November 1939

A universal 6-tube superheterodyne receiver for battery and/or a-c, d-c operation which offers nearly ten times the output for line operation as it does for battery operation. It also has other unusual features. (See page 52.)
Don't be decoyed by a condenser that just looks like an *FP* (Fabricated Plate) CAPACITOR

You can no more expect FP (Fabricated Plate) Capacitor performance out of any other condenser... no matter how much it may look like an "FP"... than you could expect flight from a wooden duck.

It was only natural that the success of FP (Fabricated Plate) Capacitors would invite imitation in appearance. But the real difference cannot be imitated. FP (Fabricated Plate) Capacitors are constructed by a patented process that involved great investments of time and money to develop. The result is a capacitor that sets a new high in characteristics and performance.

Low R. F. Impedance... better filtering efficiency... surge proof construction... smaller sizes without a sacrifice of safety or efficiency... freedom from corrosion... these are just a few of the revolutionary features of FP (Fabricated Plate) Capacitors.

**Over a Million Now in Use**
**As Original Equipment**

Best evidence of the superiority of FP Capacitors has been their prompt adoption by leading set manufacturers. In addition to the million already in use, future schedules call for the use of millions more.

You'll be seeing them in all leading sets... and although they are being imitated in appearance, you can identify them by the number (1) or (3) in a circle, stamped on every genuine Fabricated Plate Capacitor.
Is That Rider's New Book?

Yes, Servicing by Signal Tracing.

What d'ya think of it?
I think it's swell.

I don't mean the book, I mean do you think this new System of Rider's is any good?

Any good? Say, where have you been for the past two years! Don't tell me you don't know about servicing by signal tracing—it's the only true method of dynamic testing!

So what? I can find out what's wrong with a receiver by the same method I've used for ten years.

Sure, you can, and you can deliver your jobs on horseback, but it's quicker and cheaper to use a car. Receiver designs aren't as simple as they were ten years ago, the sets we're getting in here right now are so complicated that this new system of Rider's is a Godsend.

Yes, for Riders.

OK, get smart about it. But just take my word, you better read up on it today, because you're going to be using it tomorrow. If you're gonna keep up with competition you've gotta shoot troubles a lot faster than you have been because every year it gets tougher and tougher to "outguess" the new sets when they go bad.

So, how's what you call servicing by signal tracing going to make it easier?
By tracing the signal!—the one thing that's fundamental in any make receiver.—Find out where that departs from normal and you have found the trouble.

Then that method could be applied to servicing P. A. systems, television or most anything.
Sure, any type of electrical equipment through which a signal passes. It doesn't make any difference whether it's a new or old receiver or one they bring out next year—tuned r-f or superhet—three tubes, or thirty—they all are diagnosed by the same procedure if you use the signal tracing method.

JOHN F. RIDER, Publisher
404 FOURTH AVE. • NEW YORK CITY
Export Div. Rocke Int. Elec. Corp., 100 Varick St., N. Y. C. Cable: ARLAB

It seems too good to be true, it sounds so simple.
It's like a lot of things. You feel like saying, 'it's a wonder nobody thought of that before,' but when you understand it you can't quarrel with it—it's good.

What's the book tell you?
In the first seven chapters Rider tells, in his easy to understand style, about the behavior of a normal signal from the antenna post to the loudspeaker, and signal characteristics at the points between. The rest of the book explains the signal tracing method step by step.

Let's see that book!
Sure, but you can't borrow it. It only costs $2.00 and besides it's about time you spent some time and money getting ready for tomorrow's business.

Is that all that book costs? Why it's got 360 pages. I'm going to the jobbers this afternoon. I'll pick up my own copy.—And I hate to admit it to you, but thanks a lot for a darn good tip.

Believe Me
The Ten Rider Manuals
and the system of Servicing by Signal Tracing make a combination that can't be beat for faster, easier, better trouble shooting—and when I say that I'm saying they mean profits with a capital "P." They help every serviceman help himself to bigger money.

SERVICE, NOVEMBER, 1939 • 503
ANTENNA

ARD on the heels of other innovations, frequency modulation is rapidly coming into the limelight. Without making any predictions we feel that you should endeavor to learn all you can about every new possibility just as early in the game as you can. We suggest that you read Mr. Yocum's article on the subject, which starts on page 507 of this issue, and make sure that you will receive a copy of the December issue so that you can follow his interpretations to their conclusion.

CHRISTMAS approaches and with it your customers go giddy. Why not take advantage of the season and wrap up your principal product in Christmas finery for added profits.

A "Gift Certificate" or "Serviticate" that means service of a set for a beloved listener-in, or friend or member of the family, presents an attractive and practical gift. There are so many things that may be secured for Santa's sack that you can come to his aid by capitalizing on Christmas. Parts, novelties, accessories, or orders for special services, small sets, especially battery portables, and popular items in allied lines—records, appliances, Christmas tree lighting effects, electric train accessories, and repairs, etc.—can all be decked out as "Last minute gift suggestions". The homeliest gadget when covered with gift glamour makes a charming and especially when needed a most welcome gift.

The holiday season may be used to bring other sources for added income. Many companies and organizations give Christmas parties a day or two before Christmas or New Year's Day. The enterprising Service Man can rent radio tuners, record players and amplifiers for such events. No large selection of records is needed; a few old standbys such as "Auld Lang Syne" and "Silent Night" plus several popular numbers should be quite sufficient.

Now is the time to prepare for the increase in business which the holidays should bring. Stock up on tubes and replacement parts so that you will be able to devote your full time to profitable ends when the rush comes.

CONTENTS

Automatic Announcing. By Lewis Winner. 517
F-M Receivers 518
Frequency Modulation. By Charles H. Yocum. 507
Preview of Test Equipment for 1940 522
Voltage Measurement. By Jack Avins 511
Associations 542
Auto Radio 525
Auto-Radio Data 528
Book Reviews 536
Case Histories 544
Circuits 511
AVC Circuits 511
Aerovox 95L-C Checker 540
Early Voltmeter 513
Electronic Voltmeter 512
Emerson DF302, DF306 Front Cover
GTC L Porta Power 538
Potentiometer Type Voltmeter 514
Resistance A-F 512
Slide-Back V-T Voltmeter 514
Stromberg-Carlson 425 F-M Receiver 518
Stromberg-Carlson 480 F-M Receiver 519
Cover Diagram
Emerson DF302, DF306. By Henry Howard 535
Index to Advertisers 546
On the Job 541
Dial Strings 541
GTC L Porta Power 538
Public Address 517
Automatic Announcing. By Lewis Winner
Test Equipment
Aerovox 95L-C Checker 539
Preview of Test Equipment for 1940 522
Voltage Measurement. By Jack Avins 511
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KOOLOHM channels, and insulated electrically, by insulation. Proof ceramic wires! Resistance values you can use anywhere at full wattage ratings, even for the highest resistance values — resistors that are completely insulated and operate cooler — resistors that are different in construction and outstandingly superior in performance. All wire in KOOLOHMS is coated before winding with Rubencote, a new heat-proof, moisture-proof insulating material. This permits tightly interleaved windings, larger wire sizes, higher resistance values in less space, and perfect insulation throughout. No bare resistance wires! No cements or enamels! Moisture-proof ceramic jackets provide rugged mechanical protection and high voltage insulation.

WIRE TOUCH — BUT THEY DON'T SHORT!

Note the interleaved winding pattern of Sprague Koolohms made possible by perfect insulation of the wire itself. Note also (cut-away view) how units are protected mechanically, and insulated electrically, by a hard ceramic outer shell. No danger of chipping or breakage.

BY THE MAKERS OF FAMOUS SPRAGUE CONDENSERS

TRUE

DYNAMIC MUTUAL CONDUCTANCE
TUBE TESTER

Model 1510
DEALER NET
49.67

HERE IS THE PROOF

TRIPLETT Models 1510-11

You can see from a glance at the diagram that Models 1510 and 1511 are actually—not simulated—Dynamic Mutual Conductance Testers, an important point when considered along with Triplett precision manufacturing, at the attractive price of these models.

Model 1510 Dynamic Mutual Conductance Tube Tester shows GOOD and BAD on the illuminated dial. Gas and Ballast tube continuity test included. Checks all receiving tubes, including the new high-voltage series. Filament voltages in 20 steps from 1.4 up to and including tests for 117-volt tubes. Rotating chart enables quick selection of instructions. Separate line voltage meter. Tester positively will not deactivate 1.4-volt tubes. For absolutely conclusive tube testing use a Triplett TRUE Dynamic Mutual Conductance Tube Tester. Has REDDOT Lifetime Guaranteed instrument.

Model 1510 Tube Tester in attractive quartered oak case; sloping etched panel.

Dealer Net Price $49.67

Model 1511—same as above but with Volt-Ohm-Milliammeter

Dealer Net Price $59.67

DYNAMIC EMISSION

All elements have A.C. connections. Control grid voltage is varied to change output reading. Connected as shown, the plate current is pulsating D.C. and must be brought to same value for all tubes, regardless of their capacity, in order to read in "Good" section of scale. This is NOT Dynamic Mutual conductance, and rated D.C. voltages are not applied to the elements. Tube readings vary with grid voltage, spacing of elements and cathode emission.

WRITE for CATALOG!

Section 1711; Harmon Ave.

THE TRIPLETT ELECTRICAL INSTRUMENT CO.
Bluffton, Ohio

NOVEMBER, 1939

www.americanradiohistory.com
FREQUENCY MODULATION

An up-to-the-minute summary on frequency modulation. This is the first of a series of two articles on this interesting subject.

By CHARLES H. YOCUM

Something new and vital has come to radio. Wide-band frequency modulation offers the set manufacturer, the seller, and the user of radio the possibility for a new era in which performance will be paramount. The industry welcomed the recent upward trend in prices, small as it was. F-m is a proven system, standing ready to free it from "price" standards, give it instead a "quality" standard.

Fortune magazine, in its October issue, insists that 40,000,000 home receivers and 750 or 800 transmitters became obsolete on the day the f-m system was perfected. Engineers within the industry are more conservative. They know that years may be needed to change two-billion dollars worth of equipment to another system, no matter how superior that system might be.

Those who have not followed the progress of f-m will be amazed at its advancement. Look at the list of stations in Table I. They are on the air or actually under construction. All will be on the air before next spring.

The scientist and engineer has presented this development to us all. Will the public demand the refinements and greater enjoyment promised by f-m? A tremendous replacement volume hangs on the answer.

From the standpoint of the consumer, f-m transmission has two major advantages. First, it is its amazing fidelity. Music and speech have a natural sound, you hear a truer duplication of the original program in the studio. High fidelity is commercial, not experimental.

<table>
<thead>
<tr>
<th>OPERATOR</th>
<th>LOCATION</th>
<th>POWER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Armstrong</td>
<td>Alpine, N.J.</td>
<td>50 Kw.</td>
</tr>
<tr>
<td>WABC, Inc.</td>
<td>Meriden, Conn.</td>
<td>1</td>
</tr>
<tr>
<td>Yankee Network</td>
<td>Paxton, Mass.</td>
<td>2</td>
</tr>
<tr>
<td>Yankee Network</td>
<td>Paxton, Mass.</td>
<td>50</td>
</tr>
<tr>
<td>Jansky &amp; Bailey</td>
<td>Washington, D.C.</td>
<td>1</td>
</tr>
<tr>
<td>Hofstra Broadcast</td>
<td>New York City</td>
<td>1</td>
</tr>
<tr>
<td>Stromberg-Carlson</td>
<td>Rochester, N.Y.</td>
<td>1</td>
</tr>
<tr>
<td>Mutual Broadcast</td>
<td>New York City</td>
<td>1</td>
</tr>
<tr>
<td>Milwaukee Journal</td>
<td>Milwaukee, Wis.</td>
<td>2</td>
</tr>
<tr>
<td>WNEC, Inc.</td>
<td>Rochester, N.Y.</td>
<td>2</td>
</tr>
<tr>
<td>Worcester Telegram</td>
<td>Worcester, Mass.</td>
<td>1</td>
</tr>
<tr>
<td>Travellers Inn. Co.</td>
<td>Hartford, Conn.</td>
<td>1</td>
</tr>
<tr>
<td>Western Electric</td>
<td>Holbrook, Ill., N.Y.</td>
<td>10</td>
</tr>
</tbody>
</table>

Table I. A list of f-m stations either on the air or under construction.

Noise reduction

The freedom from atmospheric disturbances and local noise, which the buying public group together as static, is equally noteworthy. No longer will it be necessary to turn off your favorite program because a thunder storm is brewing. A bolt of lightning may strike the transmitter and cause only a mild click in your receiver. All interference is reduced. Faults associated with radio since its earliest days are wiped out or reduced far below what is considered acceptable today.

Many technical factors combine to give this vastly improved reception. One advantage of the f-m system is that radio-frequency noise which may occur between the transmitter and receiver is not evenly distributed throughout the audible range when it is reproduced in the speaker. It is a peculiarity of f-m that these noises, due to what we normally call static, are minimized at the lower audio frequencies. They increase steadily as we approach the limit of human hearing at about 15 kc. The noise and interference continue to increase still further up to 75 or 100 kc, and some part of this disturbance may pass through the receiver.

No human ear, however, can detect the part of this distortion which occurs above about 15 kc. The human ear also is much more sensitive to distortion at low pitch. Thus, this peculiar distribution, of what we may call the disturbance energy, occurs in such a way that the human ear rejects by far the greatest part of it, and is most sensitive in the region where the f-m system most completely wipes out the disturbing sounds. The amount of advantage accruing to f-m depends, of course, upon the keenness of hearing of each individual. A number of tests, however, show that at least 50% more actual audible distortion may be present in an f-m program than in an a-m program, yet the human ear would rank them both equally acceptable and free from objectionable disturbances. This means that an f-m program may be received with enjoyment in an area where local electrical disturbances, whether natural or man-made, would normally make pleas-

![Diagram](image-url)
nt listening an impossibility. See Fig 1.

In addition, some disturbances are themselves of definite bandwidth, or affect only a certain band of frequencies in the transmitted signal. If the program we hear in our receiver is carried to us through a system which is only 10 kc wide, then a disturbance affecting a band 1 kc wide will cause a certain amount of distortion. If, on the other hand, our receiver brings us a program by means of an energy band 100 kc wide, then this 1 kc disturbance will cause less distortion than occurred in the first case. If one f-m system operates with a swing of 50 kc each side of its carrier, and another with a swing of 5 kc each side of its carrier, the first transmitter should show an improvement of at least 10 to 1 as compared to the second in its ability to suppress noise.

The actual figures are astounding. When the peak value of the disturbance is less than 10% of the signal (both measured in the limiter stage of the f-m receiver) then the energy of this disturbance after rectification will be reduced by almost 1100 to 1. For noise voltage upwards of 25% of the signal voltage, the noise reduction in the rectified signal will be about 200 to 1. When the noise is one-half the signal it appears in the output reduced by a factor of about 400 to 1. If the noise and signal become approximately equal, the actual improvement drops to some very low value of 2 or 3 to 1. Although the primary service area would be considerably enlarged if the suppression could be kept up to 400 or 500 to 1 when noise and signal were about equal, let us not forget that high-fidelity a-m reception requires signal to noise ratio of about 100 to 1. This is the region where the f-m system’s ability to suppress unwanted noise is a maximum.

inter-station interference

Reference has been made to the efforts of early experimenters who tried to use f-m in order to pack more transmitters in the broadcast band. A big advantage of modern f-m transmitters is that a number of them may be assigned to the same frequency, provided they are several hundred miles or more apart. There will be no cross-modulation or interference. This is due to the fact that the f-m receiver will reproduce only the stronger of two signals, suppressing the weaker one, and provided the ratio of the signal voltages in the receiver is 2 to 1 or more. F-m is at present limited by the FCC to frequencies of 40 mc or higher. The limit of satisfactory signal strength for such transmission is somewhere between 100 and 150 miles. We can visualize a large number of transmitters, all on the same wavelength, scattered across the country at distances of approximately 300 miles from each other. Each one covers its own primary service area without being interfered with, or interfering with, the other transmitters on the same band. Present experiments indicate that even better results could be had if the assigned frequencies of the stations were separated by amounts as small as 10 or 15 kc. Due to the action of the detecting device in the f-m receiver, the suppression of unwanted signals would be still further increased. It is often possible, however, to pick up the weaker signal with a directive antenna which would increase the amount of desired signal available to the receiver. Map, Fig. 3.

The ability of the f-m transmitter to minimize natural and man-made interference and to magnify the wanted signal gives the system a cumulative advantage over present types. If we calculate the performance of an f-m transmitter and an a-m transmitter, both drawing about the same number of kw from the lines of the local utility, the f-m system with a band width of 150 kc and the a-m system with a band width of 10 kc, we find that we have a practical overall improvement of more than 1000 to 1 may be secured. This improvement is measured by the accepted method: comparing the ratios of signal to signal-plus-noise permissible for high-fidelity reproduction.

Actual comparisons have shown the possibility of approaching this range in practical, every-day operations. Some allowance should be made for the circumstances attending the test, since u-h-f transmission of any type has advantages over the same system operated in the broadcast band. The tests would have been more acceptable had they compared a-m and f-m, both at the same high frequency. Sufficient additional improvement exists, however, to convince many investigators.

phase shift

Another operating advantage of f-m rests upon the fact that high audio frequencies are transmitted with the minimum phase shift in output, and low frequencies with the maximum. In a typical case cited by Major Armstrong, 30 cycles per second would be represented by a phase shift of 30 degrees; 10,000 cycles by a shift of but 0.09 degrees. Even after the series of multiplications required to change this shift to an f-m wave, the highest audio frequencies lie

Table II. Roder's calculations for frequency-modulated amplitude variations. Phase modulation (last column) should be restricted to less than 30° to avoid serious distortion. Note that in phase modulation the phase shift varies inversely as audio frequency; in true frequency modulation the frequency deviation varies directly as the audio frequency.

<table>
<thead>
<tr>
<th>Side Frequency Amplitudes</th>
<th>Side Frequency</th>
<th>Side Frequency</th>
<th>Side Frequency</th>
<th>Side Frequency</th>
<th>Side Frequency</th>
</tr>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10000</td>
<td>2.5</td>
<td>10000</td>
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</tr>
<tr>
<td>5000</td>
<td>5.7</td>
<td>5000</td>
<td>5.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2500</td>
<td>11.5</td>
<td>2500</td>
<td>11.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>28.6</td>
<td>1000</td>
<td>28.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>57.3</td>
<td>500</td>
<td>57.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>250</td>
<td>114.6</td>
<td>250</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>286.7</td>
<td>100</td>
<td>286.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Amplitudes are expressed as percent of unmodulated carrier.
closest to the assigned carrier in phase relationship. Thus, a considerable amount of additional amplification may be given to all the higher audio frequencies without causing interference with adjacent programs. Pronounced amplification of the highs in an a-m transmitter is limited in order to prevent cross-modulation of adjacent channels.

cost factors

Another advantage of the f-m system is that the modulation of even the largest transmitter can be accomplished using the same type of tubes and components found in radio receivers, except for the final stages. A 50-kw modulator bay (Fig. 2—pictures) is reduced to the approximate size of an 8 or 10-tube receiver chassis, although it includes its own power pack.

The maximum voltage (plate supply) applied to any component part of the modulator is only 180 volts. Such voltages are easily handled and filtered and represent an economical design which is reflected in the initial and lower maintenance cost of the complete transmitter. Voltages over 200 are found only in the power stages.

Further economy results from the fact that for equal transmitter power rating only about half the electrical energy is required from the power lines by an f-m system as compared to a-m.

This economy is partly due to the fact that f-m lends itself admirably to the use of Class C output stages and also because the antenna current does not vary (during program transmission) from the carrier level.

Some criticism of f-m is voiced because, in its modulating system, a small phase shift of not over 30° must be multiplied, with strict linearity, several thousand times. The answer to this is that the modulator is relatively inexpensive. The carrier is modulated at a low energy level and the majority of the parts used in its construction, both tubes and components, are identical with those used in home receivers. This complexity of parts is merely that of numbers, since the actual circuits are doublers and tripplers of a conventional type.

economic status

Reference has been made earlier to an article in Fortune which strongly criticizes the FCC and the broadcast industry for their apparent failure to enable the public to enjoy f-m programs. Granting every advantage claimed by the strongest advocates of f-m, how can the industry begin to replace any major part of the a-m transmitters and receivers now in use? Their replacement value runs into billions of dollars. No program has yet been evolved which offers the industry an economically
Alpine transmitter. If f-m continues to advance in public acceptance, a double system may be needed, until the public makes a final choice.

The variety and quality of American radio entertainment is admirably the best in the world. It is paid for by advertisers, who buy time on the radio only because they can thus reach more people for a given expenditure than they can by competitive media. The individual broadcaster or chain cannot change to f-m unless enough f-m receivers are in operation in his primary service area to permit him to charge the sponsor an adequate fee. The maker of receivers can offer f-m sets at attractive prices only if he is assured of a volume of sales. The public cannot be expected to buy an f-m receiver if it means that he must sacrifice the reception of his favorite programs, or if the price is too high.

Since radio broadcasting in this country is a private undertaking, many factors must be weighed before a change can be authorized. Existing contracts with sponsors, competition, stockholders, patents, licenses, are but a few. The remarkable point, in the opinion of many, is that a new and radical departure from the established system can have made the rapid progress which f-m has, in spite of these factors, all nominally opposed to sudden change.

transmission fundamentals

In order to compare the f-m and a-m systems in operation, we must first return to the fundamental problem of transmitting intelligence by radio. There are two variables which must be sent from the transmitter to the receiver, if we are faithfully to reproduce in the latter the program originating in the studio. Each of these variables suffers wide changes independently of the other. They are the pitch or frequency of the program material, and its volume.

In a conventional a-m transmitter the change in pitch is indicated by a change (in cycles per second) from the fixed carrier frequency. Thus, if an a-m transmitter, operating with double side-bands, were assigned a frequency of 42.8 mc, a 1000-cycle note would be broadcast when this transmitter was sending out a wave, the side frequencies of which would be 42.799 and 42.801 mc. Change in volume is signalled by a variation in the amount of current fed into the antenna of the transmitter. For example, if the antenna current is 10 amperes when no signal is being broadcast, this current would be increased to 20 amperes for 100% modulation, or the loudest sound which this system could transmit. An antenna current of 15 amperes would represent a sound about one-half as loud as the first, etc.

The first point of difference between the above system and f-m transmission is that the f-m station broadcasts a signal of constant amplitude whether modulated or not. Zero, 50 or 100% modulation would call for a 10-ampere antenna current in all cases, if we use the carrier power assumed for the a-m transmitter. The loudness of the sound presented to the microphone of the f-m system would be indicated by the frequency deviation of the side frequencies. If this station likewise operated on a carrier of 42.8 mc, 100% modulation would be indicated when the emitted frequency contained side frequencies of 42.725 to 42.875 mc. If 50% modulation was to be indicated, the frequency would vary between the limits of 42.7625 and 42.8375 mc. If no modulation was present, the transmitter would emit a single continuous frequency of 42.8 mc. If a 1000-cycle note is being fed into the microphone at an f-m station, the frequency swing will take place 1000 times in every second. Note that under no circumstances will the antenna current deviate from 10 amperes.

We may summarize the comparison by stating that a-m indicates pitch by changing the frequency of the radiated energy; f-m by the time rate of change of frequency. The a-m system indicates percentage modulation by proportionate changes in the antenna current; f-m by varying the amount of frequency swing above and below its assigned carrier.

See Fig. 5.

Experimenter's have tried to apply frequency modulation to solve radio problems since the earliest days. It was tried on both spark transmitters and the early phone sets without success in either case. We can see now that one probable reason for these failures was that the experimenters were trying to compress the normal audio band of 10 kc into one only 2- or 3-kc wide. This, if successful, would have permitted many more transmitters to operate in the broadcast band. As we have seen, f-m has a solution to that problem today. It has achieved its success, however, by an exactly opposite method of attack. Today's f-m transmitter transmits a band 100 or 150 kc wide to reproduce in the home receiver an audio band of 15 kc with fidelity. But there were many other problems which had to be overcome, however, before f-m could reach its present state of development.

(To be concluded)
**VOLTAGE MEASUREMENT**

**By JACK AVINS**

LET'S say that you're working on Mr. Jones' set. It seems to operate well on most stations but the output is distorted on strong locals. Sounds like overloading. One of the first things therefore, is to check the AVC circuit. It is possible, with a modern voltmeter, to measure the AVC voltage directly at the grids of each of the controlled tubes without disturbing the operation of the receiver. If a tube is not receiving the proper control bias the defect will be indicated immediately.

On the other hand, if your measuring equipment is the times, instead of the simple and rapid measurement, you'll have to break into the circuit and indirectly determine grid bias by inserting a suitably by-passed milliammeter in the plate circuit of each of the controlled tubes. From the value of the plate current, you'll be able to estimate the control voltage. Even then you'll have to assume that other conditions in the tube circuit are correct before you can depend on your estimate of the voltage.

**Simplified measurements**

Simpler, more direct, and more positive, the new way gives you your answer by indicating the true voltage directly on the meter scale without any necessity for breaking into the set or in any way disturbing its operation. Fig. 1 shows the contrast between the old and the new methods.

Let's take another illustration. Suppose you've localized trouble to the first A-F stage of a receiver so that naturally you want to see whether the grid bias and the plate voltage are normal. With a modern voltmeter you can measure these voltages—even in a high-gain resistance-coupled stage—under actual operating conditions and with no reaction on the circuit. With a lower impedance voltmeter, however, the circuit conditions are so greatly disturbed that the voltages you read differ widely from the actual voltages when the voltmeter is removed. Fig. 2 shows a typical example of how loading of a circuit by a low-resistance voltmeter causes large errors in the measurements. In the case of the plate-voltage measurement, the error is about 50%, while for the grid-bias measurement the error is about 100%. Had a modern voltmeter been used the true voltages would have been indicated in each case because of the absence of loading of the circuit.

Every Service Man has encountered leaky coupling condensers. Often these coupling condensers are intermittently leaky, a condition which makes the trouble more difficult to detect. In cases of this sort where there is reason to suspect the coupling condenser, it is helpful to be able to monitor the actual voltage while the receiver is operating. If the receiver should cut out and the output becomes distorted as a result of the leaky condenser (or a gassy tube), then the voltmeter reading will change accordingly. Thus with a modern voltmeter you can keep a constant check on the actual voltage at any point while a signal is passing through the receiver. As we shall see later, the fact that an r-f or a-f signal may be present at the point of measurement does not interfere with the accuracy of the measurement.

We could go on indefinitely citing examples to show you how a modern voltmeter simplifies servicing. But more illustrations are not necessary because undoubtedly you can recall any number of examples where a modern voltmeter would have saved time—examples taken from your own practical servicing experience. What it all amounts to is this: When you make a voltage measurement you want to read the actual voltage present in the circuit. You'll agree that servicing is interesting enough without using an instrument that indicates voltages different from the actual voltages you're trying to measure. Why figure out what the voltage would be if the voltmeter didn't load the circuit, when instruments are available which will give you the true voltage directly?

**Electronic measurement**

To see modern voltage-measuring instruments in the proper perspective, it is helpful to trace briefly the development of voltmeters. The first voltmeters used in radio work consisted essentially of a current measuring instrument in series with a standard resistance of known value. As Fig. 3 shows, Ohm's law was used to determine the value of voltage across the terminals of the current meter and the resistance. Since the current through the combination was proportional to the voltage across the terminals, it was possible to calibrate the scale in terms of this voltage rather than in terms of the current.

These early voltmeters were entirely satisfactory for a considerable number of years, but then gradually conditions arose more and more frequently where the voltmeter gave an incorrect reading. This is not to say that the voltmeters did not indicate the voltage across its terminals. What happened however is that the voltmeters drew too much current from the radio circuit and altered the voltage conditions in the circuit.

The first voltmeters required about ten milliamperes for a full scale deflection. These voltmeters were said to have a resistance of 100 ohms-per-volt because the resistance of the voltmeter for any range could be computed by multiplying the full-scale voltage reading of the range by the ohms-per-volt value of the meter. For example, using this rule the resistance of a 100 ohms-per-volt meter on the 250-volt range would thus be equal to 250 x 100 or 25,000 ohms.

Later the resistance of voltmeters was increased from 100-ohms-per-volt to 1000 ohms-per-volt. Thus the current meter part of the voltmeter was reduced from ten milliamperes full scale to one millampere full scale and at the same

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**Fig. 1. A modern electronic voltmeter (a) measures the actual control voltage at the grid. Without it the measurement must be made by indirect methods (b).**
time all the resistance or multiplier values were multiplied by a factor of ten.

For many years the 1000 ohms-per-volt meter was able to meet the needs of Service Men. So widely was this true that up until recently many receiver manufacturers specified all voltage data in terms of readings taken with a 1000 ohms-per-volt meter. In an increasing number of instances, however, we find statements like this appearing in voltage data: "This is the actual operating voltage; cannot be measured with a 1000 ohms-per-volt meter. " Measured with the 500-volt range of a 1000 ohms-per-volt meter."

Now what did all this mean? While receiver circuits had been advancing steadily, the Service Man's testing instruments had apparently been standing still. New automatic control circuits, new high gain a-f circuits, decoupling circuits, etc., had been developed for receivers--circuits which used high values of resistance and in which currents of only a few microamperes flowed. Yet voltage measurements were still being made by means of a meter which required 1000 microamperes for full scale deflection. Unfortunately the 1000 microamperes required for the deflection of the voltmeter could not be supplied from a circuit in which only a few microamperes were flowing.

The first step to cut down the current taken by the voltmeter was an obvious one: a more sensitive meter was used to replace the one-milliampere movement. Thus we find, for example, 5000 ohms-per-volt meters using a 200-microamperes meter, and 20,000 ohms-per-volt meters using a 50-microamperes meter. These higher-resistance voltmeters constituted a real step forward over the earlier 1000 ohms-per-volt meters. A 20,000 ohms-per-volt meter, for example, requires only one-twentieth the current from the circuits for a given deflection. Thus, it loads the circuit less and its reading is considerably closer to the actual voltage than that of lower resistance voltmeters. However, even these voltmeters which use a more sensitive current meter often disturb the conditions in the radio receiver circuits. When the voltage distribution of the circuit is affected an incorrect reading is obtained.

For a number of reasons it is not practical to increase the sensitivity of the meter movement used in voltmeters and at the present time a 50-microampere movement, corresponding to a sensitivity of 20,000 ohms-per-volt, represents about the extreme practical value. The use of a more sensitive movement is undesirable because the meter becomes less rugged and because the cost of the unit increases as the sensitivity is raised.

potentiometer types

One of the earliest methods known to engineers for the measurement of d-c voltages without drawing current was the potentiometer method. Like many laboratory methods, this method makes use of a balancing or null action. No attempt is made to measure the voltage directly, but instead the unknown voltage is matched against a known value of voltage which is provided from a separate source.

As Fig. 4 shows, a galvanometer is used to indicate when the variable voltage $V_x$, is equal to the unknown voltage being measured. When no current flows through the galvanometer with the switch closed, the unknown voltage is equal to the bucking voltage $V_r$.

The voltmeter which is used in a potentiometer-type voltmeter need not be a high-resistance voltmeter because the current required for its indication is drawn from the internal voltage source and not from the circuit being measured. However, the galvanometer should be sensitive enough so that the minimum current required for an indication will not be sufficient to load the circuit.

This brings us to an important point in connection with potentiometer-type voltmeters, which have also been called "zero-current" or "infinite-impedance" voltmeters. Actually of course the galvanometers used in commercial service instruments of this type do require a certain value of current to provide a noticeable deflection, so that some current is drawn from the source. In one commercial instrument a 350 microampere meter is used so that the least detectable current would be about one microampere. If this instrument is used on say the 10-volt range its effective resistance will be about 10 megohms.

As is evident from Fig. 4, the potentiometer-type voltmeter must have a self-contained voltage source which is equal to the highest voltage intended to be measured. If a voltage multiplier is used, then a power supply having a smaller range can be used. In any event, the power supply must be carefully isolated from ground in order to avoid errors due to leakage between either side of the internal power supply and ground.

Although the input resistance of potentiometer-type voltmeters is sufficiently high, this type of voltmeter is not direct reading because a balance adjustment must be made each time a voltage reading is taken.

slide-back types

A modification of the potentiometer-type voltmeter is the so-called slide-back voltmeter. Shown in Fig. 5, this instrument also uses the same bucking principle, but the galvanometer is replaced by a vacuum-tube indicator. In opera-

Fig. 6. It is possible to calibrate the scale of a vacuum-tube or electronic voltmeter so that it will read the voltage across its terminals directly.
moved by the potentiometer and slide-back types, these did not solve the problem completely because of the excessive time required to take a measurement.

So far none of the instruments which we have considered has made full use of the amplifying property of the vacuum tube. Why not use the fact that a vacuum tube has a very high input resistance and that any change in the d-c voltage applied to its grid will result in a relatively large change in plate current? In other words, why not use a vacuum-tube voltmeter for d-c voltage measurements? The obvious advantages of these are the high input resistance, the high sensitivity, and the fact that a milliammeter rather than a microammeter can be used as the indicator.

Furthermore with proper circuit design it is possible to introduce enough degeneration to make the calibration essentially independent of the variations in tube characteristics. Another point, by no means unimportant in service work where the instrument must be shifted from range to range, is the fact that the circuit can be arranged so that it is impossible to damage the meter.

Let us examine a simple electronic or v-t voltmeter circuit such as the one in Fig. 6. A triode is used which is self-biased by means of the resistors R0 and R. In combination with the low value of plate voltage that is used, the total cathode resistance is such that the plate current produces a center-scale reading on the meter. When a negative voltage is applied to the input circuit, the plate current decreases so that the deflection is to the left of the center zero. Similarly when a positive voltage is applied to the grid, the meter deflects to the right of the zero. It is thus possible to calibrate the scale directly in terms of the voltage at the grid, and hence the instrument can be used as a direct-reading voltmeter.

The use of a large value of cathode resistance brings about a degenerative action which makes this voltage calibration essentially independent of tube characteristics and at the same time straightens the tube characteristic so that the calibration is practically linear.

When tubes are changed in the voltmeter circuit, it is always possible to correct the calibration by readjusting the calibration control R0. The plate voltage control R provides a zero adjustment which makes it possible to set the meter pointer to exactly center scale.

Because of the center-zero arrangement, both positive and negative voltages can be measured directly without switching leads and without the necessity for a polarity switch. It is also possible to arrange the circuit so that the zero is at the left as in the conventional voltmeter. However, this requires the use of a highly linear circuit and the incorporation of a special polarity-reversing switch which is located directly in the meter circuit rather than in the test lead circuit.

With reference to the range covered by the voltmeter (Fig. 6) we note that this is dependent on the setting of the range switch. Maximum sensitivity is obtained with the switch in the number 1 position. As the switch position is changed to numbers 2, 3, and 4 positions, the scale of the voltmeter is multiplied in accordance with the values of the resistors in this voltage divider. The range of the voltmeter can be extended indefinitely without the necessity for using excessively high values of resistance in the multiplier. The only limitation is that the resistors must be capable of handling the applied voltage.

An interesting feature of the circuit is the filter formed by R-C. Primarily the purpose of the filter is to attenuate any a-c or signal voltages which may be present at the points where d-c voltages are being measured. Thus these a-c voltages are prevented from reaching the grid of the tube and interfering with the reading of the d-c voltage. Actually a reasonable value of a-c voltage at the grid will cause no error because the linearity of the circuit prevents rectification from taking place.

accuracy

With proper circuit design and adjustment, the d-c vacuum tube voltmeter or electronic voltmeter has an accuracy which is more than adequate for service needs. In the first place, the amplification obtained from the circuit permits a rugged meter to be used which tends to hold its calibration more permanently than would a more sensitive meter. Secondly, the calibration control which we have already described can eliminate the initial ±2% error which is inherent in the meter movement itself. In production this control can be set at the factory so that the voltmeter is "on the nose" regardless of deviations from the rated value of meter sensitivity. An important consideration affecting the accuracy is the proper design of the voltmeter multiplier resistors. These should be precision resistors which are accurate to ±1%. In production a further improvement in accuracy is often made by grouping these resistors so that all "plus" or all "minus" resistors are used in a given voltage divider or multiplier network. This effectively reduces the error due to the multiplier resistances to less than 1%.

signal circuit probe

We all have had the experience of applying an ordinary voltmeter test probe to the grid or plate of an r-f or i-f tube only to find that the receiver ceased operating. Even with high-resistance voltmeters it is often not possible to make these measurements under actual operating conditions because of the detuning, loading, and feedback caused by the stray capacitance of the voltmeter test leads.

In service work, it is often desirable and convenient to be able to measure or monitor d-c voltage under actual operating conditions while a signal is passing through the receiver. Typical examples where this would be helpful are shown in Fig. 7: (a) the a-c voltage directly at the grid of a controlled tube while an r-f or i-f signal is present at this point; (b) the grid bias directly at the control grid, or the plate voltage directly at the plate in a resistance coupled a-f stage with an a-f signal present at each of these tube electrodes; (c) the rectified grid voltage at the grid of an oscillator tube while the oscillator signal is (necessarily) present at the grid.

In each case the point at which the measurement is made is indicated in the figure by an asterisk (*). We could
continue and cite other illustrations but this is unnecessary; the important point in all of these cases is that to make

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**Fig. 4.** The internal voltage of the potentiometer type voltmeter is varied until zero deflection on the galvanometer indicates that it is equal to the external voltage $V_x$. Voltage measurements that are truly dynamic, it must be possible to determine d-c voltages while an r-f or a-f signal is present. And in order not to disturb the circuit conditions the voltmeter must not interfere with the signal by detuning or loading the circuit in any way.

This detuning can be eliminated by means of a special test lead probe which contains an isolating resistor. A cutaway view of a probe of this type, used in an instrument which was introduced to Service Men last year, is shown in Fig. 8. Because of the isolating action of the resistor, the capacitance shunted across the point of measurement is approximately the shunt capacitance of the isolating resistor $R$. This capacitance, including the stray capacitance to ground of the test prod, is of the order of 1 mmfd, so that effectively the circuit is detuned by about 1 mmfd. As far as the loading effect is concerned, the isolating resistor reduces the r-f loading of the circuit to a value greater than 1 megohm. The d-c input resistance is of course sufficiently high since it is equal to the 1-megohm isolating resistance plus the input resistance of the voltmeter.

**center zero**

Aside from the convenience and ease of use made possible by the center-zero arrangement there is another more important reason for the use of this type of scale. We have seen that with the center-zero arrangement, the ground side of the voltmeter is clipped to the ground or low side of the voltage being measured. As a general rule in receiver servicing this means that the ground side of the voltmeter is clipped to the chassis of the receiver on which the measurements are being made. The "high" voltmeter lead is then connected to the point of measurement and whether this point is plus or minus with respect to ground, the voltage will be indicated directly; the voltage is plus if the deflection is to the right of the zero and minus if to the left of the zero.

Would it not be possible to use the full scale for either plus or minus voltages and then reverse the test leads as we do in the case of an ordinary voltmeter? Such a reversal of the test leads ordinarily ignores the fact that this connects the high side of the voltmeter input to the chassis of the receiver. As a result of this connection stray voltages are impressed on the grid of the vacuum-tube voltmeter and erratic readings are obtained. The results that are obtained are not unlike the effect produced by reversing the normal connections of a phono pickup to an audio amplifier.

The center-zero arrangement completely eliminates possibility of error from this source by invariably keeping the low side of the voltmeter at chassis or ground potential. Thus we see that in addition to the convenience of not having to change test leads, the center-zero arrangement eliminates errors due to faulty grounding and stray pickup.

Where a special circuit is used, it is possible to use the full scale of the voltmeter for either positive or negative voltages with the zero at the left of the scale. However, the polarity switch which must be used in instruments of this type is connected in the meter circuit rather than in series with the test leads. As we explained above, the instrument must be maintained at ground potential in all cases. Instruments which use the left-zero arrangement usually employ a balanced circuit so that equal changes in current through the meter are obtained for equal input voltages whether positive or negative.

**conventional voltmeters**

Although the lower-resistance voltmeters do not have the advantages of the d-c vacuum tube voltmeter—accuracy in high resistance circuits and the ability to measure control and operating voltages with the signal present—the error in making measurements in high-resistance circuits can be reduced somewhat if proper care is taken. For example, although it is general policy in using meters to choose the range which gives a reading well up on the scale, the error will be reduced by

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**Fig. 5.** In the slideback type voltmeter the plate current meter indicates, when the internal and external voltages are equal.

By Ohm's law this voltage drop across the load resistor is 500,000 ohms times 0.000250 amperes—125 volts, and the actual voltage at the plate is 125 volts.

With an electronic type voltmeter, time consuming measurements and computations such as those just discussed are avoided. The true voltage is measured directly at the point in question under true dynamic conditions.

---

**Fig. 8.** The isolating resistor placed close to the probe point prevents the capacitance of the test leads and voltmeter input circuit from reacting on the circuit under test.
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516 • SERVICE, NOVEMBER, 1939
By LEWIS WINNER
MARKET RESEARCH ENGINEER

The creation of the new automatic time and weather announcing units is paving the way for an interesting and profitable business for Service Men everywhere. The flexible design of these unusual instruments affords an extremely wide application to many industries where duplicate message announcements are essential. In the department stores, for instance, it will not be long before you will be hearing sales announcements in the elevators as you pass each floor. This will be made possible by the use of a group of units with the messages recorded photo-electrically or mechanically on film drums or plates, operated by specially synchronized motors, eccentric cams and gearing mechanisms, as described recently in Communications.

Since these automatic announcers employ components so familiar to every Service Man, plus popular sound system circuits, operators of these devices will feel inclined to call on the Service Men more than anyone else. This fact has already been established in many towns where the new automatic time devices are now in use. In Hartford, a large service organization is maintaining the time-service device there on a 24 hour service basis. In New Haven, the boys at station WELI are taking care of the unit. In Montclair, a Service Man is entrusted with the unit used by the Montclair Trust Company. In a majority of the other cities where these devices have been adopted, the Service Man has been named as the guardian, in complete charge.

Of course, it will not be possible for Service Men to just walk in and offer complete assistance, until they have thoroughly learned the design, operation and applications of these instruments. Thus it is suggested that Service Men be extremely alert to the development of this new business; not only by reading and studying all available material, but by conducting their own surveys where the devices are already in operation and where they may be put into operation soon.

Department stores were mentioned as a possible source of automatic announcing installation, to further sales. But automatic units can be used for time-weather announcements, in the same manner as they are used in the telephone circuits. Offering this unusual service will certainly stimulate good will. The department stores can install phones in strategic points to enable customers to learn the required information. Many stores now employ a personal service with a series of standard phones, offering, buying assistance. Thus they are somewhat familiar with the advantages of such trunk line phone systems. It is suggested, therefore, that Service Men study department store house telephones . . . methods of running lines . . . volume levels . . . resistance line problems . . . balancing of circuits . . . motor synchrony . . . voice diffusion . . . relays . . . amplifiers . . . etc.

Airports and railroad stations are another source of installation. Here the instruments can transmit automatically... (Continued on page 532)
F-M RECEIVERS
STROMBERG-CARLSON 425, 480

The Stromberg-Carlson Models 425 and 480 receivers are designed for the reception of the five frequency-modulated station channels (42.6, 42.8, 43, 43.2, and 43.4 mc) assigned by the FCC. The Model 480 provides, in addition, for reception of standard amplitude-modulated broadcast and short-wave programs.

Model 480 Circuit

The Model 480 is essentially two receivers with a common audio amplifier. In the upper section of the accompanying diagram the circuit of the r-f amplifier, converter, i-f amplifier, limiter and demodulator for the f-m portion is shown. The lower portion of the diagram is that of a conventional high-fidelity superheterodyne. Twenty tubes are used in all to provide three ranges, two for standard a-m reception and one f-m band. The ranges of the former are from 540 to 1700 kc and from 5.8 to 18 mc. The f-m range covers the five channels mentioned above from 40 to 44 mc. An electric tuning circuit is arranged so that seven favorite stations located in the standard a-m broadcast range may be set up for selection by means of the push buttons located on the front of the receiver, and eight stations may be set up for selection by means of the push buttons located on the remote control box which is furnished with the receiver. Two additional push buttons are also provided on the remote control box for controlling the volume.

The balanced transmission line from the u-f antenna is connected to the posts marked FM on the rear of the receiver. The signal from the antenna (upper left portion of circuit) is fed to a 6SK7 r-f amplifier which in turn feeds a 6SA7 demodulation oscillator-modulator stage. This stage produces the i-f signal by heterodyne action. Three i-f stages are required to drive the 6SJ7 limiter tube as indicated in the schematic. The i-f transformers are of special design, inductively tuned and suitably damped and overcoupled to provide the proper band pass without appreciable attenuation. No a-c is provided in the r-f or i-f stages of the f-m portion of the Model 480 receiver. The carrier limiter is essentially a fourth i-f stage with a sharp cut-off tube. Under suitable limiter operation all amplitude components of noise and modulation are effectively attenuated.

The detector is essentially a diode discriminator circuit similar to that used in receivers for providing automatic frequency control. This detector produces a d-c voltage which varies at an audio rate and depends upon its magnitude on the deviation of the intermediate-frequency signal from the mid-frequency and has a polarity depending upon the direction of this deviation. The detector circuit shown comprises two series-connected diode loads.

A six-gang variable condenser is used to tune the receiver. Three sections of the gang (C1, C2, and C3) are used for the f-m portion and the remaining three (C4, C5, and C6) for the standard a-m broadcast and short-wave bands. The switches labeled A and B are used to switch between the bands or to switch to f-m reception.

As mentioned above, the standard broadcast and short-wave portions of the receiver are conventional. Separate antenna posts are provided and an r-f stage is used on both bands. A single i-f stage, with variable selectivity, feeds a half-wave diode detector. The audio amplifier which follows is common to both portions of the receiver.

In the lower right corner of the accompanying circuit 6SQ7 Q tube circuit is shown. This operates only on the f-m range of the receiver and is used to reduce interstation noise while tuning.

The tuning indicator in this receiver will operate differently when tuning stations in the f-m range from its operation in the a-m ranges. In the latter case one aperture will operate better on weak signals and the other will operate better on strong signals. Resonance is indicated by the maximum reduction in size of the apertures. When tuning stations in the f-m range the aperture will act as follows: when the receiver is first turned on, and no signal is received, one aperture will be nearly closed while the other one will be open. As a signal is tuned in, the aperture which was nearly closed will start opening and the other which was open will start to close; continuing tuning, resonance will be indicated by the maximum closing of both apertures.

The audio amplifier employs a 6R7 in its first stage which feeds a 6CG6 dual-triode. One section of the latter tube is used as another audio amplifier stage and the second section is used as a phase inverter. A pair of 6L6s are used in a push-pull output stage. Two

(Continued on page 532)
NEWARK, N. J.  October 19, 1939  NUMBER T-535-3

LIST:  T-3

SUBJECT:  REVISION OF LIST PRICES AND COMPENSATION
          TUNG-SOL RADIO TUBES

When list prices were lowered May 1st we took an opposite course to competitors who were promoting high list prices and extraordinary discounts to dealers.

It had often been stated that no one manufacturer could reform the tube industry but it has been demonstrated that one manufacturer, with the help and complete cooperation of its wholesalers could take a constructive position and maintain it.

The industry trend toward constructive merchandising is one that we would naturally endorse and it is logical, therefore, that we should do so by revising Tung-Sol schedules of list prices and compensation to conform with those already announced by our major competitors.

List prices which will be effective beginning with November business are shown on the attached price card, Form T-11. Using per cent of sales by type, indicates that the reduction will amount to only approximately 3% of old list prices.
PREVIEW OF TEST

Weston • • •

Model 774 Checkmaster. Provides complete tube checking facilities as well as voltage measurements to 1,000 volts, in both a-c and d-c, in 5 ranges; output measurements to 1,000 volts, a-c, in 6 ranges; direct current measurements to 100 ma in 3 ranges; and resistance measurements to 10 meg in 4 ranges. Equipped for use with Weston 666-18 socket selectors and test leads. Weston Electrical Instrument Corp., Newark, N. J.

Supreme • • •

Model 560 Vedolyzer. Designed for visual dynamic testing. Includes a self-powered 3-in-c-r oscilloscope with linear sweep. Three-band variable tuner from 65 kc to 2,050 kc for r-f amplification and testing. A vacuum-tube voltmeter with 29 ranges in r-f, d-c and a-c volts and ohms is also provided.

Webber • • •

Model 210LP Imperial service estimator. Combination tube tester and volt-ohm-milliammeter. 29 ranges in d-c and a-c volts, at 1,000-ohms-per-volt; d-c ma; output volts; ohms and db. Spare sockets provided for future tubes.

Precision • • •

Model 920P set analyzer. Provides complete tube checking facilities as well as 33 set analyzing features. Has 6 a-c and d-c voltage ranges to 3,000 volts, at 1,000-ohms-per-volt; 5 direct current ranges to 12 amp; 4 resistance ranges to 10 meg; 6 db ranges to +64 db; and 6 output ranges. Resistance ranges have self-contained power supply. Precision Appliance Co., 647 Kent Ave., Brooklyn, N. Y.

Radio City Products • • •

Model 801 combination tube and set tester. Has complete tube testing facilities. Provides, in addition, 26 ranges for set testing. These are: 4 ranges to 1,000 volts, in a-c and d-c volts; at 1,000-ohms-per-volt; 5 direct-current ranges to 10 amp; 4 ohm-meter ranges to 10 meg, plus 5-ohm center-scale range; db and output ranges. Radio City Products Co., 88 Park Place, New York City.

Hickok • • •

Model 145 a-c and d-c appliance tester. Dual-meter instrument checks line voltage and power consumption of electrical appliances. Has two ranges, 0 to 750 and 0 to 1,500 watts, and one range, 0 to 300 volts. Hickok Electrical Instrument Co., 10514 Du Pont Ave., Cleveland, Ohio.

Simpson • • •

Model 260 set tester. A high-sensitivity, high-voltage tester for the Service Bench. Provides 6 voltage ranges, to 5,000 volts, at 20,000-ohms-per-volt on d-c and at 5,000-ohms-per-volt on a-c; direct current readings as low as 1 microampere and up to 0.5 amp; resistance readings from 1/2 ohm to 10 meg; and 5 db ranges, from −10 to +52 db. A 4 1/2-in square meter is used. The Simpson Model 215 offers similar ranges at 5,000-ohms-per-volt, d-c and 1,000-ohms-per-volt, a-c. Simpson Electric Co., 5214 Kinzie St., Chicago.

522 • SERVICE, NOVEMBER, 1939
EQUIPMENT FOR 1940

Cornell-Dubilier

The Cornell-Dubilier capacitor test equipment line includes the Model 8550 capacitor analyzer, the Model BN midget capacitor bridge, and a series of three direct reading capacitor decades, the types CDA, CDB and CDC. The latter are standards of ± 5% and 3% tolerances. Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

Solar

Model EX 1-60 Exometer. In addition to the usual condenser and resistor tests, this instrument can be used as a peak reading vacuum-tube voltmeter. A 6ES visual indicator tube is used. Capacity ranges from 0.00001 mfd to 1,600 mfd; resistance from 50 ohms to .5 meg. Solar Manufacturing Corp., Bayonne, N. J.

Meissner

Model 9-1006 signal calibrator. A precision secondary frequency standard employing a special silver-plated 100-kc quartz crystal. Multivibrators and amplifiers provide frequencies at 10 kc, 50 kc and continuous from 100 kc to 40 mc in 100 kc steps, modulated or unmodulated. Meissner Manufacturing Co., Mt. Carmel, Ill.

Sprague

Tel-Ohmike, a condenser and resistor analyzer which permits the Service Man to use his own milliammeter and voltmeter. Capacity measurements from 0.00001 mfd to 2,000 mfd; resistance measurements from 0.5 ohms to 5 meg; insulation and breakdown at 1,000 volts up to 10,000 meg and also power factor indication up to 50% are provided. Sprague Products Co., North Adams, Mass.

Clough-Brengle

Model 230 a-c bridge. The instrument provides for capacity measurement in 3 ranges from 2 mmfd to 200 mmfd; resistance, in 2 ranges, to 20 meg; inductance with external standards as desired, power factor; transformer turns ratios from 0.01 to 100 and leakage and insulation resistance tests to 2,500 meg. Clough-Brengle Co., 5501 Broadway, Chicago.

RCA

Three new pieces of television test equipment by RCA. A 5-in wide-range c-r oscilloscope; a piezo-electric calibrator for use in all high frequency work; and a television alignment oscillator designed specifically for the visual alignment of the r-f and i-f circuits in television receivers. RCA Manufacturing Co., Camden, N. J.

Readrite

Model 423A742 combination tube tester and volt-ohm-milliamp meter. Separate panels provided for tube and set tests. 5 ranges in a-c and d-c volts, to 2,500 volts; 3 d-c ranges to 100 ma and 2 resistance ranges to 1/2 meg plus 0.5 to 500 ohm range. Readrite Meter Works, Bluffton, Ohio.

Triumph

Model 330 multi-range meter. Provides 32 ranges as follows: A-c and d-c volts to 3,000 in 5 ranges; d-c to 15 amp in 5 ranges; output volts to 600 volts in 4 ranges; resistance from 0.2 ohms to 10 meg in 4 ranges; and 2 sets of db ranges. A 400-microampere 4½ in meter is used. Push-button range switches are used. Triumph Mfg. Co., 4017 W. Lake St., Chicago.

(Continued on page 526)
MERRY CHRISTMAS
and Happy New Year

To

Boys' or Girls' Model
Retail Value, $34.50
Immediate Delivery on Dealer Deposit of $16.00

ELGIN WATCHES

Men's or Ladies' Styles
Retail Value, $37.50
Immediate Delivery on Dealer Deposit of $11.00

- Ladies' Elgin DeLuxe Wrist Watch, semi-baguette, 17 jewels, 10 K gold filled case, silk cord with ratchet center, Raised figure dial
- Men's Crusader 8/0 size, 17 jewels, 10 K natural gold filled case, raised blue figure dial and leather wrist strap.

ROGERS SILVERWARE
Retail Value, $60.00
Immediate Delivery on Dealer Deposit of $12.00

- 87-piece service for 8 persons in Good Housekeeping approved tarnish-proof, fine wood chest. Encore design Xtra quality silver plate, double plated at points of greatest wear. Made and guaranteed by Simeon L. & George H. Rogers Company, famous Oneida silversmiths.

Steelart Style "F" sets offer folding bridge furniture that the most exacting hostess will be proud to use. Rigid steel table and folding chairs with pinchproof hinges and no sharp corners to snag garments.

COLSON BICYCLES
- Boys' model: double bar streamlined 18-in. frame, chrome truss rods, light tank with horn, luggage carrier, chain guard, Texas steer handle bar, fine saddle, new departure coaster brake, balloon tires. Also available in girls' model with similar features.

STEELEART BRIDGE TABLE AND CHAIRS

Steelart Style "F" sets offer folding bridge furniture that the most exacting hostess will be proud to use. Rigid steel table and folding chairs with pinchproof hinges and no sharp corners to snag garments.

...and many other items

NATIONAL UNION

524 • SERVICE, NOVEMBER, 1939
THE LADY of the RADIO BUSINESS

For you and your home — Luxurious things you have long wanted but never felt that you could afford . . . a real treasure chest of products made by the leading quality manufacturers in this country . . . to make this the most memorable Xmas you ever had.

Immediate delivery made on any item on the receipt of the down deposit required — no interest rates — no weekly or monthly payments to make — JUST USE NATIONAL UNION TUBES AND CONDENSERS . . . And you will receive your DEPOSIT back after the required number have been purchased.

* This N. U. plan has been used for 9 years. Over 50,000 dealers are benefiting — Why not you?

SEND COUPON!

RADIO CORPORATION

TIME IS SHORT ACT NOW!

National Union Radio Corp'n.
57 State St., Newark, N. J.

□ Please send me catalog and complete information on your GIFT MERCHANDISE:
□ I am particularly interested in:

Ind. Name
Dealer Name
Street Address
City
State

SERVICE, NOVEMBER, 1939 • 525
PREVIEW OF TEST EQUIPMENT

(Continued from page 523)

Televiso • • •

Jackson • • •
Model 700 Service Lab. Contains 4 standard Jackson units designed for rack and panel mounting. These units are:

- Model 640 all-wave oscillator, provides modulated or unmodulated signal from 100 kc to 30 mc in 6 ranges; Model 642, 20,000-ohm-per-volt multimeter, with 21 ranges and 7 functions; Model 630 condenser tester for determining the characteristics of all types of condensers from 0.00001 mfd to 100 mfd; and the Model 634 tube tester, which provides means for testing all types of tubes. Jackson Electrical Instrument Co., Dayton, Ohio.

Aerovox • • •
Aerovox Model 95 L-C checker may be used for determining the characteristics of all types of condensers without disconnecting them from the receiver circuits. This unit is illustrated and described in full on page 539 of this issue.

(Continued on page 530)

In AERIALS, RADIART has the world with a ring around it

RADIART WATCH
for announcement of RADIART'S NEW CORONA DISCHARGE EQUALIZER
(Patent Pending)

RADIART AERIALS ALWAYS BETTER Mechanically AND ELECTRICALLY

Only
8 MODELS
HANDLE 90% OF ALL SERVICE CALLS!

For $10.25 a service dealer can stock 8 Halldorson Transformer models that answer 90% of all radio service calls covering both power and audio requirements. And—the design of each transformer covers the requirements of all the makes of sets for which it is intended. When the investment is so low, why not be prepared to give prompt transformer service prepared to give prompt transformer service prepared to give prompt transformer service prepared to give prompt transformer service prepared to give prompt transformer service prepared to give prompt transformer service prepared to give prompt transformer service prepared to give prompt transformer service.
s p e a k i n g  o f  P R O F I T S
R A C O N ' S  a r e  M O N E Y - M A K E R S
for all P-A and Sound Men

The buyers of bigger and better sound installations specify Racon Horns and Speakers as they will not compromise with quality.

Racon's sometimes cost more than other units that look quite similar though inferior in performance. Expensive research and developmental engineering must be paid for—but experience proves the extra investment is justified because

1. The sound system buyer gets more value and trouble-free use from his installation.
2. The seller of the sound systems meets with less sales resistance and can "deliver more than he promises" when he uses Racons.

A well sold and completely satisfied customer is the only kind that is profitable as he will throw more business your way.

RACON HORNS, SPEAKERS AND UNITS are available for every sound distribution application. Models not illustrated here are described in our general bulletin S10. Send for your free copy today.

RACON ELECTRIC CO.
52 East 19th Street
New York City

PERMANENT MAGNET UNITS—Available in all sizes—from the "baby unit" having an operating capacity of 5 watts to the "bull unit" with an operating capacity of 50 watts.

MARINE CONE TYPE SPEAKERS—Re-entrant type speakers using cone type driving units for indoor and outdoor applications. Baby size for 2" or 3" speakers, miniature for 6" speakers, regular for 8" speakers, giant for 12" speakers.

MARINE HORN UNIT SPEAKERS—Re-entrant type speakers using horn type units for marine and general P-A applications—may be used as loud speaker or as a microphone. In all sizes, miniature, midget, marine and bull handling from 5 to 50 watts.

ARMORED CONE PROJECTORS—For high concentration of sound within short or long areas—various size models in all steel or aluminum bell with steel backs to take 6"-8"-10"-12" speakers.

PERMANENT MAGNET UNITS

MARINE CONE TYPE SPEAKERS

MARINE HORN UNIT SPEAKERS

ARMORED CONE PROJECTORS

RADIAL 3½' TRUMPET—In either the radial projective type for 360° distribution or the uni-directional type for forward projection. Occupies space 16" deep, bell opening 19" diameter.

RADIAL CONE SPEAKERS—Types for high fidelity, giving even intensity sound projection over a circumference of 360° radially. Best adapted for permanent auditorium installations. Will handle 5"-6"-10"-12" speakers.

RADIAL CONE PROJECTORS—Adjustable from 360° radial projection to uni-directional. Models available for 10" cone speakers only.

TRUMPETS—Available in all sizes from 3½' to 6'. Made of RACON acoustic material for indoor and outdoor types. Also made of all metal. Single unit or multiple unit types in all sizes.
## AUTO-RADIO DATA

(Continued from August)

### Pierce-Arrow

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1. *CW denotes clockwise rotation. CCW, counterclockwise. By clockwise rotation is meant that receiver is being tuned to a higher frequency when the dial scale or pointer rotates in a clockwise direction when viewed from the front of the control head.
2. No remote control is used.
3. Information not readily available.
4. Serial numbers below 20,000.

(To be continued)
The PRECISION line of quality test equipment offers a range of 40 different models for your selection. Dynamic Mutual Conductance Tube Testers from $29.95. Combination Tube Testers and Set Testers from $49.95. Multi-Range Testers from $10.95. Signal Generators from $24.95. See them on display at all leading radio parts distributors or write for our 1940 Catalog.

PRECISION TEST EQUIPMENT

Approved
By Leading Manufacturers, Servicemen, Experimenters, Laboratories, Engineers, Schools, etc.

PRECISION APPARATUS COMPANY • 647 KENT AVENUE • BROOKLYN, NEW YORK
Export Division: 45E BROADWAY, NEW YORK CITY, U. S. A.

SERVICE, NOVEMBER, 1939 • 529
NEW FREE
CAPACITOR MANUAL FOR RADIO SERVICING
1939-40 EDITION No. 1
over 240 Pages!
COMPLETE REPLACEMENT INFORMATION
Read how to get your free copy of the C-D Manual that reduces required capacitor types to a minimum... speeds service work...

The book that took months to prepare... the book that provides the serviceman with a reference source stripped of non-essentials, is ready now and free to you. All standard set data was checked in order that replacement information might be complete. You'll find the Manual, in its concise and orderly form, an invaluable guide in determining proper capacitor replacement for any type receivers.

Set manufacturers' names appear alphabetically. Model data covers capacitor values, working voltages and standard C-D capacitor types required for replacement (number of standard types has been reduced to an absolute minimum), references to illustrative circuits (over 165 are given in the back of the Manual), manufacturer's original part numbers, and the volume and page of Rider's in which complete schematic circuit is to be found for general checking purposes.

Find out from your Distributor how you can obtain this valuable 240 page "Capacitor Manual for Radio Servicing." There are no strings attached to the offer. Here is something for nothing—a book to save you time, quicken turnover, give you a simple trustworthy source for all capacitor stock requirements. See your C-D Distributor today.

CORNELL-DUBILIER ELECTRIC CORPORATION
35-37 Remsen Street, Brooklyn 1, New York

PREVIEW OF TEST EQUIPMENT
(Continued from page 526)

Consolidated • • •
Model 9000 dynamic conductance tube tester. The instrument provides complete tube testing facilities. In addition, Christmas tree bulbs, pilot lights and plug-in resistors may be checked. Consolidated Wire & Associated Corps., 518 S. Peoria St., Chicago.

Philco • • •
At least 3 new instruments are featured in the 1940 Philco line. Model 013 is a device for checking vibraters that functions without controls, meters or visual indicator tubes. Model 077 is an all-wave signal generator which provides r.f., modulated or unmodulated, from 15 kc to 37 mc in 5 ranges. The Model 026 is a 21-range, 6-function circuit tester of compact portable design. Philco Radio & Television Co., Tioga & C Sts., Philadelphia, Pa.

A "MUST" ON THE BENCH OF EVERY SERVICE MAN
GTC PORTA-POWER MODELS "U" & "L"

No more clattering up your bench with four or five different batteries for testing various types of sets with different plugs. G T C PORTA-POWER saves you this bother and cost. Model "U" supplies any portable or battery radio using 1½ volt tubes. Model "L" supplies "A," "B" & "C" power to any battery-operated farm radio (1 to 8 tubes) using 2-volt tubes. No alert, progressive serviceman can afford to be without these time-saving profit-producing PORTA-POWER instruments. Full voltage and peak efficiency always. PORTA-POWER on your bench means less expense, less work, more profits, more customers.

MODEL "U"
Easily carried on service calls... weighs 4 to 6 lbs.

SERVICEMAN'S NET PRICE
Model "U", $4.50 • Model "L", $5.97.
Free literature. Further information on request.

GENERAL TRANSFORMER CORP.
1525 W. VAN BUREN ST. • CHICAGO, ILLINOIS

Simpson Model 320 giant set tester. Provides 50 ranges for 7 functions on a 9-in. meter. Instrument dial is illuminated and wings can be provided for rack and panel mounting.
Save Time and Money

with THE MEISSNER ANALYST

The Meissner ANALYST is not only highly efficient—covering every conceivable phase of signal testing—but it is surprisingly easy to read and operate. This up-to-the-minute instrument will work wonders in raising the standard of service in your shop. It will take the kinks out of your toughest servicing problems... step up your efficiency... save valuable time... increase your profits.

It accurately measures both control and operating voltages without affecting the operation of the set. Channels can be tested individually or simultaneously. Reading is greatly simplified. There's an individual panel for each channel.

And best of all, you buy the ANALYST in KIT FORM... Save nearly HALF the cost of a factory-wired set of comparable quality and efficiency. And at the same time acquire a fundamental knowledge of this instrument and what it will do for you that could not otherwise be obtained by weeks of study and experiment.

Get the facts on this revolutionary TIME and TROUBLE SAVER... See the Meissner ANALYST at your Parts Jobber's—or mail coupon below for FREE FOLDER... It tells the whole story!

NEW TIME-PAYMENT PLAN

You can now buy the ANALYST and other Meissner Products on TIME. Ask your Parts Jobber or write us for details.

For superior performance in any type of receiver—try this remarkable midget I. F. Transformer. Simplified construction permits maximum space efficiency and a lower cost. Only 2 1/4" long—1 1/8" square. Complete range of operating frequencies. Input, interstage or output.

FREE FOLDER

Meissner MFG. CO.
Dept. S-11
Mt. Carmel, Ill.

Mail Folder on the Meissner ANALYST and your complete '39-'40 Catalog.

I Name
I Address
I City
State

SERVICE, NOVEMBER, 1939 • 531
JT-Series Microphones Give Quality Performance at Unusually LOW PRICE

This semi-directional crystal microphone of contemporary design, fills a long standing demand for a really good, low priced microphone for universal use. New, massive cartridge, freely suspended, within housing makes this microphone dead to vibrophonics. Output -52 db. Wide-range (JT-30) and voice-range (JT-40) models. Choice of three finishes.

LIST PRICE $16.50
See jobber or write for Catalog No. 12.

F-M RECEIVERS (Continued from page 518)

speakers are used (with acoustic labyrinths), one for high and one for low audio frequencies. A portion of the signal from the voice coil circuit is fed to the cathode of the 6CH6 audio amplifier stage to provide degeneration.

model 425 circuit

The Model 425 receiver is an 8-tube superheterodyne designed for the reception of f-m signals only. (See accompanying diagram.) The antenna circuit of this receiver feeds a 6S7A7 oscillator-modulator stage directly. Two f-i stages using 1852s are employed to drive the 6S7J limiter. As in the f-m section of the Model 480, no avc is provided in the Model 425. The 6H6 discriminator feeds a 6SF5 audio amplifier stage which in turn drives a single 6F6G output tube. A portion of the signal from the voice coil is fed back to the cathode of the 6S7F5 audio amplifier stage to provide audio degeneration.

When a receiver designed only for the reception of amplitude modulated stations (standard broadcast and shortwave stations) is available, and it has a high quality audio system, the Model 425 receiver may be connected to it so that frequency modulated transmissions may be reproduced through the high quality audio system. A single pin jack with plug (labeled phono jack in accompanying diagram) is located on the rear of the Model 425 to enable it to be connected for this purpose to the phono jack on the amplitude modulation receiver.

If the Model 425 is operated in this manner its speaker will act as the treble speaker and the desired amount of treble response can be controlled by means of the volume control on the Model 425. The off-on control should remain set for maximum treble response.

AUTOMATIC ANNOUNCING (Continued from page 517)

announcement of time, instead of the electric ticker tape announcement, I said . . . careful design of sound distribution . . . a problem with which all Service Men are undoubtedly familiar. The sound must be concentrated to cover a restricted area to avoid infraction of noise and nuisance laws. But, already, such systems have been made available, offering a variation of sound distribution to within any degree desired.

The automatic systems that will undoubtedly prove themselves most popular with the merchants will be those permitting a rapid and simple change of recordings.

RADIART'S "CBH-I" AERIAL...is really Universal.

- It now includes 3 BRACKETS for the price of 1 aerial
  A—Hinge mount.
  B—UNDER HOOD for side opening hoods.
  C—UNDER HOOD for top opening hoods.
- New Type C3-X will fit 1940 sloping panel bodies.
- Have you heard about RADIART'S New noise-reducing Corona Discharge Equalizer?

DRAKE Electric Works INC.
3656 LINCOLN AVE., CHICAGO, ILL.

532 • SERVICE, NOVEMBER, 1939
It is desirable to have a completely equipped service shop, but your "Bread and Butter" instruments deserve your first consideration. Look around your own shop and see if your "Bread and Butter" instruments are satisfying your needs. (1) Will your tube tester accurately test all the new tubes being announced? (2) Is your set-tester complete, fast, and reliable? (3) Is your condenser tester accurate? (4) Does your test-oscillator cover all the ranges needed; is it accurate and stable? The Supreme 504 and 571 meet all these basic requirements, and make a strong foundation upon which to build your business.

The Supreme 504 in a single unit answers your first 3 requirements without unnecessary bulk and at low initial cost. Correctly tests all present or future tubes regardless of tube base terminations or filament voltages. Patented filament return automatically re-connects all sockets for any possible tube base arrangement. New vari-volt selector provides 23 filament taps for testing all tubes from 1.5 volts to full line voltage. Fast tube test—just "follow the arrows" from roller chart.

The set testing functions of the Supreme 504 cover all ranges encountered in general service work.

Seven D.C. voltage ranges from 0.1 to 2500 volts.
Five A.C. voltage ranges from 0.1 to 1000 volts.
Seven Direct Current ranges from 10 microamperes to 10 amperes. Five output ranges from 0.1 volt to 1000 volts. Five Ohmmeter and Megohmmeter ranges from 0.1 ohm to 20 megohms. Guaranteed over-all accuracy of 2% on D.C. and 3% on A.C.

All paper condensers checked for leakage up to 20 megohms. All electrolytic condensers checked for leakage at their rated voltage on an English reading scale. Settings on roller chart for every capacity and working voltage.

The Supreme Model 571 oscillator guarantees you (1) Accuracy, (2) Stability, and (3) Range.

By the use of variable iron core coils, calibration can be held well within 1/8 of 1%. To eliminate error in reading, a hair line illuminated shadow indication is used. A dual drive mechanism provides fast and easy setting of the precision cut tuning condenser. Use of air dielectric trimmers in a special circuit has eliminated frequency drift with change in line voltage and temperature to a point where it can be disregarded.

The Model 571 has five fundamental ranges which cover the following frequencies: 65 to 205 KC, 205 to 650 KC, 650 to 2050 KC, 2050 to 6500 KC. 6.5 to 20.5 MC. Harmonics of these ranges extend these frequencies to 82 megacycles. All these are read on two scales so that there is no confusion as to which is the proper band.

Besides these features, the Model 571 provides signals with two different levels of modulation: 30% and 75%. Double shielding throughout minimizes leakage.

FOR COMPLETE DYNAMIC TESTING

Choose either the 562 Audolyzer or 560 Vedolyzer

MODEL 562—The need of a fast, simple, inexpensive, but complete dynamic testing instrument prompted the design of the Model 562. With its one probe, it can be used to localize troubles on any receiver. A built-in voltmeter with an input impedance of 10 megohms allows measurements to be made in grid, A.V.C., A.F.C., or any other circuit without altering the operation of the set. A built-in speaker offers an audible system of testing which is the simplest and fastest yet devised. Servicemen are now acclaiming the Audolyzer to be the instrument of the year. Write for descriptive literature.

MODEL 560—In selecting a Model 560 Vedolyzer you are providing yourself with the most modern up-to-date dynamic testing instrument available. Signals of all types, A.C., D.C., R.F., I.F., A.F., are measured on a vacuum tube voltmeter and at the same time all the alternating signals are studied for waveform on a 3" cathode-ray tube. A three-stage video amplifier makes possible the study of R.F. and A.F. whose level is only .01 volt. By using this instrument, you are looking ahead, for its video amplifier has many television applications. Write for descriptive literature.

SUPREME INSTRUMENTS CORP.
GREENWOOD, MISSISSIPPI, U.S.A.

EXPORT DEPT.,
Associated Exporters Co.,
145 W. 45th Street, New York
Cable Address: LOPREH, N.Y.

SERVICE, NOVEMBER, 1939 • 533
The Varitone Audio Unit is the Only Transformer of its Kind Giving Continuously Variable Low End, High End, or Low and High End Equalization.

The UTC Varitone is a revolutionary audio device which permits full control of the frequency response of any audio amplifier or receiver. Using this device, tone correction can be affected for defects in acoustic conditions or overall audio response. It is also possible to produce new tonal effects from phonograph recordings or radio reception and to bring back notes which would otherwise be lost completely.

VT-1 — This Varitone is incorporated with a universal audio transformer. Two primaries are provided. One is suitable for working from a single or double button microphone a low impedance pickup, or a line; the other primary is designed to work out of the plate of a tube or from a high impedance pickup. The secondary winding is center tapped and is equally suitable for working into one or two grids. Net price: $5.10

VT-2 — The VT-2 is a Varitone control unit, incorporated with an impedance matching device so that it can be connected directly across a 200 or 300 ohm line, or low impedance pickup or mike, or in shunt with the plate circuit of any triode or a high impedance pickup. The circuit is not changed in any other way. The VT-2 is solely an addition for tone correction. The original audio circuits are not disturbed. Net price: $3.60

VT-4 — The VT-4 is a complete self contained wired unit including a variable control so arranged that with the control at one end high fidelity performance is effected that with the control at one end the high response is reduced to diminish static, line noises, and heterodyne whistles. The unit is connected directly from plate to B plus of first audio triode. This unit is designed to work in the plate circuit of low impedance tubes such as 01A, 12A, 30, 31, 26, 27, 25, 50, 85, 262A, 864, 37 triode, 6C6 triode, 77 triode, etc. Net Price: $3.60

VT-10 — Band pass filter for amateur service removes unnecessary low and high frequencies, reducing QRM, increasing efficiency and intelligibility. Connects in plate circuit of triode. Net Price: $6.00

UNITED TRANSFORMER CORP.
150 VARICK STREET NEW YORK, N.Y.
EXPORT DIVISION: 100 VARICK STREET NEW YORK, N.Y. CABLES: "ARLAB"

534 • SERVICE, NOVEMBER, 1939
the output current is necessary for both plates and filaments while the beam-power section handles about 1/3 watt of audio power.

filament current

A novel method of supplying the filament current for line operation is used. Since the 70L7GT requires 50-ma cathode current, it is feasible to connect the four 1.4 volt, 50-ma filaments in series to take the place of the usual cathode bias resistor for this tube. Besides, the economy involved there are two definite advantages for this connection. Less filtering is required for a given percentage of hum and a substantial amount of voltage regulation is secured. With 10% change in the power line voltage, for instance, the filament voltage will vary only about 3 to 5%. The compensation is obtained through the plate current characteristic of the tube.

When battery operation is contemplated, the line cord is coiled up in a separate compartment reserved for it at the rear of the set. The line plug is inserted in the special receptacle provided for it at the rear. This closes the battery circuit. The receiver will not operate on batteries unless this plug is in place. For a-c or d-c operation (105 to 125 volts), the small door containing the line cord is opened and the plug removed, disconnecting the batteries. The plug may then be inserted in the wall outlet. In this mode of operation the receiver consumes 30 watts.

The tube complement is as follows: 1A7GT oscillator-modulator, 1N5GT i-f amplifier, 1H5GT second i-f, 1H5GT second-detector-avc audio amplifier, 3Q5GT beam-power output for battery operation only and the 70L7GT beam-power output and half-wave rectifier for line operation only.

The four 1.4-volt filaments discussed above, together with the 3Q5GT filament, remain in series for battery operation. An A battery of 9 volts is required to deliver 50 ma. A 90-volt B battery is also required. The B drain is 11 ma.

Another feature of this receiver is the positioning of the loop. In most battery portables the loop must be moved or removed in order to change or test the batteries, or even to check tubes. It is not always possible to replace the loop in the identical position which it occupied before being disturbed; that is, the position in which the set was tuned or aligned. Thus, it might disturb the alignment of the set when it is replaced. In this receiver the loop does not cover the battery compartment. It is on the receiver chassis and need not be disturbed when the batteries are removed.

This self-contained loop antenna operates at maximum efficiency when its position is right angles to the transmitting station. It is important, therefore, once the station is tuned in, to rotate the cabinet back and forth through at least a quarter of a circle (90 degrees), leaving it at the position where the station is received at maximum intensity. While the loop will provide sufficient volume in most locations, it may be necessary to use an external antenna and ground in remote areas or dead zones.

In this receiver the loop does not cover the battery compartment.

GIVE YOU ASSURANCE OF AUDIENCE APPROVAL

You can use Utah speakers for every original equipment or replacement requirement with full assurance that they will give PLUS performance. Utah speakers have, for years, been passing successfully the many scientific tests of leading radio engineers. They are also out in front in the all-important consumer-listener tests, which determine the success or failure of sales and service work.

 Properly selected, Utah speakers enable you to obtain maximum performance value from all other parts in receivers, P.A. systems, etc. Utah designing keeps abreast of all industry developments. Utah engineering and precision manufacturing provides maximum efficiency and performance. Insist on Utah-made parts and avoid customer dissatisfaction and the loss of time and money. If you don’t have a copy of the 32-page, illustrated Utah catalog write for it today.

OTHER DEPENDABLE Utah PRODUCTS

UTAH VIBRATORS—Well over a million radio sets are equipped with Utah vibrators.

UTAH TRANSFORMERS—A complete line to service practically every requirement—replacement, service, set builder, amateur, P.A.


Connections are made to the two leads at the rear of the cabinet. This set has tuning range from 540 to 1600 kc. Two 455 kc i-f stages are used; resistance coupling is used between them. Avc is used only on the first tube, the 1A7GT oscillator-mixer.

In order to accommodate the high power output on line operation, a 6 1/2-inch permanent magnet dynamic speaker is used. The output transformer is tapped for the 70L7GT, the full primary winding being used only for the 3Q5GT battery output tube. (The latter tube is left idle in line operation.) This changing of primary impedance is necessary to obtain normal power and optimum quality from each output tube.

Henry Howard.

Paradise, November, 1939 • 535
Mr. Serviceman:  
"Do It Now!"  
*Special Dues Concessions for Applicants Joining Now!*

MAIL THIS COUPON NOW!  
RADIO SERVICEMEN OF AMERICA, INC.  
304 S. Dearborn St., Chicago, Ill.

Name __________________________ State __________________________

City _____________________________ State __________________________

I am interested in RSA Membership. Tell me about it. □
I am enclosing $4.00 for National dues and initiation. Covers dues up to Jan. 1, 1941, in accordance with special dues concession. □
(Does not include Local Chapter dues where Local Chapters are organized.) □

$1.25

HISTORY MAKING FIRSTS

First and only national service organization to have sponsorship of RMA, Sales Managers Club, and all radio trade journals.
First national service organization to have bonded employees and officers—where a democratic setup run entirely by servicemen elected by and from the membership.
First service organization to have a cooperative agreement with broadcasters to sell RSA to the American public and to put into effect plans for making the service industry a profitable, year-round business.
First and only service organization to provide a Guaranteed Service Plan for protection of its members and their customers.

RADIO SERVICEMEN OF AMERICA, Inc.  
JOE MARTY, JR., EXECUTIVE SECRETARY  
304 S. DEARBORN STREET, CHICAGO, U. S. A.

The 1939 edition of the Sylvania radio tube complement book has a special supplement which contains the tube complements of hundreds of new receivers released during the past year. This supplement is bound as an integral part of the parent book and is also issued separately for those who already have the first edition.

The 56-page supplement contains the listings of the many receivers together with their tube complements and i-f peaks. Because of the completeness of the compilation, this reviewer believes that the supplement should prove a very valuable aid to the Service Man. It is certainly worth more than the 10c asked.

The parent book, in addition to the listings of tube complements and i-f peaks for practically all sets from far back into the early days of radio, contains material on alignment, tube testers, panel lamps, interchangeable tube types, etc. A complete listing of the names and addresses of receiver manufacturers, together with a comprehensive compilation of tube names and their respective owners should also prove of special value to every Service Man.

The Sylvania Radio Tube Complement Book should be on every Service Man's must list.

R. H.

Sylvania's Bigger and Better

Send for your copy of this big "tube fact" book today

The 1940 Sylvania Technical Manual is bigger and better than ever with a new easy-to-use arrangement. It has 264 pages packed with vital tube information for servicemen, radio technicians, engineers and amateurs.

It gives you complete data and tube diagrams for 344 types of tubes all now listed in numerical-alphabetical order for quicker reference. Operating conditions, characteristics and circuit applications for standard glass tubes, "G" types, "GT" types, Loktal, Metal, Majestic and special types. Full information, too, on Sylvania's complete line of panel lamps.

The new Manual also includes data on special tubes for particular applications in television amplifiers, cathode-ray tubes, etc., with new circuit information and diagrams covering the latest type tubes.

Send the coupon for your copy! This new edition is a bargain at only 35c.
Centralab

UNIVERSAL SPLIT-KNURL REPLACEMENT CONTROL

Shh! It's a dank dark secret . . . known only to several thousand service men . . . it takes a special shaft to fit the knobs on many of the new (1938-39-40) sets.

So, instead of tearing your heart out thinking up new cuss words, get in touch with your nearest Centralab jobber for a Universal Split-Knurl control with the shaft that cuts as easily as butter.

Shaft is brass—3½" long from mounting surface. For switch type add Midget Radiohm switch covers K155, K156, K157, or K158. Be sure you say "Centralab."

CENTRALAB
Div. of Globe-Union Inc.
Milwaukee, Wisc.

GTC L PORTA POWER

The General Transformer Corporation Model L Porta Power is designed to convert the average two-volt receiver to line power operation. It will supply A, B and C power for from four to eight two-volt tubes. The B supply is tapped at 67½, 90, 112½ and 135 volts. Adaptation may be made for 45 volts. Any of the taps may be used separately or they may be used together in any combination. The C supply is variable from 4½ to 22½ volts. Two C voltages can be obtained where necessary.

A 5W4GT is used in a full wave rectifier circuit with brute-force filters to provide the B and C current. A copper sulfate rectifier is used in a full wave bridge circuit for the A power. The brute-force filter in the A circuit uses a double choke and three condensers. The A and B circuits are isolated both electrically and magnetically.

IRC APPOINTS BURLINGAME

The October issue of Service announced the appointment of Bruce O. Burlingame, 69 Murray St., New York City, by the International Resistance Co., Philadelphia, to handle the IRC fixed and variable resistance products to the jobber and industrial trade in this territory. His territory will specifically be parts of Eastern Pennsylvania, Maryland, Delaware, New Jersey and the District of Columbia.

Mr. Burlingame takes over the territory which has previously been handled directly from the IRC general office. This appointment entails no changes in the sales organization, and Perry Safler will continue to represent IRC in the New York metropolitan area.

BRACH AUTO AERIALS

Radios' Smartest Auto Aerials Are Made by Brach

New streamlined design—smooth, noiseless; anti-rattle construction. Made of chrome-plated Admiralty brass. Approved and recommended by leading auto manufacturers.

See our new 92-inch Cowl Aerial with concealed mounting insulators.

Send for Latest Catalog Covering Complete 1940 Line

L. S. BRACH MANUFACTURING CORPORATION
World's Largest Makers of Antenna Systems
55-67 DICKERSON STREET
NEWARK, N. J.

Choose the Sound You Want to Amplify—with TURNER 44X CRYSTAL MICROPHONE


$27.50 The TURNER Co.
List
CEDAR RAPIDS, IOWA
Licensed under Patents of The Brach Development Co.

538 • SERVICE, NOVEMBER, 1939
AEROVOX 95L-C CHECKER

The Aerovox Model 95L-C checker is designed to measure the capacity of condensers at radio frequencies without the necessity of disconnecting them from the circuit. It is also designed to permit the determination of the resonant frequencies of circuits and the measurement of inductance.

The frequency at which a circuit becomes resonant is a function of the inductance of the coil and the capacity of the condenser.

capacity measurement

The frequency at which a circuit becomes resonant is a function of the inductance of the coil and the capacity of the condenser.

connected in series with the coil. The capacity of the condenser used with the coil can be determined from the frequency necessary to produce resonance.

To use this method two conditions must be obtained: first, the variable frequency supply must cover an extremely wide range and be accurately calibrated. Moreover, the oscillator must be inherently stable as to variations in line voltage and load. Second, the coil used for comparison should be very stable and of low resistance.

This is accomplished by the design of a compartment for the condenser to eliminate line-voltage variations.

The coil used is one-half turn of phosphor-bronze strip of small diameter (C cord), which has a very low resistance and inductance.

The condenser to be measured is connected across the clips of the C cord making certain that the C cord is connected as close to the condenser as possible. The loop of the output lead is then snapped into the groove of the C prod. After the line cord has been plugged into a 110 volt outlet, the eye control knob is turned to the right, turning on the checker. When the tubes warm up, the control is adjusted until the eye just closes.

The main dial is then tuned, using various ranges while the eye is watched. A sharp opening of the eye indicates that a resonant point has been reached, and the capacity of the condenser is read from the proper scale. Care should be taken not to confuse the gradual opening of the eye at the ends of the scale with the sharp widening when resonance is reached. The degree of opening is a measure of the quality of the capacitor. A good condenser will cause the eye to open wide while a slight opening indicates a poor condenser. An internal short circuit will not allow the eye to open at all, although external short circuits will allow the eye to open to almost normal width. Thus the checker can be used to measure condensers in the circuit without their removal from the circuit.

An open condenser is indicated by the opening of the eye at a frequency much higher than normal for a condenser of that size. Thus an open 1-mfd condenser might measure 0.0004 mfd. In addition to the false indication, the opening of the eye is sluggish and very small.

To measure capacities less than 0.0004 mfd use a capacitor slightly larger than 0.0004 mfd and measure its capacity. The condenser to be measured is then connected in parallel with the first condenser and the total capacity of the two condensers found. The required capacity is the difference in

WITH SERVICE ON THE MOVE:
YOU and a SIMPSON TESTER can 'go places!'

WHEN servicing jobs were scarce, you may have hesitated to "treat" yourself to some much-needed Simpson Testing Equipment. But now it's a different story. With service again on the march, Simpson speed, convenience and accuracy can put dollars right into your pocket.

A few of the "hit numbers" of today's Simpson line are illustrated here. Notice the wide range of requirements they cover—and the better way they cover them. Men who know testers have acclaimed Simpson equipment the first real advance in ten years of instrument building—and the proof of this is as close as your jobber!

See the Simpson line today and you will decide to put it to work tomorrow. You and Simpson Testing Equipment can form a mighty profitable partnership right now.

SIMPSON ELECTRIC CO., 514 Kinzie Street, Chicago

SIMPSON INSTRUMENTS THAT STAY ACCURATE

The line cord and loop of the Aerovox 95L-C checker can be housed in a neat compartment on the side of the instrument.

AEROVOX 95L-C CHECKER

MODEL 260

- The new high-sensitivity, self-generator tester for television and radio servicing. At 20,000 ohms per volt, this instrument is far more sensitive than any other in its price range. Six voltage ranges, both A.C. and D.C. Resistance ranges from 0.5 ohm to 10 megohms. Current readings from 1 microamp to 500 milliamps.

Your price: $27.50

MODEL 320 GIGANT SET TESTER

- First set tester with giant (9") high-speed illuminated dial meter—first with 50 resistance ranges which include nine voltage ranges both A.C. and D.C.; milliampere ranges; five resistance ranges; seven Decibel ranges. Volt leads insulated for 5000 volts furnished with each tester. Entirely A.C. operated—no batteries needed. Wings are available for rack mounting.

Your price: $37.50

MODEL 440 "TEST MASTER" Tests All Tubes—Tests All Circuits

Filament Voltage 1.5-120 Volts

- Has screen fluorescence and angle test; hot cathode-leakage neon test; "high sensitivity" neon short check; "good" and "bad" scale, and "noise test". Has six A.C. and D.C. voltage ranges; three resistance ranges; four milliampere ranges; and 320 Ohms.

Your price: $59.00

MODEL 325 GIANT TUBE TESTER

Tests All Tubes—Filament Voltage 1.5 to 120 Volts

- Has handsome, illuminated red, green and black scale on a silver etched dial with full 1.5 inch meter. Checks each element separately through two dual-sensitivity neon tubes. Has jack for noise test. Complete tester contains neon tube charts. Meter is reversible for horizontal use. Wings available for rack mounting.

Your price: $34.50

SERVICE, NOVEMBER, 1939 • 539

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with RED-DOT
Lifetime Guaranteed Instrument
$17.85 NET


This tube tester checks Loelals, Single Ends, Bantam Jr., Gaseous Rectifiers, the New High Voltage Series (including 117Z6G) and others recently announced. Also has Ballast Tube Continuity Test. Direct reading GOOD-BAD Meter Scale. Will not deactivate 1.4 volt or other type tubes. Furnished in Rich Black Leatherette Covered Portable Case—Professional in Appearance.

Model 739
POCKET-VOLT-OHM-MILLIAMMETER

With Selector Switch MOLDED CASE.

Dealer Net $9.90.

For More Information Write:
Section 1117, College Dr.
READRITE METER OWKS
Bluffton, Ohio

A type 6E5 visual indicator tube is used as a grid-dip indicator in the L-C checker.

The L-C checker can be used to measure the resonant frequency of a tuned circuit. This is done by coupling to the tuned circuit by means of the loop and varying the frequency of the oscillator. At the resonant frequency the eye will open sharply. The amount of opening is determined by the degree of coupling. Low resistance circuits tightly coupled will cause a large opening, while high resistance circuits will not cause as large an opening. For more accurate determination of the frequency the coupling is decreased until a barely noticeable flicker is noted as the checker is tuned.

Wherever the coil is enclosed in a metallic case which may prevent magnetic coupling, capacity coupling can be used. The two binding posts at the lower left hand corner of the panel are for this purpose. The black post is grounded to the case; the red binding post is coupled to the oscillator through a 3-mfd capacitor. The grounded terminal of the circuit to be measured is connected to the black binding post, and the high potential terminal to the red binding post. The L-C checker is then turned as before for the opening of the eye.

The method used to determine the frequency of r-f transformers is as follows:

The black lead is connected to the ground or chassis of the receiver. The red lead is then connected to the grid cap or plate lead of the transformer to be tested and the

The cathode resistor (R2), shunt capacitor (C1) and compensating resistor (R1) are changed for each range as indicated below:

<table>
<thead>
<tr>
<th>RANGE</th>
<th>FREQ.</th>
<th>CATHODE RESISTOR (R2)</th>
<th>SHUNT CAP (C1)</th>
<th>COMPENSATION (R1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>50-175Kc</td>
<td>2000</td>
<td>125</td>
<td>60,000</td>
</tr>
<tr>
<td>B</td>
<td>175-500Kc</td>
<td>2000</td>
<td>100</td>
<td>35,000</td>
</tr>
<tr>
<td>C</td>
<td>500-1750Kc</td>
<td>2000</td>
<td>250</td>
<td>35,000</td>
</tr>
<tr>
<td>D</td>
<td>1-4.4Mc</td>
<td>400</td>
<td>150</td>
<td>10,000</td>
</tr>
<tr>
<td>E</td>
<td>4-12Mc</td>
<td>0</td>
<td>5</td>
<td>4000</td>
</tr>
<tr>
<td>F</td>
<td>9-26Mc</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Everywhere the new highline is changing habits and customs. Wherever a highline goes in, Model "L" GTC Porta-Power is a necessity. This new Model "L" is charted to follow the sensational success of the original Model "U" Porta-Power, because it fills the needs of thousands of farm radio owners living in Rural Electrification districts. Supplies "A", "B", & "C" power for any 4 to 8 tube farm battery set using 2 volt tubes. Free literature and further information on request.

**EASILY INSTALLED**
List price $9.95 --- Serviceman's net price $5.97

**GENERAL TRANSFORMER CORP.**
1252 W. VAN BUREN STREET • CHICAGO, ILLINOIS

---

**DIAL STRINGS**

A few of the new receivers with rather complicated stringdrives on the dial system are causing trouble because the string keeps slipping off the guide pulleys. If the string is to stay on the pulleys, it is necessary that the string be tight and the pulleys in line. Some receivers have several positions to which the tension spring on the dial cord may be connected to give the proper tension. The various pulleys may be aligned by bending their strings.

**Money-Making Suggestions**
You can reap big profits by converting battery "traded-in" sets to all-electric radios.

**A SERVICE BENCH NECESSITY**

---

**LAFAYETTE P.A.**

Every special event in your area is an opportunity for you to make money today renting and installing sound systems. The auto show, price fights, football game, political campaign — these are just a few of the pressing needs for P.A. Cash in on them all with Lafayette — the P.A. line that costs less to own.

**EASY TO BUY.** Lafayette offers a complete line of modern sound systems priced surprisingly low. Because they pay for themselves more quickly, because they're outstanding in dependability, will last for many units that cost twice the money, your profits are greater with Lafayette. Send today for new FREE 1940 catalog. See this amazing P.A. line, note the features, and the prices.

**Radio Wire Television Inc.**
(formerly WHOLESALE RADIO SERVICE, INC.)

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**SERVICE, NOVEMBER, 1939** • 541
RADIO SERVICEMEN OF AMERICA

The current efforts of service organizations, like the National Association of Broadcasters (NAB) and the Radio Service Association (RSA), are focusing on promoting new products and improving membership engagement. With the "Curtain Raiser" program, RSA has embarked on a promotional campaign to introduce new products to members and the public. The program involves joint meetings and the distribution of pamphlets and brochures to encourage the sale of newly demonstrated products.

In the Boston area, John F. Rider, publisher, spoke at a joint meeting held in the Crystal Ballroom of the Hotel Kenmore on Sept. 26. The enthusiastic response needs no comment.

In Chicago, a regular meeting was held on Wednesday, Sept. 13. Dr. Robert Thompson of Metropolitan discussed and demonstrated the Metaxas television set. The "Standing Room Only" sign was hung out early in the evening and late comers were forced into the hall. Leon Polonaksky of Spragie Products Co. was sponsor of the meeting of Sept. 21. On Sept. 28, RCA sponsored John F. Rider, publisher, who spoke at length on test equipment.

In Dallas, at last Dan Cupid and his soldering iron got busy on Dee Spoenel and connected him to a running mate and loudspeaker. Which goes to prove that Service Men are human after all, even if they do yell about their equipment with most women. Best wishes Dee, don't let the t-c get shot out.

The Texas Broadcaster.

ASSOCIATIONS

BUSINESS

SERVICE, NOVEMBER, 1939

A GOOD NAME GOES A LONG WAY

Ken-Rad Radio Tubes are used by many radio manufacturers as original equipment because they are thoroughly dependable.

KEN-RAD TUBE & LAMP CORPORATION Owensboro, Kentucky

SAVE $1.00!!!

- The Group Subscription Plan for Service enables a group of service men, dealers or jobbers to subscribe at one-half the usual yearly rate.
- The regular individual rate is $2.00 a year. In groups of 4 or more, the subscription rate is $1.00 a year. (In foreign countries, $2.00.)
- Each subscriber should print his name and address clearly and state his occupation—whether a dealer, jobber, independent service man, service organization, etc.

Remember this Group Plan when Your Subscription Expires

542 • SERVICE, NOVEMBER, 1939

www.americanradiohistory.com
RECEIVER ALIGNMENT SIMPLIFIED

A Crystal Calibrator cannot be beat for rapid accurate receiver alignment—it is indispensable for a quick check of sensitivity and alignment. Your Blilely Distributor can supply the SMC100 Crystal Unit for only $7.75. Bullet: E-7 (free) contains complete information, Bliley Electric Co., Erie, Pa.

BLILEY DUAL FREQUENCY CRYSTAL

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912 AND MARCH 3, 1933

OF SERVICE—A Monthly Digest of Radio and Allied Maintenance published monthly at New York, N. Y., for October 1, 1939.

County of New York, } 

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared B. S. Davis, who, having been duly sworn according to law, deposes and says that he is the Business Manager of SERVICE—A Monthly Digest of Radio and Allied Maintenance, and that the foregoing is, to the best of his knowledge and belief, a true statement of the ownership, management, (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, contained in sections 55, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, managing editor, and business manager are: Publisher, Bryan Davis Publishing Co., Inc., 19 East 47th Street, New York, N. Y.; Editor, Robert H. Heron, New York, N. Y., Managing Editor, None; Business Manager, B. S. Davis, Ghent, N. Y.


3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

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D. C. Strong

PREVIEW OF TEST EQUIPMENT
(Continued from page 531)

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