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DECEMBER 1955

RADIO - ELECTRONICS

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Rainbow Patterns with your Signal Generator
How to Build a Tremolo Circuit
Signal Injection with Transistor Probe
Make Your Own Photetched Circuits
Complete 1955 Index

HUGO GERNSBACK, Editor

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**THE MIGHTY NINE VOM LINE**

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<tr>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>631</td>
<td>Combination V-O-M—VTVM</td>
</tr>
<tr>
<td>630-NA</td>
<td>For Reset Testing Around The Lab, Production Line or Shop</td>
</tr>
<tr>
<td>630</td>
<td>The Popular All-Purpose V-O-M</td>
</tr>
<tr>
<td>630-A</td>
<td>A Good Lab and Production Line V-O-M With Switch</td>
</tr>
<tr>
<td>310</td>
<td>The Smallest Complete V-O-M With Switch</td>
</tr>
<tr>
<td>630-T</td>
<td>For Telephone Service</td>
</tr>
<tr>
<td>666-HH</td>
<td>Medium Size For Field Testing</td>
</tr>
<tr>
<td>633-NA</td>
<td>The First V-O-M With 10,000 Ohms/Volt AC</td>
</tr>
<tr>
<td>666-R</td>
<td>Medium Size With 630 Features</td>
</tr>
</tbody>
</table>

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DECEMBER, 1955
DECEMBER 1955

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HI-FI AT CARNEGIE HALL was demonstrated by English sound authority Gilbert A. Briggs, designer and manufacturer of the Wharfedale speaker. Briggs used four of his creations together with Acoustical Quad II amplifiers, a Garrard variable-speed transcription motor, Leak and Ferranti pickups and a large array of other high quality audio equipment.

The show was a followup of a similar successful demonstration in London and featured the playing of records in conjunction with live performances of the same works by the same artists. The conclusion reached by a majority of the audience was that, though recorded music has not yet reached the point where it can rival the live presentation, there were at least a few times during the program that the ear did not immediately detect the changeover from one to the other.

METAL-CERAMIC TUBE developed by General Electric is of radically new design and construction. The first of this line, designated as microminiature ceramic tubes, is the 6BY4 triode (technical characteristics are given in the New Tubes section). Other designs will include a series ranging from diodes to multi-element types. The tubes consist of small ceramic and metal layers arranged alternately. The width of these layers is not indicative of the spacing of the internal parts. Inter electrode spacings within the tubes are measured in microns. Size of the tube is almost the same as that of the grid can on the old 6A7 or 6D6.

The ceramic-metal construction promises successful operation at temperatures far in excess of that obtainable with conventional glass tubes. The parallel-plane layout gives the 6BY4 a considerable improvement in u.h.f. performance over the conventional coaxial construction common in miniature tubes. Major factors in the improved operation of the tube are its low lead inductance and nearly complete isolation of input and output circuits.

WEATHER PREDICTIONS can be considerably improved through wider use of radar. According to weather men attending the recent 139th national American Meteorological Society meeting in Asbury Park, N. J., radar and other electronic equipment can be used to forecast flash floods and help track and spot more accurately such severe storms as the recent East Coast hurricanes.

Radar will improve precipitation forecasts because it can show where and how much rain or snow is falling as it falls. This permits warning of possible flash floods. With part of the $7.5 million especially appropriated by Congress at its last session, the Weather Bureau plans to purchase 40 new radar sets, mostly for installation in the Middle West and along the East Coast. This new radar equipment will have sufficient power to penetrate to the heart of hurricanes, as the set now operating at Cape Hatteras, N. C., proved when it went into operation for the first time this year scanning hurricane Connie.
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THE RADIO MONTH

ELECTRONIC TOLL SYSTEM has been installed at toll booths on the new 241-mile superhighway, the Ohio Turnpike. The equipment, recently developed by International Business Machines Corp., consists of a combination of devices that permits weighing all vehicles while they are in motion as they approach the toll booths (see photo).

Operation of the new system is simple and automatic. As each vehicle approaches a toll booth at any one of the turnpike’s 17 interchanges, a special weighing trolley built into the traffic lane pavement separates weighs each axle and a photoelectric detector counts the number of axles. At the same time, the toll collector, having inserted a fare card in the IBM toll recorder, determines by visual inspection the number of axles on the vehicle and depresses a corresponding key on the recorder.

Depression of the proper axle key automatically totals the individual axle weights and the recorder registers the vehicle’s classification, along with other information, on the fare card. If the operator presses the wrong axle key, the toll recorder locks to prevent improper validation of the fare card and an indicator on top of the recorder lights up to display the correct axle pattern. The attendant, at a glance, may correct his error by depressing the proper axle key.

A fare card, indicating the amount to be paid for the trip, is given to the driver for presentation at the exit gate with his toll.

AUDIO ENGINEERING Society held its seventh annual convention, in conjunction with the Audio Fair, at the Hotel New Yorker (New York City) Oct. 12-15. The fair, held concurrently, started on the 13th and ran through the 16th, giving the assembled engineers an opportunity to study the latest audio products after the sessions ended. Eight sessions were held, during which 47 papers were presented, covering the whole field from properties of magnetic tape to consumer reaction to “high fidelity.”

The society’s John H. Potts award for outstanding achievement in audio engineering was given to Dr. Lee de Forest for his invention of the thermionic amplifier tube; detector, amplifier and oscillator circuits; for improvements in sound motion pictures. The Audio Engineering Society award for service to the society was presented to Norman C. Pickering of the company bearing his name. Honorary memberships were also bestowed on Prof. Leo Beranek, author of Acoustics and less recently of Acoustic Measurements, as well as on Dean W. L. Everitt of the University of Illinois for his work in electronics and the writing and editing of technical books.

More than 30,000 people flocked to see more than 175 exhibits at Audio Show, despite heavy rains and floods which inundated New York City and cut off whole sections of the country to the north and east. A most noticeable feature was the new electrostatic high- and middle-range speakers presented by Janzen and Pickering. The greatly increased participation of foreign firms and especially foreign products was also remarked on. Both Telefunken and Blaupunkt, large German audio manufacturers, were exhibitors, and products of other foreign manufacturers, notably German and British, were exhibited by their American representatives. Asia was represented by exhibitor Matsushita Electric of Japan, with speakers and portable radios.

SEVEN NEW TV STATIONS have gone on the air since our last report:

- WITN Washington, N. C. 7
- KDMB-TV Bismarck, N. D. 5
- WORU-TV Columbus, Ohio. 4
- WOAR-TV Marysville, Pa. 5
- KDLO-TV Florence, S. D. 4
- WDIL-TV Indianola, Va. 7
- WHNT-TV Hutchinson, W. Va. 5

Canada’s 29th station, CKVR-TV, Barrie, Ont., channel 3, has gone on the air.

RADIO TOWER AND LABORATORY, built at Alpine, N. J. by the late Maj. Edwin H. Armstrong in 1938 to perfect frequency-modulated radio transmission, has been acquired from Armstrong’s estate by Columbia University for its School of Engineering. It will be known as the Edwin H. Armstrong Field Laboratory and will be used for research in radiation and propagation of various types of waves.

1,000-MC TRANSISTOR was announced recently by Paul Galvin, president of Motorola, Inc. The transistor is to be made by semiconductor methods at a new plant in Phoenix, Ariz., and will be produced in volume in 1 or 2 years.

The transistor is a “diffused-base” type, originally developed by Bell Laboratories. To produce it, a slab of germanium is placed in a controlled atmosphere containing impurities (bismuth or arsenic) in gaseous form. By applying heat, these impurities can be made to penetrate the germanium in controllable quantities. This system, according to Motorola scientists, is a much simpler way of adding the “donor” impurities to the germanium than present methods, and greatly reduces the number of rejects. END

(Continued)
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NATIONAL MANUFACTURER of Mobile Communications Equipment has several openings in the Southwest for FCC licensed, experienced technicians in the field of 2-way Radio Mobile Communications. Salary commensurate with experience and ability.

TECHNICIANS: Wanted by nationally known Airlines at Washington, D. C. office, in all phases of aircraft and ground radio maintenance and troubleshooting. Starting salary $340 per month with automatic advancement under present wage scale. 1st or 2nd class license required.

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DECEMBER, 1955
LOWTHER-VOIGT
"CONFUSION"

Dear Editor:

With reference to the letter from D. M. Chave in your July issue, Mr. Chave is correct in stating that confusion exists in mentioning the name of P. G. A. H. Voigt in connection with the development of the Lowther driver. For those who read Mr. Augspurger's words carefully however, there was no confusion at all. He gave Mr. Voigt the credit for the design of the Voigt corner horn and did not convey the idea that Mr. Voigt's pioneering work had had any influence on the design of the Lowther driver.

The confusion is of Mr. Chave's own making for he now tells us, in connection with what is surely a most vital part of the driver, namely the diaphragm, that "the Voigt patent of the twin cone had already expired when we developed our P.M. 2 diaphragm . . ." Those words give only a tiny fraction of the whole story, for it is within my personal knowledge that Lowther has long been making Voigt twin diaphragms.

In prewar days when Mr. Lowther himself owned Lowther, the Lowther-Voigt combination was the Rolls Royce of British hi-fi—Lowther making tuners and amplifiers, Voigt the speakers. Just when Voigt Patents Ltd. first had Lowther make diaphragms for them was never publicized, but the information I have from most reliable sources is that it was in the 1946-47 period when impaired health limited Mr. Voigt's activities. At that time the Lowther Manufacturing Co. (owned by Mr. Chave) and Voigt Patents Ltd. must still have been working in close harmony, for at the annual radio show in 1947 Lowther-Voigt products were featured on the Lowther stand. Three years later, in 1950, Lowther advertised in Wireless World illustrating the P.M. 2 driver and describing it as being fitted with a Voigt diaphragm.

Nowadays, the name Voigt does not appear on the label of the Lowther driver, but it is my opinion that Mr. Voigt's methods and teachings have been faithfully incorporated.

Now I, and I am sure, the readers of Radio-Electronics, are always glad to give credit to those pioneers and inventors who have done so much for progress in general and hi-fi in particular. Mr. Voigt's invention of the twin diaphragm for extending the upper frequency range of moving-coil
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CORRESPONDENCE (Continued)

loudspeakers is surely one of the neatest tricks in hi-fi.

Mr. Auspurgger described the Lowther P.M. 2 as "fabulous" when used with a suitable horn load. I am certain about one reason for the outstanding performance—when Mr. Voigt taught Lowther how to make diaphragms, he did the job thoroughly and they have not forgotten what they learned.

L. T. A. BECKETT
Burlington, Ontario

DAMPING FACTOR

Dear Editor:

As the one originally responsible for introducing the term "damping factor" I feel some responsibility for finding an alternative form now that we are so deeply in the morass. The term had many shortcomings but it could be used safely so long as it was always finite and positive. The commercial release of amplifiers with negative damping factors has been very confusing to engineers, to say nothing of the general public. For an increase of 22% in total circuit damping, the "damping factor" increases from 10 to infinity, then returns back from infinity to 10. All these extraordinary changes in the damping factor would lead one to believe that something important was happening. In reality nothing has happened except a slight and steady increase in the total damping. The tricks played by the so-called damping factor are due merely to an unfortunate choice of definition. With this definition, instability occurs when the damping factor \( \leq 1 \).

The total circuit damping is a function of the total circuit resistance, that is, the algebraic sum of the voice coil resistance (always positive) and the amplifier output resistance (positive or negative). I therefore put forward the following as a much more satisfactory and logical substitute for damping factor:

\[
\text{Damping ratio} = \frac{R}{R_0 + R_0} \text{ (positive)}
\]

where \( R \) = load resistance; \( R_0 \) = output resistance of amplifier and where both \( R \) and \( R_0 \) are referred to the same side of the transformer.

The following table is for \( R = 15 \) ohms and is purely as an example:

<table>
<thead>
<tr>
<th>( R_0 ) ohms</th>
<th>( R_0 + R_0 ) ohms</th>
<th>Damping factor ( \frac{-R}{R_0} )</th>
<th>Damping ratio ( \frac{R}{R_0 + R_0} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>150</td>
<td>0.015</td>
<td>0.031</td>
</tr>
<tr>
<td>15</td>
<td>30</td>
<td>0.05</td>
<td>0.033</td>
</tr>
<tr>
<td>15</td>
<td>60</td>
<td>0.083</td>
<td>0.051</td>
</tr>
<tr>
<td>15</td>
<td>150</td>
<td>0.109</td>
<td>0.054</td>
</tr>
<tr>
<td>15</td>
<td>200</td>
<td>0.15</td>
<td>0.075</td>
</tr>
<tr>
<td>15</td>
<td>250</td>
<td>0.25</td>
<td>0.101</td>
</tr>
<tr>
<td>15</td>
<td>300</td>
<td>0.333</td>
<td>0.114</td>
</tr>
<tr>
<td>15</td>
<td>350</td>
<td>0.45</td>
<td>0.143</td>
</tr>
<tr>
<td>15</td>
<td>400</td>
<td>0.583</td>
<td>0.171</td>
</tr>
<tr>
<td>15</td>
<td>500</td>
<td>0.8</td>
<td>0.285</td>
</tr>
<tr>
<td>15</td>
<td>600</td>
<td>1.25</td>
<td>0.416</td>
</tr>
</tbody>
</table>

It will be seen that the proposed damping ratio is positive and finite so long as instability does not occur. It is also proportional to the actual damping in the circuit. It appears to be the only

---

Slender, modern dynamic at a fraction of the price you expect

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Model BL-6 Sheekmounted matching desk stand: $7.50

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"Just about four months have passed since I made my first recruiting trip to CREI. As a result of that visit Mears, Kobs, Plante and Wenger are now members of the Laboratories and Mr. Krege soon will be...we have some openings now and will have others..."—Bell Telephone Laboratories, Murray Hill, N. J.

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CORRESPONDENCE

(Continued)
available function with all the desired qualities.

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McINTOSH MC-30 AMPLIFIER

Dear Editor:
I wish to extend sincere thanks from Mcintosh Laboratory for the excellent article (August) covering our MC-30 amplifier.
There are several technical comments I wish to offer. Let me say, however, that these comments are not intended to in any way deprecate the article. To the best of my knowledge it is 100% correct.
Regarding the 1614's in the output stage, they do approach class-B operation. However they do not operate into grid current as one might expect, except on peaks when the amplifier is operated above the rated 30-watt level. The 12AX7 cathode follower is used to not only handle these peaks, but primarily to provide a relatively low d.c. impedance to ground for the 1014 control grids. This low impedance is necessary to prevent a change in bias for the 1614 tubes due to reverse grid current. Such a bias change can cause excessive plate and screen dissipation in the output tubes.
Regarding the 12BH7 load resistor connection, the a.c. load impedance presented to the plates of the 12BH7 is greatly increased above the 12,000-ohm value of the resistors used, as you mentioned. This impedance is four times that, or 48,000 ohms.

SIDNEY A. CONDERMAN
Chief Engineer
McIntosh Laboratory, Inc.
Binghamton, N. Y.

DIFFERENCE OF OPINION

Dear Editor:
That was a nice write-up in the August issue, page 47, for the Cabinet Rebel V. However, I would point out one difference of opinion. The third paragraph states, "There is some fundamental response below that (60 cycles) which can be accentuated with bass boost in the amplifier." Actually the cutoff is closer to 90 cycles and accentuation merely raises the distortion.
It is extremely unfortunate that amplifiers, once equalized for record turnover, tape response or other pre-emphasis, can not be "locked up." I know we couldn't sell an amplifier without a lot of knobs—the more knobs the more sales—but it is as wrong as a $3 bill to play any of them other than flat. I have no tone controls on my demonstration equipment. The only knob is volume!
To boost the bass level to attempt to compensate for lack of bass range in a speaker puts a "hump" just above cutoff and likely adds distortion to the resulting boomy quality.

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Klipsch & Associates
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High gain: Low band, 7 to 9 DB. High band, 8.5 to 10.5 DB. (Single bay figures). Balanced for COLOR.

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Knocks out "Venetian Blinds"!

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<tr>
<th>Description</th>
<th>List Price</th>
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</thead>
<tbody>
<tr>
<td>Low Band &quot;K.O.&quot;, Model No. 1026</td>
<td>40.97</td>
</tr>
<tr>
<td>Covers ch. 2-6</td>
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<tr>
<td>High Band &quot;K.O.&quot;, Model No. 1073</td>
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<td>Covers ch. 7-13</td>
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<tr>
<td>Broad Band &quot;K.O.&quot;, Model No. 1023*</td>
<td>57.64</td>
</tr>
<tr>
<td>Covers ch. 2-13</td>
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thrust bearing. Handsome
modern cabinet with meter
control dial, uses 4 wire cable.
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plete with handsome new, modern
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Television Is Growing Fast Making New Jobs, Prosperity

More than 30 million homes now have Television sets and thousands more are being sold every week. Well-trained men are needed to make, install, service TV sets and to operate hundreds of Television stations. Think of the good job opportunities here for qualified technicians, operators, etc. If you're looking for opportunity, get started now learning Radio-Television at home in spare time. Cut out and mail postage-free card. J. E. Smith, President, National Radio Institute, Washington, D. C. Over 40 years' experience training men at home.

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Train at Home to Jump Your Pay as a RADIO-TELEVISION Technician

Get a Better Job—Be Ready for a Brighter Future in America's Fast Growing Industry

Training PLUS opportunity is the PERFECT COMBINATION for job security, good pay, advancement. When times are good, the trained man makes the BETTER PAY, GETS PROMOTED. When jobs are scarce, the trained man enjoys GREATER SECURITY. NRI training can help assure more of the better things of life.

Radio-Television is today's opportunity field. Even without Television, Radios are bigger than ever before. Over 3,000 Radio Broadcasting Stations on the air; more than 115 million home and Automobile Radios are in use. Television Broadcast Stations extend from coast to coast now with over 30 million Television sets already in use. Over 400 Television stations are on the air and there are channels for hundreds more.

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"Thanks to NRI, I operated a successful Radio Telegraph Station. Then I got a job with WSPR. I am now engineer for WHPE.

W. Verman, High Point, N.C.

Quit Job for Own Business
"I decided to quit my job and start my own business. It is making a good living.

T. W. Hay, D.C.

Extra Money in Spare-Time
"I am a police captain and also have good extra-time service business. I have increased salary and wages of new appuratus and shop.

W. C. Lewis, Pensacola, Fla.

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Garry Moore

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CBS TELEVISION

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I'll send you my new 48-page book, "How to Make Money in Television, Radio, Electronics," a free sample lesson, and other literature showing how and when you can get a top-pay job in Television.

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In few endeavors has electronics solved so many knotty questions as in flying—yet we are only at the beginning for the most important and difficult problems are still to be overcome.

One has only to step into the cockpit of a modern four-motored plane and see the bewildering array of the more than a hundred meters, indicating dials and controls to realize that nowadays no large aircraft could possibly navigate and land without electronics. The radiophone, radar, DF, altimeter, ILS (Instrument Landing System) and a multitude of other purely electronic gadgets on board—all are in constant use by the operating crew.

On the ground, we have GCA (Ground-Controlled Approach radar) and omnirange, new standard requirements of the Civil Aeronautics Administration for civilian airports. Soon all our principal airports will be equipped with GCA. The new radar installations will eliminate most delays in landings due to fog and low visibility during instrument flight approaches.

A recent instrumentality, "video mapping," reproduces a map electronically, showing the pilot runways, terrain obstacles and hazards as well as the proper flight plans for approaching and departing planes. This system will also enable pilots to land and take off at the rate of one every minute, despite poor weather conditions, at even the most congested airports.

In addition to these we have TACAN (Tactical Air Navigation) that instantaneously informs the pilot of his true distance and bearing from a fixed ground station. VOLSCAN, another recent aviation aid, is an electronic computer that controls dense air traffic automatically. With it the U. S. Air Force can now control 120 jets under conditions where no human can direct more than 40 planes per hour.

Some of the larger new plans are also being equipped with weather radar. Storms, thunderstorms and adverse air turbulence show clearly on the radarscope—these can often be either flown over or sidestepped by the pilot to make possible smoother flights. This also safeguards the plane from excessive wear and tear—or worse. The equipment will also indicate large obstacles, such as mountains, straight ahead of the plane.

But as time goes on, planes become much faster and far more numerous. Today's speeds of 250 to 370 miles will soon be memories. Passenger jets are now even flying at 600 miles. Soon all planes will be flying near subsonic speeds. In the U. S. today we have around 1,500 multi-engined commercial planes. There are an even larger number of military and foreign planes. Add to this some 20,000 business and various private planes.

If we consider that there are now over 30,000 daily scheduled airline arrivals and departures in the U. S., we realize that the skies are really becoming crowded. What will the situation be 10, 20 years hence?

In the meanwhile, planes still collide with various obstacles, such as buildings, mountains—and other planes. Unless steps are taken to remedy this, such fatalities—rarely are there survivors—will become worse. We have, for many years, advocated special anticollision radar in this publication. They should be made mandatory by law. Until recently commercial airlines were not interested in such safeguards because of their great weight, bulk and high cost.

With today's miniaturized components and transistors becoming mass-produced, such objections are rapidly being overcome.

A good deal of research and know-how does remain to be done. A plane must be safeguarded from six directions: front, rear, both sides, above and below. Obviously, a single unidirectional radar won't do. A revolving search radar cannot be placed inside the metal-covered fuselage. It must remain outside and protected by a plastic or other non-metallic enclosure. But such igloo-shaped structures on top (and beneath) the fuselage pose certain aerodynamic problems which also must be solved—as they will be in the near future.

How necessary and important anticollision radar has become can best be demonstrated if we consider trans-Atlantic air traffic. There are now an average of 58 passenger flights daily over the Atlantic at the peak season. There are more than 30 planes over the Atlantic at one time. These figures disregard military and freight planes.

On a recent westward trans-Atlantic flight, we counted over 15 commercial four-motored passenger planes on the airport runways of both Shannon (Ireland) and Gander (Newfoundland). Nearly all were ready to depart but had to waste valuable time due to a new ruling which requires that 15 minutes must elapse between takeoffs of all planes flying at the same altitude. Without such spacing collisions would be inevitable.

One might think that such a rule is foolish, considering the vastness of the ocean. It is not. Planes fly a very narrow route in each direction—the shortest line between two airports. The weather too dictates the planes' altitude; they all fly approximately 10,000, 15,000 or 20,000 feet above the ocean. These heights may be varied by 1,000 or more feet in heavy traffic so as to space the planes safely in various "layers." So the air routes are, perforce, crowded.

Airplane captains look with concern toward the 1956 season, when, so we were told, there will be twice as many planes over the Atlantic as in 1955. ... Anticollision radar is imperative now!

—H. G.


The Editors wish you a Happy Christmas and a Wonderful New Year

DECEMBER, 1955
Cathode-Ray Engine Analyzer

By C. B. DeHUFF*

DEFECTS in the ignition system of an engine are responsible for poor operation in a great many cases. To provide technical service to customers using petroleum products, the Socony Mobil Oil Co. developed an instrument to analyze quickly the ignition performance of automotive engines. The idea of a raster sweep oscilloscope was conceived to display the ignition characteristics events in each cylinder to enable direct comparison of all cylinders. The ignition characteristics of each cylinder are spread for detail to the full width of the cathode-ray tube.

The instrument may be connected to any engine merely by attaching two capacitive clips to the insulated spark-plug wires. This supplies all the syn-

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Panel view of the engine analyzer.

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Fig. 1—Basic auto ignition system.

Fig. 2—Breaker points are closed

Fig. 3—Ignition circuit—points open.

Fig. 4—The complete ignition cycle.

Fig. 5—Appearance of the raster, showing the sweep voltages applied to the four deflecting plates (left) before and after tilt compensation.

Fig. 6—Normal six-cylinder pattern.

Fig. 7—Defective distributor points.

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*Research and Development Department, Socony Mobil Oil Company, Inc., Paulsboro, N.J.
chronization and pattern information. Panel controls are relatively simple and power can be supplied from a 115-volt 60-cycle source.

The Allen B. Du Mont Laboratories, who assisted in the development, produced a limited number of these instruments for use by the Socony Mobil laboratories and field engineers. With this instrument, ignition-system defects such as fouled spark plugs, plug gaps, distributor points and coil operation are analyzed. The device should find wide use from large fleet type automotive maintenance shops and with the progressive automotive dealer to the tune-up pits of racing enthusiasts. The idea of the raster sweep makes it unique, and its ease of engine connection will increase acceptance. Sooner or later the electronic service technician is going to meet it face to face.

A typical automotive ignition system (Fig. 1) consists of a battery, coil primary, distributor breaker points and capacitor in the primary circuit, and coil secondary, distributor rotor and spark plugs in the secondary circuit. The value of capacitance on a 6-volt system is usually between 0.15 and 0.40 µf to reduce arcing across the points and to insure a sudden collapse of the magnetic field about the coil. A typical 6-volt ignition coil may have a primary resistance of from 0.9 to 2.0 ohms and a primary inductance of from 5 to 10 mh. The turns ratio, secondary to primary, may fall in the range of 40:1 to 100:1 with between 9,000 and 25,000 turns on the secondary.

At the instant of closing the primary breaker points, the capacitor is short-circuited (Fig. 2-a). The coil primary circuit is completed and current flows from the battery in a manner similar to curve I, in Fig. 2-b. At the instant of point contact a very slight oscillation occurs in the coil secondary circuit. This may be seen with a high-gain oscilloscope and is shown in Fig. 2-b as the curve of E, reflected into the secondary. Time t, is the instant the distributor breaker points close.

When the distributor breaker points open, the ignition circuit may be represented by Fig. 3-a which shows the secondary still open-circuited. At this instant the capacitor is thrown into the primary circuit in series with the primary inductance of the coil. The magnetic field about the coil suddenly collapses, aided by the capacitor, and a very high negative voltage is generated in the secondary winding as indicated by the expression:

\[ e = N \frac{d\phi}{dt} \times 10^{-4} \]

where \( e = \) volts, \( N = \) number of turns in the secondary winding, and \( \frac{d\phi}{dt} = \) rate of change of magnetic lines of flux.

When the voltage reaches a high enough value to arc over, the secondary circuit becomes loaded (Fig. 3-c) by the spark. In Fig. 3-c the portion of the secondary voltage waveform between A and B represents the sudden surge to the point of arcing, after which the voltage returns to a much lower value—B to C. At a time corresponding to C there is no longer sufficient energy in the coil to maintain the arc and the arc goes out, removing the secondary load. With the secondary unloaded the remaining energy is dissipated in the form of a damped oscillation, starting at point C, until it reaches zero (Fig. 3-c). When the breaker points close again, the ignition cycle is repeated.

Fig. 4 shows a typical oscilloscope pattern of an ignition cycle if the horizontal sweep begins with a large negative pulse coincident with the opening of the points, t. Time \( t' \) would correspond to the time of points open, or the spark, for the next cylinder in the firing order. There are many instances in which it would be satisfactory to examine just one of these ignition events at a time. More frequently, however, it is a distinct advantage to be able to compare what is occurring during one ignition cycle with similar events in other cylinders. For oscilloscope ignition analysis of a six-cylinder engine six patterns must be strung out in parade fashion.

On a 5-inch cathode-ray tube, detail is definitely obscured by this arrangement and it becomes desirable to lengthen the time base appreciably so that details may be observed for comparison and measurement. One way to lengthen the sweep time base and still keep the six patterns on the tube face would be to use a circular sweep. This would result in roughly a threefold increase in time-base length, but events occurring during the portion of the sweep at the bottom of the tube face would appear inverted and reversed. This is definitely not desirable for comparisons.

Obtaining the raster

The method used in the new cathode-ray engine analyzer is to apply a saw-
tooth wave to the vertical deflection plates and synchronize this with the engine once every complete engine cycle. The result is a vertical sweep coincident with a horizontal sweep. If the horizontal sweep is synchronized to the same point in every ignition cycle, the result is a series of horizontal traces displaced from each other vertically. This arrangement provides for a maximum of detail, and comparison of ignition events—cylinder to cylinder—is possible.

As described, however, each horizontal trace will have a downward slope due to the vertical sweep. This can be compensated for by coupling a portion of the horizontal sweep voltage into the vertical channel to bring the lines back to the horizontal.

The high negative pulses (at t) from the ignition coil trigger the horizontal sweep and initiate trace blanking and flyback. This produces a horizontal trace on the left side of the tube face at time t, instead of time t. The action of the rotor in the distributor is to distribute the energy from the coil to the proper spark plug in the engine firing order. If the high negative pulse at No. 1 spark plug is used to trigger the vertical sweep, then the top trace in the analyzer raster represents events occurring from the time of spark in No. 1 cylinder until the time of spark in the next cylinder in the firing order of the engine—and so on until No. 1 again fires and begins the raster over again.

Fig. 5 shows the final analyzer raster for a six-cylinder engine before and after tilt compensation.

Since, for a four-cylinder engine, there are two crankshaft revolutions for every engine cycle and one complete analyzer raster represents one complete engine cycle, at any engine speed the crankshaft turns through 720° during the time from t for cylinder No. 1 to t for the next firing of cylinder No. 1. During this interval the distributor has gone through only one revolution, or 360°. Neglecting the minute fraction of time required for flyback for each line, each trace of a six-cylinder raster represents 60° of camshaft rotation. The face of the tube can be scaled to measure directly the duration of points closing, or dwell time, in terms of camshaft degrees. This is a very important and accurate check on the setting of the distributor breaker point gap.

Using the instrument

It is a very simple matter to set up the analyzer for operation (see block diagram). If it is desired to take the instrument in a vehicle—this is frequently necessary to permit the engine to develop the trouble to be analyzed—the analyzer can be connected to the battery through a suitable inverter. Plain, unshielded, single-conductor test lead wire terminating in a capacitive clip is used to clip onto the high-voltage lead from the coil to the distributor rotor for horizontal synchronization and signal information, and onto the high-voltage lead to No. 1 spark plug for vertical synchronization.

A portion of the horizontal synchronization signal is taken off at the input and fed through one half of a differential amplifier. This signal contains all the secondary voltage information pertinent to all cylinders and is applied to the vertical deflection plates. The input to the differential amplifier may be switched to cut out the ignition information from the secondary voltage, and to cut in an external pickup which may be used to study detonation, spark advance, pre-ignition and manifold pressures.

A front-panel control adjusts the amount of vertical sweep fed to the vertical deflection amplifiers so that the line spacing may be controlled. Continuous adjustment is possible from zero spacing—all lines superimposed on one another—to maximum spacing which allows for practically individual observation. Adjusting the gain in the horizontal deflection amplifier permits a magnified view of selected portions of the ignition cycle for very close detail. A 0–200-usec meter is connected in series with the constant-current tube of the horizontal sweep generator to indicate engine r.p.m. The meter reads the average tube current which is proportional to the frequency and therefore the speed of the engine. A selector switch connects capacitors in the sweep generating circuit to maintain meter calibration for engines of different numbers of cylinders. Other front-panel controls include: intensity and focus, horizontal and vertical lock, horizontal and vertical positioning.

Some typical displays are reproduced in Fig. 6, a standard six-cylinder ignition pattern, and Fig. 7, a case of bad distributor-point contact. An examination of the points in this case would reveal pitting such that, as the points start to close, a momentary contact is first made when the buildup on one point brushes the edge of the crater on the other. As the points continue to close this momentary contact is broken until the buildup on the point rests firmly in the crater of the other, at which time final contact is made.

The effect of a wide gap in one spark plug, as compared with the gaps in the other plugs, is shown in Fig. 8. In this photograph line 4, corresponding to cylinder No. 6 in the firing order 1-5-3-6-2-4, shows a much shorter spark line. With a wide gap more energy is required to maintain the arc and so the condition is reached much earlier where there is no longer sufficient energy to maintain the arc and the arc goes out. The slightly larger oscillation illustrates the greater energy in the coil-capacitor circuit left over after arc-out.

Fig. 9 shows the pattern observed with spark plug No. 3 (line 3) completely fouled to a dead short by deposits. In this case there is still a spark gap left in series with the secondary circuit. It is the gap between the distributor rotor and the posts in the distributor cap. With only one gap left in the circuit much less energy is required to maintain the arc, which continues for a much longer time. When the arc does go out, there is much less energy left in the coil-capacitor circuit and a much lower amplitude oscillation follows arc-out.

Fig. 10 shows a stage of spark plug fouling which often precedes shorting

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**Fig. 11**—Poor secondary voltage waveform caused by distributor point bounce.

**Fig. 12**—Normal coil charging current.

**Fig. 13**—Poor primary current waveform caused by distributor-point bounce.
SEISMIC WAVE (artificial earthquake) exploration for new underground oil deposits is a little-known field to many electronic technicians. However, many skilled technical workers manufacture, operate and service seismic electronic equipment all over the world. Excepting its peculiar language, this apparatus is easier to understand than an ordinary radio set. For example, a “geophone” (Fig. 1) acts like and is made similar to a dynamic phonograph pickup. Twelve such geophones pick up ground vibrations and feed into 12 amplifiers, each of which drives recording elements to produce the 12 separate traces of Fig. 2 (an actual seismogram).

Many such seismograms, together with other information, produce a geological map of some locality where wells are to be drilled in the hope of finding oil. If the locality has not been previously drilled for oil, this hope is fulfilled about once in eight trials. To understand the reasons for so many failures, to comprehend the electronic part (the major part) of a seismic exploring system and what such a system accomplishes, we must turn to the fascinating story of the shape of the Earth and, more important to this discussion, the underground shape.

Structure of the Earth

Geology tells the story that the outer crust of our Earth has changed many, many times in the past billions of years. This crust—10 or so miles thick—has wrinkled many times with advancing age. The outermost parts of the wrinkles are our present-day moun-

He deposit on the porcelain. In this case spark plugs No. 5 (line 2), No. 6 (line 4) and No. 2 (line 5) show a shortened spark line which is also very distorted. This condition in an engine limits engine power and frequently does not become evident until full power is demanded from the engine.

Sometimes the distributor points may actually bounce open during the period that the coil is saturating before the spark. This is shown in Fig. 11 where a spark occurs during the dwell time on line 2. In this case the bounce produced a spark of low energy, insufficient to trigger the horizontal sweep of the analyzer. It did, however, cause a severe engine roughness which would have been extremely difficult and time consuming to locate without the engine analyzer. Fig. 12 shows what happens to the primary coil current when the distributor points open accidentally during dwell, as compared to Fig. 12 which shows normal coil charging current.

Both Figs. 11 and 13 were exposed for two successive firings. The photograph in Fig. 13 was not taken at the same time as Fig. 11, but in this particular instance of malfunction the trouble showed itself frequently enough to make possible the photograph of two nearly identical events, once when observing secondary voltage and once when observing primary current. Through the use of the engine analyzer, the mechanic was immediately led to finding the cause of the distributor-point bounce and the trouble was traced to a worn distributor drive gear. Replacement of the faulty component corrected the poor performance of the engine.

Under a recent licensing agreement Du Mont Laboratories will manufacture and sell the instrument, known as the Type 901 Cathode-Ray Engine Analyzer. Du Mont expects to market the analyzer on a regional basis, beginning with the New York area.

SEARCHING FOR OIL with ELECTRONICS

Exploring for underground deposits with seismic waves

By JAMES A. McROBERTS

ELECTRONICS

www.americanradiohistory.com
not restrained, the oil eventually reaches the surface of the ground. Underground oil and water do not ordinarily exist as large lakes or pools, but in spongelike pore holes of rock. Most of the oil fields of the world have their oil stored in these rock pores or holes which average about 50 to the inch. Some rocks do not have big pores and may not pass oil toward the surface. The oil collects underneath these so-called cap rocks at points where there is a fold pointing upward (an "anticinal" fold). Such a fold with a possible oil deposit under cap rock D is shown in Fig. 3.

Another common trap for oil is a fault in combination with a cap rock as shown in the center of Fig. 3. These are known as structural traps for oil and the location of such traps is the primary purpose of seismic and all other information used in making the geological map to locate oil.

Seismic exploration systems

You probably know how depth is measured by a sound wave sent from a shipboard sound source and reflected from the ocean bottom. The time taken for the round trip indicates the depth of the ocean. In oil exploration, an explosion of blasting gelatine produces seismic waves whose frequencies are from about 10 to several hundred cycles. The differences in time of travel of a seismic wave tell how far down some reflecting rock layer is from the surface. The geologist wants to know how deep below some level—sea level, for example—several rock layers are.

From the explosion seismic waves travel in all directions. Those going downward hit a layer that reflects a part and transmits a part of the seismic wave. The reflected part returns to the surface and is picked up, amplified and recorded. The transmitted portion goes still farther, hits another layer with partial reflection and partial transmission, and the reflected portion returns surfaceward to be partially reflected and transmitted at the first rock layer again. This last transmitted portion travels to the surface for pickup and recording. Thus, a number of rock layers give us information in seismic work. Fig. 4 is a typical layout of a "reflection" seismic system so called since it deals with seismic-wave reflections.

In the system of Fig. 4 an arbitrary
line is laid out across the area to be surveyed by the seismic method. It is labeled X and is the surface of the

ground. Seismic people call depth below ground Z. Along X pickup units are placed to receive the reflected seismic waves which are fed into channel amplifiers. Each amplifier feeds or drives a recording element in a recording oscillograph, so the trace on the final record is really an amplified version of what the geophone pickup of that channel receives. Usually the geophones are placed at 200-foot intervals on either side of the point (SP) where the explosive is set off. Such a layout is called a double spread. If all detectors are on one side of the shot point, it is a single spread.

Seismic waves generated at point SP travel in all directions with a uniform speed so long as the physical properties of the uppermost rock layer remain constant. In traveling along the surface of the ground, the seismic waves pass the detectors at different times causing (through pickup-amplification-recording) the different starting times Z of the seismic wavefront on the moving seismic record. Seismic waves traveling downward strike layer Z1 with some reflection due to different physical characteristics which comes back to be recorded as Z2 on the moving seismic record. Of the seismic energy hitting the Z1 layer or rock bed, some is transmitted downward to hit Z2 and is partially transmitted and partially reflected. The partially reflected wave reaches the surface to form the "reflection incident" labeled Z3 in Fig. 4. Thus the time for a seismic wave to travel to some reflecting (usually partially reflecting) rock layer becomes a permanent record of that wave.

Now examine layer Z2. Note the upward curve which indicates the presence of that part of the syncline between points A and B on the diagram. You will see that the time needed by a seismic wave to reach the bottom of the syncline is greater than the time to reach an adjacent dome, or anticline, or other higher point. This shows up as a different time for the same reflection incident on seismic records are put on the dome or fold and over the valley or syncline.

Observe the "trap" structure of the fault to the right bottom of Fig. 4. A sharp drop on the same record or an adjacent record will be seen in the reflection incident for a fault as shown on Z3, in this instance contrasted to the relatively even reflection incident taken over the syncline in the middle of Fig. 4. This is how reflection seismographs help find structures which may trap oil.

Only areas with good prospects as to oil source material and good structural features are drilled for oil. If there is no structure or seismic evidence of structure, the present use of the seismic exploration system fails. I have taken seismograms from areas unknown to me and have been able to detect on them the presence of oil regardless of structure with a 1,000 batting average and have foretold with accuracy the depth of producing areas not given in oil drilling statistics.

The electronic equipment

The amplifiers are easy — they must have fairly faithful reproduction from about 10 to about 1,000 cycles, so conventional audio amplifiers with low-frequency compensation are used. Each of the amplifiers has its own screwdriver controls, a volume control and "frequency" controls which are ordinary tone controls. Prior to seismic operations, the gain of the individual channels is equalized with a constant signal input from a test record. Special test circuits tell the operator of failures. An automatic gain control is a recent-day innovation because of decreasing strength of the reflected seismic energy from great depths (it is really an a.v.c. with a large time constant due to low-frequency input). The time constant is too low however for peak detection. The a.v.c. is fed to the different amplifiers through a decoupling network although its input is from only one or two of these.

The geophone is exactly like a dynamic phonograph pickup except that the needle is replaced by a "spike" (Fig. 1) to be pressed into the ground. The seismic energy vibrates the spike and moves the pickup coil in the magnetic field and thereby develops a voltage corresponding to movement of the ground. This forms the input signal to the amplifier.

Recording galvanometer elements work like d.c. meters; a variable current passes through a coil in a magnetic field, turning the coil. Instead of a pointer, the element rotates a tiny mirror which moves a beam of light focused on it. This beam of light is arranged to hit a special moving photographic paper. The up-and-down motion of the beam of light is thus spread out — ordinarily at 10 inches per second. The recording oscillographs (Fig. 4) shows one element for each channel, but each has a magnetic field for up to 36 elements. Timing lines are recorded on the sensitive paper by a rotating slit making one vertical line every 1/100 second and a heavier one every tenth line or 1/10 second — these are numbered later by hand. The sensitive paper and the elements are in a light-tight box and the paper is processed photographically later.

Older seismic equipment used a land telephone line to tell the operator in the recording truck to start the recorder which automatically connected the telephone line. The operation of the blasting machine transmitted over the telephone line momentarily broke or interrupted the trace, marking a record of the time of the explosion.

Refraction system

In this setup the equipment does not change; however, the detector spacing does, being much greater than the 200 feet customarily used in reflection work. Geophone spreads of up to several miles are common and are all on one side of the shot point. In refraction work, only the time the detector is of interest and subsequent events as in reflection work are ignored. Refraction work was used to find changes of speed in material near the surface which differ materially from the surrounding material and would cause an appreciable difference in the time of arrival of a seismic wave. By the refraction method, some salt domes in the Southwest have been discovered. These salt domes have depositories of oil around them.

The length of the record in reflection work is about 2 1/2 to 3 feet long. This length corresponds to a time of travel of the seismic wave of about 2.5 seconds both down and up. The speed of seismic waves is the same with different structures. Usually 2 seconds of travel represent a depth of about 12,000 feet but as the speed is variable with different areas this is only a rough guide. I have been able to discern the difference between oil and no oil on seismic records (reflection) at 9,700 feet with an error of 100 feet — less than the error with which the depth of a drilled well can be measured.

Reflection records are somewhat long. The usual length is about 4 feet due to the longer detector spacings. The refraction method has fallen into disuse in the last 10 years with the reflection method being used almost exclusively in seismic exploration for oil. Determining the fact that its current use is to locate structural traps for possible oil deposits, it is the most reliable of all "finding" methods to date.
By RUFUS P. TURNER*

THROUGH the use of one low-priced transistor, a photoelectric relay which may be used as an intruder alarm and for several other purposes can be built for exceptionally low-current operation. There are no tubes to be replaced (transistor life is tremendous) and only the tiniest amount of heat is generated.

The simple circuit is shown in the diagram. A self-generating photocell is connected to the input of a CK722 transistor. A milliamperere type d.c. relay is connected to the transistor output. The d.c. operating voltage for the transistor is furnished by a simple voltage doubler composed of a 6.3-volt filament transformer, two 1N34 germanium diodes (D1 and D2) and two 50-µf electrolytic capacitors (C1 and C2). This simple power supply circuit delivers 17.5 volts when operated from a 115-volt power line.

Normally, the d.c. output current of the transistor, only a few microamperes, is too low to operate the relay through whose coil it flows. But when the photocell is illuminated, the direct current it generates flows into the transistor input and causes an amplified transistor output current high enough to energize the relay. If the cell is then darkened, as it will be when a person or object passes between it and the source of light, the collector output current decreases and the relay is de-energized.

*Author, Transistors, Theory and Practice.
The normally closed contact of the relay is used as indicated in the diagram. As long as the photocell is illuminated the relay armature is pulled away from this contact and the circuit connection to output terminal A is broken. When the cell is darkened the armature returns to the normally closed contact and closes the circuit. This applies 6.3 volts a.c. from the transformer to the output terminals, and this voltage may be used to operate a bell, horn or other alarm device or to start the operation of an external circuit.

The circuit is fast-operating and will work with the cell illuminated either by an incandescent bulb or by daylight. If the connection is made between a lamp bulb and the photocell it is greater than about 3 feet (the width of most residence doors), a lens may be needed in front of the lamp or cell for focusing the light rays.

Transistor and diode life is almost limitless with the small amounts of current flowing through them. Since there are no tube filaments to heat slowly, the circuit is ready for instant operation. The amount of power taken from the 115-volt line is less than that used by an electric clock. Operating expense thus is negligible.

Battery operation may be used if desired, using the power components (C1, C2, D1, D2, and T) and connecting a single 22-volt battery to leads X and Y. Connect the positive terminal of the battery to X and the negative terminal Y. Wire the on-off switch in series with lead Y and the battery. The length of service will depend upon battery size, being longest for larger batteries.

The photocell used is an International Rectifier Corp. type DP5. This unit has high d.c. output voltage for a given amount of illumination. However, any other type of self-generating cell can be used. Several models are found in the surplus market.

The d.c. relay is a Sigma type 4F. This unit normally closes on 1.6 ma but can be made to operate reliably on currents as low as 1 ma by unscrewing its pilot screw a small amount. Type 4F relays still may be found from time to time in the surplus market.

Construction
The photos show the construction of a burglar alarm. The unit is built in an aluminum chassis box 6 inches long, 4 inches wide and 3 inches deep.

The photocell, relay, on-off switch and transistor socket are mounted on the rear of the front panel. The power supply components are mounted on the bottom, the output terminal binding posts on the top.

The transistor “socket” is a Cinch-Jones type 3-141 three-screw terminal block; the transistor pigtailed are fastened under its screws. This arrangement is better than soldering the transistor into the circuit since it removes the chance of heat damage. Also, the transistor can be removed easily for testing or for temporary use in experimental circuits when the burglar alarm is not needed. The output binding posts are mount-

![Schematic of the transistorized alarm.](image)

EDUCALON

COMPACT GEIGER COUNTER

Keeping with the expanding demands in the field of uranium prospecting, a small Geiger counter capable of measuring tiny increases in radiation over normal background count has been introduced. The Ura-Finder (see photo) is powered by a small penlight cell. Extremely compact, the instrument is about the size of a pack of cigarettes. It is being marketed by El-Tronics, Philadelphia.

The operation of the Ura-Finder can be seen from the diagram. In this circuit the Geiger tube serves three purposes: it rectifies the several thousand volts of a.c. from the transformer; it acts as a voltage regulator and is the radiation-sensitive device.

The transformer-vibrator (El-Tronics part VT-1) steps up the penlight-cell voltage to approximately 2,000. After rectification, a potential of 500 volts d.c. is applied to the Geiger tube.
The need for high-powered amplifiers for home reproduction is being accepted by a rapidly growing minority of audio enthusiasts. Many still feel that "10 watts is enough," but the author is a member of the group which believes that power capabilities above 25 watts are required to attain maximum fidelity. Extended listening tests indicate that high-powered amplifiers of about 50 watts are clearer than low-powered 10-watt units, particularly in the bass region.

One disadvantage of high-powered amplifiers has been their cost. Now it is practical to build a Williamson type amplifier that delivers 50 watts of clean power at a cost only $10 higher than either the 15-watt triode or 25-watt Ultra-Linear unit (assuming that top-grade transformers are used in these amplifiers). It is also feasible to connect existing Williamson amplifiers to high-powered use with a considerable improvement in listening quality. This is made possible by the Tung-Sol 6550 tube, now commercially available.

The 6550 is a ruggedized beam-power tetrode with a total plate and screen dissipation rating of over 40 watts. It is an efficient tube with high-power sensitivity that offers high quality and high power without corresponding high cost. Tung-Sol suggests several types of operation ranging from 28 watts in triode connection to 100 watts as a tetrode with 600 volts on the plate. The triode connection does not take full advantage of the power-output capabilities of the tube and the 100-watt circuit requires a complicated and expensive power supply.

Design considerations

Most Williamson amplifiers have power supplies which provide 425 to 450 volts at about 200 ma. These can be used with the 6550 operated with 450 volts on the plate and screen and 48 volts bias. The bias can be obtained from a 200-ohm cathode resistor adequately bypassed, but it is preferable to use fixed bias to make full use of the tube's capabilities. Fixed bias is obtained as shown in Fig. 1. An a.c. voltage divider consisting of a .05-µf capacitor and 47,000-ohm resistor is placed across half of the high-voltage secondary of the power transformer. Its output is fed to two small selenium rectifiers—connected in series for an adequate voltage rating—and filtered by the 40-µf electrolytic capacitor. The d.c. voltage divider consisting of the 10,000-ohm control and 15,000-ohm resistor provides the voltage. The output bias is adjusted to the desired value with the bias control. To convert present amplifiers, the 10,000-ohm potentiometer can be inserted in the hole which previously held the bias balancing pot.

If the B plus voltage runs a full 450, for extra safety the conventional 5V1-G rectifier should be replaced with a 5U4-GB. This will lower the plate supply slightly (and keep it under 450 volts even if the line voltage is high) and will adequately handle the additional current drain of the 6550's which runs about 180 ma. It is not desirable to operate the 6550's with more than 450 volts, so the 5U4-GB is generally preferable.

The other basic change in circuitry lies in the output stage. The 6550's have the same baxand arrangement as KT-66's or 6881's and, therefore, can be directly substituted. However, they require a different impedance match for optimum performance. This means that a different output transformer must be used. This is also necessary to handle the 50 watts which the converted circuit can provide.

Experiments with impedance matching showed that maximum power could be realized with a low plate-to-plate load of about 3,000 ohms and 40 volts bias. This condition resulted in excessive power dissipation in the tubes which could not be remedied by an increase in bias without a corresponding

Fig. 1—Schematic diagram of the 50-watt modified Williamson amplifier.
increase in nonlinearity. Maximum linearity is attained with a plate-to-plate load between 4,000 and 4,500 ohms and 48 volts bias. This reduces maximum power from about 56 to 52 watts (depending on the supply voltages) but cuts the distortion below the 50-watt range to about one-half of what it is with the lower primary impedance.

On the basis of these considerations a transformer was designed with 4,300-ohm primary impedance and a continuous 50-watt rating for all frequencies from 20 cycles to 20 kc. This unit, the Dynaco A-430, has a bandwidth of from 6 cycles to over 60 kc ±1 db to minimize phase shift over a band far in excess of the audio spectrum. Other transformers of comparable specification can be used if their design permits a satisfactory margin of stability under feedback conditions.

The circuit (Fig. 1) uses a screen tap to provide d.c. for the screens of the 6550's and a small degree of screen loading. Since the primary impedance was selected to furnish optimum linearity, the screen tap was not used for this purpose but to reduce the internal impedance of the tubes and provide suitable damping. The damping factor of the complete amplifier, after applying inverse feedback, is over 20—greater than normally found in high-fidelity equipment of this power bracket.

The final variation in the design from the original is a change in the phase characteristics to provide additional stability at both high and low frequencies. The lack of adequate stability was one of the serious weaknesses in quality of the basic Williamson design. Many of these amplifiers, whether home designed, kit assembled or commercially produced, had a tendency to motorboat at low frequencies or to oscillate above audibility when used on a loudspeaker load. They measured well on a resistive load but their listening performance was frequently marred by this instability under listening conditions.

The 0.25-muf capacitors connected to the grids of the 6550's are bridged by 1-megohm resistors. At the very lowest frequencies, these reverse the phase shift introduced by the coupling capacitors, so the stage is direct-coupled for very low frequencies while capacitively coupled for higher frequencies. This reverse phase shift compensates some of the phase shift due to the 0.25-muf coupling capacitors preceding the 6SN7-GT driver. The d.c. voltage reaching the grids through the 1-megohm resistors is compensated by adjusting the bias control.

Thus, the amplifier phase shift at certain low frequencies is due solely to the phase shift in the output transformer since the phase shifts due to the R-C networks are opposite in sign and cancel. The frequencies at which this effect takes place are in the 1- to 2-cycle range where the circuit would otherwise approach 180° of phase shift with a tendency to motorboat when speaker-excited. This type of phase correction eliminates all traces of low-frequency instability.

High-frequency phase correction is made by the capacitor across the feedback resistor and the capacitive internal feedback loop connected to the first cathode. This feedback loop is effective primarily at ultrasonic frequencies. The capacitor and feedback loop prevent ultrasonic oscillation or serious ringing whether the amplifier is used with resistive load, speaker load or open-circuited. In short, it is stable under any condition in which it would normally be used.

The underchassis photo shows the location of many components of our Williamson-type amplifier. The small filter choke next to the selenium rectifiers is not used in all models. The two
The power rating of the output transformer permits full power at all audio frequencies without visible distortion or attenuation of the waveform as viewed on a scope. Many power ratings indicate that amplifier response is flat at rated power but they ignore distortion at frequency extremes. In this design high-powered response is essentially distortion-free, indicating that the intermodulation products must be small for any combination of frequencies within the 20-cycle to 20-ke spectrum.

The final and most important test of an amplifier is the listening test. The 6550 passes this with flying colors and has amazed many who felt that there was no more room for improvement of audio power amplifiers. The high power capacity provides clean sound through the heaviest passages. Some muddiness which had been attributed to the program material vanished when the high-powered amplifier was substituted for a 25-watt Ultra-Linear amplifier.

The improved sound quality is due in part to the extra power handling; in part to the wide stability margin. This insures instantaneous recovery on percussive sounds and translucent, smooth listening on high-frequency string and wind instruments. Small transient sounds such as tambourines assume a different spatial perspective, possibly because the low phase shift does not disturb the harmonic pattern of complex nonrepetitive tones. The total effect is greater naturalness and less impression of reproduced sound.

### AUDIO—HIGH FIDELITY

jacks, used for metering output cathode currents, are not shown on the diagram.

**Performance**

The maximum power capability of the amplifier is determined largely by the effectiveness of the power supply. With the average supply used in Williamson amplifiers a power output slightly over 50 watts can be attained before the intermodulation distortion reaches 1% (based on 60 and 6,000 cycles mixed 4 to 1). If a power supply of better regulation is used, such as a pair of SVL-4's in parallel with a choke-input filter, the power capability is increased to over 60 watts.

The distortion curve (Fig. 2) is based on a unit using a conventional 200-ma power supply with a single 5U4-GB rectifier. The combination gives less than the permissible 450 plate volts and at high output the B plus drops to about 400 volts. Even with these limitations, the distortion characteristics are excellent. At 35 watts, the 1% distortion is still below 0.2%. At lower levels, distortion is below 0.1%. These figures are in sharp contrast to high-power amplifiers which depend on class-AB or B operation—either of these types of operation create minimum low-level dis-

**Fig. 2—Amplifier distortion curve.**

wartons components of 0.25% or even higher.

Frequency response of the Williamson type circuit is generally outstanding and far in excess of the customary audio spectrum. The high-powered Williamson arrangement does not impair this and response is extended smoothly from below 10 cycles to over 100 ke with minor frequency discrimination. The peaks which normally indicate instability in many circuits are completely eliminated and the smooth extended bandpass permits excellent square-wave transmission from 20 cycles to 20 kc.

**SOUND SELLING**

By ROBERT E. RIDDLE

Here is a copy of a letter—the signature has been changed—that recently came to my attention:

Sir,

Could you, of Midland Engineering Company, fix me up with an unusual method of advertising my business?

I have signs of every description, both inside and outside, as well as display aids in the newspaper. I want a permanent, cheap means of advertising.

Respectfully,

Richard Roe

The writer didn't say what kind of business he was running or its location. I was about to file it in the wastebasket, when the clock on the next desk started tolling the time. Then it hit me! Why not a chiming clock that could be heard over a wide area?

One of the fellows plays an electric guitar in the company dance band. Fortunately this happened to be their day to rehearse.

I removed the pickup from the guitar, fastened it to the side of the clock, plugged in the amplifier, turned the amplifier volume on full and sat back.

It wasn't long coming. Instead of the soft mellow chime, there was the thunderous roar of a gigantic gong. Turning the gain down I again restored the soft mellow chime, but with enough volume so that it could be heard over a radius of several blocks.

I had the technicians rig up a similar unit (see diagram) and install it on the front of the department store next door. At the end of a week the manager told us that business that week was a good 40% over the same period a year ago.

The only modification we made in the unit was to use outside speaker horns and hook the amplifier to a time clock that shut it off at a few minutes past midnight and on again about five in the morning.

To get the correct time we used a shortwave radio tuned to WWV at 2.5, 5, 10, 15 and 20 mc, and set the chime clock by this at least once a day.

WWV may be identified by a tone signal and a beat, similar to the ticking of a clock. Every 4 minutes the tone stops and a message is sent out in Morse code, a voice announces the time, another message in code follows, then the tone returns on the exact 5-minute mark on the clock at the U. S. Bureau of Standards’ Naval Observatory at Wash-ington, D. C. All time is given in Eastern Standard Time. Compute the time by subtracting one, two or three hours, depending on which time zone you happen to live in.

If you don't want to go to the expense of getting a shortwave radio you can get the time by calling your local Western Union office, telephone company or railroad station.

Remember, when you broadcast the time, people want the right time, not just any time. Inaccurate time will reflect on your time as well as on your shoddy service or sold inferior merchandise.
THE transistor can be used effectively in a remote preamplifier, a self-powered unit constructed as a lightweight, compact gain stage for a microphone. A very inexpensive two-wire audio cable or 300-ohm lead-in will carry the signal with little loss (Fig. 1). We have used over 250 feet of transmission line successfully and there is no reason why lengths up to 1,000 feet cannot be used when there is adequate audio gain at the terminating amplifier.

For our needs the terminating unit was a tape recorder, though it could just as well be any type of recorder—tape, wire or record. The termination could also be the phono input of a high-fidelity installation, radio, television, public address system, etc. In our particular application we used the transistor amplifier (see photo) and tape recorder for some amateur tape recording of wild bird songs. As shown in the photograph the amplifier was mounted in a large colander that can be purchased wherever kitchen utensils are sold. Thus the pickup characteristic was more directional and background noises were reduced. In addition to a hole drilled in the colander to mount the preamp, two more were made to insert a small U bolt (such as those used to mount u.h.f. antennas to masts) so the unit could be fastened to a mast, pole, tree limb, etc.

The transistor amplifier (Fig. 2) is a basic grounded-emitter circuit with a stabilizing emitter resistor. The transistor stage operates at a medium input impedance to provide a suitable termination for a small crystal microphone cartridge. The degeneration resistor also minimizes overload when the sound level is high. The crystal microphone cartridge is cemented to one side of the case.

The battery is clip-fastened to one side of a channel-lock type of case (see photo). All components, including battery and transistor, are soldered and mounted firmly to permit rough handling in the field. Rugged binding posts permit a firm attachment of the audio line to withstand considerable tugging.

The output impedance of the grounded-emitter transistor stage is high enough to provide good gain and low enough to permit driving a long length of cable without serious high-frequency loss. Inasmuch as a battery powers the amplifier, there is no hum pickup. Hum does become a problem when using long lengths of line, a problem overcome rather easily. In our application a very inexpensive and, therefore, expendable audio cable is used. After one day of wood tangles and dampness we prefer to discard the line and start with new line on the next field trip. It is easier than trying to protect high-quality shielded line.

Lack of shielding does give us hum pickup at times in the vicinity of power lines. When hum level is high, we drive a 3-foot metal stake into the ground (Fig. 3). As short a lead as possible is then run between the ground terminal of the transistor amplifier and the metal stake. For a severe case of hum an intermediate stake can be used and connected to the ground wire of the cable. When used indoors, hum can be reduced by finding a good grounding spot as near the amplifier as possible.

With the availability of lower-priced

Fig. 1—Cable and terminal units.

Fig. 2—Schematic of transistor preamp.

Fig. 3—Connections for hum reduction.
transistor transformers, it is economical to use low-impedance transformer coupling (Fig. 4). This helps minimize hum and noise pickup by the long length of line between the remote amplifier and the input of the amplifier or recorder.

Remote-amplifier applications

A remote amplifier has numerous applications. It can be used for recording all types of sounds. It is excellent for picking up crowd noises, traffic sounds, aircraft, animals, locomotives, etc. If you are trying to build up a library of sounds, a simple remote amplifier is most helpful. A transistorized unit permits you to position your microphone at a site inconvenient to an a.c. outlet such as in woods, open fields, athletic fields and rooftops.

There are also many listening-in applications for a remote transistor amplifier. In this service the transistor preamp can be used to supply a signal to any type radio or television set with a phono input. Thus it can be used as a baby sitter, intruder-warning device, one-way intercom, etc. It is convenient because it can be moved about, indoors or outdoors, with regard to nearness of an a.c. outlet. Long lengths of line can be attached, permitting wide separation between the microphone and listening receiver.

The transistor unit can serve as a remote microphone for a high-fidelity installation or public-address system. In PA work two or three of these units can feed signals to an audio mixer. Thus, a number of widely separated pickup points can supply information to a single audio control center. Remote pickup points can be planned and shifted without regard to separation.

The transistor preamp can be tested by connecting its output to the vertical input of an oscilloscope. If you whistle a reasonably pure tone into the microphone, you can observe its sinusoidal makeup on the scope screen. This waveform should not be distorted until you whistle loudly very close to the microphone. Then the waveform will flatten off, indicating an overload of the transistor amplifier.

If the amount of overload is too great for close-in use of the microphone, it can be reduced by increasing the value of the emitter resistor. For our application we desired the utmost sensitivity, realizing the sounds to be collected would in general be well separated from the microphone.

Add Bias—Erase Indicator to Tape Recorder

H ave you ever tried to record an important event only to find that upon playing the tape back it had low level and was very distorted in spite of the fact that the program sounded normal in the monitor and the recording-level indicator showed proper setting of the gain control?

This was most likely caused by failure of the high-frequency bias and erase oscillator. A simple but effective precaution is to add a high-frequency coupling capacitor C should be as small as possible while still keeping the neon lamp ionized. I used a 10-μf unit on a Pentron 9T3C. Values as high as 50 μf may be necessary on other tape recorders. The NE51 neon lamp indicates the output of the bias oscillator. Coupling capacitor C should be as small as possible while still keeping the neon lamp ionized. I used a 10-μf unit on a Pentron 9T3C. Values as high as 50 μf may be necessary on other tape recorders. The NE51 neon lamp indicates the output of the bias oscillator.

The a.c. voltage across the erase head is not high enough—65 or more—to ionize the neon lamp, C should be connected to the plate or plates of the bias oscillator tube. Here again Fig. 1 is used with single-ended oscillators and Fig. 2 with push-pull units.

In addition to indicating bias failure, the neon lamp will also show when the tape machine is set for recording, helping to prevent any accidental erasure of tapes intended for playback.

A few of the popular tape recorders are listed below for balanced or unbalanced circuits.

UNBALANCED

| Dukane | 11ASSF, 11B55 |
| Masco | 52, 52C, 52CR, 52L, 52LR, 52R |
| Penton | 9T3C |
| Revere | T-7053, T-7057, T-7067, T-7077, T-7087, T-7097 |
| | T-7117, T-7127, T-7137, T-7147, T-7157, T-7167 |
| Tapemaster | PT125 unbalanced head only |

BALANCED

| Brush | BK-437, BK-437S, BK-439, BK-440, BK-441P |
| Penton | BK-437, BK-441P |
| Tapemaster | PT125 balanced oscillator only |

—Frank J. DiElsi

RADIO-ELECTRONICS
TREMOLO where you want it...

Amplitude modulator applies tremolo selectively

By TOM JASKI

The high cost and tremendous space requirements of a pipe organ, the king of musical instruments, have inspired a rash of more or less successful electronic organs in the past 20 years. Some give a fair imitation of the grand musical effects of well built pipes, although the trained ear would not be fooled for long.

For many electronic organ builders it has been more attractive to provide their instruments with a great variety of sounds, frequently imitating instruments such as violins, clarinets, oboes, etc., rather than copying the organ-pipe representation of these sound characters. Some organ pipes such as the harmonic flute, viole celeste and bourbon in the higher-pitch ranges are almost impossible to reproduce. In some cases it's a lot easier to reproduce the sounds made by the original instruments. Acoustic coupling enters into the picture, for a moving column of air is an entirely different thing from an almost flat diaphragm transducer.

It is probably due to the attempts to reproduce music from instruments that almost universally a tremolo has been adopted for electronic organs, a characteristic never found in a pipe organ. That and economics, although some manufacturers such as Allen with the whirling speakers, will spend a good deal of money on their vibrato. The fact that a tab or stop reads tremolo or tremulant does not mean that it is necessarily so.

It is not the purpose of this article to discuss the merits of vibrato vs. tremolo. However, if you are sensitive to the thought that perhaps Bach and Mendelssohn may be turning in their graves when they hear, respectively, some of their chorale preludes and some of the slow movements of an organ sonata played with a juicy vibrato, you may enjoy the thought that a simple inexpensive electronic tremolo is at hand.

Vibrato is produced by varying the pitch or frequency of a note, as the violinist does by wagging his finger on the string. In electronic organs it is most frequently produced by introducing a variation in the plate supply to the oscillators.

Tremolo consists solely of an amplitude variation and, in a pipe organ, is produced by mechanically driven bellows which modulate the air supply to the pipes. The tremolo in a pipe organ is almost never severe enough to cause Doppler side effects; when it is the result is rather horrible because the pipes will be for fractions of a second

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overblown and underblown, producing undesired transients.

No vibrato circuits are shown here because many electronic vibrato circuits have been published in Radio-Electronics, particularly in the series of articles on electronic organs by Mr. Richard Dorf (July, 1960—September, 1965).

If the object is to build an electronic organ which produces music as does a pipe organ, there will be a number of pipes which virtually never get a tremolo. These include the 32- and 16-foot bourdon, 32- and 16-foot contra bass, 32-foot open diapason, the bombardes or the diaphones. Some of these would function very erratically or not at all if supplied with modulated air.

Thus a tremolo circuit should be sufficiently selective to provide tremolo only where it is desired. Such a circuit need not be complicated nor need it require a complicated bus arrangement to separate the various footage stops.

The first requirement will be a reliable low-frequency oscillator with excellent waveform. Even an apparently minor distortion may produce as part of the tremolo the very undesirable "plop-plop" heard even in some of the poorest below tremolos. The circuit chosen by me is shown in Fig. 1.

The tremolo circuit

The oscillator (Fig. 1) has provisions for four different frequencies from 4 to 8 cycles and an "off" position. There is a stepped volume or "depth" control, a frequency "preset" control and a series of switches to provide the tremolo on the desired stops. Tentatively the selection on my organ will be tremolo on the 4- and 8-foot swell stops and the 4- and 8-foot great stops. This may not be the best arrangement and it is certainly only one of many possible ones. Also shown is a master switch which will put tremolo into all stops except for the pedal clavier. These were purposely excluded for the reasons mentioned above. Future expansion of the tremolo section will be easy—it will only require addition of switches and modulators. All switches are s.p.d.t. except the master switch which is five-pole double-throw and so arranged that the lines to the modulators are grounded when not in use.

The oscillator should have a separate power supply or be well isolated from the power supplied to the rest of the organ by a low-reactance filter. This prevents undesirable coupling through the power supply.

The oscillator drives the modulators, one of which is shown in Fig. 2. It consists of a cathode follower coupled to a low-gain amplifier. The gain of the amplifier section with the values shown is about 3, with or without tremolo. The amplifier could be used as a booster or preamp, depending on its location in the circuit. Or the overall gain may be reduced with the volume "preset" control. The amplifier grid receives the signal from the tone buses, oscillators or formant filters and reproduces at the plate the signal with tremolo. Fig. 3-a shows an oscillogram of an 80-cycle note with 6-cycle tremolo. Figs. 3-b, c, d, respectively, show 125-, 250- and 1,000-cycle signals with 6-cycle tremolo. In all of these cases the tremolo has purposely been exaggerated for illustration. In actual use a 15–20% modulation will give a full tremolo and as little as 5–10% modulation is noticeable. The distortion of the low-frequency modulating voltage in these oscillograms is the result of nonlinearity in my oscilloscope sweep circuit and vertical amplifier at 6 cycles.

The circuit of the modulator is simple, compact and inexpensive. It is not frequency-sensitive over the range of

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**Fig. 3—Notes with 6-cycle tremolo**

3-a—80 cycles

3-b—125 cycles

3-c—250 cycles

3-d—1,000 cycles

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**Fig. 4—Block diagram shows tremolo oscillator feeding two modulators.**

**Fig. 5—Tremolo oscillator can feed several modulators without strain.**

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frequencies dealt with in organs and considerably beyond that point. No serious alterations of waveform occur and the tremolo oscillator output is not significantly loaded even by a number of them. Even a fair number of the modulators would cause no great strain on the organ builder's budget. As shown in the typical block diagrams (Figs. 4 and 5) they could be used in many different combinations with other organ circuit units.

By using a separate modulator, for example, for 4-foot reeds and flutes, 8-foot reeds and flutes and a common one for all strings, one could perform with a tremolo in a solo part and no tremolo in the chorus and base, and produce very realistic organ music.

Fig. 6 shows my tremolo control panel on one end of the console. Figs. 7 and 8, respectively, show the rear and bottom of the oscillator chassis. The peculiar shape of the chassis was caused by the available space in the console. The Westinghouse 55C 55-volt panel lamps (one G-E 236/5 115-volt 3-watt indicator lamp may be used instead) are mounted on a piece of heavy fishpaper. By cutting in the paper an 1 slot, about ⅛ inch long and ⅝ inch wide and bending the flaps, these slide-base lamps can be held in place and the connections soldered. The fishpaper can then be mounted as any mounting board.

**Parts for tremolo oscillator**

- Resistors: 1, 1, 2 ohms, 4, 4, 4.7 ohms, 6-10,000 ohms, 1-22,000 ohms, 3-47,000 ohms, 6-100,000 ohms, I-220,000 ohms. 1/2 watt; 1-1,000 ohms, I-10,000 ohms; 5 watt; I-20,000 ohm potentiometer.
- Capacitors: 2-0.25, I-1 uf; 200 volts; I-46 pf, 350 volts, electrolytic; I-125 pf, 450 volts, electrolytic.
- Switches: 1-2-pole 3-position rotary; 1-1-pole 3-position rotary; 4-pole 5-position; 1-5-pole double-throw.
- Miscellaneous: 1-6AK5 and socket; I-6AQ5 and socket; 3-lamps, Westinghouse 55C or G-E 236/5115-volt, 3 watts; I-chassis; power panel; I-power supply socket; I-output socket.

**Parts for tremolo modulator**

- Resistors: 1-600, 1-12,000, 1-17,000 ohms, 1-500,000 ohm potentiometer; I-6-il uf capacitor; 1-1,700 uf capacitor; I-170UF and socket; I-chassis for modulator.

As shown in Fig. 4, the use of tremolo does not in any way interfere with vibrato applied to the basic oscillators. Thus if vibrato is desired as well, it can easily be applied. Conversely, an existing organ with vibrato only can easily have this pipe-organ-like tremolo added. For some really weird effects both could be used together.

The injection of tremolo must always occur ahead of the "swell" pedals. The control of volume must control the modulated signal since otherwise the depth of tremolo would vary with the volume. Since the swell pedal is most frequently used to control the final amplifiers or preamplifiers, this criterion is easily satisfied.

Although the modulator (see photos) was especially developed for use in electronic organs, it has already proven useful in other applications. One of these is the amplification of very low-frequency signals in a carrier-type amplifier.

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Fig. 6—The tremolo control panel.

Fig. 7—Rear of the tremolo panel.

Fig. 8—Tremolo oscillator chassis.
the excellent appearance of the Pilotrol PA-913 deluxe control unit, with its similarity to a broadcast console (see photo), will no doubt have a tremendous appeal to the audiophile who wants the most complete control and versatility, and the performance will not disenchanted. The only thing I have found to criticize is the distortion at low levels which—though about average for control units—is considerably higher than that of the Pilot AA-904 amplifier with which it might be used. All other characteristics are excellent and some features are unique. The response in the "flat" position is flat from 20 to 20,000 cycles and the really nice thing is that it remains commendably flat at various settings of the volume controls.

The dashed lines in Fig. 1 give the response at successive -10-db volume levels as the control is turned down (loudness control in maximum position). The high-end response is flatter at the 25% point (where it is most likely to be in home use) than at higher levels. This is because no fewer than four volume controls are frequency-compensated.

The solid curves give the loudness contours, again in 10-db volume steps. There is no switch to disable the loudness control but none is needed. Instead there is a "separate volume" control. If the loudness control is turned to its maximum position and the volume controlled with the volume control only, there will be no loudness compensation. However, various combinations of the volume and loudness controls can provide a very wide range of loudness contours at any volume level.

Fig. 2 gives the tone control curves. The bass control is particularly satisfying because it provides for a sliding turnover point so that, for example, a moderate amount of boost can be applied below 100 cycles with very little effect above it. The treble control, however, is of the hinge type. Still the compensated volume and level controls and the excellent loudness control make the treble control all but unnecessary. The only use I found for it was to compensate some types of prerecorded tapes, which unfortunately still vary widely in their recording curves. The hinged treble control is better for this purpose than the sliding-turnover type.

The preamp-equalizer is the most satisfactory commercial model I have ever used. It provides 26 combinations of bass turnover and treble slope. Furthermore, as Fig. 3 shows, the equalization is highly accurate. It is easy to hear the difference when either the turnover or treble slope is changed. A calibrated potentiometer provides the proper load for any pickup. A low-noise pentode is used in the input stage (Fig. 4) and d.c. is applied to the heaters of the low-level stages. This, with excellent hum filtering, produces a noise level so low that at normal home listening levels it amounts to a complete absence of noise. Equalization is controlled by pushbuttons which change the constants of an interstage bypass network. The 0, 8, 16 and 20 treble buttons indicate the attenuation in db at 10 kc. The bass button marked 800 is for an 800-cycle turnover.

There is a microphone channel with a separate preamp and an independent compensated volume control so the mike can be mixed with any input channel. A tape output ahead of both the tone and loudness controls provides an unequalized input if desired. If the program needs some equalization for proper balance in recording, the tape output can be shifted to a jack in parallel with the jack feeding the amplifier where it can obtain an equalized signal. These two jacks can be used also for feeding two amplifiers or an amplifier and a line.

There are inputs for tape, radio and an auxiliary. The first two have compensated level controls on the back of the chassis so that the output level of all sources can be made about the same. For my money the biggest feature of the Pilotrol is the use of pushbutton switches for the phone equalizers and...
Miracord XM 110 single-play turntable.

The Miracord XA 100 record changer.

Pilotrol PA-913 preamplifier—equalizer.

The input selector. They are not only inherently quieter than rotary switches but because only one switching action is required to choose any input or equalization, there can be only one transient at worst. A rotary switch, passing through intermediate switch positions to reach a desired one, may produce six or seven transients. In this instance no thumps or chirps are audible and a sensitive meter shows the merest trace of transients. I predict that all deluxe control units will sooner or later use pushbuttons for this reason.

The Pilotrol has an excellent db meter using an integral two-tube v.t.v.m. and one of the clever new edge-mounted segmental meters. The meter is calibrated in db with a range of +2 and -12 db. A rotary switch (the only one in the gadget) provides six multipliers and an off position. Although the multiplier uses 5% resistors I found it accurate and linear to within 1 db on all ranges. The frequency response is excellent, too, over the whole audio range. The unit is extremely sensitive—one of the lowest scale 0 db represents an output of 65 µv. The meter will be most useful to those who have recorders without meters and those who do a lot of experimenting and want to make frequency runs and other measurements. But the Pilotrol would clearly make an excellent control panel for the centralized sound system in a school, restaurant, airport, hotel or elsewhere and could even be used as a small broadcast console especially in college carrier type systems and on remote pickups for small broadcast stations.

There is a most interesting and subtle design feature to reduce even-order harmonic distortion not evident from

Fig. 4—Schematic diagram of the Pilotrol PA-913 hi-fi preamplifier—equalizer.
the diagram. The loss in the tone control network is just about equal to the gain in the half-section of the 12AX7 which precedes it. Therefore the current flowing through the second half-section of the tone control network is practically identical to that in the first section except that it is 180° out of phase. The first section produces a certain amount of distortion; the second section an equal amount. The result is that they cancel each other.

From the standpoint of hum the changer is also top notch. This is partly the result of the motor, its extremely sensitive shock mounting and isolation, the shielding and the two-wire shielded cable provided in place of the normal one-wire shield. As a changer it is extremely versatile, simple and practically foolproof. The mechanism is an extension of the principle used in the RCA 45-r.p.m. changer. All the work is done by the clever and precisely crafted spindle which holds the top records in a stack by an expanding spring while dropping the lowest one with retracting cams. Early models produced some troubles in dropping, and the new spindle will occasionally fail to drop a record if a portion of the paper label overlaps the center hole and jam up the mechanism (simply trim off the offending paper carefully with a sharp knife) or if a record is abnormally thick or thin.

Ten and 12-inch records of the same speed can be mixed without any adjustment. There is a feeler which "measures" the diameter of the record as it drops and adjusts the setdown mechanism to conform. If inserts are used, 45-r.p.m. records can be played on the same spindle but cannot be mixed, or a big-hole spindle is available as an extra. Placing the speed switch in the 45-r.p.m. position automatically adjusts the arm setdown. The changer is particularly immune from bad effects if the arm is seized or moved during the change of direction. On some changers this may result in a complete misadjustment requiring an expert to correct. Here, as far as I have been able to determine, the worst that can happen is that the changer may skip a change or set down in the wrong position. Incidentally, the nature of the mechanism is that the arm can be adjusted so that it misses the edge of a 10- or 12-inch record, it will merely hang in free space instead of banging on some part of the changer. When the last record is played, the arm comes back to rest and power is automatically shut off.

But the above by no means exhausts the possibilities. You can have two types of repeats: delayed—the record won't repeat until it has been played to the end; immediate—the arm lifts almost immediately on pressing of both the starter and repeat buttons and returns to the beginning of the record.

Furthermore, you can adjust the pause between records in five steps ranging from 5 seconds to nearly 2½ minutes in the case of 78's, and from 12 seconds to 2 minutes in the case of 45's. This should be very useful for music, music appreciation, dancing and skating teachers, and no doubt also for dancing parties in the home to permit everyone to catch a breath or find a better partner between numbers. Finally, one of the push buttons inserts a low-resistance load across the pickup to roll off highs and thus reduce scratch on records. As a recording is commenced, the resistor is cut for the G-E, but it is easily replaced. Moreover the switch itself could be converted to such purpose as changing the load when different cartridges are plugged in. Because it locks in, it will remain engaged through any variety of changing keys or manipulation of the other buttons.

The XA 100 can also be used as a single-record turntable and makes a particularly good one because there is no superstructure to interfere with record placement. The spindle is merely changed to a shorter one and no other adjustment or button pressing is needed. Incidentally, clips hold the various spindles in place when not in use. There is also a big-hole insert for use with 45-r.p.m.'s. Operation can be manipulated by simply putting the record on the turntable, one can merely press the start button. The arm will lift, the turntable will start revolving and the arm will set down in the proper place, to be returned automatically at the end of the record. Or, you can put the arm down by hand at any point on the record except the final inch or so where the trip mechanism is difficult to circumvent even if one tries to sneak up on it. If you want to repeat a record over and over while practicing a dance, you merely turn the short spindle upside down.

Despite all this rather awe-inspiring versatility the mechanism is surprisingly uncomplicated, sturdy-looking and positive enough in action to appear to guarantee considerable freedom from trouble.

XM 110 single-play turntable

For those who do not care for a changer, Miracord offers a single-play turntable (see photo) with many of the fine qualities of the changer. The rumble, noise level and wow are also extremely low. The same speed switching method is used and neutral positions between all playing speeds disengage the idler. Operation is manual. After putting the record on the table you simply pick up the arm, move it slightly to the right—engage the needle and set it down on the record. At the end of the record the motor is turned off. Very simple to use, it would be especially useful when children use the hi-fi outfit. The plug-in heads for the cartridges are the same as those used in the changer and will accommodate just about any cartridge with ¼-inch mounting centers. Needle pressure is adjustable as in the changer.

Both changer and turntable use a record on a spindle with cover which should provide a minimum of transfer of dust and dirt from mat to record. A sensible feature is that the mat is easily removed and washed. Both
The changer and turntable are very easily mounted and in a very compact space. The distributor also offers inexpensive but handsome fabric-covered boxes already cut; it takes some 10 minutes to put either outfit together. The German manufacturer deserves commendation for the very clever method of packing these instruments and for providing a packing chart, a useful feature for those who have to move often.

New records review

Note: Records below are 12-inch LP and play back with the RCA curve unless otherwise indicated.

The Sounds and Music of the RCA Electronic Music Synthesizer

RCA-Victor LM-1922 experimental

This may become a historical recording, the first expression of what could well be a radical revolution in music and sound. But whether it is or not I think everyone interested in either music or sound will find it entertaining and it would be valuable for any discussion-provoking item in any hi-fi concert.

The sound both of the jacket and one of the records in the series is similar to that of the original exponent of new music. The technical quality of which the record would be much more impressive if the disc were labeled. The RCA Family (about 10% of which will not attract to summarize except to say that this is the first recorded example of completely synthetic music, produced by the RCA Laboratories in almost measurable detail by any performers and direct, as it were, from the pen of (in this case) an engineer. There is some questionable inaccuracy in this bi-polar view except the clear indication that the best of it would have been impossible without the developments in audio produced by the high fidelity engineers; the music itself is noteworthy mostly for its mechanical quality. Many an audioophile will find it helpful for its logical analysis of the elements and components of music and how they are combined to produce a given tone or effect.

Sound of Frequency

A Test Record with notes by Peter Bartok

Folkways FPX-100

A must usefull addition to available technical test records with some absolutely unique material including a palette of 100- and 1,000-cycle square waves and a novel and simple intermodulation test.

Side 1 is recorded at 78 r.p.m. but can be played with either 1- or 3-mil needles. It is recorded with a 500-cycle crossover and flat treble response from 15.6 to 22,000 cycles.

Optical examination of the record is excellent flat and even the 22.5-3 cycles is captured solid throughout. Unfortunately, the response of LP cartridges when played back at 78 r.p.m. is not accurately representative of the response at 33 r.p.m. and the run is not as useful as it might be. However, the increased speed will exaggerate any peaks and irregularities and will also provide fairly valid side-by-side comparisons of different cartridges or keep track of the performance of one cartridge over a period of time. Side 2 also promises excellent performance, but turntable tracking is very disappointing by offering identical frequencies on the outermost and innermost bands. A test of loss of over 6 dB will indicate either a poor needle or poor tracking or both. Finally, this record shows how much the three standard pitches for A—440, 435 and 416. These can be used to check a turntable's speed against a pitch pipe, tuning fork or accurately tuned piano or the audio tone of WWV and also to adjust speed for proper pitch if the turntable has an adjustable speed. Many agree that the better pickups do an extremely good job of reproducing them although there is always a range. A pitch pipe at 16 cycles is at least partially recorded. Aside from a measure of transient response and stability these give a quick look at the frequency response.

There are two bands for checking IM: a 15 kc wave and an 8-kc wave both amplitude-modulated by 60 cycles. If the system is completely linear and neither side of the envelope is rectified, the ear will have no trouble following the sound wave. The only reason that the ear hears nothing when a r.f. wave modulated with a sound wave is fed into an amplifier is that the individual tones on the two sides are out of phase and as long as both sides are passed without distortion, cancellation occurs. But if the distortion is caused by rectification or distortion the modulation will become audible to some extent. I have some reservations about the sensitivity of the tone for the quick check of transient. My quick and perhaps inadequate checks appear to indicate that the distortion has exceeded 9% before it is evident in the sharp ear and 15% before it is all obvious. But, though this may limit the usefulness of the bands for absolute measurement, there is no possibility of reproducing music intended to show that the Bartok curve is superior to both the ancient 78-r.p.m. and RIAA curves. This is a fair test away from the usefulness but the first band will show a good check of tonal balance of 78-r.p.m. equalizers and the RIAA or RIAA equalizers.

La Danza

Carmen Dragon and Hollywood Bowl Orchestra

Capitol P-8314

A top-notch demonstration and showoff recording with eminently sharp and clean highs, not especially notable bass but a nice presence and liveliness despite the fact that it was recorded in a great hall. My favorite band will please all but the most blase includes the Mexican Hat Dance, Tico-Tico, Sibenio, Czeczotka, Lindo and Amerindian dances in lus orchestations. Played moderately loud on a good system it will produce a highly satisfying and impressive example of the worth of high fidelity.

Folk Songs of the New World

The Roger Wagner Chorale

Capitol P-8324

I recommend this as possibly the best showoff or demonstration of choral capabilities of high-fidelity recording. Many of the voices is startling although a little artificial since it represents what the conductor rather than an audience would define as a limitation on vocalists which will please all but the most blase includes the Mexican Hat Dance, Tico-Tico, Sibenio, Czeczotka, Lindo and Amerindian dances in lus orchestations. Played moderately loud on a good system it will produce a highly satisfying and impressive example of the worth of high fidelity.

PROKOFIEFF: Sonata in D Major, Op. 91

HANDEL: Sonata No. 4 in D Major

VITALII: Chasseon

Nathan Millstein, violin with piano accompaniment

Capitol P-8315

The music is not at all likely to appeal to anyone not a fiddler or connoisseur of violin music, but the recording possesses an incidentally test value for those who do like the music. Capitol in these Millstein disc has been doing a fine job reproducing the fiddle in all its rosiny resiliency when heard close up. Improper equalization or a peak in the treble or harmonic structure, however, producing an unpleasant shrillness with a boost or peak and an unnatural mellowness when rolled off. The disc is very useful for quick checks on pickups, equalizers, poor needle condition, etc.

BIZET: L'Arlésienne Suite

FAURE: Pelléas et Mélisande

Orchestra and Radio, conducted by Le Conte

Capitol P-8311

Very felicitous recordings of these popular works with a nice liveliness, excellent definition and very clean except for a touch of stridency in the violin and distinct lack of the Pelléas. There are excellent, drums in the Paradisal de l'Arlésienne whose complexity makes for an excellent and quite audible distortion. The Pelléas has an excellent string bass and its Siediensse one of the loveliest melodic tunes in the whole show. I am inclined to cut the extremities of the range, especially the last the portion of the record.

STARGUTT ENCores

Hollywood Bowl Orchestra

John Barnett, conductor

Capitol P-8296

This is almost as good demonstration material as Capitol's Studies of the First Million and turntable fidelity is not as good as on those specially cut discs but the music here covers a wider range of effects. The performance is obviously more proper in this classic side of the Studies. The selections are: Ponchielli's Dance of the Hours, Liszt's Second Hungarian Rhapsody, Tchaikovsky's Andante Cantabile and Marcke Slave (quite spectacular), Saint-Sen's Danse Macabre and Offenbach's Opernle in the Underworld.

BACH: Partita No. 2 in D Minor

Sonata No. 1 in G Minor

Nathan Milstein, unaccompanied violinist

Capitol P-8298

Capitol gives us another startlingly realistic recording of the violin in the expensive bands of his. Though they are almost never used the peculiar low-frequency transient produced as his fingers release the strings, here, especially in the theme of the Partita, these transients are beautifully reproduced. The presence is phenomenal; Milstein appears to be right at your side.

RIVERBOAT SHUFFLE

Preacher Ben and His Five Saints

MGM E-220 (10-inch LP)

Very good revival Dixieland and sounds good on his systems. Just about worth the price alone is the Blues, a selection of slow blues in which a piano, tuned for a chime tone, backed by a bass bowed in its lowest register to imitate the best notes produced when several bells are rung, produces a beautiful and novel effect. The other selections are Riverboat Shuffle, Maskat Revels, Livery Stable, Tap Me, Jazz Me and Royal Garden Blues.

LATIN AMERICAN DIXIELAND

Panama Francis and his Dixie Don

MGM X-1128 (extended play 45 r.p.m.)

A novelty for aficionados of Dixieland, consisting of the rhythm of some kind of Caribbean music, these two are in keeping with the original. The bass is excellent—extremely fine for testing speaker response if you play it at 33 instead of 45 r.p.m., which incidentally results in fairly acceptable music. There are four selections: Beale Street Blues, Panama, Dead End Blues and Fiddity Foe.

BELL RECORDS

You may have noted in your corner druseter or newstand a bank of 7-inch recordings at the low price of 35c each and labeled Bell and distributed by Pocket Books, In. In case you've wondered if they're worth the money, I can assure you that they add a great deal of music interest in them except that the voices often have a pleasantly closeups naturalness. For the most part they are vocal renditions of parlor tunes. Technically they are of considerable interest because they are available not just 78-r.p.m. with the big hole, but also in 78-r.p.m. microgroove with the small hole, a type of recording better than any other. If you use microgrooves, I recommend them over the 45 r.p.m. The quality seems to be slightly better at both extensions of the range, especially in the extreme portion of the record.

NAME AND ADDRESSES OF MANUFACTURERS OF ANY DEVICES menioned in the tests of noise performance by writing Monitor, Radio-ELECTRONICS, 25 West Broadway, New York 7, N.Y.
Electrostatic Speaker  
Electrostatic radiator, made by Janszen Labs, is not only a tweeter but operates efficiently at frequencies down to 500 cycles. Speaker consists of four radiator units, placed to disperse sound. Photo shows a complete speaker with four radiating sections, which look like the unit in the insert.

Circuit Connections  
Corrosion-resistant, solderless connections which are expected to provide trouble-free joints for the whole life of the equipment on which they are used are made by a new machine developed by Bell Laboratories. The connections are made by wrapping six turns of wire around rectangular terminals. The wires bite into the terminals, with a pressure of about 15,000 pounds per inch at each contacting area. Photo above shows a board wired by the new method compared with a conventional wiring job. Inset shows how the wired connections look, and the arrow points to one of them. The Bell machine is programmed with a tape and can wire up a whole circuit board of the type shown above, stripping insulation from the wire ends, wrapping them around the correct terminal, then proceeding to the next as instructed by the tape. The method has also been used with hand-controlled tools.

Electronic Organ  
The organ at the right was conceived, designed and constructed by H. Meijer, Jr., of Amsterdam, Holland, who has followed the articles on electronic music in this magazine with great interest, and to which he gives credit for inspiration and a great deal of help in the details of design. Mr. Meijer informs that in his latest modification the two speakers now visible have been removed.
Hi-Fi Do It Yourself

Enterprising owner of the Audio Repair Service, Miami, Fla., found a way to cash in on the “great deal of free information” he was called on to provide customers building their own audio equipment. Facilities and tools are provided and advice given the audio constructor at a fee which the builder considers nominal and which turns the former liability into a profit. “Any type of audio service work may be undertaken in our shop, even cabinetry,” says Vic Rondel, the owner. “Work is supervised to a successful conclusion and the cost remains nominal. Local hi-fi dealers look on the idea as a means of promoting sales, and it even proves a stimulus to our own service work.”

Japanese Transistor Portable

New Nipponese five-transistor radio compares very favorably with American receivers of similar size. It has two i.f. stages, two audio stages, converter and uses two diodes for detector and a.g.c. Maximum output is 100 milliwatts, and output at 10% distortion 50 milliwatts. The power supply is four penlight cells (6 volts). Either a 2½-inch dynamic speaker or an earpiece can be used. Transistors are made under Western Electric license, and the company, Tokyo Tsushin Kogyo, is putting out a class-B seven-transistor model at an early date. The seven-transistor job is rated at 100 milliwatts maximum output and 50 milliwatts at 10%, using a class-B output circuit.

Miniature Radio—at Last

A buttonhole-size FM radio is announced by Glen Ecker, California inventor. Hardly a cubic inch in dimensions, this little FM receiver actually does pull in stations. Performance is not to be compared with that of larger sets, but is surprising for one subminiature tube. With a pair of headphones in place of the single earpiece, the reception can be said to be on the entertainment level. The set uses a superregenerative circuit, and detection is by the slope method, in which the set is tuned slightly off the signal to be received. Tuning device is a compression-type mica trimmer capacitor. The power supply is a penlight A cell and a 30-volt battery, which are mounted on the plastic tile shown in the photograph above.

Biggest Heathkit

This job is an analog computer in kit form for use of schools, laboratories and research organizations. The kit will sell for around $750, contains 6,000 parts, 65 tubes, 5 relays and 35 diodes. Extending the principle of the sliderule to the log-log power, it is expected to be a valuable means of training future engineers and to permit universities and small industries to investigate projects previously impossible because of the length of time required to make the computations.
THE printed circuit shown in Fig.
1 was made in my own laboratory.
Any electronics worker—profes-
sional or hobbyist—can make his
own printed circuits in the same way
without any special industrial equip-
ment and without any more space re-
quirement than needed for ordinary
chassis work. The circuit of Fig. 1 is
a tone generator panel for Schober
Electronic Organ kits. Instead of
spending perhaps several hundred dol-
ars on professionally made samples
to determine the correct final design,
the panel was made in my laboratory
at a total investment of perhaps $25 in
equipment and materials and an indi-
vidual cost for each experimental
panel of much less than $1.
Almost any electronic device pro-
duced in any kind of quantity can be
made more cheaply with etched circuits
because of the vastly shorter time re-
quired for assembly. But aside from
low cost in production, printed circuits
have advantages appealing to any
user, even the amateur and hobbyist
who may make only one or two of a
particular gadget. No other electronic
construction lends itself to easier
trouble shooting and servicing. All wir-
ing and component leads are immedi-
ately accessible for test and measure-
ment. To replace a component or lift
one end from the circuit to measure
its resistance or capacitance, it is
necessary only to apply a soldering
iron briefly to the proper solder blob
and lift the component. The capacitor
or resistor is not damaged by this op-
eration and can easily be replaced by
simply pushing each lead through its
hole and again applying the soldering
iron.
Very often printed-circuit devices
are more compact than those with ordi-
nary wiring. Tie points and terminal
boards are not required. Wiring is neat
and orderly so that such factors as
interwiring capacitance are fixed and
predictable. The panel can be marked
with the schematic symbols for the
components so that each can be lo-
cated quickly—note the R and C num-
bers in Fig. 1—without a single extra
operation.

The industrial procedure is to make
a drawing of the required circuit in
ink (though several firms now make
available the necessary lines and dots
which can simply be stuck down on
drawing paper without using any ink).
The drawing is then photographed to
make a negative. The negative is pro-
jected onto a foil-clad panel coated
with a light-sensitive acid resist. Those
areas struck by light harden and re-
main while the rest washes off in the
developing. The panel is then immersed
in acid which eats away the foil not
protected by the hardened resist.
This process is by far the most prac-
tical for any printed-circuit work. It
can be carried out for small quantities
—even for single panels—in any work-
shop or laboratory at very low cost
and without any special training or
equipment, even to the making of the
negative from the drawing.

Making the drawing
The first procedure is to make the
drawing. It should be in ink on a good
grade of drawing material such as
Bristol board. Use India ink. Beauty is
a matter for individual esthetics, the
important items being schematic cor-
rectness and such small points as mak-
ing sure the lines are wide enough—
1/16 inch is enough for almost any-
thing—and have enough separation,
1/16 inch also being a good minimum
figure. A line this wide will carry
enough current for any normal chassis
use, including filaments.

Provide a ground bus if one is re-
quired. A good trick is to carry it to
at least one point where the screw or
branch fastening the panel to the
metal chassis, if any, will make ground
automatically. At each point where a
component or other lead is to be con-
ected to the panel make a pair of
concentric circles, the inner about 1/32
inch in diameter and the outer around
3/16. Then fill the space between the
two with ink, obtaining the connection
dots seen in Fig. 1. Fig. 2 is the origi-
nal drawing from which the tone gen-
erator panel was made. If any holes
for mounting or such purposes are to
be made in the panel, draw two con-
centric circles at the spot, the inner
always about 1/32 inch and the outer
the size of the final hole. The small
circle serves as a center for drilling;
the foil circle will be raised and will
guide the drill automatically, just as a
center-punch mark does in a metal
chassis. It is very often useful to mark
the panel extensively. Letter com-
ponent symbols, B plus and ground
identification, input and output points,
etc., on the drawing, either by hand
or with lettering guides. These will be
reproduced on the final piece in the
form of foil just like the circuit lines.
They will conduct, so make sure they
will not interfere with circuit opera-
tion.

Making the drawing requires thought
in layout so that the circuit will be
compact, yet complete. Usually it is
necessary to make several pencil draw-
ings as trials before obtaining a satis-
factory scheme. When the final pencil
drawing looks good, fasten it on top
of the Bristol with drafting tape. Then,
using the finest-pointed tool avail-
able—usually the steel point on the
nonbusiness-end leg of a drawing com-
pass—prick holes through the penciled
paper into the Bristol. When you re-
move the paper, the Bristol will have all connection points marked by the pricks and you will then simply draw the dots and connecting lines in the proper places by referring to the pencil drawing. Do not make the pricks too deep in the Bristol board as they may then appear dark; you want light dots in the middle of the black connection dots for drill guiding in the finished piece.

Before going further, clean the drawing where necessary with white. Perhaps the best white to use for this purpose is a new product called Snopake, a 1-oz brush-cap bottle of which, plus some thinner, can be obtained for $1 from Fototype Corp., Chicago 13, Ill. Snopake may be brushed over any unwanted ink marks and allowed to dry for a few seconds. It is quite opaque and when used to correct errors it can be inked over without any difficulty. Rich Art moist water color, No. 14 poster white, or a similar product, is also suitable for opaquing ink marks but is harder to use and cannot be inked over. It may also crack and flake, which Snopake will not do.

Making the negative

A photographic negative must now be made from the drawing and it will be used to expose as many panels as may be desired. In commercial quantity work it is usually desirable that the drawing be three or four times the size of the finished panel; the negative is made in reduced size by a copy camera so that small inaccuracies disappear. However, if any care has been taken in making the drawing—and especially if mere appearance is not of the highest importance—the drawing may be made the same size as the panel. If it is, no camera need be used.

Whatever the size of the drawing, one easy, though not necessarily cheap, way to make a negative is to hand the drawing to a local photographer or photocopier and have him photograph it with a copy camera. If you do this, be sure to tell him to make the negative on film, not on photostat paper, and insist several times that he measure the focused image on his ground glass very carefully to see that the negative size will be right. You may indicate outlines on the drawing either by an inked border or by a right-angle mark at each corner.

If you are interested in doing the whole process yourself or if you may have occasion to do more than one kind of panel and want to save money in the long run, you can make the negative yourself—provided the drawing is the same size as the printed panel is to be. To do this you will need two kinds of Kodak film plus ordinary photographic developer and fixer, and a simple exposing system.

The first step is to transform your drawing, on opaque board, to black lines on a translucent medium. For this Kodak Autopositive film is easy to use. It, together with the other Kodak products mentioned in this article, may be obtained at any Kodak outlet which sells industrial products. If you are in a small town without such an outlet write to Eastman Kodak, Rochester, N. Y., for information about where to buy.

The Autopositive film comes in cut sizes. Choose a size large enough to cover any future printed-circuit panels you may want to make. To expose it you can use any ordinary vacuum frame or print exposure device accessible to you. The light must be yellow. With ordinary light sources you get the yellow by placing Kodak yellow sheeting between the light source and film.

You can, if you like, make a simple light box (Fig. 3). This is a wooden box with several gold-colored fluorescent lamps in the bottom and a sheet of glass on top. There is a flat board hinged cover with a thick sheet of foam rubber cemented to it. When the cover is down and locked, the foam rubber presses the materials together so that good contact prints are obtained. Using the gold fluorescents makes yellow sheeting unnecessary. This same box, incidentally, can be used for making Autopositive paper prints from drawings, letters and the like.

A third and even simpler setup is just a sheet of heavy glass and a table with a lamp suspended above it. This is just as good, provided the drawing is not so large that the light at the edges will be much less than in the center. Raising the light higher will offset this condition.

To make the print, arrange the materials as shown in Fig. 4. The emulsion side of the film is the gray side. This process gives a reflex positive, with light values the same as in the original drawing. The light passes through the film without affecting the emulsion. It is then reflected from the white parts of the drawing onto the emulsion, but not reflected from the inked parts. With Autopositive film and paper, unlike ordinary photographic media, the emulsion turns white or translucent where lightstruck and goes...
black where there has been no light, except the translucent film. Be sure the materials make good, flat contact at all points so that there will be no image blurring. If the job is done just with glass on a table top, use glass at least 3/16 inch thick so that its weight will press the materials flat. (The glass goes on top of the yellow sheeting.) You can use a Photoflood lamp to give quicker exposures. The exposure time will vary, depending on the type of lamp and the distance, but it will usually be several minutes. To test, use small strips of film until the proper time is determined. The developer should show dense black lines but the white will usually not be pure white, which does not matter. Strive for the biggest contrast.

Almost any developer can be used. Ordinary paper developer does not, however, give particularly good contrast. Kodagraph developer is satisfactory, but Kodalith developer gives even better contrast and is ideal. Use a glass or enameled tray for the developer and fixer. (For details of the art, study the manufacturers’ instructions. Ordinary Kodak Acid Fixer is fine for the second step. Let the film remain in the fixer about twice as long as is necessary for the yellowish dye on the nonemulsion side to clear. Then wash it by holding two corners and letting a stream of cold water run for a minute or so over each face of the film. Hang it up by a corner to dry.

When the film positive is dry, the film negative can be made. Almost any type of film can be used, but one which is very slow is better than the usual fast film. I use Kodalith Transparent Stripping Film simply because it’s around for other purposes. Like almost all films except Autopositive it requires a darkened room (the room need not be light-tight and very small amounts of light can be admitted from another room). With Autopositive film or paper ordinary room lights can be left on, though the film or paper should be handled with emulsion down or away from the lights to avoid more exposure than necessary.

To make the final film negative, arrange the materials as shown in Fig. 5. Viewed from the emulsion side the Autopositive film positive will have a reversed image, and the same should be true of the negative. With even slow films the exposure will be very short. And if the same light source used for making the positive is employed, it may be necessary to intersperse something between light and materials to reduce the exposure. A sheet of typewriter paper without any flaws will work well. With the light box of Fig. 3, for instance, a 4-minute exposure is required for making the Autopositive film but the shortest possible flick of the switch is enough to make the negative. Even then a sheet of typewriter paper must be placed between the light and the Autopositive to prevent over-exposure.

One other possibility should be mentioned. It may be desirable to make a printed panel from a drawing larger than the final desired size. One way to do this without having the negative made outside is to have a glossy positive photostat of the final size made from the drawing. (This usually costs less than a dollar.) The photostat is sufficiently translucent if on ordinary paper to take the place of the Autopositive film in Fig. 5. Use it, however, with the emulsion side against the final film so that the film will have a reversed image. The bad point about photostats or any part of the process using photographic paper is that the paper will not hold its size and shape. The photostat method should be used only if exact finished size does not matter. Film holds its size well—though not perfectly—over a period of time.

Whatever film is used should be developed in whatever developer is recommended, using the highest-contrast procedure. Kodalith is good for stripping film as well as Autopositive. The finished film negative must have clear transparent lines (representing the conducting lines which will be left in metal on the finished panel) and be dense black in the areas which are to be etched out. Because of the high-contrast character of Kodalith Transparent Stripping Film it will give this result, even from a film positive which has gray in the “white” areas, if developed in Kodalith developer.

Remember to keep the room in which the developing is done dark. I use a bathroom, with the developer and fixer trays on the washstand. During the day a blanket is placed over the window, about 7 feet from the washstand, but at night nothing is necessary despite some light from neighboring windows. A light is left on some distance away in an adjoining room so that the developing film can be seen. As soon as it is put in the fixer, the lights can be turned on. When the negative has been developed, leave it in the fixer about twice as long as is necessary to clear the reddish dye from the rear. I judge this by holding up the film against the white bathroom tile and noting whether the white comes through the transparent areas untinted. Wash the film under running water for a couple of minutes and hang it up to dry by a corner.

TO BE CONTINUED
RACI ng signal circuits while troubleshooting is largely a matter of following the paths of alternating currents and voltages through tubes, resistors and capacitors. Tubes are easy—signals go in at the grid or cathode and come out at the cathode or plate. Resistors cause no confusion. Obviously, a resistor marked 39,000 ohms opposes signal flow much more than another marked 680 ohms.

But when signal current or voltage divides between a resistor and a capacitor, which way will most of it go? The answer isn't always easy. How a signal divides depends on the relation between ohms of resistance in one path and ohms of capacitive reactance in the other path. To visualize the relative oppositions to signal flow in capacitors and resistors, values of both should be in ohms. You have to think of a capacitor as providing so many ohms of reactance.

Although reactance is the all-important thing in two-thirds of the capacitors in a receiver, they cannot be marked in ohms for reactance varies with frequency. A 100-µuf capacitor in carrier-signal circuits of a TV tuner would have a reactance of approximately 7 to 30 ohms, depending on the v.h.f. channel received. Were the same capacitor put into audio signal circuits its reactance would be 300,000 to 15,000,000 ohms, depending on the audio frequency.

Any value of capacitance may be translated into equivalent reactance by putting the capacitance and the frequency of operation into suitable formulas—but formulas are time consuming. Reactance values accurate enough for practical purposes may be read directly from the charts by laying a straight-edge at capacitance on one scale, at operating frequency on another scale, then reading reactance where the straightedge crosses the third scale.

To learn how much capacitance is needed to provide a certain reactance at a given frequency, put the straight-edge on scales for reactance and frequency and read capacitance on the third scale. To determine the frequency at which a known capacitance will provide a desired reactance put the straightedge on the known capacitance and reactance.

Figs. 1 to 4 are circuit diagrams illustrating a few capacitor applications where reactance is the important characteristic. On each diagram these capacitors (coded C) are marked with subscript letters which identify their functions: a, blocking; b, bypassing; c, decoupling; d, coupling; f, tone compensation; g, signal injection.

The following paragraphs carry letters corresponding with those for capacitors on the diagrams. All values given in the examples are approximate. Since most receiver capacitors have tolerances of 10%, with only a few as good as 5%, precise values are not called for.

The symbol X, stands for capacitive reactance.

Operating frequencies for each diagram are: audio, 100 to 5,000 cycles; TV horizontal sync, 15.75 kc; TV i.f. amplifier (average) 3 mc; TV tuner (low-band average) 70 mc; TV tuner (high-band average) 195 mc.

A. Blocking

A blocking capacitor protects one circuit, usually a grid circuit, from d.c. voltage in another circuit, usually a plate circuit. These capacitors pass sig-
RADIO

Reactance chart for 2 to 250,000 ohms.

Reactance chart for 10 ohms to 1 megohm.

C. Decoupling

Capacitors for decoupling provide small-reactance paths between the cathode of a tube and the low sides of its screen grid and plate circuits, also between screen and cathode. Decoupling capacitors are used in conjunction with decoupling resistors marked R₄ in Figs. 1 and 2. The resistors oppose the flow of signal currents between decoupled elements and B supply circuits used also for other stages.

In Figs. 1 and 2, conditions are as follows:

\[
\begin{align*}
\text{C}, \ X, \ R₄ \quad &\text{Signal} \quad \text{Frequency} \quad \text{(µf)} \quad \text{(ohms)} \quad \text{(ohms)} \\
100 \text{ cycles} &\quad 10 \quad 160 \quad 1,000 \quad 86 \% \\
5,000 \text{ cycles} &\quad 10 \quad 3.2 \quad 1,000 \quad 99.8 \% \\
43 \text{ mc} &\quad 0.0015 \quad 2.5 \quad 47,000 \quad 99.5 \% \\
\text{Signal currents returning to cathodes pass from decoupling capacitors to ground and from ground through cathode resistors and their bypasses. Added opposition in cathode lines does not greatly affect decoupling.}
\end{align*}
\]

D. Coupling

Coupling capacitor C₄ of Fig. 2 is in the output or plate circuit of the amplifier and also in the input or cathode circuit of the detector. Signal voltages across the reactance of this capacitor are in both circuits, coupling the circuits for signal transfer. Coupling is adjustable. At 43 mc the minimum capacitance of 1 µf provides a reactance of about 3,700 ohms for maximum coupling; maximum capacitance of 11 µf provides about 330 ohms for minimum coupling.

E. Tone compensation

Blocking capacitors oppose and attenuate low frequencies more than high frequencies. A compensating effect is produced by increasing the plate load of the first a.f. amplifier of Fig. 1 at the lower frequencies, thus increasing gain at these frequencies. The effective plate load consists of 47,000 ohms in parallel with the reactance of capacitor C₄. The plate load increases when the opposition of blocking capacitor C₄ increases.

F. Voltage division

Capacitors in series divide an applied alternating voltage proportionately to the reactances. Capacitors C₃ and C₄ of Fig. 4, in series between the horizontal oscillator plate and ground, form the drive control for the horizontal output amplifier. The fraction of oscillator voltage across the adjustable capacitor is applied to the amplifier grid. It works out as follows:

<table>
<thead>
<tr>
<th>Drive C₂ of C₄ of C₁</th>
<th>Input Reactance</th>
<th>Reactance Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. 40</td>
<td>250,000</td>
<td>100</td>
</tr>
<tr>
<td>Min. 450</td>
<td>22,000</td>
<td>50</td>
</tr>
</tbody>
</table>

Many miniature tubular capacitors are rated for only 200 working volts.

Fig. 4—Simplified horizontal drive—parts not needed in example left out.

some for only 100. If a small-capacitance low-voltage unit is in series with a relatively large capacitance, the small one may get too much voltage. Should there be any doubt, determine the reactances. Then divide the larger reactance by the sum of the reactances to find the fraction of total applied voltage across the smaller capacitance.

G. Signal injection

The 1-µf capacitor C₄ of Fig. 3 allows oscillator voltage to enter the mixer grid circuit, at the same time blocking the oscillator d.c. plate voltage. Reactance at the middle of the low band is about 2,500 ohms and for the high band about 820 ohms. This voltage is strong enough that these reactances cause no serious attenuation. The very small capacitance avoids upsetting tuning of the high-frequency circuits. END

Fig. 3—Simplified oscillator circuit.

www.americanradiohistory.com
A TRANSISTOR d.c. TRANSFORMER

Fig. 1 shows basic elements of a transformation circuit, which converts the d.c. from a battery to a.c. This may be a transistor audio or ultrasonic oscillator. The a.c. is stepped up as required, then rectified. A transistor is a logical choice for d.c. to a.c. conversion because of its efficiency and small size. Voltage multiplication and rectification can be combined with a voltage doubler.

In designing a transistor oscillator, the first circuit that comes to mind is a Hartley with a center-tapped coil. A push-pull transformer is used. The tapped winding becomes the Hartley tank. The other coil is thus freed for a.c. only and for matching the impedance of the load.

This scheme did not work, the main difficulty being there is no satisfactory push-pull transformer in the price and size range desired. But there are plenty of miniature single-ended audio transformers listed in the catalogs, so one of these was used in the electronic transformer.

Fig. 2 shows the final circuit. It is a conventional audio oscillator with a capacitor isolating the secondary. This gives a series-resonant network which can step up voltage. The potential across the coil or capacitor is many times greater than the total voltage between emitter and base. To light a neon lamp I took the voltage across the 240-µaf capacitor which has been multiplied more than 10 times and fed it to the voltage doubler.

As C is reduced, the oscillator frequency rises and so does the stepped-up voltage. If C is made too small, oscillations cease altogether. A small capacitor here may also send the frequency above audibility. The base resistor is another component that may call for trial and error. The smaller it is, the greater the current through the transistor. With a CK722, the maximum flow should not exceed 5 ma. The smaller this resistor, the greater the output power. With the values shown in Fig. 2, the input to the transistor is about 3.8 ma.

After completing the instrument, it may be tested to find the optimum load by connecting various resistors across the output while measuring output voltage and current. The product of these two gives output power. The results obtained, with two type N cells as the supply source, are shown below.

<table>
<thead>
<tr>
<th>Load (megohms)</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>volts</td>
</tr>
<tr>
<td>0.12</td>
<td>17</td>
</tr>
<tr>
<td>0.18</td>
<td>23</td>
</tr>
<tr>
<td>0.22</td>
<td>28</td>
</tr>
<tr>
<td>0.27</td>
<td>30</td>
</tr>
<tr>
<td>0.33</td>
<td>32</td>
</tr>
<tr>
<td>0.62</td>
<td>40</td>
</tr>
<tr>
<td>1.10</td>
<td>45</td>
</tr>
</tbody>
</table>

Optimum power is obtained with a load of about 220,000 ohms.

The open-circuit voltage is nearly 70. Short-circuit current is about 350 µa. Maximum output power is 3.5 mw for an input of about 10 mw.

Ripple is present in this circuit, but for most applications this is not a problem. If pure d.c. is necessary, an R-C filter may be added. A large capacitor

DECEMBER, 1955
ELECTROLYSIS PROBLEM

By J. PERKINSON, JR.

WAS recently called upon to service a small twin-engine boat that showed signs of excessive salt-water electrolysis on the zinc housing anode of the port propeller shaft. A second zinc anode on the starboard side showed little corrosion. (For some reason skippers all believe electrolysis is a job for the marine radio technician.)

All metallic equipment on board was bonded to a common strap which ran to a 6-inch-wide copper strip above the water line. The strip then ran along the underside of the hull to a ground plate on the keel. I installed a second copper ground plate 1 x 12 feet on the other side of the keel and bonded its mid-section with a large brass bolt to the other ground plate. After a week of coastal fishing runs, the boat was put back in dry dock. One look told me that the extra ground plates had not improved the situation—zinc anode on the port-propeller-shaft housing was deteriorating rapidly.

Zinc anode should last for a year. This one looked like it had had its year, after one week of fishing. Zinc anodes cost approximately $8. Their function is to centralize the various electrical currents by providing a low-resistance path between the metallic components on the hull and the salt-water ground. This reduces the electrolysis action on those components and extends their life. I have seen costly propellers and shafts almost eaten away when zinc anodes were either not used or not inspected periodically and replaced.

I made low-resistance checks with a v.t.v.m. between the keel grounding plates and inside hull bonding to the engines and all metallic installations, but found nothing extraordinary. Low-resistance measurements were made to check the electrical bonding of the zinc anodes to both propeller housings and rudders, but still nothing significant could be found. The readings on the v.t.v.m. were so low that I was on the verge of constructing a very-low-resistance meter so that small resistance variations might be studied in greater detail.

Impurities in the zinc anodes, especially small quantities of iron, may cause them to become inactive after a short period in salt water. But both zinc anodes on the boat were identical and from the same supplier, so that theory was out.

The boat's ignition system was of the positive-ground type so I visited a boatyard to look at other zinc anodes to learn if this polarity ground gave more electrolysis trouble that the negative ground. The results were about even.

One old skipper told me that he had seen the same trouble many times before and the only cure was the installation of a new engine. I went back and checked and double-checked the ignition systems and all engine grounds, but didn't find anything; so I quit and went back to speculation and theory.

The skipper said that the radio had been used very little during the recent week of fishing and I dropped the r.f. current theory. But for good measure I buffed clean both copper grounding plates on each side of the keel, cleaned and resoldered all ground connections from the keel to the inside hull. I forgot to put on goggles for the keel buffing and some copper dust got into my eyes. At the end of the day, I was cussing and in general pretty miserable about the whole thing.

While the boat was out on another trip, I wrote a Government agency for technical data on boat electrolysis. It appears that very little in the way of technical information has been made available to the public. I could not find a boat handbook or a manual on the subject and was referred by the Government agency to a private concern. They appeared interested, but wanted a life history and a volume of technical information for special analysis. I figured that if I could get that information, it would not be necessary for me to have it specially analyzed as I had found a number of answers by direct tests.

My final speculation was that a battery action was being set up somewhere between the port propeller shaft and its housing, and that iron was somewhere in the system. But both shaft and housing were brass. I asked a buddy of mine who had worked on boats about the metallic parts installed in the propeller-shaft packing or water seal between the outside and inside of the hull. He said "washers are used, usually made of brass, but sometimes galvanized."

That was the answer. Inspection revealed galvanized washers in the defective area. After their zinc plating had corroded, the situation was ripe for local action. The zinc anode and iron washers formed the dissimilar plates, and the sodium chloride made an excellent electrolyte. Installation of brass washers solved that one.

END
YOUR RECEIVER
as an AUDIO GENERATOR

Need a tone generator for occasional use in the shack? If so, try this simple trick

By FRED LINGEL, W2ZGY

A SHORTWAVE receiver can be used as an audio-frequency signal generator for modulation and other audio checks merely by feeding some of the b.f.o. second harmonic back to the antenna. To do this the beat-frequency oscillator output is capacitively coupled to the antenna connection of the receiver. This can be done either by wrapping a section of hookup wire around the tube or by inserting an insulated section of hookup wire into the oscillator coil. If greater coupling is necessary because of low signal output, the antenna can be coupled directly to the plate pin of the b.f.o. through a 100-µµf capacitor. Turning on the b.f.o. or CW oscillator and tuning to or near the b.f.o. second harmonic produces a variable-frequency audio signal in the speaker.

The principle of operation is: If the i.f. of the receiver is 453 kc, and the b.f.o. is set at zero beat then the b.f.o. will generally have a very strong second harmonic at 906 kc. By coupling this signal back to the antenna terminal and tuning the receiver to around 906 kc (in the broadcast band) a signal will be heard in the loudspeaker. The frequency of this signal can be adjusted from near 0 to 20 kc or higher, depending upon the receiver components, the loudspeaker, etc. This can be done by varying either the main tuning dial or the CW pitch control.

If the main tuning dial is used to adjust the signal, the approximate frequency can be determined from the dial markings of the receiver. For example, if zero beat is obtained at exactly 906 ke on the receiver tuning dial, then at the 911-ke mark the output will be 5,000 cycles, at 916 kc it will be 10,000 cycles, etc. This is based on a 453-ke i.f., a second harmonic at 906 kc, the receiver local oscillator operating on the high side of the input signal and the CW pitch control at zero.

Similar frequencies will also be obtained when the receiver dial is tuned to the low side of 906 kc, that is to 0, 1,000, 2,000 and 3,000 cycles of audio will also be obtained at the 906-, 906-, 904- and 903-ke dial settings.

This system provides an audio voltage at a low impedance, around 5 ohms, from across the speaker coil. In addition, a high impedance, around 5,000 ohms, through a 2-pf external coupling capacitor can be obtained from the plate of the output tube. In addition to these two output impedances, an audio signal can be obtained directly from the loudspeaker. In this way sound may be applied to a microphone for an over-all response check of the audio system.

The receiver, arranged as an audio signal generator, is shown in the block diagram.

The volume control of the receiver acts as a level control. An external rectifier type a.c. voltmeter can be connected across the output to measure the approximate amplitude of a.c. voltage for audio checks. Most multimeters set to read a.c. output voltages on a lower voltage range will give a fair measure of the a.c. voltage. Higher-voltage a.c. ranges may be considerably in error because of the distributed-capacitance shunt effect across the multiplier resistors. This is especially noticeable on the 5,000-ohm-per-volt (and higher) a.c. rectifier voltmeters. If a v.t.v.m. is used to check the audio system, it should be realized that these are generally peak-reading instruments and distortion in the waveform may cause considerable error in output level readings.

This generator has served very well for modulation checks in my amateur station. While it is not a final answer by any means, it is certainly a lot better than trying to whistle a prolonged 2,000-cycle constant-level note. Too, you can send code to the Jr. Op with a key across the b.f.o. switch.

END
The MILVAMP

Amplifier extends low range of v.t.v.m.

By FORREST H. FRANTZ, SR.*

The milvamp mounted on a v.t.v.m.

MOST denizens of the electronic realm possess a v.t.v.m. Be it home-rolled, kit-constructed or factory-made, the vacuum-tube voltmeter perch on the bench of every serious technician and hobbyist, ready to provide several types of important information about electronic circuits. The standard v.t.v.m. will measure a.c. and d.c. voltages and resistance. The a.c. and d.c. ranges may be extended upward to cope with any commonly encountered high-voltage measurement problem. But the low-voltage ranges are limited. Most v.t.v.m.'s do not have a range lower than 1.5 volts; this is not low enough to make audio voltage measurements in audio amplifiers. One solution is to purchase an audio vacuum-tube voltmeter that has ranges extending down into the millivolts. Another solution not as expensive is to build the milvamp for use in conjunction with a standard v.t.v.m.

The milvamp is not a complicated device. (The name milvamp is derived from milivolt amplifier.) It is a simple two-stage resistance-coupled amplifier (Fig. 1) with inverse feedback. A single twin-triode tube is used and power is supplied by the v.t.v.m. It may be permanently connected and fastened to the v.t.v.m. without affecting its operation. To use the milvamp, the a.c. probe of the v.t.v.m. is plugged into its output jack, the v.t.v.m. is set to the lowest a.c. range and measurements may be made by reading the scales already printed on the meter face. The lowest range is .01 times the lowest range on your v.t.v.m. The lowest range on my v.t.v.m. was 1.5 volts; with the milvamp, it became .015 volt or 15 millivolts. Response was +1 db from 25 to above 30,000 cycles. The feedback could easily have been reduced to make the lowest range 0-5 millivolts without a noticeable change in response. The low-frequency response may be extended by increasing the value of the a.c. input capacitor in the v.t.v.m.

Construction of the milvamp is simple. The chassis may be a commercial type, as I used, or it may be cut and bent from a sheet of aluminum. Fig. 2 gives the chassis layout. The tube socket is mounted on a bracket. Components should be wired and soldered to the socket before mounting. Leads should be kept short to prevent hum pickup and feedback (miniature input and output capacitors are used for this purpose). The operating voltage leads should be left long enough to allow some play when the v.t.v.m. is out of the cabinet (see photo). A capacitor and resistor (shown in dashed lines in Fig. 1) were installed in the v.t.v.m. to isolate and filter the B supply for the milvamp. A small notch was cut out of the v.t.v.m. cabinet (lower left-hand corner) for the voltage supply lead grommet. Two holes were drilled in the side of the v.t.v.m. cabinet so the milvamp could be attached with self-tapping screws.

The B plus from my v.t.v.m. to the milvamp was 50 volts. Other v.t.v.m.'s may supply higher voltages. If so, the response of the milvamp will be even better than indicated because more feedback may be used (by adjustment of the feedback control). In any case,
the B plus voltage should be limited to 75 by using a large filter resistor in place of the added 10,000-ohm unit in the v.t.v.m. The effect of increasing voltage above this value would not be detrimental to the operation of the millvamp, but it might impose too large a load on the v.t.v.m. voltage divider for stable v.t.v.m. operation. My arrangement did not alter the stability or calibration of the vacuum-tube voltmeter to any measurable extent.

The voltage divider for the millvamp is a 1-megohm audio-taper potentiometer. The pot was used for simplicity and economy. Points were marked on the front of the panel corresponding to settings for .015, .05, 0.15, and 0.5 volt.

Calibration

The basic calibration is the setting of the 10,000-ohm feedback control so that the v.t.v.m. reads full scale when 1/10 of the voltage required for full-scale deflection on the lowest v.t.v.m. range is applied to the millvamp. (The 1-megohm range control is set to maximum for the adjustment.) This may be done by calibrating against an audio voltmeter or by making up a calibration circuit as shown in Fig. 3. Measure the line voltage with the v.t.v.m. Then connect the v.t.v.m. to the arm of the 2,000-ohm potentiometer and adjust it to the point where 1/10 of the line voltage is read on the v.t.v.m. Thus, if the line voltage is 115, adjust the pot for a 1.15-volt meter reading. Then disconnect from the a.c. line without allowing the 2,000-ohm potentiometer arm to change position.

Connect the potentiometer as shown in Fig. 4. Adjust the 100-ohm potentiometer for full-scale v.t.v.m. reading between the common return and the arm of the 100-ohm pot on the lowest v.t.v.m. scale. Now plug the a.c. v.t.v.m. probe into the millvamp output jack and connect the millvamp input probe to the arm of the 2,000-ohm pot. Adjust the feedback control for full-scale deflection of the meter. This procedure establishes proper amplifier gain.

To calibrate the millvamp 1-megohm range control for the 1/10 range (0.15 volt if the v.t.v.m. full-scale reading is 1.5 volts), simply rotate the control until the v.t.v.m. reading decreases to 1/10 of full scale. Mark the point on the millvamp chassis adjacent to the pointer hairline. The appropriate voltage range designation may be lettered in India ink opposite the mark. The same procedure may be used for calibrating other range marks. If you have precision resistors you may wish to use a range switch in preference to the potentiometer.

The 1-megohm range pot should be an audio taper type for easy calibration. The millvamp input lead should be shielded. Return all ground leads to a common point on the millvamp chassis and connect this point to the grounded input terminals on the v.t.v.m. If the meter needle does not return to zero when the input leads are shorted, check to be sure that the heater leads are dressed against the millvamp chassis. It may be necessary in some cases to reverse the millvamp heater connections at the v.t.v.m. Be careful to push the voltage supply leads into the v.t.v.m. cabinet where they will not short when

**Fig. 3—Simple calibration circuit.**

**Fig. 4—Adjusting the amplifier gain.**

**Parts for the millvamp**

- **Resistors:** 1—10,000, 3—70,000 ohms, 2—10 meg-ohms, ±5 watts; 1—10,000-ohm potentiometer, 1—1-megohm potentiometer (audio taper).
- **Capacitors:** 2—0.05, 1—0.1 µf, 40-volts (Aerovox P-82 or equivalent); 1—40 µf, 150 volts, electrolytic.
- **Miscellaneous:** 1—12AX7 and socket, 2—connectors (input and output); 1—chassis 1/8 x 4 1/2 x 2 1/8 inches (ICA 29079 or equivalent); 2—terminal strips.

The millvamp extends the usefulness of the standard v.t.v.m. and makes the measurement of small audio voltages possible. It may also be used as an auxiliary preamplifier for other purposes, without any changes in its circuitry.
Miniature audio oscillator serves as test instrument

Transistor Signal Injector

PROBE

By HOMER L. DAVIDSON

CONSISTING of a CK722 Radio-phon transducer, miniature interstage transformer, two small capacitors, one resistor and a hearing-aid B battery, this unit is actually an audio signal oscillator. All the small components are packed snugly in a plastic tube 5½ inches long.

At first a breadboard layout was used and various circuits were hooked up and tried before the finished product was built. A 1-megohm variable resistor was used in place of the 470,000-ohm unit R1, to bring the probe to oscillate at approximately 1,000 cycles. By varying this resistance and changing C1 different frequencies can be obtained.

The circuit (see diagram) is very simple and easy to wire. The CK722 collector is wired to the primary of the small UTC 50-3 interstage transformer. The other primary lead is soldered to the small hearing-aid battery and bias resistor. The base is connected to C1 and the resistor. The emitter is wired to one side of the secondary of the miniature transformer. If the unit does not oscillate, reverse the secondary connections. Coupling capacitor C2 isolates the injector probe from any high voltages and couples the injector signal into the circuit to be tested. There is no return or ground connection from the probe. To increase volume hold one hand on the chassis being tested while pressing firmly on the switch on the injector probe.

The 5½-inch plastic tube has a diameter of ¾ inch. It cannot be any smaller or the small transformer will not slide into it. The .01-μf capacitor, resistor and transistor were soldered together first and placed in one end of the tube. Then the miniature transformer was soldered to them and pushed in. Capacitor C2 is soldered to the probe pointer, which is a long plastic bottle cap with a 6/32 bolt fastened to one end. To hold the pointer in place a hole was drilled through the cap and tube and a 6/32 bolt and nut put through it.

The only components left to mount are the hearing-aid battery and homemade switch. Solder the bias resistor return lead to the negative terminal of the battery and push the battery in place. The battery was inserted about ¾ inch inside the plastic tube. Then the switch was soldered into place.

The switch is made of a ¾-inch diameter steel washer, a 6/32 bolt and nut, a small spring and copper strip. The small bolt was inserted through the washer and the small spring put in place. The nut was then put on and snuggled up so that the bolt would snap back into place when pushed. If the bolt is too long, saw the end off and solder over the nut so it will not come off.

The switch was soldered to the end of the plastic tube. To hold the switch in place a copper strip with a hole drilled in it was soldered to the washer and with a hot iron was pushed into the sides of the tube. Then by pressing down on the small bolt it makes contact with the top positive side of the hearing-aid battery.

The audio oscillator was tested with a small 1.5-volt penlight cell. The volume was fair but for stronger signal injections a 22½-volt hearing-aid battery was used. This transistor injector does not have a volume control but signal strength can be controlled somewhat by varying the capacitance coupling between the press switch and touching the chassis.

This transistor audio oscillator is useful in any equipment having audio trouble. In a television set the signal was injected in the discriminator stage and traced through to the speaker. Also, it can be used on shooting TV trouble in the home. The sound can easily be checked by inserting the nose of the probe into the phono jack, if one is provided. The unit can be used to check audio amplifiers and radio receivers.

You can even place the probe on a voice coil, hold the other side with your hand and hear a trace of 1 kc coming through.

END
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V-7A VACUUM TUBE VOLTOMETER: Easily the world's largest selling VTVM. Features peak-to-peak scales—etched metal circuit board—1% precision resistors—full wave rectifier and AC input circuit—reads rms and peak-to-peak AC, DC, and ohms.

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1 Heathkit ETCHED CIRCUIT
COLOR-TV
5" OSCILLOSCOPE KIT
This deluxe quality oscilloscope has proven itself through thousands of operating hours in service shops and laboratories. Features the best in components—and the best in circuit design.
Features amplifier response to 5 Mc for color TV work, and employs the radically new sweep circuit to provide stable operation up to 500,000 cps. In addition, etched metal, pre-wired circuit boards cut assembly time almost in half, and permit a level of circuit stability never before achieved in an oscilloscope of this type.
Vertical amplifiers flat within ±2 db —5 db from 2 cps to 5 Mc, down only 1½ db at 3.38 Mc. Vertical sensitivity is 0.025 volts, (rms) per inch at 1 Kc. 11 tube circuit employs a SUP1 CRT.
Plastic molded capacitors used for coupling and bypass—preformed and cabled wiring harness provided.
Features built-in peak-to-peak calibrating source—retrace blanking amplifier—push-pull amplifiers and step-attenuated input.

2 Heathkit ETCHED CIRCUIT
5" OSCILLOSCOPE KIT
This is a general purpose oscilloscope for the more usual applications in the service shop or lab, yet is comparable to scopes costing many dollars more.
Features full size 5" CRT (BPPI), built-in peak-to-peak voltage calibration—3 step input attenuator—phasing control—push-pull deflection amplifiers—and etched metal pre-wired circuit boards.
Vertical channel flat within ±3 db from 2 cps to 200 Kc, with 0.09 V. rms/inch, peak-to-peak sensitivity at 1 Kc. Sweep circuit from 20 cps to 100,000 cps. A scope you will be proud to own and use.

3 Heathkit LOW CAPACITY
PROBE KIT
Scope investigation of circuits encountered in TV requires the use of special low capacity probe to prevent loss of gain, or distortion. This probe features a variable capacitor to provide correct instrument impedance matching. Also the ratio of attenuation can be controlled.

4 Heathkit ETCHED CIRCUIT
SCOPE DEMODULATOR PROBE KIT
Extend the usefulness of your Oscilloscope by observing modulation envelope of R.F. or I.F. carriers found in TV and radio receivers. Functions like AM detector to pass only modulation of signal and not signal itself. Applied voltage limits are 30 V. RMS and 500 V. DC.

5 Heathkit ETCHED CIRCUIT
3" OSCILLOSCOPE KIT
This compact little oscilloscope measures only 9¼" H. x 6¼" W. x 11¾" D., and weighs only 11 lbs! Easily employed for home service calls, for work in the field or is just the ticket for use in the ham shack or home workshop. Incorporates many of the features of the Model OM-1, but yet is smaller in physical size for portability.
Employing etched circuit boards, the Model OL-1 features vertical response within ±3 db from 2 cps to 200 Kc. Vertical sensitivity is 0.25 V. RMS/inch peak-to-peak, and sweep generator operates from 20 cps to 100,000 cps. Provision for r.f. connection to deflection plates for modulation monitoring, and incorporates many features not expected at this price level. 8-tube circuit features a type 3GPI Cathode Ray Tube.

HEATH COMPANY
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BENTON HARBOR 20, MICHIGAN

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Besides measuring AC (rms), DC and resistance, the modern-design V-7A incorporates peak-to-peak measurement for FM and television servicing. AC (rms) and DC voltage ranges are 1.5, 5, 15, 50, 150, 500, and 1500. Peak-to-peak AC voltage ranges are 4, 14, 40, 140, 400, 1400, and 4000. Ohmmeter ranges are X1, X10, X100, X1000, X10K, X100K, and X1 megohm. Also a dB scale is provided. A polarity reversing switch provided for DC measurements, and zero center operation within range of front panel controls. Employs a 200 µ meter for indication. Input impedance is 11 megohms. Etched metal, pre-wired circuit board for fast, easy assembly and reliable operation is 50% thicker for more rugged physical construction. 1% precision resistors for utmost accuracy.

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The MM-1 is a portable instrument for outside servicing, for field testing, or for quick portability in the service shop. Combines attractive physical appearance with functional design. 20,000 ohms/v. AC, and 5000 ohms/v. AC. DC and DC voltage ranges are 0-1.5, 5, 50, 150, 500, 1500, and 5000 volts. Direct current ranges are 0-150 µa, 15 ma., 150 ma., 500 ma., and 15 amperes. Resistance ranges are X1, X10, X100, X10,000, providing center scale readings of 15, 1500, and 150,000 ohms. DB ranges cover -10 db to +85 db.

Features a 4½* 50 µa. meter. Provides polarity reversal on DC measurements. 1% precision resistors used in multiplier circuits. Not affected by RF fields.

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3 HEATHKIT ETCHED CIRCUIT RF PROBE KIT
The Heathkit RF Probe used in conjunction with any 11 megohm VTVM will permit RF measurements up to 250 Mc with ±10% accuracy. Uses etched circuits for increased circuit stability and ease of assembly.

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The Model M-1 measures AC or DC Voltage at 0-10, 30, 300, 1000, and 5000 volts. Measures direct current at 0-10 ma. and 0-100 ma. Provides ohmmeter ranges of 0-3000 (30 ohm center scale) and 0-3000,000 ohms (3000 ohms center scale). Features a 400 µa. meter for sensitivity of 1000 ohms/volt. Because of its size, the M-1 is a very handy portable instrument that will fit in your coat pocket, tool box, glove compartment, or desk drawer. Makes a fine standby unit in the service shop when the main instruments are in use, or is ideal for the hobbyist or beginner. An unusual dollar value.

MODEL M-1
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BENTON HARBOR 20, MICHIGAN

DECEMBER, 1955
The Model TS-4 features a controllable inductor for all-electronic sweep, improved oscillator and automatic gain circuitry, high RF output, center sweep operation, and improved linearity. It sets a new high standard for sweep generator operation, and is absolutely essential for the up-to-date service shop doing FM, black-and-white TV, and color TV work.

Voltage regulation and effective AGC action assures flat output over a wide frequency range. Electronic sweep insures complete absence of mechanical vibration. Sweep deviation controllable from 0 un to 40 Mc, depending upon base frequency. Effective two-way blanking.

Fundamental output from 3.6 Mc to 220 Mc in 4 bands. Crystal marker provides markers at 4.5 Mc and multiples thereof. Crystal included with kit. Variable marker covers from 19 Mc to 60 Mc on fundamentals, and up to 180 Mc on harmonics. Provision for external marker.

Heathkit LINEARITY PATTERN GENERATOR KIT

The new-design Model LP-1 produces vertical or horizontal bar patterns, a cross-hatch pattern, or white dots on the screen of the TV set under test. No internal connections required. Special clip is attached to the TV antenna terminals. Instant selection of the pattern desired for adjustment of vertical and horizontal linearity, picture size aspect ratio, and focus. Dot pattern presentation is a must for color convergence adjustment on color TV sets.

Extended operating range covers all television channels from 2 to 13. Produces 6 to 12 vertical bars or 4 to 7 horizontal bars.

Heathkit LABORATORY GENERATOR KIT

The Heathkit Model LG-1 Laboratory Generator is a high-accuracy signal source for applications where metered performance is essential. It covers from 100 Kc to 30 Mc on fundamentals in 5 bands. Modulation is at 400 cycles, and modulation is variable from 0-50%. RF output from 100,000 µv. to 1 µv. 200 µa. meter reads the RF output in microvolts, or percentage of modulation. Fixed step and variable output attenuation provided.

Features voltage regulation, and double copper plated shielding for stability. Provision for external modulation. Coaxial output cable (50 ohms).

Heathkit CATHODE RAY TUBE CHECKER KIT

This new-design instrument holds the key to rapid and complete picture tube testing, either in the set, on the work-bench, or in the charting of TV sets for shorts, leakage, and emission. Features Shadowgraph test (a spot of light on the screen) to indicate whether the tube is capable of functioning.

The Model CC-1 tests all electromagnetic deflection picture tubes normally encountered in television servicing. Supplies all operating voltages to the tube under test, and indicates the condition of the tube on a large “GOOD-BAD” scale. Features spring loaded test switches for operator protection.

The CC-1 is housed in an attractive portable case and is light in weight — ideal for outside service calls.

Heathkit DIRECT READING CAPACITY METER KIT

Not only is this instrument popular in the service shop, but it has found extensive application in industrial situations. Ideal for quality control work, production line checking, or for matching pairs.

Features direct reading linear scales from 100 mmf to 1 mfd full scale. Necessary only to connect a capacitor of unknown value to the insulated binding posts, select the correct range, and read the meter. The CM-1 is not susceptible to hand capacity, and has a residual capacity of less than 1 mmf.

BENTON HARBOR 20, MICHIGAN
This is one of the biggest signal generator bargains available today. The tried and proven Model SG-8 offers all of the outstanding features required for a basic service instrument. High quality components and outstanding performance.

The SG-8 covers 160 Kc to 110 Mc on fundamentals in 3 bands, and calibrated harmonics extend its usefulness up to 220 Mc. The output signal is modulated at 400 cps, and the RF output is in excess of 100,000 v. Output controlled by both a continuously variable and a fixed step attenuator. Also, audio output may be obtained for amplifier testing. Don't let the low price deceive you. This is a professional type service instrument to fulfill the signal source requirements in the service lab.

1. **Heathkit . . . IMPEDANCE BRIDGE KIT**

   The IB-2 features built-in adjustable phase shift oscillator and amplifier, and has panel provisions for external generator. Measures resistance, capacitance, inductance, dissipation factors of condensers, and storage factor of inductance.

   D, Q, and DQ functions combined in one control. 1% resistors and 1½% silver-mica capacitors especially selected for this instrument. A 100-100 microammeter provides null indications. Two-section CRL dial provides 10 separate "units" with an accuracy of 0.1%. Fractions of units read on variable control.

2. **Heathkit "Q" METER KIT**

   The Heathkit Model QM-1 will measure the Q of inductances and the RF resistance and distributed capacity of coils. Employs a 4½" 50 microampere meter for direct indication. Will test at frequencies of 150 Kc to 18 Mc in 4 ranges. Measures capacity from 40 mmf to 450 mmf within ± 3 mmf. Indispensable for coil winding and determining unknown condenser values. A worthwhile addition to your laboratory at an outstandingly low price. Useful for checking wave traps, chokes, peaking coils, etc. Laboratory facilities are now available to the service shop and home lab.

3. **Heathkit 6-12 VOLT BATTERY ELIMINATOR KIT**

   This modern battery eliminator will supply 6 or 12 volt output for ordinary automobile radios as well as 12 volts for the new models in the latest model cars. Output voltage is variable from 0-8 volts DC, or 0-16 volts DC. Will deliver up to 15 amperes at 6 volts, or up to 7 amperes at 12 volts. Two 10,000 microfarad filter capacitors insure smooth DC output. Two panel meters monitor output voltage and current. Will double as a battery charger. Definitely required for automobile radio service work.

4. **Heathkit DECADE RESISTANCE KIT**

   Twenty 1% precision resistors provide resistance from 1 to 99,999 ohms in 1 ohm steps. Indispensable around service shop laboratory, ham shack, or home workshop. Well worth the extremely low Heathkit price.

5. **Heathkit VIBRATION TESTER KIT**

   Tests vibrators for proper starting and indicates the quality of the output on a large "GOOD-BAD" scale. Checks both induction and self-rectifier types in 5 different sockets. Operates from any battery eliminator delivering variable voltage from 4 to 6 volts DC at 4 amps. Ideal companion to the Model BE-4.

6. **Heathkit DECADE CONDENSER KIT**

   Provides capacity values from 100 mmf to 0.011 mfd in steps of 100 mmf. ± 1% precision silver-mica condensers used. High quality ceramic switches for reduced leakage. Polished birch cabinet. Extremely valuable in all electronic activity.

BENTON HARBOR 20, MICHIGAN

DECEMBER, 1955
The Heathkit Model TC-2 is an emission type tube tester that represents a tremendous saving over the price of a comparable unit from any other source. At only $29.50, you can have a tube tester of your own, even if you are an experimenter, or only do part time service work. Extremely popular with radio servicemen, it uses a 4½" meter with 3-color meter face for simple "GOOD-BAD" indications that the customer can understand. Will test all tubes commonly encountered in radio and TV service work.

Ten 3-position lever switches for "open" or "short" tests on each tube element. Neon bulb indicates filament continuity or short between tube elements. Line adjust control provided. The roll chart is illuminated.

Sockets provided for 4, 5, 6, and 7-pin, octal, and loctal tubes, 7 and 9 pin miniature tubes, and the 5 pin Hytron tubes. Blank space provided for future socket addition. Tests tubes for opens, and shorts, and for quality on the basis of total emission. 14 different filament voltage values provided.

The Model TC-2P is identical to the Model TC-2 except that it is housed in a rugged carrying case. This strikingly attractive and practical two-tone case is finished in proxylin impregnated fabric. The cover is detachable, and the hardware is brass plated. This case imparts a real professional appearance to the instrument. Ideal for home service calls, or any portable application.

The Heathkit TV picture tube test adapter is designed for use with the Model TC-2 Tube Checker. Test picture tubes for emission, shorts, and thereby determine tube quality. Consists of 12-pin TV tube socket, 4 ft. cable, octal connector, and necessary technical data. (Not a kit.)

Use this Condenser Checker to quickly and accurately measure those unknown condenser and resistor values. All readings taken directly from the calibrated panel scales without any involved calculation. Capacity measurements in four ranges from .00001 to 1000 mfd's. Checks paper, mica, ceramic and electrolytic condensers. A power factor control is available for accurate indication of electrolytic condenser efficiency. Leakage test switch—selection of five polarizing voltages, 25 volts to 450 volts DC to indicate condenser operating quality under actual load conditions. Spring-return test switch automatically discharges condenser under test and eliminates shock hazard to the operator. Resistance measurements can be made in the range from 100 ohms to 5 meg-ohms. Here again, all values are read directly on the calibrated scales. Increased sensitivity coupled with an electron beam null indicator increases overall instrument usefulness. For safety of operation, the circuit is entirely transformer operated. An outstanding low kit price for this surprisingly accurate instrument.

This signal tracer is extremely valuable in servicing AM, FM, and TV receivers, especially when it comes to isolating trouble to a particular stage of the circuit under test. This visual-aural tracer features a high gain RF input channel to permit signal tracing from the receiver antenna input clear through all RF, IF, detector, and audio stages to the speaker. Separate low-gain channel provided for audio circuit exploration. Both visual and aural indication by means of a speaker or headphone, and electron beam "eye" tube as a level indicator. Also incorporates a noise locator circuit for DC noise checks, and a built-in calibrated wattmeter (20-500 watts). Panel terminals provided for "patching" output transformer or speaker into external circuit for test purposes. Designed especially for the radio and TV serviceman. Cabinet size: 9½" wide x 6¼" high x 5" deep. A real test equipment bargain.
Used with a sine wave generator, the Model HD-1 will check the harmonic distortion output of audio amplifiers under a variety of conditions. Reads distortion directly on the meter as a percentage of the input signal. Operates between 20 and 20,000 cps. High impedance VTVM circuit for initial reference settings and final distortion readings. Ranges are 0-1, 3, 10, and 50 volts full scale. 1% precision resistors. Distortion scales are 0-1, 3, 10, 30 and 100% full scale. Requires only 3 volt input for distortion test.

1. Heathkit Audio Analyzer Kit

This instrument consists of an audio wattmeter, an AC VTVM, and a complete IM analyzer, all in one compact unit. Use the VTVM to measure noise, frequency response, output gain, power supply ripple, etc. Use the wattmeter for measurement of power output. Internal leads provided for 4, 8, 16, or 600 ohms. VTVM also calibrated for DBM units. High or low impedance IM measurements made with built-in 6Kc and 60 cps generators. VTVM ranges are .01, to 300 volts in 10 steps. Wattmeter ranges are 15 mv. to 150 w. in 7 steps. IM scales are 1% to 100% in 5 steps.

MODEL AA-1

Shpg. Wt. 13 lbs.

$59.50

2. Heathkit Audio Generator Kit

This new Heathkit Model features step-tuning from 10 cps to 100 Kc with three rotary switches that provide two significant figures and multiplier. Less than 1% distortion. Frequency accurate to within ± 5%.

Output monitored on a large 4½" meter that reads voltage or db. Both variable and step-type attenuation provided. Meter reads zero-to-maximum at each attenuator position. Output ranges (and therefore meter ranges) are 0-600 Ohms, .01, .03, 1, 3, 3, 10, 10 volts. Step-tuning provides rapid positive selection of the desired frequency, and allows accurate return to any given frequency.

MODEL AG-9

Shpg. Wt. 8 lbs.

$34.50

3. Heathkit Audio Oscillator Kit

(Sine Wave — Square Wave)

The Model AO-1 features sine wave or square wave coverage from 20-20,000 cps in 3 ranges. It is an instrument specifically designed to completely fulfill the needs of the serviceman and high fidelity enthusiast. Offers high level output across the entire frequency range, low distortion and low impedance output. Features a thermistor in the second amplifier stage to maintain essentially flat output through the entire frequency range. Produces an excellent sine wave for audio testing, or will produce good, clean, square waves with a rise time of only 2 microseconds.

MODEL AO-1

Shpg. Wt. 10 lbs.

$24.50

4. Heathkit Resistance Substitution Box Kit...

Provides switch selection of 36 RTMA 1 watt standard 1% resistors ranging from 15 ohms to 10 megohms. Numerous applications in radio and TV work, and essential in the development laboratory.

MODEL RS-1

Shpg. Wt. 2 lbs.

$5.50

5. Heathkit Ac Vacuum Tube Voltmeter Kit...

The Heathkit AC VTVM features high impedance, wide frequency range, very high sensitivity, and extremely wide voltage range. Will accurately measure a voltage as small as 1 mv. at high impedance. Excellent for sensitive AC measurements required by laboratories, audio enthusiasts and experimenters. Frequency response is substantially flat from 10 cps to 50 Kc. Ranges are .01, .03, .1, .3, 1, 3, 10, 30, 100, and 300 v. RMS. Total db range -52 to +52 db. Input impedance 1 megohm at 1 Kc.

MODEL AV-2

Shpg. Wt. 5 lbs.

$29.50

6. Heathkit Condenser Substitution Box Kit...

Very popular companion to Heathkit RS-1. Individual selection of 18 RTMA standard condenser values from .001 mfd to .22 mfd. Includes 18" flexible leads with alligator clips.

MODEL CS-1

Shpg. Wt. 2 lbs.

$5.50

BENTON HARBOR 20, MICHIGAN

DECEMBER, 1955
HEATHKIT HAM GEAR
for high quality at moderate cost

DOLLAR VALUE: You get more for your Heathkit dollar because your labor is used to build the kit instead of paying for someone else's. Also, the middleman's margin of profit is eliminated when you deal directly with the manufacturer.

1 Heathkit DX-100 PHONE & CW TRANSMITTER KIT

The reception given this amateur transmitter has been tremendous. Reports from radio amateurs using the DX-100 are enthusiastic in praising its performance and the high quality of the components used in its assembly. Actual "on the air" results reflect the careful design that went into its development.

The DX-100 features a built-in VFO, modulator, and power supplies, and is completely bandswitching for phone or CW operation on 160, 80, 40, 20, 15, 11, and 10 meters. All parts necessary for construction are supplied in the kit, including tubes, cabinet, and detailed step-by-step instructions. Easy to build, and a genuine pleasure to operate.

Employing push-pull 6205's modulating parallel 6146's for RF output in excess of 100 watts on phone and 125 watts on CW. May be excited from the built-in VFO or from crystals (crystals not included with kit). Features five-point TVI suppression: (1) pi network interstage coupling to reduce harmonic transfer to the final stage; (2) pi network output coupling; (3) extensive shielding; (4) all incoming and outgoing circuits filtered; (5) inter-locking cabinet seems to eliminate radiation except through the coaxial output connector. Pi network output coupling will match 50 to 600 ohm non-reactive load. Illuminated VFO dial and meter face. Remote control socket provided.

The chassis is made of extra-strong 216 gauge copper-plated steel. It employs potted transformers, ceramic switch and variable capacitor insulation, solid silver loading switch terminals, and high-grade well-rated components throughout. Features a pre-formed wiring harness, and all coils are pre-wound.

High-gain speech amplifier for dynamic or crystal microphones, and restricted speech range for increased intelligence. Plenty of audio power reserve. Measures 20¾" W x 13¾" H x 15" D. Schematic diagram and complete technical specifications on request.

MODEL DX-100 $189.50

2 Heathkit VFO KIT

The Model VF-1 covers 160-80-40-20-15-11 and 10 meters with three basic oscillator frequencies. Better than 18 volt average RF output on fundamentals. Features illuminated and pre-calibrated dial scale. Cable and plug provided to fit crystal socket of any modern transmitter.

Enjoy the convenience and flexibility of VFO operation at no more than the price of crystals. May be powered from plug on the Heathkit Model AT-1 transmitter, or supplied with power from most transmitters. Measures: 7" H x 6½" W x 7" D.

MODEL VF-1 $19.50

3 Heathkit CW AMATEUR TRANSMITTER KIT

The Model AT-1 is an ideal novice transmitter, and may be used to excite a higher power rig later on. This CW transmitter is complete with its own power supply and covers 20, 40, 80, 15, 11, and 10 meters. Features single-knob bandswitching, and panel meter indicates grid or plate current for the final amplifier. Designed for crystal operation or external VFO. Crystal not included in kit. Incorporates such features as key click filter, line filter, copper-plated chassis, pre-wound coils, 33 ohm coaxial output, and high quality components throughout. Instruction book simplifies assembly. Employ a 6AG7 oscillator, 6L6 final amplifier. Operates up to 35 watts plate power input.

MODEL AT-1 $29.50

4 Antenna Coupler Kit

The Model AC-1 will properly match your low power transmitter to an end-fed long wire antenna. Also attenuates signals above 30 Mc reducing TVI. 50 ohm coax input power up to 75 watts--10 through 80 meters—tapped inductor and variable condenser—neon RF indicator—copper plated chassis and high quality components. Ideal for use with Heathkit AT-1 Transmitter.

MODEL AC-1 $14.50

HEATH COMPANY
A Subsidiary of Daystrom, Inc.
BENTON HARBOR 20, MICHIGAN

www.americanradiohistory.com
MODERN DESIGN: You can be sure of getting all the latest and most desirable design features when you buy Heathkits. Advanced-design is a minimum standard for new Heathkit models.

1 Heathkit COMMUNICATIONS-TYPE ALL BAND RECEIVER KIT

The new Model AR-3 features improved IF and RF performance, along with better image rejection on all bands. Completely new chassis layout for easier assembly, even for the beginner.

Covers 550 Kc to 30 Mc in four bands. Provides sharp tuning and good selectivity over the entire range. Features a transformer-type power supply-electrical bandspread-separate RF and AF gain controls-antenna trimmer-noise limiter-AGC-BFO-headphone jacks-5 1/2" FM speaker and illuminated tuning dial.

CABINET: Fabric covered cabinet with aluminum panel as shown. Part No. 91-15, shipping weight 5 lbs. $4.50.

2 Heathkit "Q" MULTIPLIER KIT

Here is the Heathkit Q Multiplier you hams have been asking for. A tremendous help on the phone and CW bands when the QRM is heavy. Provides an effective Q of approximately 4,000 for extremely sharp "peak" or "null." Use it to "peak" the desired signal or to "null" an undesired signal, or heterodyne. Tunes to any signal within the IF band-pass of your receiver. Also provides "broad peak" for conditions where extreme selectivity is not required.

Operates with any receiver having an IF frequency between 450 and 460 Kc. Will not function with AC-DC type receivers. Requires 6.3 volts AC at 300 ma, and 150 to 250 VDC at 2 ma. Derives operating power from your receiver. Uses a 12AX7 tube, and special High-Q shielded coils. Simple to connect with the cable and plugs supplied. Measures only 4-11/16"H.x7/16"W.x3/4"D. A really valuable addition to the receiving equipment in your ham shack.

MODEL QF-1

$9.95

(Shipped Wt. 3 lbs.)

3 Heathkit VARIABLE VOLTAGE REGULATED POWER SUPPLY KIT

Provides well filtered DC output, variable from zero to 500 volts at no load and regulated for stability. Will supply up to 10 ma. at 450 VDC, and up to 130 ma. at 200 VDC. Voltage or current monitored on front panel meter. Also provides 6.3 VAC at 4A, for filament. Filament voltage isolated from B+, and both isolated from ground. Invaluable around the ham shack for supplying operating potentials to experimental circuits. Use in all types of research and development laboratories as a temporary power supply, and to determine design requirements for ultimate power supply.

MODEL PS-3

$35.50

(Shipped Wt. 17 lbs.)

4 Heathkit ANTENNA IMPEDANCE METER KIT

Use in conjunction with a signal source for measuring antenna impedance, line matching, adjustment of beam and mobile antennas, etc. Will double as a phone monitor or relative field strength indicator. 100 µa. meter employed. Covers the range from 0-900 ohms. An instrument of many uses for the amateur.

MODEL AM-1

$14.50

(Shipped Wt. 2 lb.)

5 Heathkit GRID DIP METER KIT

This is an extremely valuable tool for accomplishing literally hundreds of jobs on all types of equipment. Covering from 2 Mc to 250 Mc, the GD-IB is compact and can be operated with one hand. Uses a 500 µa. meter for indication, with a sensitivity control and headphone jack. Includes prewound coils and rack. Indispensable instrument for hams, engineers, or servicemen.

MODEL GD-1B

$19.50

(Shipped Wt. 4 lbs.)

HEATH COMPANY A Subsidiary of Daystrom, Inc. BENTON HARBOR 20, MICHIGAN

DECEMBER, 1955 75
The 25 Watt Model W-5 is one of the most outstanding high fidelity amplifiers available today—at any price. Incorporates the very latest design features to achieve true "presence" for the super-critical listener.

Features a new-design Peerless output transformer, and KT66 output tubes. Frequency response—within + 1 db from 5 cps to 160 kc at 150 watts. Harmonic distortion only 1 ½% at 25 watts, 0.5% at 200 watts, and 2% at 3,000 cps. IM distortion at rated output is 1.5% at 20 watts, 2% at 3,000 cps, and 3% at 150 watts. Output impedance 4, 8, or 16 ohms. Hum and noise—99 db below rated output. Uses two 12AU7's, two KT66's, and a 5R4G.

**W-5 Amplifier Kit:** Consists of main amplifier and power supply, all on one chassis. Complete with all necessary parts, tubes, and comprehensive manual. Shpg. Wt. 36 lbs. Express only.

**W-5 Combination Amplifier Kit:** Consists of W-5 Amplifier Kit listed above plus Heathkit WA-P2 Preamp. Complete with all necessary parts, tubes, and construction manuals. Shpg. Wt. 39 lbs. Express only.

**W-3M Amplifier Kit:** Consists of main amplifier and power supply for single chassis construction. Includes all tubes and components necessary for assembly. Shpg. Wt. 28 lbs. Express only.

**W-3 Amplifier Kit:** Consists of W-3M Kit listed above plus Heathkit Model WA-P2 Preamp. Listed on opposite page. Shpg. Wt. 37 lbs. Express only.

**W-4A Amplifier Kit:** Consists of main amplifier and power supply for single chassis construction. Includes all parts necessary for assembly. Shpg. Wt. 28 lbs. Express only.

**W-4 Amplifier Kit:** Consists of W-4AM Kit listed above plus Heathkit Model WA-P2 Preamp. Listed on opposite page. Shpg. Wt. 35 lbs. Express only.

**W-4M Amplifier Kit:** Consists of main amplifier and power supply for single chassis construction. Includes all parts necessary for assembly. Shpg. Wt. 28 lbs. Express only.

**W-4 Amplifier Kit:** Consists of main amplifier and power supply for single chassis construction. Includes all parts necessary for assembly. Shpg. Wt. 28 lbs. Express only.
ATTRACTION STYLED. Heathkit high fidelity instruments are not only functional, but are most attractive in physical design. Such units as the preamplifier and the W-5 main amplifier are designed for beauty as well as performance. They blend with any room decor and are the kind of instruments you will be proud to own.

1. **Heathkit High Fidelity Preamplifier Kit**

This outstanding preamplifier is designed specifically for use with the Heathkit Williamson type amplifiers. It completely fulfills the requirements for remote control, compensation and preamplification, and exceeds even the most rigorous specifications for high fidelity performance.

Features five separate switch-selected input channels (2 low level and 3 high level), each with its own input control. Full record equalization with four-position turnover control and four-position rolloff control.

Output jack for tape recorder — separate bass control with 18 db boost and 12 db cut at 50 cps. — treble control offering 15 db boost and 20 db cut at 15,000 cps — special hum control to insure minimum hum level — and many other desirable features. Overall frequency response (with controls set to "flat" position) is within 1 db from 25 cps to 30,000 cps. Will do justice to the finest available program sources. Beautiful satin-gold finish.

Power requirements from the Heathkit Williamson type high fidelity amplifier — 6.3 VAC at 1 amp., and 300 VDC at 10 Ma. Uses two 12AX7's and one 12AU7.

2. **Heathkit 20-Watt High Fidelity Amplifier Kit**

This Heathkit Model offers you the least expensive route to high fidelity performance. Frequency response is ± 1 db from 20-20,000 cps. Features full 20 watt output using push-pull 6L6's, and incorporates separate bass and treble tone controls. Preamplifier and main amplifier are built on the same chassis. Four switch-selected compensated inputs and separate bass and treble tone controls provide all necessary functions at minimum investment. Features miniature tube types for low hum and noise.

Uses 12AX7, two 12AU7's, two 6L6G's and a 5V4G. A most interesting "build-it-yourself" project, and an excellent hi-fi amplifier for home use. Well suited, also, for public address applications because of its high power output and high quality audio reproduction. Another Heathkit "best-buy" for you!

3. **Heathkit 7-Watt Amplifier Kit**

The redesigned Model A-7D features a new type output transformer for tapped screen operation, and provides improved sensitivity, reduced distortion, and increased power output.

The full 7-watt output of the Model A-7D is more than adequate for normal home installations. Frequency characteristics are ± 1 1/2 db from 20 to 20,000 cps. Potted output and power transformers employed. Push-pull output — detailed construction manual — top quality parts — high quality audio without great expense. Output transformer tapped at 4, 8, and 16 ohms. Bass and treble tone controls provided on the front chassis apron.

Model A-7E: Provides a preamplifier stage with two switch-selected inputs and RIAA compensation for variable reluctance or low level cartridges. Preamplifier built on same chassis as main amplifier. Model A-7E. Shipping weight 10 lbs. $18.50.
The new Heathkit Model FM-3 features tremendous circuit improvements and brand new physical design. Sensitivity is better than 10 µv. for 20 db of quieting, and it employs a completely modern tube line-up for high gain and stable operation. Incorporates its own power supply, and has provision for low-level or high-level output at low impedance.

The attractive Model FM-3 matches the WA-P2 Pre-amplifier in color, styling, and physical size. Incorporates automatic gain control, a highly stabilized oscillator, and illuminated tuning dial. Educational treatment of construction manual simplifies assembly for the newcomer to electronics. IF and ratio transformers are pre-aligned, and the front-end tuning unit is pre-assembled and aligned. Uses 63Q7A as a cascode type RF stage, 6U8 oscillator-mixer, two 6CB6's as IF amplifiers, a 6AL5 ratio detector, a 6C4 audio amplifier, and 6X4 rectifier.

Features

- Brand New, Modern FM Circuit Using Latest Type Miniature Tubes.
- Low-Noise Cascade RF Stage—Two IF's—Ratio Detector—Stage of Audio.
- Extremely Good Sensitivity and Band-Pass for Outstanding Performance.
- Strikingly Attractive Satin-Gold Finish to Match Heathkit Model WA-P2 Pre-amplifier.
- Compact Physical Dimensions for Most Pleasing Appearance and Increased Circuit Efficiency.

HEATHKIT BROADCAST-BAND RECEIVER KIT

Build your own radio receiver with confidence, even if you are a beginner. Complete instructions supplied.

Features transformer-type power supply, high-gain miniature tubes, built-in antenna, 5½" speaker, and planetary tuning from 550 Kc to 1500 Kc. Adaptable for use as AM Tuner and phonograph amplifier. Educational treatment of the construction manual helps the beginner learn about radio circuits and parts as he builds.

CABINET: Fabric covered plywood cabinet with aluminum panel as shown. Part 91-9, Shpg. Wt. 5 lbs., $4.50.

MODEL BR-2 Less Cabinet

$17.50

Are you on our mailing list? If not—how about sending us your name?
WHEN the complaint is "sound but no picture," the obvious thing to check is the high-voltage system of a television receiver. This is a relatively easy task in the shop. In the customer's home, with little test equipment available, the situation is altogether different. One widely used check for high voltage is to pull the high-voltage lead from the picture tube and note the arc when the lead is held a short distance from the second-anode connection. This check, while simple, leaves much to be desired. Not only is it hazardous and inaccurate, but usually next to impossible to perform on a metal picture tube. What is needed then is an accurate instrument that is much smaller than a v.t.v.m. and high-voltage probe.

The midget TV kilovoltmeter was inspired by a home-made electroscope and pretty well fills the bill in so far as size, weight, ruggedness and accuracy are concerned. It can be constructed in an hour or so. The instrument operates on the electrostatic principle—a high voltage is applied to a metal plate and a piece of foil attached to one end of the plate is repelled. The distance that the foil is deflected varies as the applied voltage. As the electrostatic force acting on the foil is very small, the instrument will produce a readable indication only for voltages in the order of several thousand.

Construction

A 1/4 x 1/2-inch plastic or Bakelite medicine bottle cap is used as the case of the instrument. Two 1/4-inch holes are drilled in the edge of the cap at a 90° interval. In one of these holes cement the handle of the instrument, a 3-inch length of 1/4-inch polystyrene rod. In the other hole insert a 1/4-inch length of 1/4-inch polystyrene rod having a 1/8-inch drill hole through the center. Bend a 1/4-inch hook in a 1 1/2-inch length of No. 16 tinned copper wire and insert the wire in the 1/4-inch piece of polystyrene rod as shown in the diagram. With a small blowtorch, heat the ends of the short polystyrene rod until the rod melts slightly and anchors itself to the case and the wire. Don't be tempted to cut corners and use cement to hold the wire in place or to hold the rod to the instrument case. Doing this will spoil the insulating qualities of the polystyrene. Solder a 1 x 1/4-inch thin brass or copper plate to the hook in the wire inside the case as shown.

Cut a circular piece of white cardboard to fit inside the case, inscribe an arc on it and cement it to the inside of the instrument case. Cut a 1 1/16 x 1 1/4-inch piece of very light metal foil, taper one end slightly, bend and clamp the tapered end around the left end of the metal plate. Make certain that the metal plate is clean at this point and that the foil is tightly clamped. Place a spot of service cement over the lower edge of the foil after it has been clamped to secure it to the metal plate. Adjust the foil so that, when the instrument is right side up, the foil just rests on the metal plate. Cut a celluloid disc the size of the case to form a face, but don't attach it yet.

Holding the instrument by the polystyrene handle, touch the projecting wire to the anode terminal of a television receiver known to be operating at approximately 10 kv. Note the position of the foil and mark the dial scale accordingly. My instrument is calibrated at only one point—10 kv, as voltages above and below this value can be estimated fairly accurately. Deflection is determined by foil thickness and the amount of taper at the end of the foil. The foil used in my instrument was obtained from a chewing-gum wrapper and tapered to give a 10-kv indication about midway on the scale. Polystyrene must be used as an insulating bead or the instrument will not function properly. After calibration is completed, cement the celluloid face to the instrument case.

An advantage of this little gadget is that it isn't necessary to touch the probe wire to a bare high-voltage point. There is enough leakage in most of the insulating materials used to give good foil deflection by just touching the probe to the insulated high-voltage lead or metal picture-tube sleeve. Thus, the presence of high voltage in the anode lead of the picture tube can be determined without removing the lead from the picture tube. After use, the foil is collapsed by touching the case and probe of the instrument with the hand. A modified fuse clip attached to the side of the service kit will hold the instrument in an upright position while not in use. Repeated jarring while inverted tends to bend the foil away from the metal plate.

Two things are very important in the construction of this instrument—use polystyrene to insulate the wire probe from the case; be sure the foil strip makes good contact at the end of the metal plate.

Since this instrument operates on the principle of electrostatic repulsion between the foil and the plate, it is very possible that under conditions of high humidity the meter will read low as a result of leakage. The only protection against this is for the technician to familiarize himself with his instrument and observe its operation in humid weather. Humidity should not be too great a problem since the inside of a TV cabinet is usually fairly warm and dry if the set has been operating for several minutes.

END
R-C CONTROLLED OSCILLATOR

Easily constructed and calibrated, instrument provides highly stable sine-wave output

By JOHN W. STRAEDE

AUDIO-FREQUENCY oscillators have a number of uses, the most obvious being the measurement of amplifier frequency response, loudspeaker testing and signal tracing.

When an amplifier is being built, it is very desirable to have a variable-frequency oscillator for finding the resonant frequencies of microphone, pickup, coupling transformers and loudspeaker. It is important that the resonant frequencies of these components do not occur too close together.

Three main types of a.f. oscillators are used to produce sine waves.

There is the "direct L-C" type wherein an oscillatory circuit (consisting of an inductance and capacitor in parallel) are connected to an amplifier, part of the output being returned to the oscillatory circuit to maintain oscillation. This simple type of oscillator is reliable but has a marked disadvantage: it is not easy to obtain a wide frequency range because low frequencies demand huge values of inductance and capacitance. Such a circuit is good where a small output at one fixed frequency is required; a suitable circuit is shown in Fig. 1.

To obtain a wide range of frequencies, the rectification of the "beats" from a pair of high-frequency oscillators can provide a signal, the frequency of which is the difference between the high-frequency oscillators. A block diagram of such an arrangement (called a beat-frequency oscillator) is shown in Fig. 2. Beat-frequency oscillators, though widely used, are not too suitable for the home constructor because very careful layout and shielding are necessary.

To produce a "straight-out" oscillator, attempts have been made to use combinations of resistance and capacitance as the frequency-controlling device. An example of such a circuit is the multiplier which, however, suffers from exceedingly poor waveform (poor because rich in harmonics).

Other examples are the Nichols (Fig. 3) and van der Pol (Fig. 4) oscillators. The Nichols uses a three-stage phase-shifting network with a single high-gain tube. In the van der Pol the single tube is replaced by three—inserted between the sections of the resistance-capacitance network.

The Willans circuit

This arrangement consists of a two-stage amplifier (so that input and output are in phase) together with a resistance-capacitance network very similar to that used in two arms of a Wein bridge. The network consists of two capacitors equal in value connected together, and two resistors of equal value. Resistor R1 is in series with C1, and R2 is in parallel with C2 (Fig. 5).

The Willans circuit has several advantages over a beat-frequency oscillator: the range is easily divided, permitting rapid frequency changing and ease of adjustment; the same calibration marks can be used on each range if good components are used and care is taken with the construction; the oscillator is very free from drift—no zero-set device is required; the oscillator can be synchronized for the generation of multiple and submultiple audio frequencies. This last advantage makes the oscillator very suitable for demonstrating Lissajous figures.

Because the frequency is inversely proportional to capacitance (not to its square root as in tuned oscillators), a large frequency ratio can be covered with one sweep of the tuning dial. At low capacitances, however, stray inter-element and interlead capacitances become troublesome, so each range is limited at its high-frequency end by providing a fixed capacitor in parallel.
WIRE
AND
CABLE
FOR EVERY
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WIREMAKER FOR INDUSTRY
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DECEMBER, 1955
81
TEST INSTRUMENTS

with each tuning capacitor (Fig. 6). One of the fixed capacitors is 150 µf, the other is made up of a trimmer in parallel with a 100-µf capacitor.

With a standard four-gang variable capacitor, the frequency ratio is approximately 1 to 5 for the ends of each range. The ranges can be changed by switching resistors in or out of the circuit.

The low-frequency limit is set by the maximum permissible resistance in the grid circuit of the first tube; the upper limit by the reduction in gain of the second tube when the resistances are too low.

Good waveform is obtained by running each tube well within its limits. Negative feedback is used over the output stage and over the two-stage amplifier in the Willans circuit. Because the two-stage amplifier requires a gain of only 3, plenty of feedback can be used.

The waveform is best when the positive feedback via the Willans circuit just produces oscillation. Two automatic devices are used to insure this:

First, there is automatic volume control, obtained by rectifying part of the output from the second tube and using it for bias. This second tube has a fairly remote cutoff and the variation in bias does not cause as much distortion as an overload would.

Second, the negative feedback circuit consists of a voltage divider, part of which is a 470,000-ohm carbon resistor; the other part is a metal filament lamp. Carbon behaves in an opposite manner to metal when it is heated. If the output from the second tube increases, more a.c. flows through these resistors and they are heated. The carbon resistor decreases in value while the other rises, thereby giving increased negative feedback and reduced gain.

(Mr. Straede is in Australia and some tubes readily available to him might be difficult for some of us to find. Such is the case with the 6E8-G. If one is not available, you can substitute a 12C8 and 12-volt equivalents of the other tubes along with a transformer with a 12-volt or two 6-volt windings.

Also, you can stick to 6-volt types and substitute a 6SF7 or 65V7 or even any standard r.f. amplifier pentode and a 1N34 or similar germanium rectifier. When substituting any type other than a 12C8, you will probably have to experiment with the values of the screen, bias and a.v.c. resistors.

Lamp LM is a 250- or 10-watt unit and substitutes a 1056/10 or equivalent—available from many large lamp distributors. If this lamp cannot be located, the constructor may use a 2.5-watt 115-volt unit. This may change the time constant of the feedback circuit and necessitate experimenting with the values of the other components in this circuit.—Editor)

If desired, the circuit can be simplified by omitting the a.v.c. and using grid-leak bias for the second tube—grid-leak bias gives a small amount of automatic control because the bias voltage is approximately equal to the peak value of the signal voltage and the gain drops when the bias passes a low voltage.

The waveform is also improved by fitting a shunt capacitor across the output—this reduces only the higher harmonics and is of a different value on each range.

The oscillator circuit

Fig. 6 shows the complete circuit. The four tubes are standard types, the Willans amplifier using a 6J7-G and a 6BR-G (single-ended GT types are O.K.), the output (and buffer) stage a 6V6-GT and the rectifier a 6X5-GT.

The 6V6-GT output tube is connected as a triode (to reduce effects of varying output load) and fitted with a permanent load consisting of a 39,000-ohm 1-watt resistor.

Bias for the output stage is from the usual cathode resistor shunted by two capacitors, one a 100-µf 26-volt electrolytic, the other a 6.1-µf paper unit.

Best waveform can be obtained with the regeneration control which can be either in the form of an adjustable volume control as shown in the diagram or another bank on the range control can provide separate adjustments on each range. If the apparatus is carefully constructed and the resistors are accurate, this regeneration control is unnecessary.

The four-gang capacitor (used as a two-gang 750-µf unit), must be very carefully insulated from the chassis as well as from the dial—some flexible couplings are good insulators; others are not.

Construction and adjustment

Contrary to expectations, extreme shielding was not found to be necessary. The tubes are shielded and the power transformer and rectifier are as far as possible from V1 and the R-C network.

A 12 x 6 x 2-inch chassis was used with a front panel of crackle-painted Masonite 14 x 9½ inches. Layout details are shown in Fig. 7.

When wiring, filament leads must be kept well away from grid and anode leads or waveform and frequency may go a little "haywire" around the power-supply points.

Parts list for R-C oscillator

Resistors: 1-100 to 1-150, 1-39,000, 1-47,000, 2-100,000, 1-310,000, 1-470,000 ohms, 5/8 watt, 1-1, 1-2, 1-3 megohms, ½ watt; 2-1, 1-5, 2-13 megs, ½ watt; 2-1,000 ohms, 3 watts; 2-31,000, 2-310,000 ohms, 2-1,000 ohms, 3.5 volts; 2-470,000, 2-390,000 ohms

Capacitors: 1-100 to 1-250 µf; 1-1, 1-003, 1- .005, 1- .01, 1- .02, 1- .01 to .02, 1-0.1, 4-0.5, 1-1 µf; 1-50 µf, trimmed; 4-4-gang variable, 365 µf per unit

Electrolytics: 1-20 to 35 µf, 350 volts; 1-10 to 10 µf, 450 volts; 1-100 µf, 75 volts

Miscellaneous: 1-lamp LM (see test); 1-power transformer, 700 volts c.t. @ 40 ma, 63 volts @ 2 amps; 1-6J7-G, 1-6BR-G; 1-6V6-GT, 1-6X5-GT; 4-socket sockets; 1-output transformer, 10,000-ohm primary to 4-ohm secondary; 1-chassis, 3-gang 5-position rotary switch; 1-line cord, 2-jacks.

Fig. 5—Schematic of Willans circuit.

Fig. 6—Schematic of the resistance-capacitance controlled oscillator.
Nearly two years ago, Winegard introduced its now famous Electro-Lens Focusing — the world's first antenna director system that works simultaneously and efficiently on both high and low TV bands. The ad at right, first published early in 1954, explained the exclusive, revolutionary Electro-Lens principle. This ad served as forerunner of a feature that has since been imitated by almost every manufacturer in the industry.

Today, there are more TV antennas on the market patterned after the original Winegard Interceptor than there are clowns in a circus. But the Winegard Interceptor is still the star performer . . . the leader . . . and the world's most imitated TV antenna. Sales have skyrocketed because, by every means of comparison, Winegard Interceptors set the pace. Compare performance and construction . . . compare appearance . . . compare ease of assembly and installation. Winegard Company introduced and perfected Electro-Lens focusing . . . the first all-channel Yagi . . . Hairpin Tuning (often called the bazooka) . . . Multi-Resonant Driven Elements . . . colorful Anodizing. And . . . Winegard Company will continue to originate and introduce new engineering triumphs . . . and invite comparison! Today, tomorrow . . . as in the past . . . Winegard will be stealing the show wherever you go!

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TEST INSTRUMENTS

line frequency and its harmonics. One side of the filament circuit is grounded.

When completed, connect the oscillator to a loudspeaker (any impedance will do), with preferably an oscilloscope in parallel. The gain control in the Willans circuit and the volume control are both tuned "flat out." Next the gain (or regeneration) control is turned down until oscillation ceases at each end of the range for the same setting of the control. If it is found that oscillation ceases on one range for a higher setting of the control, it means that the two resistors for that range are unequal.

and that the upper resistor (upper on the circuit diagram) is larger than the lower. Each of the 10 resistors should be within 2%, preferably closer.

If despite the resistors being equal in value the highest frequency range is apt to cease oscillation or fails to oscillate, some high-frequency compensation can be introduced in the negative feedback circuit by connecting a small capacitor (say .002 µf) across the cathode lamp resistor. Alternatively, the screen grid of the second tube can be bypassed with a small capacitor to obtain the same effect.

Failure to oscillate on the lowest range can usually be cured by replacing the 1-µf capacitor in the feedback line with one of lower value, say 0.5 µf. A low-value coupling capacitor between the first two tubes is also a source of trouble.

Calibration is best done by Lissajous figures on a cathode-ray oscilloscope, using a 50- or 60-cycle supply as the standard. Alternatively, the points for the line frequency can be found by using a loudspeaker and a filament transformer. The secondary of the filament transformer is connected in series with the high-impedance output.

END

Fig. 7—Layout of the controlled resistance capacitance audio oscillator.

and a speaker. The oscillator is adjusted until beats are heard (on the lowest frequency range), and the tuning control is adjusted until the beats cease. Now one point is fixed. Borrow a piano! Find the corresponding key on the piano and each octave of this key gives double the frequency. Each single note above this key increases the frequency in the ratio \(\sqrt{2}\) (the twelfth root of 2). Frequencies can be compared to within a fraction of a cycle per second by ear, by listening to the beats—one beat per second corresponding to a frequency difference of exactly one cycle per second.

Write for catalog TV—1558

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Best quality and consumer demand important reasons why servicemen make "Silver Screen 85" their No. 1 choice.

Servicemen gave "Silver Screen 85" the highest vote of confidence paid any picture tube in a national survey recently conducted by an independent research corporation. "Silver Screen 85" took top honors in answer to the key question, "what picture tube do you consider best regardless of price?"

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TEST INSTRUMENTS

A 1,000- and 100- cycle FILTER

Simple device can be used for alignment and measurement

By JAMES FRED

Some months ago I was employed in the engineering department of a private-brand radio manufacturer. The company decided to go into production on a u.h.f. converter, and one of the pieces of test equipment needed was an audio-frequency vacuum-tube voltmeter with a 1,000-cycle filter. We developed our own vacuum-tube voltmeter and intended to use a commercial 1,000-cycle filter. But when we placed our order, we were told delivery would begin some 8 months later. The price was $25 each. Since we needed about 15 filters we decided to make our own.

Fig. 1 shows the overall response curve (solid line) we ran of the commercial model; the dashed line shows the response curve of the model we decided to build. Both curves were made from the readings on an audio vacuum-tube voltmeter. We fed the filter various frequencies from 500 to 1,500 cycles at constant amplitude and read the output voltage on the v.t.v.m. We tried to duplicate the performance curve of the commercial model but had to compromise somewhat in the interest of cost and availability of parts.

The inductance that gave us the best performance was a 4.5-henry, 80-ohm (d.c. resistance), 250-va filter choke. This was used in the final model with a .003-pf capacitor for a 1-ke filter.

The signal generators in most radio laboratories use 1-ke modulation, while most technicians have generators with 400-cycle modulation. This is why we describe the design for a combination 1,000- and 400-cycle filter. Fig. 2 shows a schematic of the filter. When purchasing the filter choke be sure you get the unit called for (Stancor C1411). The selector switch, a Mallory 155L, is a special type used in capacitor decade boxes. With this switch and four capacitors you can put the capacitors in parallel and get 10 different combinations. With .001-, .002-, .003- and .004-pf capacitors, you can get combinations from .001 to .01 pf in steps of .001 pf. The switch and capacitors permit you to adjust the frequency of your filter ±10%. This is necessary because of the tolerance of the filter choke and the fact that all signal generators do not have exact frequencies but may vary ±5%. We can peak the filter to the desired frequency by turning the selector switch. Switch S2 is a s.p.d.t. unit for selecting either 400 or 1,000 cycles.

A Mallory type 75 plug and shielded wire connect the filter into the circuit. The components are housed in an aluminum box 3 x 4 x 5 inches. Fig. 3 is the wiring diagram of S1. Rubber grommets are used to bring the shielded wire through.

Using the filter

You will need an audio or a.c. vacuum-tube voltmeter. Many voltmeters of this type have a suitable jack. If yours doesn't, a jack must be installed. We put a jack in a Heathkit v.t.v.m. and it worked very well. The only additional parts needed are a .002-pf capacitor and a jack suitable for the
plug. Fig. 4 shows the jack and .002-µf capacitor located between the 6AV6 and 6AT6. When the filter is plugged into the voltmeter, the meter no longer reads the voltages indicated on the scale, but a lower amount. This doesn't affect its use for alignment purposes because we are interested in relative amounts only. We will still be able to measure increases and decreases in signal strength. Removing the plug from the v.t.v.m. jack restores normal operation.

If you have a signal generator, connect it to the v.t.v.m. and set the generator to 1,000 cycles. Adjust the output to half-scale reading. As you tune the generator to either side of 1,000 cycles, the meter should read a constant amount. Now plug in the filter set at 400 cycles. As you tune the generator on either side of 1 kc, the meter reading will drop off. This shows that the filter is working properly. You can check the 400-cycle filter by the same method. When making r.f. measurements on receivers, u.h.f. converters or TV sets, an audio filter should be used. The output of the signal generator, modulated at 1 kc, is connected to a u.h.f. converter. The output of the converter goes to a diode probe which removes the r.f. carrier and gives us the 1,000-cycle audio signal. This goes into an audio-frequency vacuum-tube voltmeter where the amplitude is indicated on the meter. The u.h.f. converter would also pick up electrical noise, automobile ignition and all sorts of man-made static. This, too, would cause a meter indication and give false information. By inserting a 1-kc filter in the a.f. v.t.v.m. we can bypass all other frequencies to ground. This will let only the 1,000-cycle modulation come through, giving a very accurate measurement of the sensitivity of the converter.

When checking receiver gain and alignment, we feed a signal into the radio receiver, detect it with a diode probe and feed the audio into the v.t.v.m. As before, we use the filter to get rid of unwanted electrical noises and static. We can align the i.f. and r.f. stages much more easily and accurately using this equipment. Since this is done in radio factories, service technicians would be wise to follow the same procedure. END

**Parts list for filter**

**Capacitors:** 1—.001 µf, 1—.002 µf, 1—.003 µf, 1—.004 µf; 1—.003 µf, 1—.03 µf, silver mica 5% (if unavailable in these values, parallel smaller units); 1—.002 µf (for meter).

**Miscellaneous:** 1—phone plug and jack; 1—choke, 4.5 h (Stancor C411 or equivalent); 1—s.p.d.t. switch; 1—decade type switch (Mallory 153L); 1—chassis.
FULL maintenance insurance systems for TV receiving sets has been operating successfully in Britain for some time now. It is not surprising that there should have been a wide demand for reliable all-in TV insurance. The cost of obtaining a 17-inch set and its antenna represents about 10–12 weeks’ earnings for the average working man. C-R tubes are very costly here and the 6-months’ guarantee given on them by the makers does not cover labor charges for removing the old tube and fitting in a new one. Outside the guarantee period, the replacement of a C-R tube may cost those unfortunate enough to require it the equivalent of 3–4 weeks’ earnings.

TV dealers soon found themselves up against hard cases in plenty, particularly among those customers who were buying their sets by installment payments. When an expensive replacement or repair was needed, these people were often sunk: they couldn’t find the money to cover it in addition to their regular payments.

The effect on sales was serious. Many who intended to buy were deterred by the tales they heard from their friends of the unpleasant financial surprises that might come their way if they were unlucky with their TV receivers.

Some dealers started insurance schemes of their own. Since they didn’t have sufficient data to go on, only a few of these worked well. Eventually the question of TV full-maintenance insurance was tackled by a federation to which a large proportion of the dealers in Britain belong. This is the Radio and Television Retailers Association, better known as the RTRA.

Having collected and compared average maintenance costs from dealers all over the country, the RTRA started its own insurance scheme. But business increased so rapidly that it was soon far too big for the association’s staff to tackle. It was therefore decided to launch a separate concern, managing its own affairs and its own finances, but closely linked with the RTRA.

This is Telesurance Ltd., one of the soundest and most successful maintenance insurance concerns in Britain. There are other reputable companies which operate on much the same lines, but since I am most familiar with the methods of Telesurance and since it is a system which might well appeal to American TV dealers, I’m going to confine myself to giving a brief account of the way it operates.

The root of the whole scheme is that the agents for its policies are dealers who are members of the RTRA. They collect the premiums, forwarding them to the central office, which issues the policies to viewes. If a TV repair or replacement is required by a policy holder, Telesurance authorizes the dealer concerned to carry it out and pays him the agreed rate for materials supplied and for work done.

In other words, both the dealer and his customer know exactly where they stand. The customer knows that in return for his annual (or monthly) premium any replacement or repair needed will be carried out at no further cost to him. The dealers knows that he will be adequately and promptly paid for whatever he has to do. Sales resistance readily breaks down when the dealer is able to assure his customer that he can know to a penny what his viewing is going to cost in any year: the amount of the insurance premium plus the £3 ($8.40) for his receiving license plus the trifling cost of power from the electric mains.

Now let’s see what sort of premium the insured person has to pay and what it covers. The most popular screen size with us today is 17 inches. Larger models are available, but the 17-inch set is best adapted to the rather small living rooms of the present-day home.

If you take out a Telesurance policy when you install a new 17-inch set, you can make your choice of two alternatives. By paying £10.0.0d ($28) a year or 19s.6d ($2.70) a month you have these guarantees under a “B” policy:

1. The complete cost of all maintenance, repairs and replacements, including the C-R tube.
2. Full insurance against the theft of your set or against damage to it by fire or accident.
3. Indemnity up to £10,000 ($28,000) for damage caused by the collapse of your antenna.

Alternatively, you can, if you wish, take out the “A” policy. For a set with a 17-inch tube this costs £15 ($46.20) a year or £111.6d ($4.40) monthly. In addition to the coverage already mentioned, this provides free replacement of the C-R tube, even if it is still in good condition, at the end of three years. Or, should you then prefer to go in for a new receiver, the full value of the C-R tube will be deducted from its cost.

The “A” policy can be taken out only for a new set. You can start a “B” insurance at any time up to two years after installing a set, provided that an accredited dealer certifies that it is in good working condition. There is naturally an increase in the amount of the premiums according to the age of the set. Thus, if a “B” policy is first taken out for a set that has been in use six months, the premium is £11.15 ($32.90) annually, or £1.25.9d ($3.19) monthly. Should the set be a year old when the policy is issued, the yearly premium is £13.15 ($38.50) or £1.63 ($4.70) by monthly payments.

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The Alliance Manufacturing Co., Inc.
Alliance, Ohio

DECEMBER, 1955
Post-Acceleration Tube

By FRED SHUNAMAN
MANAGING EDITOR

A NEW color TV picture tube that may have advantages over both the now almost universal shadow-mask type and its only present rival, the one-gun Lawrence tube, is in the developmental stage. Samples were demonstrated by the General Electric Co., at Electronics Park near Syracuse, N. Y., in late September. Problems of mass production are still to be straightened out but the company believes the tube may be on the market in about a year.

The new tube has three guns—arranged horizontally in a straight line (Fig. 1) rather than in a triangle—and a vertical grid or grille set in a rigid frame near the screen. The grille looks something like the grid of the Lawrence tube—though in action it resembles RCA's shadow mask—and forms an electron-optical lens system that lets more than 90% of the electrons through to the screen instead of the approximately 15% that get through the shadow mask. It also performs some of the functions of the Lawrence tube's grid, but differs distinctly in that the potential on it is fixed and no dynamic voltages are applied. All wires are at the same potential.

The faceplate of the tube is made up of vertical color stripes, about .012 inch wide in one of the experimental models shown. About .8 inch behind it, the grille—consisting of wires approximately .003 inch in diameter, spaced about .035 inch apart—is fixed. The phosphor screen is kept at a voltage of 25,000, the grille at 6,300. The voltage on the accelerating anodes of the electron guns is 6,500, 200 volts higher than the grille potential. Thus the beam is accelerated after deflection and is referred to as a post-deflection acceleration or simply as a post-acceleration tube.

Because of the difference in potential between the screen and the wire grille, the field between is so shaped as to form an electron-optical lens system that bends as well as accelerates the electron beams. The lines of equal potential are indicated in Fig. 2. An electron tends to go in the direction of the highest potential—thus the lines of equal potential at approximately a right angle. Thus, electrons that enter the grille at a right angle travel straight ahead. Electrons that enter the grille region at a slight angle travel in a parabolic path toward the phosphor face.

Direction selectivity is the key to this tube's operation. As seen in Figs. 2 and 3, a beam coming straight down the tube will—in the section shown—be focused in a narrow strip in the middle of the vertical stripe halfway between the grid wires. A beam coming in from the left—represented by a single ray in Fig. 2—will, in trying to move in the direction of greatest increase in voltage, be focused toward the right, and the one from the right toward the left. (Angles as well as sizes in Figs. 2 and 3 are exaggerated to illustrate the action more clearly.)

Focusing action is an important factor in preserving color purity. The beam, which may be as much as .035 inch wide, is focused down to about .005 inch in the center of a .012-inch stripe, thus leaving ample guard bands on each side.

The progress of the beam across the screen is interesting. As the green beam—for example—continues toward the right in Fig. 3, part of it falls beyond the right grille wire. This portion is immediately deflected toward the center of the next green stripe, and as the beam continues to sweep it becomes stronger on that stripe as it becomes fainter on the preceding one. Thus each color "walks" across the tube, stepping on its own color stripes and exciting them according to its own intensity, depending on the signal modulation.

Advantages and disadvantages

One important advantage is that the tube requires less deflection voltage than one in which the beam is accelerated by the full screen voltage. The beam leaves the electron gun at 6.5 kv and, instead of being accelerated, sees ahead of it a slightly lower voltage—that of the grille. Thus the beam is much less "stiff" since the electrons are moving at relatively low velocity and need less power to deflect. The yoke is therefore much smaller than that required for present color tubes, using only about 40% as much copper.

The convergence problem is simplified by the in-line position of the guns. The central green beam is not controlled, and the two outside beams are made to converge with it. It is necessary only to move the two outside beams horizontally. This cuts the number of convergence controls in two and simplifies the work of convergence enormously.
The greatest advantage of the new tube is brightness, which G-E engineers claim to be at least six times that of the shadow-mask type. Developmental models of the tube were demonstrated under conditions of normal night-viewing illumination (7 foot-lamberts), home daytime viewing (up to 50 foot-lamberts) and under illumination similar to the high-intensity lighting of the daytime shop. Under both the latter conditions the post-acceleration tube showed up well, while the picture on the shadow-mask tube tended to wash out, especially under the strongest illumination. (A striking but unintentional result of the demonstration was to show that television dealers apparently prefer to demonstrate their sets under the worst possible conditions.)

The tube's brightness is accompanied by a disadvantage. Secondary electrons from the grid of the post-acceleration tube may accidentally hit the screen itself, strike the screen in a random manner and cause a slight white background and consequent loss of contrast. This result is most noticeable in a darkened room and is not as apparent under normal or daytime lighting. The screen's brightness makes it possible to use a neutral-density filter type of safety glass with 50% light attenuation. This reduces the effect of external ambient light and tends to compensate for the loss in contrast.

The magnetic field has been a factor in reducing purity and various means, including heavy mu-metal shields, purity coils or assemblies of permanent magnets around the tube face have been used to counteract it. Because of the vertical stripe pattern of this tube, the horizontal component of the Earth's magnetic field—which would cause the beam to move up or down—has no effect on color purity. Its vertical component, which would move the beam horizontally, is far too weak to affect the tube. But this may not be the case when the high voltage is unaffected but the size of the raster decreased.

The symptoms pointed to the vertical circuit, and after the raster voltage was increased, the trouble was cured by jarring or shaking the chassis. If the set was set alone, hours would pass with no sign of the trouble; then it would occur and quickly clear itself in a minute or less.

The intermittent would start as a sudden random tearout of several horizontal lines. The torn lines followed no pattern—the tearout might be at the top, middle or bottom—indicating that the trouble was not synchronized with the vertical sweep. Almost immediately, the height (vertical) scan would collapse to a vertical scan of about an inch and drop to the bottom of the picture tube. Occasionally, it would drop slightly below the bottom, in which case moving the yoke would bring it into view. The atomic effect was above the horizontal stripe.

The horizontal deflection would remain apparently unaltered but no video information could be seen on any part of the vertical raster. Varying the vertical hold control changed the appearance of the atomic effect and the frequency of the lines at the base of the "mushroom." The narrowed raster was much brighter than normal, as is almost always the case when the high voltage is unaffected but the size of the raster decreased.

The symptoms pointed to the vertical circuit, so the first test consisted of using a 60-cycle voltage to drive the vertical amplifier when the trouble occurred. A 0.1-mu capacitor coupled the heater supply to the grid of the vertical output tube through a switch. When the intermittent occurred, the switch was closed. There was a considerable vertical deflection which indicated that the vertical amplifier was functioning reasonably well. The position of the raster remained low, however, and the center line of the 60-cycle deflected raster remained in about the same position as the horizontal stripe. This indicated a possible defect in the vertical yoke. The collapse of the vertical scan with known deflection of the raster by a 60-cycle voltage at the grid of the vertical amplifier led to the suspicion that all was not well with the vertical oscillator. Loss of the video indicated that something was killing the signal.

A voltmeter was placed across the plate supply to the vertical oscillator and an v.i.m. across the B supply at the focus coil takes off. The next intermittent showed that the B supply to the vertical oscillator failed. The main B plus remained practically constant, increasing very slightly. Finding the trouble was now very, very easy. The B plus lead to the vertical oscillator was traced. The trouble was a poorly soldered joint. The wire was mechanically hooked to the joint properly so that the trouble seldom occurred.

The plate of the vertical oscillator did have about 10 volts on it (through the high-resistance joint), which accounted for the failure of the vertical scan. During the intermittent the B feed to the 6A6 g.a.c. tube and the grid of the 6SN7 horizontal sync separator was open. Likewise, the feed to the screen of video i.f. amplifier tube was open. This accounted for the loss of video in the raster, the loss of sync and the loss of vertical scan. The vertical oscillator was oscillating slightly, while squegging at a very low frequency. The squegging produced the atom-bomb effect and the influence of the vertical hold control on it.
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SPECIFICATIONS:

R.F. SIGNAL GENERATOR:
The Model TV-50 Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics. Accuracy and stability are assured by use of permeability trimmed Hi-Q coils, R.F. is available separately, modulated by the fixed 400 cycle sine-wave audio or modulated by the variable 300 cycle to 20,000 cycle variable audio. Provision has also been made for injection of any external modulating source.

VARIABLE AUDIO FREQUENCY GENERATOR:
In addition to a fixed 400 cycle sine-wave audio, the Model TV-50 Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal. This service is used for checking distortion in amplifiers, measuring amplifier gain, trouble shooting hearing aids, etc.

BAR GENERATOR:
This feature of the Model TV-50 Genometer will permit you to throw an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars. A Bar Generator is acknowledged to provide the quickest and most efficient way of adjusting TV linearity controls. The Model TV-50 employs a recently improved Bar Generator circuit which assures stable never-shifting vertical and horizontal bars.

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The Model TV-50 Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect. This service is used primarily for correct ion trap positioning and for adjustment of linearity.

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Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50 will enable you to adjust for proper color convergence. When all controls and circuits are in proper alignment, the resulting pattern will consist of a sharp white dot pattern on a black background. One or more circuit or control deviations will result in a dot pattern out of convergence, with the blue, red and green dots in overlapping dot patterns.

MARKER GENERATOR:
The Model TV-50 includes all the most frequently needed marker points. Because of the ever-changing and ever-increasing number of such points required, we decided against using crystal holders. We instead adjust each marker point against precise laboratory standards. The following markers are provided: 180 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc. (3579 Kc. is the color burst frequency.)

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A COMBINATION VOLT-Ohm MILLIAMMETER PLUS CAPACITY REACTANCE INDUCTANCE AND DECIBEL MEASUREMENTS

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/7,500 Volts
D.C. CURRENT: 0 to 1.5/15/Ma. 0 to 1.5/15 Amperes
RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms
CAPACITY: 001 to 1 Mfd, 1 to 50 Mfd. (Good-Bad scale for checking quality of electrolytic condensers.)
REACTANCE: 50 to 2,500 Ohms 2,500 Ohms to 2.5 Megohms
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Slight changes in resistor and capacitor values raise havoc in TV receivers. So...

By H. L. Matsinger

**WATCH YOUR R'S AND C'S**

SHANGRI-LA would hold no allure for the harassed service technician if all the faults in a TV or radio were positive. Tubes would be dead, never weak; coils would always open, never show intermittent resistance rise; resistors would open, never change value, and capacitors would invariably short, never be leaky or intermittently open.

But we live in an imperfect world, with imperfect electronic devices whose imperfect characteristics cause imperfect results. Otherwise there would be no repair jobs, so why worry? But it does make it necessary to spend some time in thoughtful analysis.

Radios would often hobble along with several defective parts; it would take a short or open to stop the set entirely. But in TV the least deviation from nominal values may cause erratic operation. In circuits where resistance or capacitance plays the leading role, an aging part which has changed value or developed leakage can be a troublemaker.

Composition resistors are adversely affected by extreme or prolonged heat, whether it be applied internally or externally. The molecules regroup and the resistance changes. These changes take place not only in the small insulated type, but also in the larger ones with ceramic cores.

Capacitors are subject to a variety of troubles—they may short, open, leak or change value. Consider the action which takes place within a capacitor in operation. When it is charged, the pressure on the dielectric is directly proportional to the voltage. With a.c., the pressure is alternately applied, removed and reversed, causing the plates and the dielectric to flex electronically and even mechanically in accordance with the frequency. You can see that the higher the frequency for a comparable voltage, or the higher the voltage, the greater will be the strain and stress set up within the capacitor. For reliability at the higher frequencies, silver plating on ceramic or mica is used.

Because high currents flow in this circuit, the screen and cathode resistors may change in value. When the horizontal sweep becomes insufficient, and the sides start to creep in, the resistors may be the trouble. Normal practice is to suspect the output tube, but often replacement gives only temporary improvement and after a week or so the sides start to creep in again. If this happens to you, don't pull out what little hair you have left—check those resistors.

You can usually check the screen resistor without pulling the chassis by measuring between the screen prong of the output socket and the low side of the flyback transformer or the plate of the damper tube, depending upon the circuit. If the resistor is more than 20% above the listed value (or the tolerance given for the particular unit), replace it.
With a circuit like that in the Du Mont RA-116A, a variable resistor in the screen lead is used as the horizontal size control, and resistor changes are not necessary. The cathode resistor can usually be checked by measuring between cathode and ground. Replace an off-value resistor with one of the next higher wattage rating.

Except for the horizontal drive control, often an adjustable ceramic or mica, most of the capacitors associated with the output circuit, the flyback transformer and damper tube will be of the paper, dielectric type. Complete breakdown resulting in a short circuit is the usual trouble and is not too hard to find. But once in a while a capacitor will open, causing nonlinearity which cannot be corrected with the control provided. Unless you have a capacitor tester, substitution is your best bet.

**Horizontal phase and ratio detectors**

Resistor troubles in these circuits are the penalty of mass-production methods. Manufacturers buy resistors by the tens of thousands and, except for spot checks, color coding is accepted at its face value. Too often, however, two resistors representing the high and low tolerance limits may be used as load resistors (Fig. 1) where it is important that the values be matched. Obviously, if the 100,000-ohm resistors are not equal, the amplitude of the respective voltages appearing across these resistors will be dissimilar. When the tube, usually a 6AL5, is new, this may not make much difference but with age the effect becomes more pronounced. In the ratio detector you may get some audio distortion while unbalance in the horizontal phase detector can cause instability in the horizontal circuit.

Capacitors used in the ratio detector are usually mica and will seldom give trouble, but faulty capacitors in the de-emphasis filter will cause an excess of high-frequency response. In some circuits, the load resistors are shunted with capacitors which should be matched for best results. The electrolytic stabilizing capacitor must be able to hold a charge or the audio will suffer. A breakdown of this unit will cause a loss of audio.

**Horizontal and vertical oscillators**

A very common service complaint is failure of the horizontal and vertical hold controls to function correctly. Faulty tubes play a big part in the loss of sync, but when you are repeatedly pulling down the same evil, it is time to look farther. Fig. 2 shows the basic circuit of a blocking oscillator. Most sets use an adaptation of this hookup or of that of the multivibrator shown in Fig. 3. They are similar, the primary differences being the manner in which the synchronizing pulses are introduced and the method by which the oscillations are sustained. Control of frequency and amplitude can be identical.

In some sets the heating of R1, R2 or C1 may cause drift during the first hour of operation, or the action may be continuous, with frequent adjustment necessary. Fig. 3, with R3, R4 and C2, has an additional source of drift. Circuits which use frequency coil L are usually more stable than those which depend upon an R-C combination for frequency control. With the coil, an open or leaky C2 will cause loss of horizontal control.

The Bendix model 2051 is a good example of a TV set using the simple multivibrator for the horizontal sync. In some of these sets the horizontal hold control must be advanced as the set warms up. After an hour or so of operation its range limit is reached, making sync impossible. Changing the 6SN7-GT's is not the right answer for it is often necessary to try four or five tubes before you get one to work satisfactorily. A better approach is to replace C1 (Fig. 3) with a silver mica type having a zero temperature coefficient, and R1, R3 with units having the next higher wattage rating. Horizontal hold will still be critical, but more stable.

**High-voltage filter**

The resistors and capacitors which make up the high-voltage filter are very susceptible to trouble. Dirt and dust become ionized and adhere to the surfaces of these units, forming low-resistance paths. This can result in blooming when the brilliancy control is advanced. A good rule to follow is to replace any of these components which looks at all doubtful.

**Sync separator, amplifier and integrator**

Peak voltages found in these circuits are generally around 20 to 40, and very seldom will you encounter resistor trouble. Capacitors, which may be very short, open or leak, disrupting normal operation. This is especially true of the integrator. Here we build up a number of short pulses into a triggering voltage for the vertical oscillator. Leakage cannot be tolerated. A good sync pulse will bring the vertical hold in with a bounce that will momentarily compress the picture. When you get a shallow sort of lock in, replace the capacitors with silver mica units.

**Miscellaneous trouble points**

It is obviously impossible to list in one short article all the points where trouble will develop from faulty resistors and capacitors. We have tried to list the most common. Some miscellaneous trouble points are as follows:

If the set develops a wavy section in the upper right or left corner of the picture, this is often caused by an open balancing capacitor in the horizontal deflection coil. A shorted capacitor or coil will cause keystoning.

Another trouble point is the brightness control. A shorted capacitor in this circuit will give you one of those no-picture no-raster deals while an open resistor will make it impossible to control the brightness. Naturally you have no alternative but to replace the faulty part.

Faults caused by imperfect resistors and capacitors in the r.f., l.f. and a.c. circuits give very much the same effect in TV as they do in conventional radios, and they are located in much the same manner. If you agree that you cannot judge a book by its cover, you will look with suspicion upon every resistor and capacitor in a circuit which is not right. Even units that look good should be checked, but if there is any sign of blistering, bubbles or melting wax, be doubly suspicious.

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A somewhat similar condition will occur in many vertical sync circuits. After a short period of operation retrace lines flash across the picture and the horizontal blanking bar appears, sometimes followed by a slight roll. Replacing the grid capacitor C1, together with the fixed and variable hold resistor will often eliminate this condition.

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**TELEVISION**
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Rainbow Patterns

with Conventional Generators

SERVICE technicians in the larger cities are becoming familiar with the rainbow type display on a color TV picture tube. Rainbow patterns are very easy to produce; all that is required are a pair of conventional signal generators and a crystal diode (Fig. 1). The generators are in parallel and feed their combined output through the crystal diode which operates as a modulator. The modulated output from the arrangement is applied to the antenna input terminals of the color TV receiver which then develops the rainbow pattern on the screen.

The system operates by a method known as the offset color subcarrier. In other words, generator A is tuned to 3.58 mc, plus or minus a given number of horizontal scan intervals (15,750 cycles). If it is set to a frequency of 3.58 mc plus 15,750 cycles, one rainbow is produced.

Turning generator A to 3.58 mc plus two horizontal scans (31,500 cycles) produces two complete rainbows with part of the second lost during the flyback interval. As many rainbows can be obtained as generator A is offset by a given number of horizontal scans. If the generator A is set in between a horizontal scan interval, varying numbers of diagonal rainbows appear.

Generator A should be set to deliver a CW signal; if the output is modulated by 400 cycles for example, the rainbows will be cut up by black horizontal bars. Generator B must be set to the channel for which the color TV set is tuned and should be set to provide a picture carrier frequency output. The output from generator A modulates the output from generator B so that sidebands are generated at the color subcarrier frequency (offset by the chosen number of horizontal scans).

The principle of operation of the arrangement is as follows: The color subcarrier oscillator in the receiver operates at 3.58 mc and when a signal which is offset in frequency (such as 3.58 mc minus 31,500 cycles) is fed into the chrominance circuits, the vector voltage of the offset color subcarrier rotates with respect to the vector voltage of the color subcarrier oscillator. Each individual phase angle occupied instantaneously by the offset color subcarrier defines a hue, as shown in Fig. 2. Since this vector voltage is continuously rotating at an exact multiple of the horizontal scanning frequency, it sweeps through a rainbow of defining hues, returning to its starting point at the end of the horizontal scan interval.

The output from the arrangement shown in Fig. 1 is a constant modulated voltage so that the level of the offset color subcarrier does not change from one hue to the next. Neither does the arrangement provide a Y component in the output signal, and all hues have an average value coincident with each other. Hence, although all hues are implicit in the offset color subcarrier vector, true colors are not obtained in the rainbow display, which appears dim and bluish as compared with the display provided by a true color bar generator. When true saturated colors are generated, the voltages provided by the generator supplying a 3.58-mc signal at the proper phase angle to define a hue and at a suitable voltage to produce a saturated color as required by the chrominance circuits. Also, the generator provides a Y (brightness) voltage which appears as a "crankshaft" signal when the color subcarrier is stripped off. Each hue requires a certain individual level of Y voltage to display a saturated color.

Some of the more important voltage relations are shown in Fig. 3.

Why does the rainbow display appear dim and bluish? The dimness results from elimination of the brightness component. A false brightness component can be inserted into the display by advancing the brightness control of the receiver somewhat beyond its normal setting. However this inserted brightness component has a constant value and does not change from hue to hue as required for true saturated colors. The bluish cast of the rainbow pattern results from the relative Y component contained by the various hues. Yellow, for example, contains 99% Y component and is most affected by its removal. Hence, yellow is almost invisible in the rainbow display. Blue has only 11% Y component and is least affected by its removal. Hence, the other colors appear bluish in the rainbow display.

The arrangement shown in Fig. 1 does not provide sync or burst. Because sync is lacking, the AM generator must be tuned with some care to obtain a stable pattern. Vertical sync is not required since only vertical bars are developed, and rolling is either invisible or appears only as a dot of the residual hum pattern.

The lack of burst does not inhibit operation of the color sync circuits since the color subcarrier oscillator in the receiver will lock in on some average phase of the signal. But it would be a difficult matter to attempt to use this to adjust the color phase control of the receiver, since a reference is not obtainable without a scope.

However, the rainbow pattern will show whether various sections of the chrominance circuits are operative, as may be seen by unplugging the E - Y demodulator, B - Y demodulator, etc.

The arrangement shown in Fig. 1 is instructive and is of some use in servicing. Since conventional black-and-white equipment can be used, it should be of interest to the small shop.

An r.f. sweep generator can be used in the arrangement if the sweep-width control setting is reduced to zero. Should the output from the r.f. generator be frequency-modulated, severe pattern disturbances will result. In any event, no matter what type of generator is used, output should be sufficient to drive modulator and receiver circuits at a satisfactory level.

*Chief Field Engineer, Simpson Electric Co.
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*Patent Applied For
Those deadly intermittent

By ART MARGOLIS

What do you do when a good customer blows his top over a big "intermittent" bill?

HOW many times has that intermittent on the far bench misbehaved in the last 10 days so you could work on it? How many times has the owner called, pleading, crying and screaming for it back? And how much money are you going to lose when you total up the futile agonizing labor hours?

Due to the importance of the intermittent problem our company had to work out some definite policies for a receiver so stricken. Even though these common-sense policies are far from spectacular, by sticking to them religiously we have had amazing, customer-calming, money-saving results.

Webster innocently and simply defines intermittent as "coming and going at intervals." The main trouble I find with TV intermittents is they go when I come and they come when I go!

The first thing I do, when I come and the trouble has departed, is turn into a persistent inquisitor. I try to glean from the set owner everything he can possibly remember about the escaped harasser.

I was out servicing a 12-inch Philco. The customer was complaining of occasional loss of picture but of course when I arrived the video was glaring at me. I began firing questions. The first thing I learned was the complete raster was leaving, not just the video. That led the interrogation into the vein of high voltage. I then learned the picture was not snapping off but fading away slowly. That more or less eliminated the 1B3 high-voltage rectifier and the 6SN7 horizontal oscillator.

I then managed to dig out that during the fading there was no shrinking at all. That sort of put the 6BG6 horizontal output and the 5U4 low-voltage rectifier in the clear.

Hopefully, I reasoned it was the filament in the picture tube or the 6W6 damper. I ceased my inquisition and jiggled the dickens out of the two tubes under suspicion. Lo and behold—the damper filaments faded languidly away like the proverbial old soldier. A few Sherlock Holmes questions plus a new damper neatly solved what could have been a nasty intermittent.

Like any good cross-examiner, you must be careful in considering the facts a technically ignorant set owner will offer you. Unwittingly they can throw traps in your way.

I was called to look at a 12-inch three-way Magnavox that was having spells. Using the same investigating routine as with the Philco, I found what seemed to be a similar case: spasmodic loss of raster, slow fading and no shrinking. Again I jiggled the picture tube and damper but this time to no avail. The set was pulled into my shop.

A couple days later we caught the trouble. The information about the raster loss, slow fading and no shrinking, while literally accurate, was technically worthless. For when the disturbances took place the raster bloomed and the 1B3 would wink blue as it caused the trouble.
Once I receive some inkling of the trouble, I take some definite action. If a set has troubles but they are not occurring, I try to persuade them to happen.

I was out examining a 21-inch RCA. The customer told me that every now and then his picture would shrink up and down as if it was inserted into a glass pecker and went tap-tap-tapping into the vertical sweep circuits. Nothing happened. Before pulling the chassis I decided to poke around the rest of the set. Going down the line, tube after tube, I started gold. The customer who was watching the screen for me suddenly yelled, “You got it, you got it!” Glancing into my setup mirror I saw a textbook example of 60-cycle hum in the video. The entire bottom half of the picture was blacked out. It was a heater-to-cathode short in the 6BQ7 r.f. amplifier. That was the vertical trouble.

You must be careful when you try to induce the intermittent condition. Like the time I walked in on a 21-inch Silvertone sitting there when I arrived. The customer described to me what sounded like a lead-pipe cinch case of fixed brightness due to a short in the electron gun.

I began tapping the back of the picture tube. The set owner frowned at this procedure. But I was dead right, for only two or three slight knock brought on the fixed brightness. I informed my client she had a bad picture tube. She plopped into a chair and took a deep breath. Hand over heart she told me that due to financial embarrassment the job would have to wait a while. Then she politely asked me to restore the picture to the way it was when I came in. I began tapping some more with my rubber hammer. The fixed brightness refused to budge. I hit it a few times with a screwdriver. The condition ignored me. To save my life, I could not get those shorted elements off.

In the end I was practically thrown out of the house without my service charge. The worst part was the irate customer honestly believed that I broke her picture tube on purpose. All in all though, persistent interrogation and an ambitious set-poking can bring to light a lot of the easier intermittents.

Sometimes the questioning hints at an easy-to-locate disturbance but set-prodding won’t induce the spasm to take place. If you don’t have a chassis, you can enlist the owner’s aid.

I had a 21-inch Philco whose owner was complaining about a white border appearing on the bottom of the picture. I gave her these instructions: Watch the TV set while I go. As soon as the vertical foldover begins call right in and leave the set on while waiting for me to arrive. The next afternoon she called. I found the defect. I made out a bill for two service charges and a $10 service call tube, instead of the high-priced chassis pulling and bench labor charges.

Another time a customer was being tormented by intermittent pulling on his 21-inch Muntz. The end result had a satisfied customer and me two more service charges and the price of a 6BL7 that had been doing the dirty work.

The main thing is, keep your instructions simple. I gave a woman owner of a large Du Mont these same intermittent-snaring instructions, but she missed them up a little bit. On a Monday morning I told her: “Watch the TV set as usual. When the trouble starts, call right in and leave the set turned on while you are waiting for me to arrive.”

That Friday evening we received a call, but the intermittent hadn’t acted up yet. She told the astounded operator: “The TV has been playing day and night now for five days. We would like to go away for the weekend. Is it all right if we turn it off?”

When chasing must be pulled

These customer interrogations and set-poking measures are still only first aid. The rub comes when these easy checks fail. Then the chassis must be pulled and placed under observation.

When an intermittent-harbor ing chassis is pulled, dire circumstances are created. You have filed from a TV-viewing addict his evening kicks. The days or perhaps weeks you spend in tracking down the subtle spasmodic trouble leave the set owner staring at an empty TV cabinet from whence no entertainment will shine. As his evenings elapse, his aggravation vented toward you will mount.

I remember a 21-inch Du Mont that had to be pulled for intermittent loss of raster. Only once every few days would it go by itself. After two or three observations we began making tests. We ascertained that the high voltage was not at fault. The next time it went off we switched channels and discovered a raster that was inert.

That drew us into the keyed a.g.c. circuits. We began a tedious substitution-and-wait procedure.

Meanwhile 10 days elapsed with the customer calling so regularly every day you could synchronize your watch. Each phoning raised his voice about an octave. The tenth day had him calling as usual, but somehow he sounded different. He asked me in a choked voice to come out and service his second set. I didn’t remember him having a second set but, glad to be of service, I dashed over there. When I knocked on the door, he opened it slowly and quickly wrenched my tube caddy out of my hands. The door slammed in my face.

I called the set for instructions. They informed me that the last substitution of the .001-pf 2,000-volt capacitor from the high-voltage transformer to the plate of the 6AU6 a.g.c. keyer (Fig. 1) had held up. The previous capacity was leaking and putting a heavy positive bias, through the a.g.c. system, onto the r.f. and i.f. grids.

These hot-running tubes were then producing so much detected signal that the video was cut off. That was the intermittent trouble.

I drove back to the shop, picked up the chassis, stopped in at the local constabulary and with two husky members of the bandit patrol chased the chassis. Actually though, I didn’t need the policemen for the customer gladly paid
TELEVISION

The first seizure took place about 3 days later. Some frantic checks showed no high voltage and the horizontal oscillator was out of sync. The attack lasted long enough for us to check the oscillator and output circuit. The tubes and parts were O.K. The loss of oscillator frequency was caused by a positive 20 volts on the oscillator's sync input grid.

About a week later the next fit took place. Pulling out the 6AL5 horizontal sync discriminator (Fig. 2) restored the oscillator's 15,750-cycle whistle, the raster popped on, but of course it was out of sync. Voltage checks showed the misplaced 20 volts was coming from and being developed across the discriminator's 10,000-ohm balancing resistors.

The next time it popped off we were waiting with a scope. Following the sync signals out of the sync stages it was fine till it entered the 6SN7 sync inverter tube. The sync signal appearing at the plate seemed to be in phase with the signal at the grid. The inverter tube was not inverting. A closer analysis showed distorted signal and the plate voltage about 10 volts low.

We changed the B plus filter in the plate supply. That did it. The filter was intermittently opening and throwing lots of ripple into the sync inverter plate circuit. That in turn was ruining the inverter action and causing the horizontal sync discriminator to develop a positive voltage on the wrong end of its balancing resistors. This positive voltage was then being transferred to the horizontal oscillator grid. The positive voltage messed up the horizontal frequency manufacturing. This wrong frequency caused a chain reaction, killing the high voltage. Whew!

You can imagine all the trying hours spent on this toughie. I only hit the highlights. However, the adequately briefed customer paid his expensive bill and was satisfied.

Lots of times, under these conditions, you can give the customer a pleasant surprise. I was out on a 12-inch Philco that would play for a while and then the raster would pop off. I was able to do some checking in the house. I discovered there was always good high voltage, raster or not. However, when the raster popped off I could draw a high-voltage arc to ground but I could not draw one to the second-anode terminal. I told the customer that, to the best of my knowledge, it looked like an intermittent open cathode in the picture tube. Since it was intermittent, I pulled it into the shop.

Less than an hour on the bench revealed it was not the picture tube. The 680,000-ohm limiting resistor (Fig. 3) between the 1B3 cathode and the second-cathode terminal was making and breaking. It was hard to convince the customer that I wasn't kidding when I handed him a bill for about half of what I had sold him on.

Anyway, if you can repair an intermittent receiver in the house by the interrogation-and-poke method, that is the thing to do. However, if the chassis must be pulled, don't leave the TV habitué without his pix and don't surprise him with a staggering repair tab.

If you keep TV watchers as comfortable as possible during the empty-cabinet ordeal and make sure they know the service bill is going to be high, you will virtually eliminate customer pressure and actually turn those deadly intermittents from a nagging expense to a sweet morsel of profit. END

Fig. 3—High-voltage supply circuit.
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DECEMBER, 1955
TELEVISION

A simplified procedure for adjusting TV circuits

By CHARLES G. BUSCOMBE

MANY technicians bog down when it comes to aligning a TV receiver. Actually no more difficult than other phases of servicing, for one reason or another it is often avoided like a plague. When asked, the average technician may give you several reasons for not getting involved in an alignment job. He is much too busy. Or customers are often unwilling to pay for the time required to do the job properly. (This may be true where before-and-after improvements are apparent only to the trained observer.) Too often the real reasons for the technician's steering shy of alignment are unwillingness and familiarity with the necessary test equipment.

There are many reasons why a TV set may go out of alignment: normal aging of components, rough handling during transit, vibration over a period of time, or possibly the set slipped by final factory inspection without proper testing. Changes are, if a set has been serviced a number of times, somewhere along the way it has fallen into the hands of a Saturday mechanic, possibly the owner himself. Symptoms of misalignment can often result from other troubles in the receiver, so the technician must be able to evaluate such symptoms and not be too hasty in attempting alignment that may not be necessary.

Pix i.f. alignment

Trouble symptoms that may indicate misalignment of picture i.f. strip are poor contrast, loss of picture detail, a smeared or streaked picture, unbalanced sync, poor picture sound tracking (where best picture and sound are not received simultaneously). There are several methods of tuning this section, the most popular one using a modulated r.f. signal to aid a v.t.v.m. The procedure is simple. Connect the v.t.v.m. between the signal input of the picture tube and chassis. Using the gain of video amplifiers in this way provides maximum meter sensitivity, making it possible to keep the signal up at a very low level. The meter is set for a low a.c. range.

Couple the signal generator to the mixer tube, preferably to an ungrounded shield slipped part way down on the tube. To keep the shield in a fixed position, squeeze it slightly. Do not apply the generator to the first i.f. grid; the input i.f. coil is invariably on the tuner and loose coupling from the generator is important. After making the connections it is simply a matter of determining the proper frequency for each i.f. coil, tuning the generator alternately to each frequency and adjusting the coils individually for maximum meter deflection. Where there are traps in the i.f. strip, adjust them for maximum dip on the meter.

The entire procedure should be repeated at least twice, each time with the generator well attenuated and using the lowest possible range on the v.t.v.m. The antenna should be disconnected during alignment to prevent meter deflection from external signals and noise interference. The a.g.c. circuit should also be disabled and a fixed bias substituted. Many technicians prefer to align the pix i.f. strip with a grid dip oscillator. This method is fast and reasonably accurate but can be used only where i.f. coils are exposed and not enclosed in shield cans. The procedure is first to determine the frequency each coil is tuned to. This is done by holding the grid dip meter near each coil, tuning the instrument for maximum dip on its meter and reading frequency on a calibrated dial scale. Coils that are not resonant to the manufacturer's specs can be corrected by tuning the grid dip meter to the proper frequency, coupling it to the coil in question and adjusting the slug for maximum dip.

(Only a few of the more expensive grid-dip meters are accurate enough for alignment of TV i.f. circuits. The g.d.o. is most useful when the circuits are so badly out of alignment that a signal generator cannot feed a signal through on the desired frequency. In this case, the g.d.o. may be used to check the circuits and bring them into rough alignment after which the signal generator can be used to complete the job.—Editor)

Visual alignment, as used by set manufacturers, is considered the most accurate method. Unfortunately, it is not popular with all technicians for several reasons. Besides requiring the use of several expensive instruments, it is somewhat complicated and difficult to understand.

Visual alignment

Knowledge and familiarity with the instruments involved—scope, sweep and marker generators—is of prime importance. Almost any type scope can be used provided it has adequate sensitivity and frequency response. Any source of unmodulated r.f. can be used as a marker signal but it must have accurate frequency calibration. The sweep generator produces an FM signal, usually modulated at a 60-cycle rate with a deviation or sweep control calibrated up to 10 or 15 mc.

At least 50% of the difficulties experienced with this method are in setting up the instruments, their adjustments, and interpretation of patterns displayed on the scope. Once the conditions of alignment are determined, the actual alignment of the set poses few complications. Start by connecting the scope and sweep generator as shown in Fig. 1. Prepare the scope (connected across the video detector load resistor) by adjusting its brilliance, focus and centering controls. Make certain its built-in sweep oscillator is switched off, as the voltage required for horizontal trace is obtained from the sweep generator. With sweep generator's deviation dial set for 8 mc, adjust the horizontal gain of the scope until the trace line barely extends to the C-R tube limits. The r.f. cable from the generator can be connected to an ungrounded shield slipped over the mixer tube. With the vertical gain of the scope turned up, tune the generator over the i.f. range until a response curve appears and is centered on the scope screen.

The response curve we first get will probably be hard to interpret. It may appear like any of those shown in Fig. 2. Our first job then is to adjust the instruments (not the receiver) until the curve assumes the proper proportions so we can determine the set's alignment.

Using Fig. 2-a as our standard, note its symmetrical shape and how both sides slope gradually to the base line. Depending on the particular scope and receiver, the curve may be inverted. Fig. 2-b indicates excessive vertical gain, so reduce the vertical gain on the scope or the r.f. output from the generator. Fig. 2-c indicates insufficient gain. Figs. 2-d and 2-e show the result of the sweep generator being slightly off frequency in either direction. If it is off frequency by a greater amount,
we would have only a horizontal line. Where the scope trace and the generator are not in step, we may have patterns as shown in Figs. 2-f and 2-g. For this we adjust the phasing control on the generator until the forward and return traces overlap. Where the curve has a narrow appearance as in Fig. 2-h, reduce the amount of sweep with the generator deviation control. Fig. 2-i shows the reverse condition — too little sweep is being used. Fig. 2-j is the result of external pickup from interference — try switching to an unused channel or disabling the tuner oscillator by grounding its grid or removing the oscillator tube if a separate one is used. Fig. 2-k is an indication of overloading due to an excessive generator signal or insufficient a.g.c. bias on the set. Fig. 2-l shows the presence of oscillations which may disappear as alignment progresses. Try varying the a.g.c. bias or backers off on the contrast control.

Once we have the overall response curve, we can identify various spots on it with a marker signal. The marker generator may also be coupled to the mixer tube, or its hot and ground leads may be connected between any two chassis points at both extremes of the i.f. strip. This is a good method as the r.f. voltage developed across the chassis resistance is simultaneously injected into all stages without any coupling problems. With the modulation turned off and the generator set for maximum output, tune to the same frequency as the setting on the sweep generator. As the marker hits the curve frequencies, the response will become distorted or completely obscured. Reduce the marker output until the pip indication is barely discernible. If the marker cannot be reduced enough to prevent curve distortion, try looser generator coupling or reduce the vertical gain of the scope. Where the marker is too weak to be seen, try tighter coupling or increase the scope gain, which must be compensated for by attenuating the sweep generator to keep the response within the limits of the C-R tube.

The next step is to determine the high- and low-frequency sides of the curve. Here again it may be one way or the other, depending on what scope and receiver are used. The procedure is simply to tune the marker generator, noting which way the marker pip moves on the curve and comparing it with the frequency markings on the dial. After obtaining correct pip and sound i.f. carrier frequencies from manufacturer's specs, tune the marker generator alternately to them and note where the pips fall on the response curve. Also check bandwidth between the two markers situated on both slopes at the 50% level. Actual bandwidth depends on the particular receiver (Fig. 3), the better-quality sets using nearly 4 mc. On split-carrier sets, the sound marker is positioned where the curve meets the base line. For intercarrier sets, the sound marker should ride up the slope to about the 19% level.

As the swept frequency of the generator travels through the set, it is influenced by the resonant condition of each i.f. stage. For example, suppose the receiver i.f. coils are tuned to 22, 24 and 26 mc, respectively. As the FM generator sweeps through this range, a high-resonant voltage will be developed at these frequencies, and very little in between. The varying signal voltage is fed to the vertical input of the scope. The horizontal trace is synchronized with the modulation of the generator, and the scope curve will show amplitude variations as the frequency changes.

The sweep generator in this case would be tuned to 24 mc, the center frequency. If the sweep is set for 8 mc, the frequency changes will vary from 20 to 28 mc, the amount necessary for observation of the entire response curve. With a sweep of 4 mc we would see only the top portion of the curve. Too much sweep will show more than the curve frequencies, giving the curve a narrowed appearance. A marker signal injected into the i.f. strip produces a pip for identification of frequency points on the response curve.

Where misplaced markers and improper bandwidth indicate our set requires alignment, start by moving the response curve to its proper center frequency. This is done by tuning all i.f. slugs either in or out until the curve is centered on the scope. Now inject the proper marker frequency for either the sound or pix i.f. carrier, regardless of where it falls on the curve. Experimentally adjust the coil slugs slightly to position the marker correctly. Then position the other marker. Do not over- or under-tune any coil; return the slug to its original setting if it does not produce the desired effect. Due to interaction, it may be necessary to shift from one marker to the other for optimum alignment.

Some receivers can be best aligned to stage by stage. The procedure described applies except for instrument connections. The generator is fed to the grid of the tube preceding the coil being tuned. The scope is connected to the plate of the following tube, using a high-frequency probe. For this method the manufacturer usually provides a series of curves showing general appearance and marker locations for each stage.

**Sound i.f. alignment**

Trouble symptoms indicating misalignment of sound i.f. stages are: complete absence of sound on all channels, weak or distorted sound, excessive sync buzz, and poor pix-sound tracking. Although there are several methods of aligning this section, the one discussed is the simplest and fastest.

![Fig. 2](https://example.com/fig2.png)

**Fig. 2**—A group of assorted response curves, as seen on the scope. Their interpretation is given in the text.

![Fig. 3](https://example.com/fig3.png)

**Fig. 3**—Typical curves for intercarrier and split-carrier TV receivers.
TELEVISION

Feed a modulated signal to the grid of the tube preceding the point of sound takeoff. Connect a v.t.v.m., set at a low a.c. range, to the grid or plate of any a.f. tube. With the generator tuned to the proper i.f., peak all sound i.f. plugs for maximum meter reading. Repeat this a second time with the generator output greatly reduced. With the antenna connected, tune in a signal and adjust the sound discriminator transformer for minimum sync buzz. Where misalignment is extreme, it is so extreme that the signal will not get through. Adjust each stage separately by feeding the generator to the grid of each tube, working back from discriminator to sound takeoff.

Where pix-sound tracking is poor and a generator is not available (as on house calls), the following procedure is effective. Set the fine tuner for best picture contrast, adjusting it slightly until the "edge" of the sound is heard. Peak all sound i.f. plugs for maximum volume. Repeat this until the picture and sound are coincident for one setting of the fine tuner. Finish by carefully adjusting the discriminator transformer to clear up the distortion and sync buzz.

Tuner alignment

Symptoms that indicate need for tuner alignment are: no picture, sound or both on one or more channels; weak, snowy picture on one or more channels; weak, distorted sound on several channels. All weak tuner tubes should be replaced before attempting alignment.

Most tuners have one or more r.f.-mixer adjustments. The oscillator may have as many as three frequency controls: a master oscillator adjustment, individual channel plugs accessible from the front and fine tuning. Although they all accomplish the same purpose, each has its own particular use. The master adjustment can be used after the replacement of the oscillator tube or where one or more channels cannot be tuned by individual channel plugs. The fine tuner is used by the set owner to compensate for oscillator drift.

For overall tuner alignment, set the fine tuning control to mid-position. Adjust the oscillator plugs to bring in picture and sound of each channel. Remove the antenna and connect an r.f. signal generator to the antenna terminals via a suitable matching network. For a resonance indication use a v.t.v.m. across the video detector load.

Set the receiver on a given channel and tune the generator to the pix carrier. Adjust the r.f. plugs in the tuner for maximum meter reading. Tune the generator to the sound carrier and adjust the mixer plugs for greatest deflection. If the two readings differ by more than 25%, alternately adjust each until they are nearly equal. Adjust other reception on all channels and, if necessary, make a compromise touch-up in favor of the weakest one.

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SEVERAL troubles can arise from defective video detector operation. Some of them are not too evident. For example, good sound with poor or no picture and sync can be due to the video detector. (This article is based on intercarrier sets.) Furthermore, placing the crystal detector in the last i.f. can has made both its testing and replacement difficult.

The video detector performs two functions: as an AM detector it rectifies and filters the modulated i.f. input to deliver a composite video signal to the video amplifier. As a mixer it heterodynes the AM picture carrier with the FM sound carrier to produce the 4.5-ne intercarrier sound. Fig. 1 shows the course of the signals.

In the majority of modern sets, the output of the picture detector must yield a signal greater than 1 volt to peak to produce a usable picture; a good picture requires 3 or more volts. If the video detector and preceding sections are performing satisfactorily, we can measure these voltages at the output of the second detector or its equivalent, the video amplifier input. We can select a weak station to see if more than the minimum of 1 volt peak to peak is present and also to see if the output on a strong signal is 3 to 5 volts peak to peak. The sound i.f. will be present if both picture and sound signals are sufficiently strong. A very weak picture signal will heterodyne with the sound signal to procure fair sound.

**Testing procedure**

In troubleshooting, check with an oscilloscope or voltmeter at the video detector load to determine whether the output is satisfactory for the station tuned in. If so, the video detector is O.K. If not, the input to the video detector must be checked to see if the signal is satisfactory there. If it is, the trouble lies in the video detector or its circuitry.

The video detector may be a tube such as half a 6AL5. A circuit of this type is used in the Emerson chassis 1Z0168D (Fig. 2). Typical modern crystal detector usage is shown in the schematic of the RCA chassis KCS81-B (Fig. 3); the crystal is in the last i.f. can. The input to the video detector is modulated i.f. The most accessible place to test is the plate of the last i.f. amplifier tube. Check here with a demodulator or peak-to-peak probe with a voltmeter.

To check the output of a video detector, connect an oscilloscope across the detector load resistor as indicated in Figs. 2 and 3. The detector load resistor may be easily identified in other circuits since its value is around 3,000 to 5,000 ohms. The oscilloscope reads peak-to-peak values. Lacking a scope, a voltmeter may be used. Connect it across the detector load and it will read the average of the peak value of the signal. This is about one-third the peak-to-peak value. When using a voltmeter, switch the station to an unused channel to see if the measurement is really a signal or something else such as hum. Also note on an unused channel the reading caused by noise plus contact potential—the reading on a signal will be increased by the contact potential. A weak-station voltage of over ¼ volt above contact potential is required.

If proper readings on a voltmeter or scope are not obtained, test the output of the last i.f. tube as the input to the video detector. Naturally, in the case of a tube rectifier, the tube should be replaced before making this test.

The oscilloscope should be fitted with a demodulator type probe to view the signal at the output of the last i.f. stage. Commercial demodulator probes are satisfactory, although I prefer to change the values to those shown in Fig. 4 which more closely resemble a second or video detector in their action. Note the low load resistance of 4,700 ohms which approximates the video detector load. The 5-µuf blocking capacitor need not be low; up to 100 µuf is good if the unit is used with an isolating resistor such as the 2,000-ohm unit shown in Fig. 4.

Fig. 5 is a photograph of a modified commercial probe with the isolation resistor attached to the probe end. The end lead of the resistor connecting to the circuit should be as short as is practical and may have a small hook to provide good contact with a lead to a socket terminal. The ground lead which leaves the case (also grounded) is close to the probe tip, placing the 10,000-ohm shunting resistor (Fig. 4) very close to ground. The ground lead should be attached to a ground point near the tube under measurement, and not just any handy place. The center contact of a tube socket is a convenient place to connect the probe ground. The ground lead should be stranded and relatively short.

With a probe such as described above, hook the probe tip to the plate of last i.f. tube and measure the scope indication.
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Fig. 5—Typical commercial probe.

There will be some detuning, minimized by the isolating resistor. Usually, a reading of more than two-thirds of that expected at the output of the video detector can be considered satisfactory.

If no scope is available, the voltmeter may be connected across the output of the probe. The readings will be about one-third those obtained with the scope. When using a voltmeter, switch to an unused channel to determine whether the indicated reading is due to a signal or to hum or some other voltage.

Isolating the trouble

When it has been determined that the trouble is in the video detector, check for open resistors and coils with an ohmmeter. Substituting a tube rectifier will reveal a bad diode. Substitution or check on a capacitance meter will test the capacitors. The small 5-10-µf filter capacitor may be disconnected for testing since the signal will come through with it out of the circuit and this will eliminate the possibility of its being short-circuited. The capacitor may be shunted if it is suspected of being open-circuited.

The i.f. tuning in the detector circuit may be off; it can be checked by turning the slug adjusting screw while monitoring the output or the picture. Make a mark in line with the adjustment screw slot on the chassis prior to turning this screw so that you can return to the same point if there is no change. An ohmmeter check will reveal a short-circuited crystal detector.

Crystal detectors have a bad habit of changing their forward resistance. The forward resistance of a good crystal is about 75-100 ohms and the back resistance 150,000 ohms or more, resulting in a ratio of 2,000 to 1 or so. To obtain a good video signal, the ratio must exceed about 200 to 1. To heterodyne sound, a ratio of 10 to 1 will yield a good signal. This accounts for the phenomenon of good sound with no picture. In such a case, after making the tests mentioned, check the crystal with an ohmmeter or, better yet, replace it.
picture quality, so easily degraded by even the slightest of interfering signals, is carefully guarded in most TV sets by a series of traps. Designed to pass 6-mc wide channels, the low-Q front-end r.f. circuits have a broad sloping frequency response (Fig. 1) that permits passage of adjacent-channel sound and video signals causing sound bars and best notes.

With channel 3, for example, occupying 60 to 66 mc, its video carrier at 61.25 mc and sound carrier at 65.75 mc fall extremely close to the sound carrier of the lower adjacent channel (59.75 mc) and the video carrier of the higher adjacent channel (67.25 mc). Thus an i.f. amplifier having its video i.f. at 25.75 mc and sound i.f. at 21.25 mc would find its tuner passing an adjacent-channel video signal of 19.75 mc and an adjacent-channel audio signal of 27.25 mc.

Fortunately, TV frequency allocations are such that adjacent channels are not usually found in the same area. A good example of this are the New York City stations: channels 2, 4, 5, 7, 9, 11, 13. It would appear that channels 4 and 5 might interfere with each other; however channel 4 at 66-72 mc and channel 5 at 76-82 mc have a 4-mc buffer between them. But with stations continually increasing their power, more and more areas are receiving good signals from adjacent channels.

Thus it remains for the high selectivity of the i.f. amplifier to remove adjacent-channel interference. In some sets, notably RCA 1953-55 models, selectivity adequate for interference rejection is provided by i.f. amplifier design and overall alignment. In others, the additional selectivity required for full interference suppression is provided by a series of traps. In this connection traps have an additional function of removing or attenuating the associated sound i.f. in video i.f. amplifiers. In intercarrier sets the sound i.f. is reduced for optimum video detector operation; in split-carrier sets traps remove any audio i.f. signal remaining after the sound takeoff. These traps are tuned to the sound i.f. of the receiver.

Traps

A commonly used trap consists of a parallel L-C circuit tuned to frequencies to be rejected and connected in series with the signal path. Like all traps, it is sharply tuned to reject a very narrow band of frequencies. At its resonant frequency the L-C circuit offers maximum impedance. At frequencies above and below resonance its impedance decreases rapidly and signals are passed with very little attenuation. Fig. 2 shows two series type traps used between the third and fourth video i.f. stages in the Stromberg-Carlson TS-125. These traps are tuned to reduce the associated sound (21.9 mc) and adjacent-channel sound (27.9 mc).

Another common type is the parallel trap, a series-resonant L-C network connected across the video i.f. amplifier. At its resonant frequency, the capacitive and inductive reactances of the trap are equal and the circuit appears as a short circuit to the unwanted signals. At any frequency other than the resonant one the impedance of the series circuit increases rapidly and becomes an input load impedance for the following stage. As in the series wavetrap, the selectivity of the circuit depends upon the Q—the higher the Q, the more selectivity.

Fig. 3 shows parallel traps used in the Philco chassis TV-301W. The grid circuit of the first i.f. contains two adjacent-channel sound traps at 47.25 mc. These are very sharply tuned to prevent the interfering signals from entering the i.f. amplifier. The 41.25 mc accompanying sound trap attenuates the signal for the proper video i.f. to sound i.f. ratio.

A bit more interesting is the absorption trap, perhaps the most widely used rejection circuit. Like the other traps, it consists of an L-C circuit (see Fig. 4) inductively coupled to the plate load coil of an i.f. amplifier. Operation is simple. The plate circuit receives all signals including those to be rejected. Energy from all signals is induced into the absorption circuit. However, at one frequency—trap circuit resonance—a large current flows taking place in the trap circuit. This reflects impedance into the primary, lowering the Q and gain of the primary circuit, reducing the voltage developed across the plate load impedance. Again, the sharpness of this rejection depends upon the Q of the wave trap. Fig. 4 shows a section of the i.f. amplifier in the Stromberg-Carlson K-KH21-22 in which extensive use is made of absorption traps. The network at 39.75 mc attenuates adjacent-channel video.

Another popular trap is found in the cathode circuit of i.f. amplifiers. The L-C tank circuit is directly in the cathode circuit. At the resonant frequency of the trap its impedance is very high,

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producing a large degenerative (inverse feedback) voltage and reducing the gain of the amplifier at that frequency. At all other frequencies, only a small voltage appears and the cathode degeneration is very small.

The previously discussed absorption trap can also be applied to the cathode circuit. At the resonant frequency of the tank circuit, it will reflect a large impedance into the cathode circuit, reducing the gain of the amplifier at that frequency. Fig. 5 shows such a circuit in the fourth video i.f. stage of the RCA STS30. This is an accompanying sound trap tuned to 21.25 mc.

Alignment of Traps

Because they are sharply tuned circuits, resonant at one frequency, alignment is simple—so much so that considering their great effect on picture quality trap alignment should be a must.

Connect an AM signal generator (modulation off) covering the 20- or 40-mc i.f. range as the case may be, to the grid circuit of the mixer. Connect a v.t.v.m. across the load resistor of the video detector to act as an indicator. Then set the signal generator to each trap frequency in turn, adjusting that trap for minimum reading on the v.t.v.m. A somewhat more accurate setting can be made by using a scope in place of the v.t.v.m. and using a modulated i.f. signal.

Whenever available, use manufacturer's instructions for aligning a particular receiver. They will usually specify some amount of fixed bias to be applied to the a.g.c. bus and suggest a sequence of alignment. Traps are generally aligned before overall adjustment, and should be touched up afterward because of the slight interaction between the various tuned circuits.

Excessive brightness

A Du Mont RA-112 chassis came in with an unusual set of troubles. The screen was very bright and, when the receiver was switched to FM or phono, it remained bright. Varying the brightness control had no effect. The picture could be seen, but it was very faint. I first suspected the switch since the picture tube should go dark on FM and phono. However, this component tested good. I did not check the picture tube because the raster lines were sharp and clear. There was one other inter-

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**Fig. 5—A cathode absorption trap.**

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DECEMBER, 1955

TUBE PLACEMENT CHARTS
14. Top and bottom views are shown. Top view is positioned as chassis would be viewed from back of cabinet.
15. Blank pin or locating key on each tube is shown on placement chart.
16. Tube charts include fuse location for quick service reference.

TUBE FAILURE CHECK CHARTS
17. Shows common trouble symptoms and indicates tubes generally responsible for such troubles.
18. Series filament strings are schematically presented for quick reference.

COMPLETE PARTS LISTS
19. A complete and detailed parts list is given for each receiver.
20. Proper replacement parts are listed, together with installation notes where required.
21. All parts are keyed to the photos and schematics for quick reference.

FIELD SERVICE NOTES
22. Each Folder includes time-saving tips for servicing in the customer's home.
23. Valuable hints are given for quick access to pertinent adjustments.
24. Tips on safety glass removal and cleaning.

TROUBLE-SHOOTING AIDS
25. Includes advice for localizing commonly occurring troubles.
26. Gives useful description of any new or unusual circuits employed in the receiver.
27. Includes hints and advice for each specific chassis.

OUTSTANDING GENERAL FEATURES
28. Each and every PHOTOFACT Folder, regardless of receiver manufacturer, is presented in a standard, uniform layout.
29. PHOTOFACT is a current service—you don't have to wait a year or longer for the data you need. PHOTOFACT keeps right up with receiver production.
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WRITE FOR STOCK CATALOG

OHMITE MANUFACTURING COMPANY
3646 Howard St., Skokie, Ill.
(Suburb of Chicago)

TELEVISION

Testing effect. When I removed the 6AL5 d.c. restorer (Fig. 4), the brightness level returned to normal and could be fully controlled by the brightness control.

This pretty much limited the trouble to the signal input circuit. However, I have been unable to come up with defective components. The 6AC7 video amplifier and the d.c. restorer tubes have been replaced. I would appreciate help on this problem.—A. B., Brooklyn, N. Y.

Since the raster remains bright on the FM and phono positions, there is probably an excessively high negative voltage on the cathode of the picture tube or a positive voltage on the grid. The significant clue is that you have normal control of brightness with the d.c. restorer removed. This eliminates cathode voltage trouble since the circuit between the -50-volt supply and the cathode is not affected by the action of the 6AL5. However, the grid circuit of the picture tube is connected to the 6AL5 cathode. Thus, a leaky .05-µf coupling capacitor (C1) between the video amplifier and the d.c. restorer would place a high d.c. potential on the grid and cause continuous brightness at all positions. Removing the 6AL5 breaks this circuit and restores normal brightness action.

Horizontal jitter

A Tech-Master model 1930 came in with no horizontal sync and very critical vertical sync. Two capacitors and a new sync separator took care of the vertical troubles but the horizontal jitter remained. I believe I have disconnected and tested every part in the sync circuits and the horizontal a.f.c. circuit, and have substituted new tubes.

Tapping the 6AC7 horizontal oscillator control tube produces an exaggerated jitter. But tapping any other place or component has no effect. I have even gone so far as to resolder every connection in this circuit. I'm stuck and would appreciate any suggestions you might have.—D. L., Mount Pulaski, Ill.

Since you have made such an exten-
sive examination of the horizontal a.f.c. circuit, you have narrowed the possibility of trouble down to a very common defect in this chassis. In the low-voltage power supply (Fig. 7) there is a three-section bleeder resistor (R1 - R2 - R3) connected between ground and the negative supply. The lower resistor R1 is 12 ohms and frequently becomes intermittent, often changing in value. This section of the bleeder can be replaced by a 12-ohm 1-watt resistor.

The 2 volts negative fed from this point to the horizontal a.f.c. circuit is very critical. Anything less than 1.6 or more than 2.4 will almost always cause horizontal jitter. This point is often overlooked because, unless measured on a 5-volt range or so, 1/2-volt differences are usually not noticed.

Split picture

I recently replaced a horizontal output transformer in a Sentinel 1U-116 receiver with the equivalent Stancor unit. The picture came on perfect in every respect except that the horizontal blanking bar appeared in the center of the screen. I can shift the bar slightly with the horizontal control, but after a slight shift the picture breaks up. The horizontal hold and centering controls were replaced without effect.

Picture definition is good and horizontal sync is stable. All component values appear normal. I would greatly appreciate it if you could help me out on this—H. H., New Berlin, N. Y.

The blanking bar in the center of the screen and the sync stability definitely isolated the trouble in the 6AL5 horizontal a.f.c. circuit. Since this defect followed the replacement of the flyback transformer, the most probable cause of the trouble is a reversed winding on the coil feeding the output signal back to the horizontal a.f.c. circuit.

There is also an excellent chance that the feedback voltage is larger or smaller than normal. Thus, if reversing the polarity of the feedback voltage does not correct the trouble, you will have to experiment with the various resistance and capacitance values in the feedback circuit. The most efficient way to do this is to replace the resistors with potentiometers. Vary these and use different capacitor values until you find a combination that provides the a.f.c. circuit with a suitable voltage. All this should be done, of course, while watching the screen. When normal horizontal action is obtained, replace the potentiometers with fixed resistors equal to the value then in the circuit.

Noisey channel switch

A Motorola chassis in the shop has an extremely noisy channel-selector switch. This set uses the TT-15 tuner with a 6B6 r.f. amplifier and a 12AT7 converter. Both tubes have been substituted and all connections checked as well as could be done without disturbing the wiring. I am fairly sure the trouble is in the channel switch because the noise occurs on some, but not all, channels. In addition, the slightest movement of the selector shaft produces considerable noise. I applied some carbon tetrachloride to the contacts but there was no apparent reduction in the noise.

The picture and synchronization are otherwise perfect. The set is very sensitive and the defect is not at all noticeable unless the selector shaft is rotated or touched. Perhaps you could suggest some better type cleaner.—R. G., Olympia, Wash.

The type of cleaner used for removing dirt from tuner contacts is not nearly as important as the manner in which it is applied. Dirt usually accumulates on the contact friction spring or the contact friction plate. The first indications are noisy switching. When more dirt gathers, picture quality becomes very poor.

There are many good contact cleaners on the market that will do a better job than carbon tetrachloride. Apply the cleaner liberally to both the friction plate and the friction spring. Then rotate the channel selector switch at least twice through its complete range. As an added precaution tighten the nuts that hold the switch contacts and coils in place. This will give you a good connection between the contact friction spring and the contact rotor plate. Don't use too much muscle on the nuts because the insulating washer under one of them breaks rather easily—tighten carefully.

Vertical jitter and buzz

I am working on an Admiral 21B1 receiver that has a continuous audio buzz. The picture jitters most of the time. The sync pulses from the sync circuit appear to be steady and of normal amplitude. I have replaced the vertical integrator network and checked most of the components in the vertical oscillator and amplifier circuits, and have replaced the tubes.

Wiring has been checked and all audio-circuit wiring is carefully dressed away from the vertical and horizontal circuits. When I vary the vertical hold control, the buzz gets higher in pitch. However, I have worked the vertical circuit over with a scope and checked with the service manual and couldn't ask for more perfect results. I would like to hear any further hints you might suggest.—N. E., Green Bay, Wis.

The most interesting part of the information you supplied is that the pitch of the sync buzz changes when you rotate the vertical hold control. This indicates that the interference is being produced in the vertical sweep stages since the change in pitch is the change in vertical oscillator frequency. It further indicates that there is a breakdown or arcing in the vertical output transformer or vertical deflection coils. Judging from the normal ratio of breakdowns it is far more likely that the defect is located in the vertical output transformer.

Fig. 7—Bleeder and a.f.c. circuits.

Jerry Smith, Bethel, Maine
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TELEVISION

V.T.V.M. Orient TV Antenna

You can adjust your antenna direction for optimum reception of any v.h.f. or u.h.f. station, using a v.t.v.m. and a simple adapter.

With antennas of the open circuit type, such as V's and conicals, only two small resistors and capacitors are needed (see diagram).

The resistors prevent shorting the signal and yet place the a.g.c. voltage on the transmission line. The blocking capacitors prevent shorting the a.g.c. voltage through the antenna coil of the tuner.

WARNING: This method is not recommended for use with sets that are "hot to ground" unless an isolation transformer is used between the set and the a.c. line.

By having the a.g.c. voltage available for measurement directly from the transmission line, it is possible to take your v.t.v.m. on the roof and adjust the direction of the antenna for maximum a.g.c. indication on the meter after a station has been selected at the receiver.

Most v.h.f. antennas have several lobes of good u.h.f. response at various directions around the antenna. In my own case one of the v.h.f. lobes gives an excellent signal from local channel 40 when the antenna is pointed in an entirely different direction for best reception of v.h.f. signals from San Francisco, about 90 miles away.

True, you can use a field-strength meter, but more people have a v.t.v.m.; and the TV set is here used as the field-strength meter. Also many receivers (Philco for example) make the a.g.c. voltage available from a test socket on top of the receiver chassis, which is convenient for using this system.

For TV sets in which the a.g.c. bus is difficult to reach, a socket adapter can be used under the detector or a.g.c. tube so that the signal diode (or a.g.c. tube plate) may be reached without removing the set. If this is done, the a.g.c. isolation resistor should be increased to 100,000 ohms.

This method may also be used with antennas of the closed loop type, such as folded dipole, if two more capacitors are temporarily inserted in the transmission line above the point at which the v.t.v.m. is connected.

The ground lead of most v.t.v.m.'s is usually terminated with an alligator clip. It is a good idea to put one on the test prod too before taking it on the roof. This leaves both hands free for turning the antenna. (Turn the mast with a pipe wrench.)—Louis Bourget
INDIANAPOLIS

Delegates from widely separated parts of the country met at Minneapolis on Jan. 1 to discuss and, if possible, implement unification of the nation's various service groups. Joe Barg, attorney and executive director of the Cincinnati Association of Television Service Companies, was elected president and Murray Barlowe of the Radio Television Guild of Long Island, vice chairman.

At the date of writing, reports on the meeting were still somewhat confused and tended to reflect the opinions of the various reporters, but it is clear that early in the meeting the sentiment for one organization rather than a loose union of existing associations and federations prevailed over all other viewpoints.

Forest Baker of the Texas Electronic Association presented a plan based on the Texas organization of a state group made up of local associations and showed with the help of charts how the setup could be expanded to cover the country. The plan would organize 4 groups of 12 states each into a division and the 4 divisions would send representatives to a national meeting.

Murray Barlowe of the Long Island Guild, a member of the New York State federation, a somewhat similar setup to that of Texas, endorsed the proposition, pointing out that such a form of organization gave the best assurance of democracy.

Barlowe then moved that a new association be formed, incorporating all existing local, state and national groups, and that such association be democratically controlled, with direction coming from local organizations rather than from the office of the president.

The motion was seconded and presented for discussion by the chairman. Discussion followed but the motion was apparently lost sight of later in the meeting as none of the participants queried remembered either its withdrawal or other disposition.

Frank Moch, National Alliance of Television & Electronic Service Associations (NATESA) president, then took the stand, presenting NATESA as just such an organization as that outlined, and suggested it might be foolish to proceed to build a new national group under the circumstances.

Al Saunders (Boston), spoke in support, stating that he could not persuade the New England associations to go along with the idea of a new group after having worked to unify them in NATESA. John Graham, veteran member of the Columbus, Ohio, association, said that he believed NATESA had all the elements necessary for a unified national group. Mr. Al Bernsohn spoke from the chair, calling special attention to Mr. Moch's devoted work in building NATESA and urging the delegates present "not to change the foundation" even though they might want to change the form of the organization.

At the end of the session, Mr. Moch, managing director of the National Appliance & Radio-TV Dealers Association (NARDA), made an impassioned plea for unity and the need for a professional national group.

He stated that NARDA would be willing to turn over all the work done by its service division to a group of this type and to give freely of its time and experience to make such a group successful. John Hemak, of MINTSE (Minnesota Television Service Engineers), spoke of the role of the state organization and discussed the areas in which a state group would be effective. Max Liebowitz of National Electronic Technicians & Service Dealers Associations (NETSDA), outlined the "umbrella" type of organization he had introduced at an earlier Pittsburgh meeting.

Barg again took the lead and examined Mr. Moch on various phases of NATESA's structure and methods. At one point object was made by Mr. Bernsohn to Moch's statement that organizations wishing to affiliate with NATESA would have to be investigated by that body. He stated that the older Eastern organizations would consider such a demand an affront. Mr. Bernsohn then raised a point of order, stating that Barg was acting improperly in discussing NATESA as if it were already selected as the accepted organization. In this he was supported by Barlowe. After some display of feeling throughout the meeting over being investigated by NATESA, Mr. Barg suggested an emergency meeting between Mr. Moch and state representatives. The meeting agreed that a group consisting of one representative from each state in attendance, with an additional representative from NATESA in those states where there was duplication of associations, should meet to try to work out concessions and bring a resolution in to the main body. After considerable discussion, said to be chiefly concerned with the question of a suitable name for the new body, the delegates evolved this resolution:

"That we go back to the general meeting and ask our groups to join NATESA and at the next general meeting, no later than April, 1956, make any changes found necessary; and that any quorum found will be immediately accepted without investigation if application is received before Feb. 7, 1956."

The resolution was presented to the main body and accepted by a voice vote. Following adjournment, some delegates reported that about all they could do would be to take the resolution back home and present it to their members. Doubt especially, was expressed about the attitude of the older Eastern groups, who were not too well represented. The Pennsylvania federation (FRSAP, oldest and possibly strongest of all state groups in the country, was represented only by Pittsburgh, and ESFEA (Empire State Federation of Electronic Associations), only by the Long Island Guild and the New York City Association (ARTSNY). There is still a possibility of another meeting after the delegates have obtained the reaction of their local and state associations. This consideration prompted the withdrawal of a motion to disband the Electronic Service Council, and it is upon such a meeting that the possibility of further progress toward unity in the service field rests.

GUILD WANTS TO BUY!

A novel approach to the retailing distributor problem was made in a recent letter from the Radio and Television Guild of Long Island. Addressed to Mr. Don C. Mitchell, president of Sylvania, the letter said:

"The electronic industry is well aware of Sylvania's past record of cooperation with the independent service industry. The Radio Television Guild of Long Island, representing over 1,000 service dealers in the Northeastern and Middle Atlantic States, is confident that your company would not want to be instrumental in putting the independent service dealer in an unfair competitive position."

"These are the facts:

"Long Island is presently without a 'wholesale' Sylvania distributor . . . . The franchised dealers appointed by your company to serve the service dealers in this area are in open competition with them for the same customer, the retail consumer. The independent service dealer is placed in the unfair position of having to compete with his supplier, without the benefit of the franchise which provides an additional discount . . . ."

"Under the provisions of the Robinson-Patman Anti-Discrimination Act it is unlawful for a manufacturer engaged in interstate commerce to discriminate in pricing between different purchasers of commodities of like grade and quality.

DECEMBER, 1955

115
AMERICAN PHENOLIC CORPORATION
chicago 50, illinois
AMPHENOL CANADA LIMITED
toronto 9, ontario

TECHNICIANS NEWS  (Continued)

"To correct these unfair conditions as they exist today, we, the members of the Radio Television Guild of Long Island, formally request the opportunity to buy our Sylvania products from you (directly or otherwise) at the same price as do our competitors."

The letter and reply from Sylvania were published in the September issue of the Guild News.

TISA NOW TESA

The Television Installation Service Association (TISA), of Chicago, has voted unanimously to change its corporate title to the Television Electronic Service Association (TESA), thus becoming possibly the first association to put into effect the recommendation of the 1955 NATESTA convention. Because TISA has spent thousands of dollars to build up prestige for the name, which it has carried longer than most TV service associations, it is believed that the action will do much to speed up the adoption of the TESA name by other NATESTA affiliates.

TECHS VISIT CHERRY HILL

RCA Service Co. recently conducted a two-day seminar to discuss black-and-white and color TV and other matters affecting the electronics service industry. Prominent members of service organizations were guests of RCA Service Co.

The service technicians were conducted on an inspection tour of RCA’s new service facilities at Cherry Hill (Camden, N. J.) and on the second day made a tour of the David Sarnoff Research Center at Princeton, N. J. They were also introduced, by discussion and demonstration, to the experimental electronic refrigerator, music synthesizer, light amplifier and other electronic equipment of the future.

CHICAGO PROGRAM

The Associated Radio and Television Servicemen of Chicago have released a lecture program for the fall and winter. The series includes such subjects as financing and credit as well as technical information. Current lectures are: Nov. 29, Richard Harasek of Motorola, on printed circuits; Dec. 14, Eugene Reichstetter, Dun & Bradstreet, Chicago, on credit and rating practices; Jan. 17, 1956, L. J. Couch of Sylvania, on transistors. A second part of the series is being projected and will cover business topics of interest to the small shop owner. It is expected that advertising, income tax and public relations will be the main subjects.

PRSMA HAS DE LUXE HALL

The Philadelphia Radio Service Men’s Association has arranged with the Franklin Institute to use their lecture hall on the first Tuesday of each month. The hall, according to PRSMA president Dick Devaney, seats 350 people, has provision for moving pictures or slides and is air-conditioned.

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---

**Help-Freddie-Walk Fund**

We are constantly surprised and gratified by the continued response to our appeal to "Help Freddie Walk" and are certain our readers will be as happy as we are to note that the Fund has reached almost $12,000. This will go a long way towards helping little Freddie Thomason, armless and legless son of Herschel Thomason, radio technician of Magnolia, Ark., grow into a healthy, productive adult.

As we go to press, the school term has started and Freddie, like every other 7-year old, is probably deep in the mysteries of reading, 'riting and 'rithmetic... and very likely dreaming about next summer.

Born without arms and legs, Freddie is otherwise exactly like every other child, looking to the future and planning in his own way to when he will be "grown up." Freddie has already been fitted with legs and has learned to use them admirably. Soon he will be fitted with mechanical—we hope electronic—arms and hands to help him explore his world further.

But as he grows, these appliances must grow with him. It is an expensive proposition, one that the Thomasons cannot hope to handle alone.

Won't you do your bit to help? No contribution is too small to receive our sincere thanks and acknowledgment, and you will know that every penny of your donation is put to good use in a worthy cause. **Make out all checks, money orders, etc., c/o Herschel Thomason.** Send all contributions to:

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Powerway utilizes short antenna elements in series with a section of simulated 3-wire transmission line and unique reflector system. Sleeve dipole for close centering of impedance characteristic for optimum performance and match between antenna, lead-in and TV set. 2- and 4-bay models for fringe and deep-fringe areas—American Phenolic Corp., Chicago 90, III.

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Taco model 825, available as 2- and 3-way splitting devices. Weatherproof cases; designed for exterior installation, reducing long indoor runs of transmission line. Voltage-splitting type not requiring power line connections. In high signal-strength areas used in tandem. Adapted for use with broad-band, high-gain Taco Super-Fringe antenna model 1580 antenna.

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Technical Appliance Co., Sherburne, N. Y.

SUPER-FRINGE TV ANTENNA, Wizard, gives high gain, sharp directivity on all v.h.f. channels. Parasitic phase reversers (metal shield mounted in front of receiving element)

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ANTENNA, Wayne Master, uniform high gain on channels 2-13. Functions as phased collinear array on channels 7-13 and as end-loaded broad-band cords and 4 7-inch reels of magnetic tape. Mahogany or blond wood—Daystrom Electric Corp., 753 Main St, Poughkeepsie, N. Y.

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NEW DEVICES

watts to show peak load on speaker system—and positive indicator to help prevent voice coil damage.—Fisher Radio Corp., 2121 44th Drive, Long Island City 1, N. Y.

WIDE-RANGE MAGNETIC PICKUP. Flaxwax, turnover type, cartridge. Replaceable styli has high compliance for low tracking force (2-3 grams). Frequency response absolutely flat well beyond 20 kc; negligible 1M distortion; output of 25 mv at normal recording level. Entire magnetic circuit, encapsulated in tough plastic. Mounting clip for use with all standard arms acts as bearing for turnover action.—Pickering & Co., Inc., Oceanside, N. Y.

2-SPEED HI-FI TAPE RECORDER, type SR-27, tape transport mechanism and 10-watt amplifier in separate carrying cases. R-27 transport mechanism has 3 magnetic heads to record, erase, playback tape on standard 7-inch reels at 7½ or 15 ips. Single control lever for record, playback or fast-speed operation. Amplifier contains microphone, playback preamplifiers, 2 small spot well for low-level monitoring. Microphone inputs of 50 or 250 ohms. Maximum output power of 75 watts. At 15 IPS, frequency response up to 15,000 cycles, signal-to-noise ratio 50 db, 0.15% r.m.s.—Presto Recording Corp., P. O. Box 500, Paramus, N. J.

PRECISION MAGNETIC RECORDING HEAD, Micro-Gap, designed for specialized industrial applications and professional-quality tape recorders.—Shure Bros., 225 W. Huron St., Chicago 10, Ill.

HI-FI LOUDSPEAKER ENCLOSURE, Karison 8, for use with 8-inch speakers. 5 models: easy-to-assemble kit, factory-assembled kit; 3-color painted unit; 2 deluxe models finished in blond or mahogany plastic. Karison 8 kit parts precut, step-by-step account of assembly. Only hammer and glue neces-

sary, 15 pounds; 17 1/4 x 11 3/4 x 10 inches.—Karlson Associates, Inc., 1610 Neck Rd., Brooklyn 29, N. Y.

NONRESONANT ENCLOSURE, Hartley, 7-section, 2-stage acoustic filter for one or two Hartley 210 nonresonant speak-

ers. 30 x 18 x 16 inches, in blond or mahogany.—Hartley Products Co., 521 E. 102 St., New York 1, N. Y.


POCKET-SIZED KITS hold small replacement parts, particularly Delco auto radio replacement hardware. 4 clear plastic kits are divided into 8 compartments. Chart on cover names part and part number for ordering compartment refills supplied in small plastic

(Continued)
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NEW DEVICES


AUDIO GENERATOR KIT, model AG-9, features step-tuning from 10 cycles to 100 kc with 3 rotary switches that provide 2 significant figures and multiplies. Less than 1% distortion. Frequency accurate to within ±5%. Output monitored on a large 4½-inch meter that reads voltage or db. Variable output (and meter) ranges: 0 to 0.06, 0.1, 0.2, 0.3, 1, 3, 10 volts. Rapid selection of desired frequency; accurate return to any frequency.—Heath Co., Benton Harbor, Mich.

LABORATORY TYPE OSCILLOSCOPE, type 827, covers 18 cycles to 1.1 mc. Total harmonic distortion of output waveform less than 0.2%, over most of useful range. Output voltage constant within ±½ db 18 cycles to 200 kc for any output above 0.1 volt. Output level 10 volts open-circuit; hum and noise levels, mv or 60 db below signal; power supply 117 volts, 50 to 400 cycles.—Technical Products Div., Allen B. Du Mont Labs., Inc., 700 Bloomfield Ave., Clifton, N. J.

5-INCH OSCILLOSCOPE, EICO type 569, kit or wired with step-by-step instructions for assembly and operation. For laboratory, production line and monochrome and color TV servicing. Flat from d.c. to 4.5 mc, usable to above 5 mc; built-in voltage calibrator; 25-μv-per-inch vertical sensitivity; sweep frequencies 10 cycles to 100 kc, plus lower sweep frequencies with external capacitor; repeat blanking.—Electronic Instrument Co., Inc., 81 Withered St., Brooklyn 11, N. Y.

FILAMENT CHECKER, SENCO model FC 4, for finding open filament in series-string TV sets. Checks all octals, locals, and step-tune attenuation provided. Zero-to-maximum reading at each attenuator position.

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Features found only in much higher priced kits. Batteries incl. (not sold less bulk).

Geiger tube 900 volt halogen quenching type, protects against burnsouts. 100,000 counts per min. Detects minimum radiation harmful to health; detects presence of uranium or other radio-active ores. Simple operation, rugged construction. Low cost battery replacement. High gain power amplifier, ultra sensitive Geiger tube for phenomenal high sensitivity. Radio-active sample & headphone incl. Max shoulder carrying strap, long battery life, unlimited life Geiger 900 volt tube, halogen quenched, unaffected by light or temperature (−50° to 125°), finely finished all steel case.

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360 ohms
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NEW DEVICES

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GEIGER COUNTER, model AE100, completely wired, includes all batteries and tube. Supersensitive, has 900-volt halogen quenching tube to protect against burn-out. Detects presence of uranium or other radio-active ores, minimum radiation harmful to health. Model AEX100 (kit) includes batteries and tube, headphone and shoulder carrying strap. General Electronics Equipment Co., 842 Glendale & Mantua Sts., Easton, Pa.

DUAL-PURPOSE SELENIUM RECTIFIER, type 60-9150, voltage-doubler stack delivering 50 ma connected to maximum a.c. input of 175 volts r.m.s. 2 units combined as single-phase full-wave bridge circuit delivers approximately 150 volts d.c. at 0.1 amp for r.m.s. voltage input of 230. Output of 350 volts d.c. obtainable. For remote TV tuners where hum is objectionable; solenoids, variable-speed controls, field supplies for small d.c. motors, etc. 21/2 x 1/16 x 3/4 inches overall. Mountable with No. 8 machine screw through hollow brass eyelet.—International Rectifier Corp., 1621 E. Grand Ave., El Segundo, Calif.

VARIABLE CAPACITOR, MS-217, for builder of transistorized and miniature equipment. Variable from 10 to 365 mfd. 6/16 inch thick by 1/2 inches square. Bushing and shaft extends 3/4 inch; 180° rotation.—Lafayette Radio, 100 Sixth Ave., New York 13, N. Y.

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PREAMPLIFIER-AMPLIFIER. Precede model PC-200, uses printed circuits. 10 watts output. Preampmifier inputs for phone and tuner, tape input for correct preamplifier equalization for tape recorder heads. Tape output unaffected by tone controls.—Harman-Kardon, Inc., Westbury, L. I., N. Y.

CLEANER AND LUBRICATOR, Trol-Gun and Trol-Kleen, Trol-Gun loaded like fountain pen. Fits over set's volume control shaft. Tool's piston forces cleaner-solvent into area around shaft. Trol-Kleen recommended for use with the gun. Both can be used on pushbuttons, switch contacts and tuners.—General Cement Mfg. Co., 400 S. Wyman St., Rockford, Ill. In

(Continued)
OUTSTANDING FEATURES:

**G_m MEASUREMENTS**—G_m measurements are made more accurately by using filtered d-c plate, screen grid and control grid potentials. A precision voltage divider network and selector switch allows a proportionate value of signal voltage to be chosen for testing tubes having transconductances up to 30,000 micromhos. Signal voltages of 5.2, 2.6, 1.3, and 0.65 volts peak-to-peak having a frequency of 5000 cycles are provided.

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**METER MEASUREMENT OF HIGH LEAKAGE RESISTANCE**—Since tube leakage as high as several megohms can cause poor performance in TV Receivers, this tubechecker is designed to provide an accurate meter measurement of leakage resistance as high as 5 megohms between tube elements, thus being particularly useful for TV servicing and TV line production assembly.

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new Tubes & Transistors

Germanium transistors
Four new types of germanium n-p-n transistors have been announced by Texas Instruments. The 2N124, 2N125, 2N126 and 2N127 are especially designed for general-purpose switching and computer applications. The units feature a beta spread of 2 to 1: 12 to 24, 24 to 48, 48 to 100 and 100 to 200, respectively. Because of their excellent rise-time and cutoff characteristics they can be used in high-speed switching circuits. Rise time in a typical circuit is 0.15 µsec; cutoff time is 3.5 µsec.

2N115
Amperex has announced a p-n-p junction power transistor, the 2N115 (see photo), that delivers 5 watts push-pull output with a 6-volt supply. The output impedance of the 2N115 is low enough for a 5-ohm speaker voice coil to be used directly as the collector load in an audio output stage and is ideal for operation in car radios having 6-volt systems.

6521 Magnetron
Intended for use as a pulsed oscil-
NEW TUBES & TRANSISTORS (Continued)

When operated at a peak anode current of 13.5 amperes, corresponding to a peak anode voltage of about 15 kv, the 6521 is capable of a peak power output of approximately 85 kw. The tube was announced by RCA.

6CH7

Information on this miniature medium-mu twin-triode designed for v.h.f. cascode amplifier applications was given in our November column. Further data gives the basing connections (see diagram). Because of the connection of the internal shield, section 1 (pins 6, 7, 8 and 9) must be used as the input or grounded-cathode section. Except for basing, it is identical to the 6BZ7.

6BY4

A ceramic high-mu triode of parallel-plane construction, the 6BY4 (see diagram), has been announced by G.E. Designed primarily for use as a grounded-grid r.f. amplifier in u.h.f.-v.h.f. TV receivers, this micro-mini-

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2. Ceramic element gives flat response (see curve) — requires no preamplification or equalization. No deterioration problems as with other types...virtually immune to hum pickup.
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5. Needles snap in, snap out easily.

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Install this new Sonotone 1P, and give your customers exciting, true, wide range response. At one stroke, you make a good sale, cut installation time, avoid problems found with other types of cartridges... and build your reputation for quality work and professional advice. No other cartridge has all the advantages this 1P gives you! With sapphire, $7.50; with diamond, $25.00.

RESPONSE 30-15,000 ± 3 DB!

SONOTONE CORPORATION
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NEW TUBES & TRANSISTORS (Continued)

ature tube is of metal-ceramic construction. This gives it several advantages over glass receiving tubes—operation at higher temperatures, greater resistance to mechanical shock and vibration, low microphonic output.

Operating at 300 mc, the 6BY4 provides a power gain of approximately 15 db and a noise factor of approximately 8.5 db with a 10-ne bandwidth. Thus the tube can operate as an r.f. amplifier for both v.h.f. and u.h.f. in TV tuners. Maximum ratings for the 6BY4 are: plate voltage, 300; positive d.c. grid voltage, 0 plate dissipation, 1.1 watts; d.c. cathode current, 5.5 milli-ampere.

Operating as a typical class-A amplifier the 6BY4 has an amplification factor of 100, a plate resistance of 16,700 ohms, a transconductance of 6,000 microhms. Heater voltage is 6.3 at 250 ma. Plate voltage in this application may be 200, plate current 5 ma and grid bias — 1 volt.

END

CORRECTIONS
Through a fantastic printer's error in the coil table for the preselector on page 141 of the October issue, in the fourth column, labeled "Taps From Ground," data for the 160-meter coil was erroneously transposed with that for the coil used on 15, 11 and 10 meters. Similarly, the data for the 80- and 20-meter coils is transposed in this column.

Our thanks to Preston A. Taylor of Elmoira, Ind. for catching this error in the coil data.

As the result of an error in "Circuit Features in Hi-Fi Power Amplifiers" in the September issue, a 6A7-G is suggested on page 79 for V1 and V2 in Fig. 5. The tube type should be a 6AS7-G.

Radio Thirty-Five Years Ago
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HUGO GERNSBACK
Founder

| Modern Electricity | 1908 |
| Wireless Association of America | 1908 |
| Electrical Experimenter | 1911 |
| Radio News | 1919 |
| Science & Invention | 1919 |
| Science World | 1925 |
| Radio Craft | 1926 |
| Radio Craft Monthly | 1926 |
| Television News | 1931 |

Some of the larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

In December 1921 Science and Invention (formerly Electrical Experimenter)
Perfectly Synchronized Talking Movies, by Joseph H. Kraus.
Learn and Work While You Sleep, by H. Gernsback.
Invisible Ray Signaling.
Radio in a Nutshell.
A Short-Wave Regenerative Set, by William H. Grace, Jr.

RADIO-ELECTRONICS

http://www.americanradiohistory.com
Most v.t.v.m. circuits specify two similar tubes in a balanced-bridge arrangement. One reason for this requirement is the need for linear response. The same result may be obtained with a single voltmeter tube if it is biased at a voltage rectifying the signal. After filtering, a negative voltage is delivered to V2 (the d.c. amplifier or linear portion of its characteristic. This is done here.

The diagram shows an a.c. voltmeter with V1 rectifying the signal. After filtering, a negative voltage is delivered to V2 (the d.c. amplifier or rectifier circuit). The broadcast signal appears on the oscillator signal. After filtering, the signal is treated as an a.c. signal. Therefore the meter does not deflect when the signal is zero. The reading increases with signal input because V2 passes less current and unbalances the meter network. R2 controls sensitivity.

TRANSISTOR CONVERTER

Useful for mixer and converter service, this tetrode transistor has three point contacts closely spaced on the semiconductor to form a triangle. One is treated to become a collector, the others are emitters.

The diagram shows a local oscillator and mixer circuit for use in a superheterodyne radio. L-C is the tuned circuit in an oscillator consisting of the collector, emitter E2 and the base. The broadcast signal appears at emitter E1 and the oscillator signal at E2. These frequencies mix within the semiconductor and the heat is passed by the collector into the output tetrode transformer. As usual, each emitter is biased to a fraction of a volt positive. The collector battery may be about 22-40 volts negative.

COLD LIGHT

This is an efficient source of cold light. The diagram shows an elementary form of the invention. The base is a plate of glass or other transparent material. Upon this is placed a thin film of titanium dioxide, a conductor, then a thicker layer of zinc sulfide. The next layer is silicon, a nonconductor converted to an oxide state. The top layer is a conductive coating of copper or silver.

When a.c. is applied across the top and bottom layers, the zinc sulfide emits light without heat. Brightness increases exponentially with the a.c. voltage.

INTRUDER ALARM

This alarm indicates the movement of persons or objects. Its special feature is an automatic reset. For example, if a person enters a restricted area, an alarm will sound and in a short time the instrument is ready for operation again. Departure of a person can be indicated by a different alarm.

The block diagram shows how the device functions. The oscillator feeds energy to an antenna over an area to be guarded. When a person approaches, he automatically increases the capacitance of the network so the oscillator frequency drops. The discriminator (originally set for zero output) delivers voltage to a relay circuit, causing the alarm to sound.

USE A

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PATENTS (Continued)

Voltage also reaches the resistance tube through a time-delay circuit. This tunes the oscillator to rebalance the discriminator. The time delay permits sounding the alarm before the oscillator is retuned.

If another person arrives, a second alarm will sound. When a person departs, the discriminator is rebalanced in the opposite direction. If desired, this can sound a different alarm.

Instead of audible alarms, counters may be used at the output. This makes it possible to tally the number of people arriving and leaving.

COMPACT LOOP ANTENNA

Patent No. 2,702,860
Walter Farbanish, Chicago, Ill. (Assigned to Zenith Radio Corp.)

In the early days of radio, nothing less than 50 or 100 feet of wire could be used to bring in radio programs. As receiver sensitivity increased, shorter antennas became practical. The introduction of ferrite antenna coils changed all this, for it permitted remarkable pickup with a small coil. This invention is an improvement over existing coils.

Conventional coils have cylindrical cores which must be moved in or out of the coil for tuning.

This means that added space must be available when the core is withdrawn. The new idea is to use two flat cores—one fixed, the other rotatable. They are isolated by a thin disc as shown. When the cores are in the same plane, loop inductance is maximum; when perpendicular, the inductance is much lower.

Typical dimensions are given in the diagram. The coil may have 80 turns of 14 gauge, with maximum inductance 260 μh.

\[ \text{END} \]

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VOLUME COMPENSATOR

Many of us are annoyed by radio and TV commercials that are several db louder than the average program level. At least one circuit has been developed to limit commercials to a comfortable level. See “Dual-Purpose Limiter Amplifier” in the October, 1954, issue.

A somewhat similar problem sometimes exists during broadcasts of live concerts. In this case the voice of the announcer or commentator is lower than the program. This seems to be fairly common in Britain because several British publications have described circuits for equalizing the volume levels of speech and music. This experimental circuit, from The Radio Constructor, operates by developing an additional a.v.c. bias voltage when the audio output contains a large proportion of frequencies outside the normal speech range so the music is reduced to the level of the accompanying speech.

The diagram shows the circuit as added to a conventional receiver with a.v.c. The original receiver components are shown in solid lines and the added components in dashed lines. A part of the signal appearing at the power amplifier plate is tapped off and fed through a blocking capacitor to a 50,000-ohm potentiometer. The signal at the arm of this control is applied to two parallel-connected filters. The two-section low-pass filter (R2-C2 and R1-C1) greatly attenuates all frequencies above about 200 cycles and a high-pass filter (C4-R4 and C5-R5) cuts off all frequencies below about 1,000 cycles. The outputs of the filters are passed through 1-megohm decoupling resistors and fed to a diode. This diode rectifies the signal and charges the 0.2-μf capacitor to a negative voltage that depends on the amplitudes of the signals passed by the filters. This voltage is applied to the a.v.c. line in series with the a.v.c. voltage obtained by rectifying the carrier. Most speech power is in frequencies between 100 and 1,000 cycles so during announcements the rectifier output is low and volume is normal. During the musical portion of the broadcast the signal voltages passed by the filter are greater and a higher a.v.c. voltage is developed so the music volume level is lowered.

The 0.2-μf capacitor and the 2.2- and 10-megohm resistors should be mounted close to the a.v.c. filter in the set. In some sets, filtering may not be sufficient to prevent instability at low audio frequencies. In this case, R5, C5 and a switch section should be connected as shown. When this circuit is used, it greatly increases the time constant of the a.v.c. filter but this does not matter because the circuit is designed primarily for local reception.

TUBE BALANCING CIRCUIT

Several methods have been devised for static balancing of tubes in push-pull circuits. In voltage amplifiers, one common method is to feed the input ends of the plate load resistors from the opposite ends of a potentiometer with the B plus line tied to the movable arm. A second balancing system has

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RADIO-ELECTRONIC CIRCUITS (Continued)

the cathode biasing resistors connected to the ends of a potentiometer with the arm grounded.

In Electronic Engineering (London, England) R. E. Aitchison of the University of Sydney, Australia, points out that unbalance in static current in triodes of the same type is caused by differences in cathode emission. He recommends this circuit for balancing.

A potentiometer of a few ohms resistance is used to provide small variations in the voltage applied to the heaters. In a test batch of 50 12AX7's he found that the maximum difference in heater voltages required for balance was only 0.63 volt (10% of normal) while approximately half of those tested could be balanced with heater voltage differences of only 5%. The test also showed that when static current is balanced the mutual conductances of the tubes are nearly identical.

SIMPLE VOLTAGE DOUBLER

One of the simplest and most practical arrangements of voltage-doubler power supplies is relatively unknown. It rarely appears in literature, even in the application handbooks prepared by manufacturers of selenium rectifiers.

The conventional half-wave doubler circuit is shown in Fig. 1. It is arranged for continuity between B minus and one leg of the supply line, uses a resistor for surge protection and requires two independent electrolytics as well as any capacitor provided for additional filtering.

In designing instruments and accessories we usually find it necessary to provide transformer isolation from the power line. This can be done by using one of the small half-wave transformers with 125-volt plate windings which are readily available.

The circuit can then be rearranged as in Fig. 2, at considerable advantage.
8 Men on a Horse

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RADIO-ELECTRONIC CIRCUITS (Continued)

The surge resistor is eliminated, since the d.c. resistance of the transformer is high enough to provide adequate protection. The input capacitor is transferred to the negative leg and combined with the output capacitor in a two-section unit with common negative.

This arrangement has the minor disadvantage that the transformer secondary is placed off ground by a d.c. voltage equal to its own peak charge on the input capacitor. This may be neglected in ordinary applications, however, as the transformer contains a tremendous margin of safety in its insulation.—Donald H. Rogers

HEADPHONE DRIVER

Have you ever desired a set of headphones for use with your audio system? They are a great convenience for late-hour listening, monitoring and many other purposes. Surplus 600-ohm headphones, available at moderate cost, have not been convenient to use because of their low impedance. The diagram shows a simple cathode-follower circuit which will drive such a set of headphones with more than adequate volume and fidelity. For convenience, a single twin-triode tube is used. With a signal level of 0.3 volt or higher, a 12AU7 should be used; for lower signal levels, a 12AT7 or 12AX7. If a separate voltage control is available at the signal source, the 250,000-ohm control may be replaced by a fixed 220,000-ohm resistor. The 470,000-ohm grid input resistor is large enough so as to offer negligible loading on virtually all amplifiers. The 50-uF capacitor in the output presents a low reactance.—Quentin J. Evans

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CONTROL CIRCUIT

Please publish a circuit of a simple and versatile carrier-current remote control circuit for starting and stopping a distant motor over existing power lines. - D. W. P., Hialeah, Fla.

The circuit of the receiver is shown in Fig. 1. The 600-µf mica trimmer capacitor tunes L1 to the r.f. control carrier. The incoming control signal fires the OA4-G tube and actuates the relay to open or close the circuit to the remote motor — depending on the connections to the relay contacts. L1 may be the secondary of a slug-tuned broadcast antenna coil connected to pin 2 of the OA4-G.

The transmitter circuit is in Fig. 2. The oscillator uses 6V6's in push-pull. The 600-µf trimmer tunes tank coil L2. The transmitter is operated by closing the switch in the B plus circuit. L2 consists of about 150 turns of No. 28 enamelled wire closewound and center-tapped on a 1½-inch form. L3 is 8 to 10 turns of plastic-insulated hookup wire around the center of coil L2.

With the relay circuit shown in the receiver, the transmitter must remain on to maintain the desired operation at the remote point. Therefore, if you do not want to operate the transmitter continuously or if you plan to operate several devices, you can use pulse type control. One pulse turns the equipment on and the next one turns it off. In this case, power to the remote equipment is applied through the contacts of an impulse relay such as the Guardian RC-100. The coil of this relay is then wired through the normally open contacts of the 5,000-ohm control relay in the receiver.

BATTERY ELIMINATOR

I would like to have the circuit of an a.c.-operated battery eliminator for a fence charger using five No. 6 dry cells in series. - A. C. S., Branford, Ont.

The current drawn by the charger is not given but we are assuming that it does not exceed 600 ma or so. If you find that it is higher, the transformer and rectifier current ratings should be altered accordingly.

With 10 volts a.c. input to the single-phase bridge rectifier, the output will be about 7.5 volts when the unit is new. Capacitor C may be a 12-volt unit with a capacitance of around 500 mf. The output voltage will drop and stabilize at a slightly lower voltage as the
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VERSATILE POWER PACK

Please print a diagram of a power supply that will deliver 200 volts d.c. at 50 ma and 63 volts a.c. at 1 amperé for a Gramco HT-5 converter and other small equipment such as phone pre-amplifiers and mixer units.—W. J. F., East Springfield, Mass.

This circuit should meet your needs. The transformer is a Stancor PS-8416 or equivalent. Two 130-volt selenium rectifiers are connected in series to handle the a.c. input voltage. If the d.c. output voltage is too high, insert a suitable dropping resistor in series with the filter choke, an a.c.-d.c. type.

120-WATT BOOSTER AMPLIFIER

Please print a diagram and other pertinent data on a 120-watt booster amplifier using a pair of 807's or similar tubes. This amplifier is to be driven by a 25-watt amplifier with a 500-ohm output.—M. C. E., Maryland Heights, Mo.

The diagram shows the circuit of a 120-watt amplifier using zero-bias 807's in class B. Note well that the tubes operate as triodes with the signal voltage applied directly to the screen grids and to the control grids through 22,000-ohm resistors. The driver transformer should be rated at 8 watts or more and designed for matching a 500-ohm line to class-B grids. The turns ratio of primary to one-half secondary should be approximately 1:5.7.

The power supply is designed for good regulation. Do not skimp on the quality of the power transformer and filter chokes. Always make sure that the 807's and 866's have warmed up before closing the standby switch to supply B power.

The power transformer secondary delivers 1,000 volts plate to ground to each 806. The rectifiers work into a choke input filter containing a 5-25-henry swinging choke and a 5-henry unit, both rated at 300. Both filter capacitors are 4-pf units rated at 1 kv. The power transformer secondary center tap is fused.

VARIABLE CAPACITORS

I plan to build the novice transmitter described in the September, 1953, issue but I've not been able to find the 325-muf 1,000-volt variable capacitors nor the 135-volt 75-ma power transformer. Please recommend these components by brand and type number. In some instances transmitting type capacitors are rated according to the spacing between plates rather than the test or breakdown voltage. Please show the relationship between spacing and voltage.—A. F. B., Wenham, Mass.

The exact relationship between plate spacing and breakdown voltage depends on the construction of the capacitor and on the frequency and other standard conditions that the manufacturer uses for the test. Generally, capacitors having mirror-smooth plates with rounded edges have higher voltage ratings than those with the same spacing and unpolished plates with square edges.

Catalogs issued by the leading capacitor manufacturers show that some list the test voltage at 60 cycles r.m.s. and others list the maximum peak voltage. Oddly enough, the r.m.s. and peak voltages are often very nearly identical for the same air gap. The voltage vs. spacings are fairly close among various manufacturers for voltages up to 3 kv and then they begin to spread rapidly. Thus, when purchasing capacitors for higher-powered transmitters, it is always advisable to consult each manufacturer's catalog for his ratings.

A capacitor with plate spacing of .024-.025 inch will handle peak voltages of 1,000-1,200; .034-.047 inch will handle 1,600 volts; .051-.065, 2,000 volts; .07-.078 inch, 3,000-3,600 volts. For the novice transmitter you can use Hammarlund MC-325-M, National 3TH-235 or Bud TMS-300 capacitors in the pi network.

The transformer may be a Thordarson T-22R12. It is rated at 125 instead of 135 volts but the difference will not affect transmitter performance.

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RADIO-ELECTRONICS (Continued)
TV INTERFERENCE

In weak-signal areas or locations where an indoor antenna is used, cross-hatch interference in an Admiral 2021 is sometimes caused by slight regeneration in the 6AU6 4.5-mc sound i.f. stage (see diagram) without affecting the sound in any way. If this is the case, removing the 6AU6 should eliminate the interference. To correct the situation, substitute a 10,000-ohm resistor for the 1,000-ohm unit in the plate circuit of the sound i.f. stage. Similar cases were found in servicing G-E and RCA sets.—G. P. Oberto

RASTER TEARING AND FLASHING

In an RCA TV model 6T1 the source of picture and raster flashing and tearing, similar to high-voltage arcing, couldn't be located. In attempting to localize the source I found that removing the 1B3-GT high-voltage rectifier did not affect the noise but, if either the horizontal oscillator, horizontal output or 6W4-GT damper were removed, the noise stopped. Yet substituting these tubes did not help. I inspected the high-voltage and 6W4 boost-voltage circuits in a darkened room but failed to see any arc. After hours of checking and substituting components in these circuits I localized the trouble in the 6W4 boost-voltage circuit. The trouble was finally found in the power transformer.

This is what had happened. The 6W4 damper tube had its own separate heater winding above ground (see diagram), allowing the heater and cathode to be tied together to eliminate heater-cathode arc-over. This arrangement places 500 volts, plus surge voltages, on the 6W4 heater and its winding. I removed the cover of the transformer and found that the 6.3-volt 6W4 heater winding had been arcing to the transformer cover; the polyethylene insulation on the inside of the cover had broken down.

By cutting down the heater winding terminals, removing all sharp points and replacing the damaged insulation with a heavier grade, the trouble was eliminated. That was more than two years ago, and it has never recurred.

—Charles Garrett
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TECHNOTES (Continued)

HORIZONTAL PIX WIGGLE

Annoying, although small, wiggle or horizontal shaking of random spots in the picture was a complaint on a G-E 17C107. The trouble happened only on rainy days, and not on other occasions even during or after a short thunder shower. The fact that the displacement, when it did occur, was horizontal provided some useful information—the search could be limited to the horizontal deflection circuitry rather than the entire set.

In the shop, a wet rag was placed under the set and the set turned on. The rag was so shaped and placed that it would produce very high humidity around one quarter of the chassis area. After a couple hours, the rag was soaked again and placed under another quarter of the chassis area. All four quarters of the bottom of the chassis were covered in this manner, but the trouble did not occur. The conclusion was that the underside of the chassis was not causing the trouble.

The wet rag was placed near parts on the top side of the chassis and the entire chassis, except that the picture-tube face was marred with a cardboard carton to hold the moisture in. Trouble developed in about an hour.

Movement of the rag indicated the trouble spot near the under side of the picture tube. The rag was then reduced in size and balled up so that it could be attached to the end of a stick of wood with rubber bands. The trouble was localized to the underside of the middle of the bell of the picture tube. The only thing observable was the filter capacitor is touching Aquadag coating.

The capacitor was touching the Aquadag coating of the picture tube, but was insulated with a fiber covering—there seemed to be nothing wrong with this arrangement. A pipe cleaner was moistened with water and touched to the capacitor casing and the Aquadag at their point of contact. The trouble appeared immediately. Moving the capacitor away from the picture tube removed the trouble.

The explanation of the action is interesting. The Aquadag is grounded through springs, but due to high voltages with their accompanying fields, the coating is not fully at ground potential. The additional grounding altered the normal distribution of ground current and in so doing upset the electron beam.

The current flow along the bottom
of the tube set up a magnetic field in a vertical direction. A vertical magnetic field will deflect a charged particle—like the electrons in the beam current—at right angles to its direction, causing a horizontal shift. Variation in the conductivity accounted for the randomness of the time of appearance and the amount of picture area involved.

It was noted that the trouble appeared only during a prolonged rain. The owner's 6-month-old daughter's diapers were dried by the gentle heat of the TV set on a rack at its back. During fair weather daughter's pants were hung on a line and on days with thunder showers, the need was not so urgent. So with the capacitor moved away from the picture tube coating, the set still functions both as a source of amusement and a diaper drier on wet days.—James A. McRoberts

**Imploded TV Tube**

The photo of the imploded TV set on page 46 of the February issue recalls a similar occurrence in a Zenith model M2230R. The customer heard a faint sound and turned the set off. A few moments later there was a loud blast. A part of the picture-tube neck shattered and the safety glass showed lots of scratches.

I took the set to the shop and I believe that I've located the cause of the trouble. These models have a metal-sleeve width coil that fits over the neck of the picture tube. This sleeve was grounded and shorted to the yoke coil. The short circuit to ground caused excessive current to flow and overheat the tube neck at the point of the break.

—R. H. Rahn

**Slow-Blow Fuses**

The use of a fuse of the slow-blow type in the high-voltage circuit is not recommended. Slow-blow fuses generally have early life failures due to mechanical fatigue. Therefore, when it is necessary to replace a fuse, the standard-type fuse listed in the replacement parts list should be used.—RCA TV Service Tips

**Sentinel 406, 411**

Tearing and picture breakup when these models are jarred are often caused by a loose padder trimmer slug screw in the 12AT7 oscillator stage. To remedy, install a lockwasher bushing on the padder (C11) trimmer screw to hold it firmly and provide a proper ground.—Ernie Gig

**Teleton 248**

Some of these sets come in with a complaint of picture height decreasing to about 2 to 3 inches. I found that this was caused by the 1.5-megohm resistor in series with the height control. It reduced in value to about 500,000 ohms. Replace this resistor with a good-quality high-wattage unit.—Marty Britt
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**SHORTWAVE CONVERSION**

Many small broadcast receivers can be easily converted to receive the 1.5—5.5 mc band by simply switching high-Q parallel inductors L2 and L3 across the antenna and oscillator coils as shown in Fig. 1. Converted sets compare favorably with many of the small amateur communication receivers on the 75-meter band.
On some of the older sets using 6A7, 6A8, 6K8 and similar converter tubes, the oscillator may fail because of lack of coupling in the feedback circuit. To overcome this add an auxiliary feedback coil (L1) as in Fig. 2. If the oscillator fails to work, reverse the connections to L4.

A Vari-Loopstick with 25 turns removed is used for L2. L1 is approximately 100 turns of No. 30 enameled wire jumble-wound close to the ground end of L2. Oscillator shunt coil L3 is made by approximately 25 turns from a Ferri-Loopstick and adding 15 turns of No. 30 wire for L4.

Circuits are aligned by varying the number of turns for desired coverage and to peak the signal with the coil slugs almost all the way in and the tuning capacitor about half open.

For frequencies above 5.5 mc, remove all the turns from the loopstick and close-wind about 25 turns of No. 30 wire. Add or remove turns for the desired coverage with the slug almost all the way in. Adjust the slug and turns of L2 to peak the signal in the center of the band.

For higher-frequency coverage up to 15–20 mc it would be more desirable to use the conventional method of bandswitching. However, the circuit of Fig. 2 should work nicely up to 15 mc by using oscillator harmonics. The circuit of Fig. 1 should hit the 40-meter band without any trouble simply by removing more turns from the shunt coils. The oscillator could be tuned so the desired harmonic is equal to the signal frequency plus or minus the f₀, and the antenna coil could be peaked at the signal frequency. However, the main drawback is that strong low-frequency signals may ride through.

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TRI THIS ONE

(Continued)

very well on antennas from 10 to 75 feet. On some sets using loop antennas the loop alone picks up plenty of signals. I was surprised to hear several weak mobiles that were S4 on my 12-tube communications receiver. Of course the selectivity was far better on the large receiver.—G. P. Oberto

PLASTIC RADIOS

Many plastic table model radios do not have soft pads on the bottom—either the set rests directly on the furniture or else is supported on sliders. The plastic bottom or sliders are likely to mar fine furniture if the set is pushed roughly. Before placing these sets on expensive furniture, cut felt pads about the size of a dime and glue them to the bottom of the cabinet.—B. W. Welz

SOCKET REPAIRS

Broken socket contacts often occur in sets using miniature tubes. In most cases the best remedy is to replace the socket with a new one. However it is often very hard to remove the socket due to crowding of the components. A completely satisfactory repair can be made by replacing only the broken contact.

Since replacement contacts are not available on the market, a new socket of each type commonly used should be obtained. Removing the contacts is simple but use extreme care as they are easily broken or weakened. The technique varies slightly with different types of sockets, but if a careful examination is made the procedure will be obvious. In some sockets the projecting solder lug should be flattened for removal; in others it should be roiled tube like to allow it to pass through the top of the socket. One type of socket requires removal of the metal grounding sleeve in the center guide hole to remove the contacts. When the sleeve is loosened, the fiber washer is removed and the contacts taken out from the bottom of the socket.

Finally place the new contact in the socket and hold it firmly in place while bending the projecting end just enough to keep it in position.—James E. Pugh, Jr.
Howard W. Sams, president of Howard W. Sams & Co., Indianapolis, was elected chairman of the board of J. A. (Shine) Milling, ex-
executive vice president and general manager of the company, succeeds

W. W. Posey
National Union Radio Corp.

Joseph Solari
joined Federal Telephone & Radio Co., Clifton, N.J., as general sales manager of the Components Division. He comes to Federal from Jefferson Electric Co.

Robert L. Wolff
was elected vice president in charge of engineering of the Centralab Division of Globe Union, Milwaukee, Wis. He had been director of Centra-
lab products engineering.

Edward E. Wineblatt
joined Radio Merchandise Sales, New York, as general manager. He also becomes general manager of their affiliate, Ames Manufacturing Corp. Wineblatt has had wide experience in the parts distributor field.

Obituaries
Carl V. Haecker, manager of displays and sales promotion for RCA, in Presbyterian Hospital, Philadelphia.
Wallace L. Gifford, a vice president and director of Raytheon Manufacturing Co., Waltham, Mass.
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PEOPLE (Continued)

Edward L. Nelson, a former radio development engineer with Bell Telephone Labs., in Arlington, Va. He had been technical director of the Signal Corps Engineering Laboratory at Fort Monmouth, N. J.

Personnel Notes

. . . Peter Maler, who has had an extensive background in the marketing and promotion of electronic components, joined Astron Corp., East Newark, N. J., as sales promotion manager.
. . . Percy L. Spencer, vice president of Raytheon Manufacturing Co. and general manager of its Microwave and Power Tube Operation, has been elected a director of the company.
. . . Dr. William Shockley, inventor of junction transistors while with Bell Telephone Labs., joined Beckman Instruments, Fullerton, Calif., where he will direct a group of scientists in developing new uses for semiconductors.
. . . Martin W. Rogers is now director of quality control for National Co., Malden, Mass. He previously held a similar position with Raytheon.
. . . William J. Bakrow was appointed public relations manager of CBS-Hytron, Danvers, Mass. He formerly headed public relations for the Rochester Products Division of General Motors.
. . . F. L. Radford, assistant credit manager of United Motor Service Division of General Motors, Detroit, was promoted to credit manager.
. . . Donald Jonson was named sales supervisor of the Electronics Division of Elgin National Watch Co., Elgin, Ill. He was formerly sales representative for the company's Wadsworth-Halley Division.
. . . Harold Harris, vice president of sales and engineering of Channel Master Corp., Ellenville, N. Y., has written Treasure Tales of the Shawangunks and Catskills, a collection of legends and folklore about the surrounding mountain country.
. . . C. Harvey Bradley, Jones & Laughlin Steel Corp., and James A. Roemer, Mallory-Sharon Inc., were elected to the enlarged board of directors of P. R. Mallory & Co., Inc., Indianapolis, Ind.
. . . Frederick C. Bash was appointed to the newly created post of product manager of the Atomic Frequency Standards Dept. of National Co., Ma
den, Mass. He comes to National from Magnavox.
. . . Brig. Gen. David Sarnoff, chairman of the board of RCA, was awarded the 1956 Gold Medal of the Hundred Year Association of New York for his work in electronic communication. He also made the principal address and received an honorary Doctor of Science degree from Notre Dame University at the dedication of its new TV station WNDU-TV.
. . . John Havercamp was appointed Midwestern district sales manager with headquarters in Cedar Rapids, Iowa, for Walco Electronics Corp., Los Angeles.
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BUSINESS (Continued)

designed a special counter display card for its low-priced transistors for hobbyists.

United Motors Service Division of General Motors, Detroit, is co-sponsor-
ing the hour-and-a-half NBC TV show, "Wide, Wide World."

Wendell Plastic Fabrics Corp., New York, has designed a smaller sized package and display for its Mellotone grille fabric.

Astatic Corp., Conneaut, Ohio, has embarked on a new three-point merchandising program for its line of phonograph cartridges. A new stock numbering system has been devised and both the old and new numbers are shown on the cartridge box which also carries complete replacement data and the list and dealer net price.

Production and Sales

RETMA reported manufacturers' sales of 6,478,361 TV picture tubes and 300,080,000 receiving tubes for the first eight months of 1955. This compares with 5,226,775 TV picture tubes and 225,085,000 receiving tubes for the 1954 period.

RETMA reported the production of 4,820,991 TV sets during the first eight months of 1955, 27% more than for the same period last year. Radio set production of 8,725,012 was 43% ahead of the figures given for the first eight months of last year.

The Bureau of Census of the U. S. Department of Commerce reports that there are now about 32,000,000 households in the U. S. with TV sets as of June, 1955—a total of 67% of all the homes in the nation. In 1950 there were 5,000,000 homes or 12% of the total with TV sets.
BUSINESS
(Continued)

New Plants and Expansions

General Cement Manufacturing Co., has consolidated the operations of five of its subsidiaries in a newly acquired five-story building in Rockford, Ill. G-C Electronics, Television Hardware Manufacturing Co., Teico Electronics, Gec-Lar Manufacturing Co. and Wood Speciality Manufacturing Co., all are now located at 400 S. Wyman St. The Chemical Division will continue at the present location at 919 Taylor Ave.

I.D.E.A. Inc., Indianapolis, acquired control of Radio Apparatus Corp., of the same city, through the exchange of common stock. It will be operated as the Monitoradio Division of I.D.E.A.

RCA has completed plans for acquiring a 285,000-square-foot building at Lancaster, Pa., for the production of color TV picture tubes. The RCA Tube Division has begun construction on a $3,000,000 plant to manufacture semiconductors in Bridgewater Township, N. J.

Federal Telephone & Radio Co., Clifton, N. J., is constructing a new plant in Los Angeles for the production of electronic equipment for the aircraft industry.

Daystrom Inc., Elizabeth, N. J., has sold the assets, name and business of its subsidiary, American Type Founders, in order to concentrate on the electronic and electrical fields.

Elgin National Watch Co., Elgin, Ill., is combining the relay engineering and research activities of its subsidiaries, Advance Relay Co., Burbank, and Elgin-Nemotic, Los Angeles, in newly leased facilities in Burbank.

Service Instruments Co., manufacturer of test equipment and television accessories, moved from Chicago to Addison, Ill.

CBS-Hytron Sales Corp., Danvers, Mass., was established as a subsidiary of CBS for the promotion and sale of CBS tubes and semiconductors in the distributor market.

Sylvania Electric Products has begun construction on its new Data Processing Center at Millburn, N. Y.

Teleconsoonic Corp. has added another floor to its facilities at Long Island City, N. Y.

Reiner Electronics Co., Easton, Pa., will build an additional building adjoining its present facilities.

Business Briefs

... RETMA president, H. Leslie Hoffman, predicted a new TV set production record of 8,300,000 sets this year. Other industry leaders including Ross D. Strausser, Admiral Corp.; John V. Young, Burroughs Corp.; Frank Stanton, CBS, and Frank M. Folsom, RCA, predicted
BUSINESS (Continued)

that the electronic industry would be a $30 to $35 billion business by 1975, and that there would be 92,000,000 TV sets in the U. S., of which 90% would feature color.

... 50 21-inch RCA color TV sets were installed in the Governor Clinton Hotel in New York City.

... Sylvania Electric Products recently produced its 10-millionth TV picture tube at its Seneca Falls plant.

... RETMA announced six new members admitted to the association: American Electronics Co., New York; Eblen Corp., St. Anne, Ill.; Ratigan Electronics Inc., Los Angeles; Televideo Corp. of America, Los Angeles; Texas Instruments Inc., Dallas, Tex.; Vega Electronics Corp., West Los Angeles, Calif.

... Technograph Printed Electronics, Inc., Tarrytown, N. Y., licensed RCA to manufacture printed electrical circuit under Technograph patents.

... United Catalog Publishers, New York City, brought out the 20th edition of its buyers guide and reference book which was recently retitled The Radio- Electronic Master to give a more accurate picture of its contents.

... Altec Lansing Corp., Beverly Hills, Calif., is holding a series of "road show" sales meetings throughout the U. S.

... 1956 Electronic Parts Distributors Show management reports that in answer to a recent questionnaire the majority of exhibitors and distributors prefer to continue the show in Chicago in May.

... The Institute of High Fidelity Manufacturers, New York City, approved the applications of six new members: Bell Sound Systems; B. M. Marantz Corp.; Fenton Co.; Precision Radiation of California; National Co. and the Grommers Division of Precision Electronics Inc.

... Columbia Wire & Supply Co., Chicago, is now backing its 300-ohm Perm-aline television transmission line with written guarantees—15 years for the 50 mil, and 25 years for the 80 mil.

... Tru-Ohm Products Division of Model Engineering & Manufacturing Co., Inc., Chicago, recently produced its 80-millionth resistor.

... Polytechnic Institute of Brooklyn will hold an International Symposium on Nonlinear Circuit Analysis, Part II, in New York, April 25-27, 1956.

... CBS-Columbia, Long Island City, N. Y., has inaugurated a series of training seminars for service personnel of its distributors and dealers.

... ORadio Industries, Opelika, Ala., manufacturer of Irish brand magnetic recording tape, reports that September, 1955, was the best month in its history—90% better than September, 1954.

... An Atomic Exposition will be held Dec. 10-16 in the Cleveland Public Auditorium.

DECEMBER, 1955

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Response (cos)

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120° x 60°

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DECEMBER, 1955

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MASTER TV MANUAL
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ELECTRONIC PROJECTS
A 16-page Catalog No. 4 lists 80 projects for the electronic experimenter, service technician, engineer, etc. Twenty-one categories include timers, organs, relays, model controls, amplifiers, power supplies, broadcast radio, remote controls, transceivers, musical instruments, laboratory apparatus and other items. Complete circuitry, parts list and explanatory notes are given for each of them.

RADIO AND TV FACTBOOK
RETMA's Fact Book—Radio-Television Electronics Industry is a compilation of available statistics on the production and sale of radios and TV receivers; data on manufacturers' sales of receiving and picture tubes, etc. and, to the extent that such material is available, a detailed statistical analysis of the size and composition of the industry.
TECHNICAL LITERATURE and industry. Material from a variety of Government sources is also included in the factbook.

Radio-Electronics-Television Manufacturers Association, 777 14th St., N. W., Washington 5, D. C.

REPLACEMENT GUIDE
Stancor's latest TV Transformer Replacement Guide lists over 8,000 chassis and models for 118 TV manufacturers. One page contains a summary of all Stancor explosion proof.- Chicago Standard Transformer Corp., Addison & Elston, Chicago 18, Ill.

CABINET FOLDERS
Folder 1 contains information on wood cabinets and assembled, ready-to-finish equipment cabinets. Folder 2 is concerned with Cabinet kits. Folder 3 details the latest Rebel horns and the new Rebel Ortho speaker systems. Folder 4 contains a discussion on wall storage cabinets and cabinet kits and their many uses.

Cabinet, Div. of G & H Wood Products Co., Inc., 99 N. 11 St., Brooklyn 11, N. Y.

CAPACITORS
Capacitors for the Electronics Industry, GET-2417, describes in 10 pages the basic characteristics of specialty capacitors for use in electronic systems. Electronic Capacitor Selection Guide, GET-2417, is a complete listing of G-E capacitors giving basic applications, ratings, tolerances and temperature ratings.

Capacitors for Air-Conditioning Equipment, GEA-5895C, describes drawn-case capacitors for air-conditioning equipment with ratings and dimensions.

Tantaloytic capacitors are detailed in Pamphlet GEA-6258 and specifications given in Pamphlets GET-2513, GET-2502 and GET-2334.

Capacitor pulse-forming networks are described in Pamphlet GEA-4906B.

General Electric, Schenectady, N. Y.

RESISTORS
The following bulletin have been issued by International Resistance Co.: Bulletin P-1a: 4-watt resistors. Includes data on tests, applications, ranges, tolerances, stamping, ratings, graphs, etc.

Bulletin P-2a: type PW-7 and PW-10 resistors—same data as above bulletin.

Bulletin F-3: characteristics, applications, resistance values, tolerances, terminations, and voltage ratings, charts and graphs of type HFR high-frequency resistors.

Bulletin B-26: gives data on construction, tolerances, power ratings, humidity, adaptability, frequency characteristics, and detailed charts and graphs on MW wirewound resistors.

Bulletin B-28: half-watt molded boron-carbon Precisors including characteristics, applications, wattage ratings, tolerances, dimensions, insulation, charts and graphs.

Comprehensive data on IRC's complete line of resistors and special products is listed in the revised 1955-1956 Official Resistors Engineering Guide. Data given include JAR, JAR-E, MIL, MIL standards, wattage, standard tolerances, temperature rise, temperature coefficients, maximum operating temperatures, ohmic values available, dimensions and approximate prices.

International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

1956 TV REPLACEMENT GUIDE
Merit's TV Rep Replacement Guide and Catalog Form 108 lists approximately 12,000 models and chassis. Over 155 brand names of manufacturers are cross-referenced. The catalog section of the 80-page book gives the list price, unit weight and description.

Merit Coil & Transformer Corp., 227 N. Clark St., Chicago 40, Ill.

GEIGER COUNTER FACTS
A 20-page pocket-size booklet 64 Questions and Answers on Geiger Counters and Scintillators covers such subjects as claim staking; Government bonuses; assaying of radioactive ores; aerial and ground surveys for uranium, oil and gas fields; and effect of weather on radiation; etc., as layman's terms.

SECOND THOUGHTS ON RADIO THEORY, by “Cathode Ray.” Published for Wireless World by Iliffe & Sons Ltd., London SE 1, England. 6 x 8½ inches, 400 pages, 25 s.

For more than 20 years, “Cathode Ray” has written articles in the British magazine Wireless World, introducing the beginner to the mysteries of phase, harmonics, Q and cavity resonators, and the old-timer to equivalent circuits, duals, “/” and Thevenin’s theorem, all in language that made the formerly incomprehensible look reasonable and in a style that made the reader want to understand.

A selection of the best of these articles (after revision and expansion where desirable) is now incorporated in a book so that the radioman can give a few “second thoughts” to things hurriedly “learned” but which he may now have a chance to understand for the first time. “Cathode Ray” also points out that he gives a few second thoughts to points “often missed out of even the big books.”

The student will find Second Thoughts valuable for its different approach to subjects he has found hard to grasp; the instructor can study it as a guide to clear presentation and the technical author can well afford to read it for style alone.—FS


More useful information is contained in this volume than in many so-called “hi-fi” publications. It is written for the PA technician and theater sound man, but its clarity and completeness definitely recommend it to beginners as well.

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THE MOBILE MANUAL FOR RADIO AMATEURS (1st Edition), American Radio Relay League, West Hartford, Conn. 352 pages. $2.50 in U. S. A., $3 elsewhere.

A compilation of over 80 carefully selected articles on mobile radio assembled from back issues of QST magazine, this is a valuable reference work and guide to construction, maintenance and operation of mobile radio equipment. Although prepared especially for amateurs, it will prove useful to designers, operators and technicians working with frequencies adjacent to amateur bands.


For children 10 years of age and older, this is a new edition with an enlarged section on atomic energy. Written in easy-to-understand language, it introduces electronics, the atomic theory and nuclear energy, and shows what they do for us and what we can reasonably expect from them in the future.


The latest edition of a popular work compiled by the late J. G. Horner is revised and enlarged by Staton Abbey. Part I, "Modern Terms" (120 pages), covers terms not included in earlier editions. Part II, "General and Traditional Terms," has 417 pages.

AUTOMATIC RECORD CHANGER SERVICE MANUAL WITH TAPE RECORDER SERVICE DATA (Vol. 6), Howard W. Sams & Co., Indianapolis, Ind. Pages not numbered. $3.

Sixth in a series, this is a compilation of Photofact folders covering approximately 20 late model tape recorders as well as about 8 automatic record changers.

RIDER'S SPECIALIZED AUTO RADIO MANUAL (Vol. 6-A, Motorola), John F. Rider Publisher, New York. 208 pages. $3.

Reprints of factory-issued service and installation data on custom-built Motorola auto radios for all makes of cars from 1948 through 1955.

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