers of various requirements. Poor recordings may also be improved.

Figure 1 provides fixed bass reinforcement with variable control of treble. Bass reinforcement is achieved through the series-parallel arrangement of $R_1$, $R_2$ and $C_1$. $R_1$ is an electrical isolator between the bass and treble channels. $R_2$ is the standard grid resistor. Condenser $C_1$ offers very low impedance to the higher frequencies and comparatively high impedance to the bass notes. Thus, higher frequencies are by-passed to ground through $C_1$ while the bass notes reach the grid of $V_1$ and are amplified. $R_4$ and $C_2$ form a series circuit offering high impedance to the bass frequencies and comparatively low impedance to the treble. Thus, only the treble notes reach the grid of $V_2$ where they are amplified. $R_4$ is an ordinary potentiometer type of control used as a volume control for $V_2$. By varying the input to the treble amplifier ($V_2$) and keeping the bass amplifier ($V_1$) at a constant level, the effect is that of a true treble control with full bass reinforcement at all times. There is no audible interaction between the two tubes, $V_1$ and $V_2$. A dual triode 6SN7 works very well with the part values given in Fig. 1.

Figure 2 is similar to Fig. 1, with the addition of a gain control in the grid of the bass amplifier. The excellent degree of tone control afforded by this circuit makes it a valuable addition to amplifiers operated under conditions requiring varied tonal responses. For example, the quality of many of the commercially manufactured cutterheads of the "home re-

[Continued on page 31]
A NEW AID TO Rapid Servicing

by DOUGLAS H. CARPENTER

Fig. 1—"Grid Dip" Adapter.

This new instrument provides quick answers to a variety of problems encountered in electronic manufacture and repair.

FOR several years there has been a need for a simple instrument that would qualify electronic circuits and components in a simple direct reading form. The nearest approach to this universal test unit is the grid dip oscillator. It is not intended to imply that the grid dip oscillator can make every electronic measurement required; on the other hand it will duplicate many of the functions of expensive laboratory equipment in addition to doing the work usually allocated to several separate pieces of measuring apparatus. From the standpoint of all around utility it would be hard to find another instrument capable of so many diversified applications.

G.D.O. Loading

Although the grid dip oscillator may be classified as practically a universal measuring instrument, certain inherent disadvantages have restricted its use to specialized applications in the design laboratory and production line rather than the service bench. Among the most objectionable of these is frequency shift under load. Since an oscillator is inherently a source of poor regulation, any external load (specimen circuit being measured) will unbalance the oscillator circuit to a degree depending directly upon the amount of coupling and load circuit Q. This rules out its use for such measurements as aligning a selective i-f amplifier, or setting the trap circuit of a television receiver. Since the grid dip oscillator must be self contained it is bulky and inconvenient to use in hand to get at places. The indicating meter must be small because of the necessary miniature size of the total unit. Several coils must be used to cover any practical range; the effective top limit of which is in the neighborhood of 100 mc.

Tubeless G.D.O.

Conscious of these shortcomings modern engineering produced Model 915 Tubeless "Grid Dip" Adapter. This new device circumvents all of the disadvantages of the former g.d.o., and permits measurements at much higher indicating sensitivity over a greatly expanded frequency range.

Reference to the photograph of Fig. 1 (heading) reveals that the small probe can and measuring coil are connected to the main instrument case by a long length of special shielded cable. This assembly is light weight and small, permitting measurements in even the most crowded chassis. The main case of the instrument itself houses the large meter, by-pass networks, phone jack and terminating loads. The three measuring coils are plugged into the top of the instrument case when not in use eliminating the need for a separate holder.

Model 915 unlike the grid dip oscillator does not require its own power supply, and employs no tubes. The only voltage required is that of the coupling signal source, which may be the test oscillator or signal generator that the serviceman now possesses. Full scale meter deflection can be obtained with as little as one twentieth of a volt over the majority of its effective range. The three coils provided cover all frequencies between 100 kc and 300 mc. Detuning of the coupling signal source is impossible as 915 acts as a buffer between the low impedance generator output, and the high impedance measuring load. We have therefore a compact little unit that may be used with existing equipment to allow accurate measurement of practically all electronic circuits within its range.

Resonance Indication

Probably the greatest claim to fame of this new device is in its application as a resonance indicator. It would be impossible to list all of the measurements that can be made in this category, but the following are representative of some of the more important divisions.

To use 915 as a resonance indicator it is first necessary to connect the terminal strip provided in the 915 back plate. The appropriate coil is inserted in the probe can socket, and
the generator output control adjusted for near to full-scale meter deflection. If the problem were that of aligning a FM-AM or TV i.f. the following procedure would apply. The probe coil of 915 is brought close to the i-f coil to be set, and the generator dial rotated to the specific intermediate frequency. The trimmer associated with this i-f transformer is adjusted until a pronounced meter dip is observed. The trimmer must be set so that maximum meter dip is realized. In the case of a TV i.f. the generator dial can be adjusted each side of center frequency and the actual selectivity response noted. The r-f section of any receiver can be set in a similar manner. Since the receiver itself does not have to be plugged in for such alignment many possibilities are readily apparent. Pre-alignment of r-f and i-f sections before assembly, transmitter, oscillator and amplifier tank circuit adjustment are just a few of the many quick measurements that can be made. Quality control of production components such as coils, variable condensers, etc., is still another function in this category. The resonance of any antenna system may be determined by simply coupling 915 to the antenna or associated transmission line. The selectivity response of any TV antenna can be quickly determined by this method, in turn revealing relative gain and band width of any array.

Detection

To be truly universal any resonance indicator must also be capable of establishing the frequency of all oscillators, check tracking, and do this without mechanical coupling and consequent detuning. If we plug a set of standard earphones in the jack provided in 915 we have a very sensitive energized detector. The instrument is still connected to the signal generator as in the case of the resonance indicator. If it is desired to preset any receiver oscillator the appropriate coil is inserted in the probe can, and the receiver turned on. The probe may be placed anywhere near the receiver (8 feet or so from the set) on the service bench. The earphones are inserted in the case jack. Set the generator dial to the exact frequency of the receiver oscillator. If the receiver oscillator is on frequency, a loud whistle will be heard in the phones. As the exact frequency of the oscillator is reached this whistle will diminish in frequency and "zero beat" with the generator. If the oscillator is not operating at the proper frequency the trimmer must be adjusted for the preceding condition. The actual frequency may be rechecked throughout the entire receiver calibration, taking the guesswork out of location of soft spots and low frequency insensitivity.

In the same category we are able to check transmitter oscillators, localize harmonic radiation, and determine sources and frequencies of TVI. Spurious amplifier radiation, oscillator "squeeging" and pulling are still other troubles that are simple to find. A signal from 915 may be substituted for the receiver oscillator itself if a little more coupling is employed between the probe coil and set making possible immediate qualification of weak or spotty receiver oscillators.

In the preceding discussion 915 has been coupled to a voltage source (test oscillator) and used as either a resonance indicator or energized detector.

Determining Values of L&C

There is still another method of using 915 to perform measurements without a coupling signal source. If the back plate terminals are shorted the instrument will act as a visual/aural detector. In this condition the meter will read upward, as we are taking energy from the circuit under test. Some of the functions in this classification are absorption type frequency meter, field strength meter and monitor and signal tracer. With an associated calibration chart, it may be used for a host of other applications in fixed line and r-f monitoring work. The fact that no power is required makes 915 ideal for portable applications.

Frequency Calibration

In the energized detector category there is another application that should merit the attention of every serious service technician. Since model 915 consists of an inductive coupling circuit (probe coil), and a rectifier (crystal) we have a very efficient mixer and aural monitor. If it is desired for instance to calibrate a receiver or a shop built piece of test equipment such as a test oscil-

[Continued on page 30]
Audio Section

The audio voltage from the discriminator is fed through the second half of the AM-FM-Phono selector switch (SW-1) to a variable 1 megohm volume control shown as R-17 in the schematic of Fig. 1. This affords common input level control to the following audio amplifier for any one of the three inputs chosen. This audio amplifier, employing a dual triode (12AU7) is the only section of the RJ-20 chassis under discussion which is common to more than one channel input. While serving either the FM, AM or Phonograph signal input this audio amplifier offers a rather elaborate yet highly essential equalization control prior to further amplification. Components become more effective and boost however, if it is desired to feed a consistent spectrum to further amplification, we find at this point that the FM-Audio response is flat from 15 to 15,000 cycles ± 3db. For a flat response the bass and treble knobs must be turned to a fully counterclockwise position.

Between the two cascaded audio stages a frequency selective type of equalization makes available controlled performances such as indicated by the curves of Figs. 4 A, B, and C. By means of these controls, which can amply counteract variations in recordings and the pre-emphasis of FM transmissions, a gradual treble or bass boost of as much as 20 db is at hand. Many owners do not know the value of, nor the need for, well engineered equalization. Dealers can proffer themselves and their customers a benefit through a bit of discreet campaigning in this direction. The playing of two records of widely different characteristics should be enough to sell most clients.

The necessary insertion loss due to equalization has, in this case, been well handled. The cascade audio stages compensate for that loss. The audio voltage from the detector-discriminator tube is of the same magnitude as that from a crystal pickup cartridge. This eliminates the necessity for level compensation beyond that offered by the volume control R-17. (Fig. 1).

The 20,000 ohm output impedance of the audio amplifier-equalizer section minimizes the problem of matching following amplifiers. An internal 5Y3 rectifier provides heater and plate supply. The latter is isolated from the output jack by a 0.1 ufd capacitor (C44) connected directly between the final plate and ground. The output of the audio section of this tuner chassis may be fed directly into any high quality amplifier and loudspeaker. The gain of this driving amplifier should be sufficient to provide the desired output when the input is as low as 0.5 volt RMS. It is obvious that the characteristics of the amplifier should, as nearly as possible, equal those of the tuner. Its response should be linear from at least 50 cycles to the upper activity limit of the loudspeaker system employed, and the latter should be the equivalent of the better two-way speaker systems.

The AM section of this tuner-chassis employs, basically, a superheterodyne circuit. One stage of r-f amplification is included to minimize image responses and improve sensitivity. The triple ganged tuning arrangement using 360 µuf variables per section is detailed in Fig. 1. The incoming signal is fed through the 6SG7 r-f stage to the 6SA7 pentagrid converter for conversion to the 465 kc intermediate frequency.

One feature of note is the variable bandwidth transformers used in the single i-f stage. A narrow interference-reducing position having a band pass of but 4 kc, either side of the carrier, may be chosen by means of a selector knob on the tuner panel. Or a broad high fidelity position with a bandwidth of 9 kc may normally be

[Continued on page 28]
RULES for LADDERS;  
their safety, care, and use

by OSCAR H. JUNGRENN  
The Patent Scaffolding Co.

Use of Ladders
1. Always place an extension or single ladder so that the distance from the wall to the base of the ladder is 1/4 its extended length.
2. Always face a ladder when going up or coming down.
3. Do not attempt to carry bulky or heavy tools going up or down. Use a hand line.
4. Never splice together short sections to make a longer ladder.
5. Place a ladder so that it has a firm footing.
6. Use ladder feet to help make sure that a ladder does not slip.
7. Do not place a ladder in front of a door which opens towards it unless the door is blocked, locked or guarded by another person.
8. Immediately withdraw from use ladders found to have faulty or broken rungs or side rails.
9. Two-section extension ladders should have an overlap between sections of at least 2 feet for heights up to 36 feet; for ladders between 36 feet and 48 feet it should be 4 feet, and between 48 feet and 60 feet it should be 5 feet.
10. Avoid use of makeshift ladders.
11. With longer length extension ladders, use two men to raise. One man holds the bottom of the ladder on the ground while the other raises by pushing up from underneath. Extend the ladder only after it is in a vertical position.
12. Do not go higher than the third rung from the top.
13. Do not slide down a ladder.
14. Place all types of ladders so that it will not be necessary to reach too far to either side, and use a ladder of the proper length.
15. Do not use a ladder as a gun, skid or brace or for any other purposes foreign to which it was intended.

Care of Ladders
1. Upon receipt, inspect a ladder for defects. If serious faults are noted, withdraw it from use, mark it “Do Not Use,” and return it to the seller if necessary.
2. Inspect ladders periodically for broken or damaged rungs, side rails, locks, rope, and pulleys.
3. Coat the ladder with linseed oil rather than paint. Oil will give as much protection as paint, but will not add to weight or stimulate dry rot. In addition, paint covers defects which may develop.
4. Keep rungs free of grease or oil.
5. Lubricate locks, wheels, and pulleys periodically.
6. Keep joints between rungs and side rails tight at all times.
7. Replace damaged or worn rope.
8. Store ladders in a well ventilated space free from excessive heat, dampness or cold.
9. Ladders should be stored in such a position that they can be readily inspected. They should be supported to prevent sagging.


Good extension ladders are equipped with automatic spring locks as well as a good grade of rope for raising the upper section.

Here are just a few of the many kinds of ladder feet available for extension and single ladders, for use on various surfaces.
With the development of the conical type antenna as an important factor in television reception... Radiart leads the way with the lowest priced QUALITY line. Precision engineering... quality controlled manufacture combine to give you and your customers the greatest value for the dollar! Easily installed... and rigidly sturdy when installed, these Radiart products truly are "The Standard of Comparison."

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RADIO SERVICE DEALER • NOVEMBER, 1949
Howard Model 482

A feature which will probably be seen with increasing frequency is found in the Howard 482. This seven-tube a-c operated instrument is an FM convertor providing audio output to an external amplifier system. A tuned r-f amplifier is followed by a dual-triode mixer-oscillator and two i-f stages operating at 10.7 mc. Detection takes place in a 6AL5 connected as a ratio detector. A 6J5 tube raises the audio output of the detector before it leaves the set.

The feature of interest is so simple that it may escape notice in a complicated schematic. It is shown in the partial diagram printed here, and consists of a 4.3 ohm resistor in the heater circuit of the 6AL5. Use of such a component serves to minimize, to a great extent, the tendency of tubes of this nature to modulate the output at 60 cycles. The actual voltage applied to the heater is about 4.7.

Recordio Models 7D42 and 7D44

Several interesting features appear in this home instrument designed for radio reception (AM and FM), phono reproduction and recording from radio or mike to disc records. The a-c chassis incorporates 14 tubes.

One problem always encountered when it is necessary to raise the output of a mike to the level of other input sources is that of hum development in the mike pre-amplifier stage. Of the several methods of minimizing the hum, one of the best is the use of d.c. on the heater or filament. One difficult source is thus eliminated and reasonable filtering and shielding is all that is needed.

As shown in the partial schematic, in this case the tube used for mike amplification is a battery type 1T4 pentode. Voltage for lighting the filament, which takes a maximum of 1.4 volts at 50 ma, is derived from audio notes handled and will assure that the filament will not be modulated by the output tube variations. During reception or reproduction the cathode voltage develops across a 250 ohm resistor.

Method of employing d.c. on filaments of 1T4 in Recordio 7D42.

Note that there is an electrolytic capacitor of 200 µf from the cathodes to ground. This large value is a virtual short circuit for the lowest frequency notes handled and will assure that the filament will not be modulated by the output tube variations. During reception or reproduction the cathode voltage develops across a 250 ohm resistor.

During recording from the mike, a separate tube is used to drive the cutter and no harm results from switching an additional 150 ohms in series with the bias resistor. The 1T4 filament is connected across this resistor and operated by the d.c. there.

Another partial schematic shows the 6J5 cutter-driving stage. A transformer is used to match the tube plate circuit to the crystal cutter. Some instruments of this type use a neon lamp for indicating recording level; others use a magic eye tube. Both are incorporated in this set.

The neon lamp is connected across a portion of the output transformer and actually will serve two purposes. When the voltage across the lamp is high, the indicator will show the recording level. During recording from the mike, the definite cutter action attests the character of the recording which is being made. When the voltage across the lamp drops to zero, the recording process is stopped.

Cutter output stage circuit of Recordio 7D42 and 7D44.
A recent intensive survey discloses that among the major television set manufacturers, more than 75% use Sylvania cathode ray tubes!

This impressive showing is a tribute to the research and quality production techniques employed by Sylvania.

You can take advantage of this ready acceptance by having a complete stock of the various types of these television picture tubes so widely used by set makers—who in turn, of course, sell to your regular customers. See your Sylvania Distributor about the complete line! For complete data write Sylvania Electric Products Inc., Dept R-1811, Emporium, Pa.

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Stromberg-Carlson • Tele-King • Tele-tone • Temple
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What a show!
NEW PRODUCTS

TVI FILTERS

Thanks to an exclusive design developed for the armed services, Sprague Hypab 3-terminal network feed-through capacitors are ideally suited to minimizing television interference from amateur transmitters or for attenuating power line-conducted interference from diathermy machines, industrial electronic heating apparatus and other high-frequency signal sources. Sprague Hypab bulletin M-482 describing this development in detail will be sent on postcard request to Sprague Products Co., North Adams, Mass.

GERMANIUM DIODES

Germanium crystal diodes that are more compact, moisture-proof and enclosed in hermetically sealed glass cartridges have been announced by Sylvania Electric Products Inc. The new crystals are available in two types: IN34A, a general purpose diode, and IN58A, a 100-volt diode.

Electrical characteristics, ratings, and prices of the new "true" type crystals are the same as those for corresponding "ceramic" types which have been marketed by Sylvania since the war. New terminal design permits units to be mounted side-by-side without danger of shorting.

DUO-CONE SPEAKER

The new, 15-inch, duo-cone, high-fidelity speaker RCA-515S1 is designed to provide exceptionally fine tonal reproduction. It is particularly suited for high-quality radio and television receivers, low-distortion reproducing systems, and broadcast station monitoring applications.

Developed by Dr. H. P. Olson of the RCA Laboratories Division, this new speaker has a power-handling capability of 25 watts of audio power and a useful response range of 40 to 12,000 cycles per second.

Q CONTROL

IRC’s New 13/16” diameter Q Control, Knob Master Shaft, luted, flatted and slotted in 3” long, fitted with 1/4” long bushing. Can easily be replaced with any of 11 special Interchangeable Fixed Shafts—thus covering practically all replacement needs. Power rating is 1/2 watt.

WIRE STRIPPER

A husky, new all-purpose wire stripper has just been announced by the Walter L. Schott Co. of Beverly Hills, California. The Walco Wire Stripper incorporates all these features in one model: strips all wires from 16 to 22-gauge, strips 300 Ohm twin lead, has built-in wire cutter and automatic locking-device which prevents crushing of wires.

CAPACITOR CABINET

A three-drawer metal cabinet that is literally a complete capacitor department is announced by Cornell-Dubilier Electric Corporation South Plainfield, N. J. as a no-cost feature of its new capacitor kit. The kit pictured above includes an assortment of twenty different capacitors.

TV BOOSTER

Standard Coil Products Co., Inc., of Chicago and Los Angeles announces their new, high-

[Continued on page 24]
says EDWARD CROXEN
General Service Manager of Hallicrafters

In addition to providing all necessary signal sources, the new Simpson Genescope includes a high sensitivity oscilloscope of unique advanced design, complete in every detail. Sensitivity 25 millivolts per inch. Wide band response to 3 megacycles or more. Equipped with a high frequency crystal probe for signal tracking. AM and FM oscillator sections provided with large, easy to read dials with 20-1 vernier control and 1000 division logging scale. Revolutionary, ingenious. Exclusive output termination provides for various receiver impedances, either direct or through an isolating condenser.

Step attenuator for control of output.
Size: 22"x14"x7½". Weight 45 lbs. Shipping Weight 54 lbs.
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Audio Oscillator 400 cycles

FM MODULATED OSCILLATOR
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Band B—25-250 megacycles
Band C—250-2.5 megacycles
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Continuously variable attenuator
Visual method of beat frequency indication

Modern FM and TV development and servicing requires the use of test equipment made to exacting standards. With this in mind Simpson offers you the Genescope with the assurance that everything possible has been done to make it the most accurate, flexible and convenient instrument available. The Genescope will render many years of uninterrupted service and always produce accurate results.

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Basic, single-bay all-purpose antenna complete with 73 feet of 300 ohm Twin-Lead lead-in.

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**MODEL 114-301**
Conversion kit. Provides parts necessary to build single-bay (114-005) into two-bay (114-301).

**NEW PRODUCTS**
[from page 22]

Gain, all-channel TV booster, which features: high gain; low signal to noise ratio; simplified 2-knob control; turning off the booster automatically turns off the TV set; continuous tuning, fully shielded; adaptable to either a 300 or 75 ohm line with ease; printed circuit; single stage—one tube; minimum service problems.

**FUSE-CASE MERCHANDISER**
Littlefuse, Inc., 4757 N. Ravenswood Ave., Chicago 44, Ill., has developed a unique merchandising idea, in the form of a handsome plastic case to display the Littlefuse electronic assortment of fuses and holders.

**MINIATURE CONDENSERS**
Marked size reduction is one of several advantages featured by the new Aerolite or metallized-paper tubular capacitors in cardboard tubes announced by Aerovox Corporation, New Bedford, Mass. Also identified as the Type P82, these tubulars mean lower R-F impedance, protection against surge voltages, reliability and good capacitance stability with temperature change.

Available to manufacturers and jobbing trade alike, Aerolites in paper tubes are listed in standard capacitances from .01 to 2 mfd., and voltages of 200, 400 and 600 D.C.W. at the start.
television receiver tube has a funnel-shaped metal cone, with a glass face plate sealed to the large end and a tubular glass neck containing the electron gun fused to the smaller end. The new tube, however, is but 17¾ inches long, which compares to 22½ inches for the present 16-inch tube, and 18 inches for the widely used 10-inch television picture tube.

The new kinescope utilizes a wider deflection angle, 70 degrees as compared to about 55 degrees for the present tube, to make possible its shorter length. Performance characteristics remain essentially the same.

The new RCA "Filterglass" face plate has a special material incorporated in the glass, which greatly increases picture contrast. Lightening of black areas in the television picture by reflected room light is greatly reduced. Contrast is further improved by reduction of reflections within the face plate itself.

New receiving tubes, deflection yokes, transformers and other associated components, all designed specifically for the most economical operation of the new 16GP4, were also announced by the Tube Department. These are now ready for production and will be made available at the same time as the picture tube.

As with all major developments of the Radio Corporation of America, the new 16-inch kinescope is being made available to the entire electronics industry.

RMA Town Meeting

The seventh Town Meeting of Radio Technicians sponsored by the Radio Manufacturers Association was held in the U. S. Chamber of Commerce Auditorium, Washington, D. C., on the evenings of November 1, 2, and 3, Robert C. Sprague, chairman of the RMA Town Meeting Committee, announced.

The first evening saw the return of John A. Meagher, television specialist, RCA Tube Department, who was one of the headliners at the first Town Meeting in Philadelphia. Mr. Meagher spoke on the Composite Television Signal.

At the second meeting Ringland W. Kreuger, of American Phenolic Corporation, discussed phases of antennas, from their theory to impediments.

For full details and technical specifications on the rack and the nine instruments, ask your RCA Test and Measuring Equipment Distributor for Bulletin 2F719—or write RCA, Commercial Engineering, Section 55KX, Harrison, N. J.
Alliance TENNA-ROTOR
Sells with Television!

1,500,000 Demonstrations!
4,500,000 Viewers!
40 TV Stations EACH WEEK!

- Compelling one-minute television films are doing a big selling job on the Alliance Tenna-Rotor! Viewers actually see how Tenna-Rotor makes a cloudy image come up sharp and clear. Every TV set owner wants to reach out—overcome interference—get more stations! Alliance films are timed with top programs to deliver a maximum TV audience!

CHECK YOUR STATION HERE!

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WAGA-TV
WSB-TV
WBAL
WMAR-TV
Boston
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WNBC
WBKB
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WKRC-TV
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Cleveland
WEWS
WSY-TV
Columbus
WLW-C
Dallas
KBTU
Dayton
WLW-D
Detroit
WJNK-T
WJW-TV
Erie
WICU

Houston
KLEE-TV
Indianapolis
WFMB-TV
Johnstown
WJAC-TV
Kansas City
WDAA-TV
Lancaster
WGAL
Los Angeles
KFI-TV
Minneapolis
KSTP-TV
WTCA-TV
Newark
WATV
New Haven
WNHC
New York
WNB
Philadelphia
WCAU
WPTZ
Pittsburgh
WDT
Richmond
WTVR-TV
Washington, D.C.
WMAL-TV
WNB
Rochester
WHAM-TV
St. Louis
KSD-TV

Richmond
WTVR-TV
Rochester
WHAM-TV
St. Louis
KSD-TV

Sylvania TV Expands West
Sylvania Television expands to western video markets this month with appointments of distributors in six major cities. C. K. "Larry" Bagg, sales manager, Sylvania Television, starts a western business tour on October 17th to set up distributorships in Los Angeles, San Francisco, Denver, Salt Lake City, Portland and Seattle. More than 15 eastern cities already have Sylvania distributors.

Sylvania television sets are manufactured by Colonial Radio Corp., Buffalo, a wholly-owned subsidiary of Sylvania Electric Products, Inc., New York. Nine Sylvania models in 19", 12½" and 16" table, console and console combinations, the latter with three-speed record changers, all with

New GE Parts Catalog
A new catalog and price list of all receiver replacement parts for General Electric radio and television receivers is now available through all distributors of the G-E Receiver Division, according to R. S. Fenton, sales manager of the division's parts section.

This 52-page catalog is the first all-inclusive receiver parts list ever made available by the company, Fenton said. It lists all replacement parts for every G-E receiver manufactured prior to August 1, 1949.

New Antenna Control Cable
A new 4-conductor antenna control cable has been announced by Belden Manufacturing Company, Chicago, Illinois.

The new cable is designed primarily as a motor lead-in cable for antenna rotating devices requiring 4 conductors.

The Belden No. 8484—4-conductor antenna control cable is a #20 AWG, 4-conductor cable, 7 strands #28 tinned copper wire, .010" wall vinyl plastic insulation. The 4 conductors color coded black, green, red, and white parallel, .015" wall tubed jacket. Brown plastic O.D. .170".

It is furnished in standard spool lengths of 500 and 1,000 feet.

Television Ballast Replacements
Five new TV ballast replacement numbers are announced by Clarostat Mfg. Co., Inc., Dover, N. H., namely:

Emerson 387022 and 397023, Motorola 17A485459, Tele tone TPR 102D, and Belmont B9M 16087. These numbers are in addition to Motorola 17A-479038 and Emerson 571-606 already listed in Clarostat literature. All numbers carry a list price of $3.00.

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The trend is to Tenna-Rotor. Tie in with this television advertising now! Alliance Tenna-Rotor Comes with a One Year Guarantee!

ALLIANCE MANUFACTURING COMPANY • ALLIANCE, OHIO
Export Department: 401 Broadway, New York, N. Y., U. S. A.
built-in antenna, were introduced in eastern markets last month.

Audio Fair

Many of the nation's leading manufacturers in the audio engineering field exhibited their products at the Audio Fair of the Audio Engineering Society. Loudspeakers and magnetic film and disc recording equipment were featured at the meeting, which took place on the sixth floor of the Hotel New Yorker October 27, 28 and 29. Admission to the exhibits was open to all who wished to attend.

Unique Radio Glass

A unique "Radio Glass" illustrated below is offered by Olson Radio Ware-

house, 73 E. Mill St., Akron 8, Ohio, as part of a sales drive. The glass contains a number of radio symbols etched around its surface.

Amphenol Sells a TV Picture

"Sell a TV picture . . . for customer satisfaction." That's the basis of a unique merchandising campaign now being undertaken by the American Phenolic Corporation, 1830 So. 54th Avenue, Chicago 50, Illinois, makers of the Amphenol Inline television antenna.

The campaign to sell a television picture is a threefold one. There is a salesman's booklet of 16 pages—extensively illustrated and written in a non-technical, easily understood manner. Opening on the theme of customer satisfaction, it shows how great a part the antenna plays in obtaining the best possible TV picture. Snow, ghosts and fuzziness—three common examples of poor reception—are then explained, and the salesman is shown how an inadequate antenna causes them. The features of the Amphenol Inline antenna are described with particular emphasis on the satisfaction it brings the customer and the way that satisfaction increases the salesman's business.

This threefold campaign—the salesman's booklet, the customer folder and the newspaper mat—is being offered to dealers throughout the country. It represents the mutual interest the television dealer and the antenna manufacturer have in improving the quality of TV reception.

Your BEST BUY is

TV TEST EQUIPMENT by

McMurdo SILVER

Originally designed by McMurdo Silver . . . developed and constantly being improved by McMurdo Silver's staff of engineers. Manufactured of the highest quality, tested components by the trained electronic technicians in McMurdo Silver's modern factory. Compact! Low-priced! You can't beat the value that is built into every McMurdo Silver Laboratory Caliber Test Instrument!

Model 900-A "Vomax"
The new "VOMAX" makes TV, FM, and AM measurements accurately, at highest meter resistance. Giant meter, non-breakable glass; 45 ranges, new single probe; easy to read. Includes probe for a.c., d.c., f.f., volts, ohms, db. and current measurements. "VOMAX" measures TV power supply potentials up to 30 kilovolts when used with the High Voltage Adapter Probe. A world-beater at only $68.50 net.

Model 918 Multiplier Probe
Built for long life and hard usage, each probe has been thoroughly tested; ensuring safety of operation on voltages up to 30,000 volts d.c. Plug-in tips make it readily attached to your VOMAX VTM, Model 900 or 900A, on which direct meter readings can row be made from 1/10 volt to 30,000 volts c.c. Only $9.95 net.

Model 905-A "SPARX" Combining signal-tracer and universal test speaker, 905-A is amazingly sensitive yet free of usual tracer hum. Vacuum-tube prod with r.f.-a.f. switching; high-gain high-fidelity amplifier, 6" FM speaker; 12-watt output transformer gives wide choice of impedances. Two essential instruments in one, 905-A is a value far exceeding $44.50 net.

Model 915 Tubeless Grid Dip Adapter Checks oscillators, antenna systems, transmitters, trap circuits, without mechanical coupling. Determines value of all coils and condensers. Requires no power supply or tubes; connects to any signal generator. Three calibrated plug-in coils cover 100 kc. to 300 mc. Equipped with phone jack for easy identification of oscillator frequencies. Model 915 is only $34.95 net, including coils.

Model 911 TV/FM Sweep Generator
Here is an all-in-one TV service center. Continuous range of 2 thru 226 mc. Output from 0.1/2 volt 1 and 5 mc. precision crystal markers insure pin-point setting of TV and FM measurements. Phased 60 cycle sine and 120 cycle saw-tooth voltages for direct scope control. Sweep from 0-10 mc. An outstanding buy at only $78.50 net.

McMurdo SILVER CO., Inc.
1249A Main Street, Hartford 3, Conn.

Please send me — and bill through my jobber — the instruments I have checked below:

\[\text{900-A "VOMAX" @ $46.50} \]
\[\text{918 Multiplier Probe @ $9.95} \]
\[\text{915 Tubeless Grid Dip Adapter @ $34.95} \]

\[\text{906 FM-AM Signal Generator @ $116.50} \]
\[\text{905-A "SPARX" @ $44.50} \]
\[\text{911 TV/FM Sweep Generator @ $78.50} \]
\[\text{Send free catalog of Laboratory Caliber Test Instruments} \]

\[\text{MY JOBBER IS:} \]

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Address ____________________________

\[\text{Date:} \]
1949

\[\text{Send Free catalog of} \]
\[\text{Laboratory Caliber Test Instruments} \]

McMurdo Silver Co., Inc.
**NEW Tricraft “3000” Series**

**“X” ANTENNAS**

(Hi-Lo Conical Type)

- Pre-assembled at Factory, ready to install (no loose parts)
- Matches 72, 150 and 300 ohm impedance
- All-wave, high gain on all channels
- Durable construction of finest aluminum (will not rust)
- Quality at the right price
- Excellent all-around performance eliminates constant servicing and maintenance
- Tricraft “X” ANTENNAS are furnished in single, double or quad element assembly, with or without mast.

Available at leading jobbers.
Write for technical information, literature and prices.

Tricraft Products Co.
1325 North Ashland Ave., Chicago 22, Ill.

Manufacturers of complete line of TV, FM and AM antennas and accessories

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**CIRCUIT COURT**
[from page 20]

builds up to the value required for breakdown, the bulb will flash instan-
taneously and show that the peaks are too high. The bulb will also act
as a partial short circuit on part of the transformer secondary and tend to
limit the effect of the overload, at least enough to protect the cutter.

**HIGH QUALITY**
[from page 17]

used. The choice is obtained through switch SW-3 in the AM section of
Fig. 1. Tuning may be done in the Narrow position and when completed
the Broad position may be used for strong clear signals. The Narrow posi-
tion is best for the reception of weak stations or for those in crowded sec-
tors of the broadcast band. The 6AL7 Tungsten Eye aids these procedures.

Demodulation of the signal and AVC is achieved, as shown through
the use of the 6AL5 diode detector. Through the audio portion of switch
SW-1 the signal is passed forward to the same 12AU7 cascade amplifier
previously described under the FM Section.

**Phono Pickup**

Provision is made for phonograph pickup through a jack at the rear of
the chassis. A third contact on switch SW-1 Fig. 1 connects this jack (J-1)
to the same audio stage previously discussed. Benefit is thus derived from
the volume control as well as from the wide choice of equalization offer-
ed in the final audio circuit of the tuner.

A shielded lead from the actual phono pickup to its jack (J-1) should
be held in length to an absolute minimum as discussed under “Install-
ation”.

**Installation**

Regardless of how or where this tuner chassis is mounted due consid-
eration must be paid to ventilation. The position in which it is mounted
is not important, but, heed must be given to radiation of 100 watts of
dissipated heat, a price which attends dual independent channel con-
struction.

Isolation mounts of rubber or other padding must be provided where
the tuner is installed within the same cabinet housing the loudspeaker. Other-
wise directly transmitted mechanical or acoustical feedback or both will
result.

Shielded leads from the tuner to a following amplifier or from a phono-
graph pickup to connectors provided at the chassis rear are essential. The length of these leads should be held to a minimum so as not to retard high frequency response. When these runs must be lengthy, some form of coaxial cable should be installed. The central conductor of the ordinary shielded type should be tinned and flowed into the female contact provided while the shield braid should be brought up and over the shell of the plug and then soldered well to it. In some cases it may be necessary to effect a grounded bond between the tuner chassis and that of the following amplifier. Copper braid or large wire may be used for this purpose.

THE SCOPE
[from page 11]

signal tracing or aligning of various radio and television circuits.

Front panel controls for adjusting the internal sweep of the 'scope usually consist of the coarse frequency control, the fine frequency control, and the sync adjustment. The basic sweep frequency if sound by the coarse frequency control, and the pattern is adjusted for hold and lock-in by the other frequency controls.

A multiple cross-section of lines such as shown in Fig. 8 denotes improper setting of frequency controls and are meaningless to the observer until controls are properly adjusted to bring in a single-line pattern.

Fig. 8. Improper frequency setting.

Waveform frequencies up to the limits of the saw-tooth generator can be observed on the screen. Frequencies higher than the range of the saw-tooth oscillator can also be observed, depending on the frequency response of the 'scope. Thus, if the highest frequency of the 'scope sweep is 30,000 cps, we can observe a 30,000 cps waveform on the screen. By getting two patterns (cycles) on the screen. By the same reasoning, 120 kilocycles or even more can be observed, though several cycles would be visible, because we cannot get a single cycle unless both sweep and observed pattern are of the same frequency. The viewing of the higher frequencies depends on how much of a signal can get through the 'scope at these frequencies, for most of the inexpensive 'scopes do not amplify much more than 30 kc flat.

As will be shown later, however, even the inexpensive 'scopes are extremely useful tools in TV and FM alignment and trouble-shooting, and can perform almost all the tasks essential during normal servicing. The signal to be observed is placed on the posts marked V on the front of the 'scope. This connects the signal to the input of the vertical amplifying system within the 'scope. This amplifier is useful in "blowing up" signals of low voltage so that they can be observed on the screen. Within

A service Aid Kit for the record dealer or the serviceman which contains an assortment of replacement needles for all the popular cartridges.

Replacement jobs effected without delay! This practical assortment, neatly arranged, will fit all your needle needs.

It's an automatic inventory-taker! Simply replace the needles you sell by reordering immediately.

DUOTONE needles are famous the world over for their superior performance and workmanship. ORDER TODAY!

Replacement Needle Cabinet No. 700 AND ... an assortment of 14 DUOTONE NEEDLES.

LIST PRICE . . . . $38.00
INTRODUCTORY DISCOUNT . 50/10%
YOUR COST . . . . $17.10
YOUR PROFIT . . . . $20.90

DUOTONE COMPANY
799 Broadway, New York 3, N. Y.
RADIO SERVICE DEALER • NOVEMBER, 1949

Fig. 9. Appearance of sine wave with various settings of V and H amp. control.

the "scope there is also a horizontal sweep amplifier, so that the sweep can be amplified when necessary. This allows the user to spread out horizontally the signal under observation. Figure 9a shows a sine-wave under observation which has a low voltage and shows up very small on the screen. By adjusting the Vertical Amplifier Control, the image can be enlarged vertically as shown in Fig. 9b. Fig. 9c shows the same waveform Figure 9d shows the waveform with very little horizontal amplification. The control which adjust the amplification horizontally is the "Horizontal Amplifier" control.

The positioning controls mentioned earlier, will act on the image as shown in Fig. 10a to 10e. In this fashion we can regulate the image appearing on the screen to suit our needs during servicing. We can focus it, amplify it vertically or horizontally, position it to the right or left, and within limits adjust it so we can observe one pattern or a number of consecutive patterns or cycles.

[To Be Continued]

Fig. 10. Effect of positioning control on image.

A NEW AID TO RAPID SERVICING

(from page 16)

The particular component under consideration were a coil of any variety, model 915 will immediately qualify any number, with no more special circuit than that of a coupling signal generator. Since a coil is strictly an L/C circuit (due to various capacities-turn adjacency, etc.) the self resonance of the standard sample can be established in a matter of seconds. Once this has been determined any number of similar coils can be quickly checked by simply...
TONE CONTROLS

[from page 14]

cordist® variety can be improved by the emphasis of high frequencies and bass boost. Playback pickups, amplifiers, and loudspeakers' responses can be given a tonal quality that goes beyond that usually expected.

Figure 3 is another arrangement of dual tone control; but using a single triode instead of the dual triode. The bass and treble are mixed and amplified in the one stage. Resistors R5 and R6 serve the purpose of isolating the bass and treble circuits and limiting the interaction of the two potentiometers R3 and R4. The gain in this circuit is appreciably less than that of the two previous circuits due to the use of R5 and R6.

Figure 4 is an interesting combination of the three previous circuits.
3 GREAT NEW TITONES
meet changing pickup needs!

NOW a full line of Titone's amazing ceramic pickups—made by famous Sonotone! All with these great basic features: Full frequency (response from 50 to 10,000 cycles.) Bell-like supertone makes new or old players thrilling. Climate-proof, moisture-proof, fungus-proof! Lightest pressure saves needle wear, revives worn records. NO needle talk! NO crystals, magnets, filaments to fail. NO pre-amplifiers. Performs perfectly for years!

Condenser C1 goes to the rotor connection of the potentiometer R2 and, as the potentiometer is rotated from the grid side to the ground side, the tone response is varied from bass boost to treble emphasis. With the condenser at the ground side of R2, the circuit represents the treble channel of the circuits previously described; high notes are by-passed to ground due to the comparatively low reactivity of C1. With the condenser C1 at the grid side of R2, the bass is attenuated by the comparatively high reactivity of C1, and the circuit represents the treble channel of the circuits in Figs. 1, 2 and 3. Rotating the arm of potentiometer R2 gives a continuous and wide control of tonal quality to suit the ear of the individual listener.

A 6C5 triode and the parts values are given. This circuit is particularly ideal when used with crystal pickups.

This circuit is characterized by its simplicity of installation and comparatively low cost, due to the avoidance of high cost parts. In addition, it is particularly ideal when used with crystal pickups.

SPRAGUE PRODUCTS COMPANY
Distributors' Division of the Sprague Electric Co.
NORTH ADAMS, MASS.

NO TONE LIKE TITONE

Call your Jobber or write to SONOTONE, Box 5, Elmsford, N. Y.
across the input of the channel, a voltage drop appears across \( R_1 \) and \( R_2 \). This voltage drop can be computed by this simple formula and a little elementary algebra.

\[
(1) \quad E_1 = \frac{R_g \times E_2}{R_{total}}
\]

\( E_1 \) is the voltage at the grid.
\( R_g \) is the grid resistor.
\( E_2 \) is the input voltage.
\( R_{total} \) is the sum of \( R_g \) and the isolating resistor.

For example, if we consider a phonograph pickup having a voltage output of .85 volts and connect it across points \( a \) and \( c \) in Fig. 1, what voltage will appear at the grid of \( V_1 \) (ignoring the effect of \( C_1 \))?

\[
(2) \quad E_1 = \frac{500,000 \times .85}{750,000} = .566 \text{ V.}
\]

However, the gain in tonal quality achieved by these simple arrangements more than compensates for the voltage loss.

**FIELD FINDINGS**

[from page 4]

ports, tubes and accessories is breaking all past records. There are shortages of all kinds, particularly tubes. Better test equipment and CROs are in demand, and happily, many service organizations are investing in new test equipment now knowing that their investment is justified because it will enable them to render more efficient service, faster, and thus provide a correspondingly larger percentage of operating profits. Likewise, the employment situation is "tight" for there is an acute shortage of competent technicians, and wage scales are close to record peaks. The one weak spot in the whole picture is, however, just the same now as it was one, two, five and ten years ago. Servicemen are not demanding and getting enough money for their services. Yes, the service profession is still giving the public much too much value.

For example, we find many radio retailers, especially those not operating their own service departments, are selling TV sets with built-in antennas nowadays, and in order to consummate the sale quickly, are happy to let the buyer rush out without a service policy, or without a contract that includes the installation of an external antenna should one be required for optimum reception. In other words, dealers like to grab a sale and forget any further dealings with a customer, especially when they know that the dealings are of a technical nature which surely involves call-backs and servicing. Then, when these built-in antenna type sets fail to give a customer complete satisfaction, the retailer complacently washes his hands of the matter by referring the set owner to his "service branch"—usually a firm in no way connected with the retailing establishment except through "working arrangements." Then when the set owner finds he is faced with the expense of buying an

---

**COMPARE ACTUAL PERFORMANCE CURVES**

**OF THE ANCHOR TV-PRE-AMPLIFIER**

HAZELTINE REPORT No. 2801-17

The ANCHOR PRE-AMPLIFIER is engineered to amplify the signal only, not the noise. Furthermore, the inherent noise of this unit is not measurable.

The ANCHOR Booster provides maximum gain possible from the 6AK5 tube with excellent band widths. It increases signal strength without loss of picture detail.

The outstanding acceptance of the ANCHOR TV-PRE-AMPLIFIER by Service Engineers and Dealers is the best testimonial to its quality.


See your jobber or write us.

---

$1.00 to $5.00 PAID for "SHOP NOTES"

Write up any "kinks" or "tricks-of-the-trade" in radio servicing that you have discovered. We will pay from $1 to $5 for such previously unpublished "SHOP NOTES" found acceptable. Send your data to "Shop Notes Editor," RADIO SERVICE DEALER, 342 Madison Ave., New York 17, N. Y. Unused manuscripts cannot be returned unless accompanied by stamped and addressed return envelope.

---

**N-303 VARI-VOLT JUNIOR $15.00 DEALER NET**

A voltage regulating isolation transformer to make your bench test voltage exactly what you want...on 117V line, variable from 95 to 145 volts...if line drops to 90, variable from 75 to 115V...output adjustable in 1/2 volt steps...metered output voltage...capacity up to 250 Watts intermittent, 50-60 cycles...for radio and television receiver testing at under or over voltage...to isolate "hash" and live ground from AC-DC equipment...controlled voltage for meter calibration...speed up or retard heating of light soldering iron...and for many other similar uses.

See your local Halldorson distributor for complete line of replacement transformers...exact duplicates television and auto Vibrator transformer replacements, or write direct to us for complete information. THE HALLDORSON COMPANY, 4500 Ravenswood Avenue, Chicago 40, Ill.

---
outdoor antenna and having it installed, his (the set-owner's) ire is directed toward the service firm, and not toward the retailer—for it is human nature to yowl at the person with whom one is presently dealing rather than the one with whom the original transaction was made. Yes, now more than ever before, servicemen are coming into closer personal contact with set owners, and the danger of there being unjustified friction and misunderstanding is mounting. That is why we urge Service Dealers (firms that sell at retail and also operate their own service department) to assiduously try to handle their own installation and service contract work rather than farm same out to a third party.
forms two functions. Its first function is to set up the bridge automatically for either resistance, capacitance, or inductance measurements. For resistance the circuit is a standard Wheatstone bridge, for capacitance it is a conventional 4-arm bridge with capacitances in two legs and resistance in the ratio arms. The Maxwell bridge circuit is employed for measuring inductors whose Q is 10 or less, and the Hay bridge circuit for measurement of inductors with Q's higher than 10. The second function of the SELECTOR SWITCH is to select the proper rheostat for reading the dissipation factor of capacitors or Q of coils. When this switch is in its CD position, the bridge is set up for measuring capacitance, and the rheostat D is selected for dissipation factor readings from 0.001 to 0.1 (corresponding to capacitor power factor reads from 0.1 to 10%). When the switch is in its CDQ position, the bridge is set up for capacitance measurement, and the rheostat DQ is selected for dissipation factor readings from 0.01 to 1.

When the switch is in its LQ position, the bridge is set up for inductance measurement, and the rheostat Q is selected for Q readings from 10 to 1000. When the switch is in its LDQ position, the bridge is set up for inductance measurement, and the rheostat DQ is selected for Q readings from 1 to 10.

When the SELECTOR SWITCH is in its R position, the bridge is set up for resistance measurement only, and the rheostats D, Q, and DQ automatically are switched out of the circuit.

Rheostat Q has a logarithmic taper, as indicated in Fig. 2. Rheostats D and DQ have linear tapers.

The reactive standards are the self-contained 0.01- and 0.1-microfarad precision capacitors shown in Fig. 2. Both capacitance and inductance measurements are made against these capacitors as standards. Use of capacitor standards for inductance measurement (using the Maxwell and Hay bridge circuits) remove the necessity for standard inductors, greatly simplifying the bridge arrangement and reducing its cost.

**Mechanical Construction**

Resistors $R_1$ to $R_{10}$ inclusive are connected by means of their pigtails directly between points of the MULTIPLIER SWITCH and DETECTOR SWITCH. Leads to and from the 1000-cycle hummer can be made with regular, insulated hookup wire. All other wiring must be made with...
solid bus bar and must be as short and direct as possible. Rigid wiring of this kind is employed to prevent changes in circuit capacitance resulting from shaking or vibrating leads.

All bridge components except the battery are mounted on the 10" x 16½" metal panel. The instrument (See Fig. 1) is housed in a sloping-panel wooden cabinet.

**Initial Calibration**

After the bridge has been completely assembled and its wiring verified, the initial calibration may be performed in the following manner:

1. Set the DETECTOR SWITCH to its SHUNTED GALVANOMETER position.
2. Set the GENERATOR SWITCH to its D.C. position.
3. Set the D, Q, and DQ rheostats to their zero or minimum readings.
4. Set the MULTIPLIER SWITCH to its 1000-ohm position (position D in Fig. 2).
5. Set the SELECTOR SWITCH to its R position.
6. Connect an accurately-known 10,000-ohm resistor to the pair of "unknown" terminals labelled R.
7. Adjust the MAIN CONTROL rheostat until the self-contained microammeter reads exactly zero.
8. Set the DETECTOR SWITCH to its GALVANOMETER position, and adjust the MAIN CONTROL for a sharper null (zero) indication of the meter.
9. The MAIN CONTROL should read exactly 10 (which is an indication of 10,000 ohms, the value of the resistor connected to the R terminals). If it does not, loosen the setscrew of the MAIN CONTROL knob without disturbing the setting of the rheostat, set the pointer exactly to 10, retighten the set-screw.

Since precision resistors are used in positions R₁ to R₆ and accurate capacitors are used for the 0.01- and 0.1-µfd. standards, this one-point calibration automatically calibrates all ranges of the bridge, for a.c. and d.c.

The 10,000-ohm resistor used for the calibration must be a precision unit, since future accuracy of the bridge for resistance, capacitance, and inductance will depend upon the accuracy of this initial calibration. After this calibration is completed, the bridge will be ready for use.

The direct readings of the D, Q, and DQ rheostat dials are accurate only for 1000 cycles bridge frequency, such as is derived from the self-contained hummer. Their indications are only relative at other bridge signal frequencies.
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