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DECEMBER 1955

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HUGO GERNSBACK, Editor

In this issue:

Rainbow Patterns with your Signal Generator

•

How to Build a Tremolo Circuit

•

Signal Injection with Transistor Probe

•

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•

Complete 1955 Index

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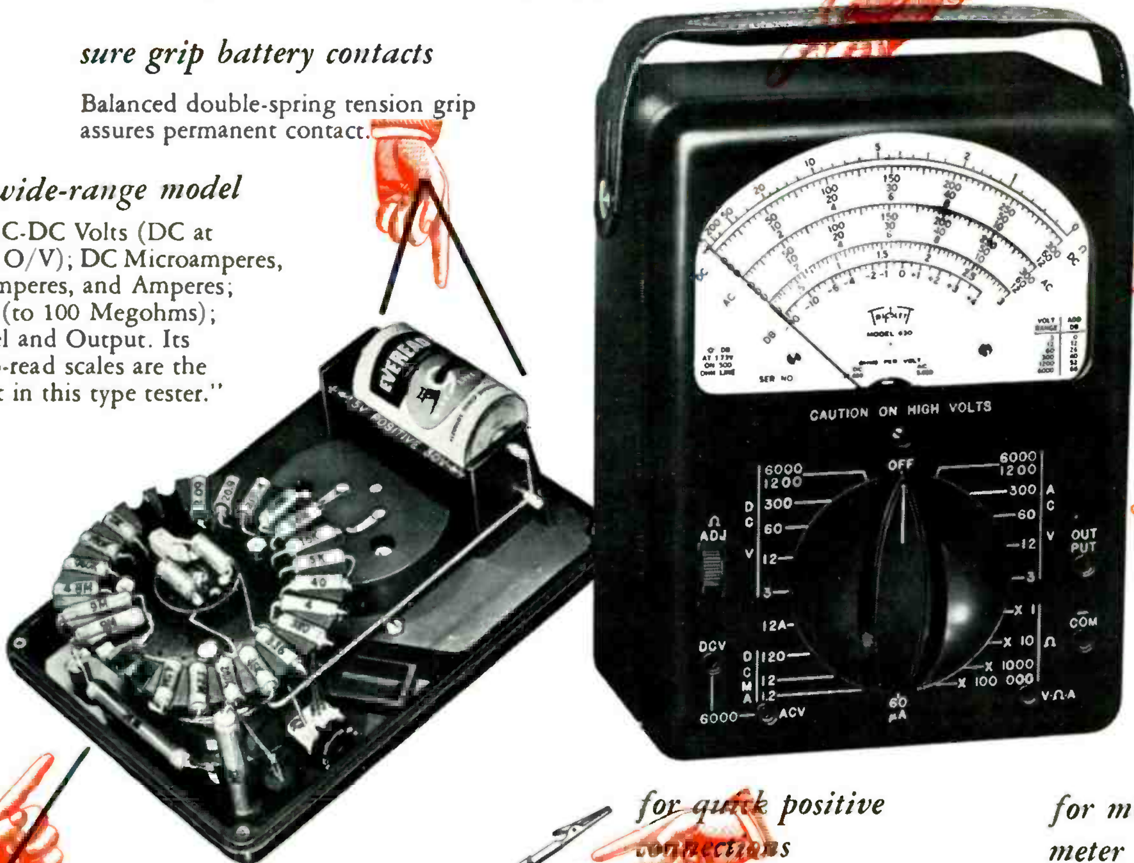

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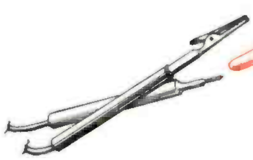

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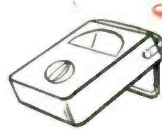

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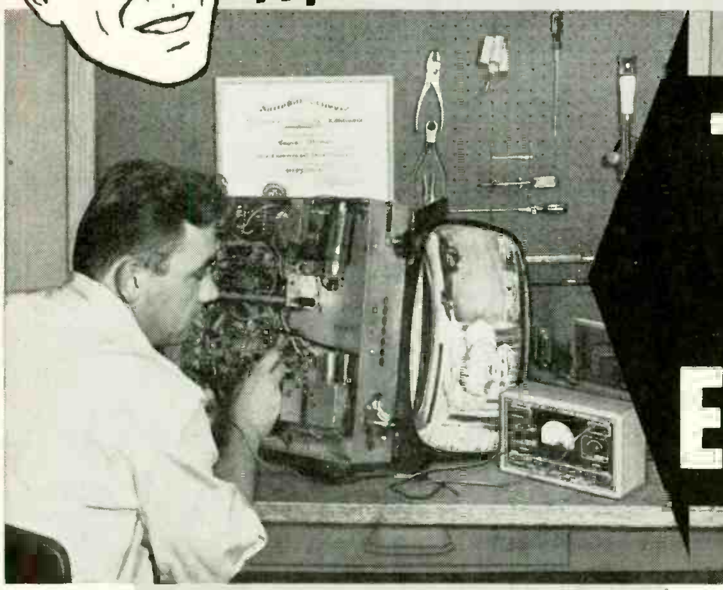

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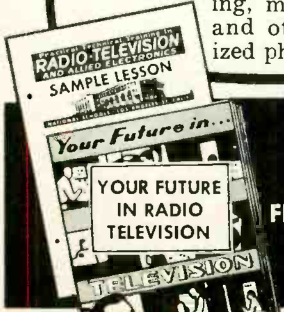

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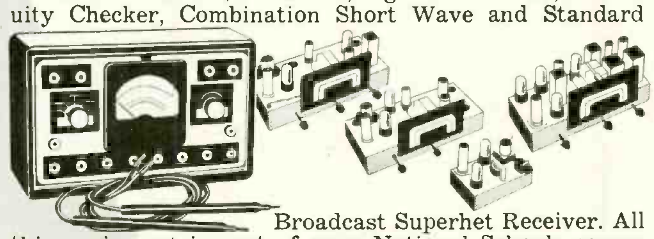

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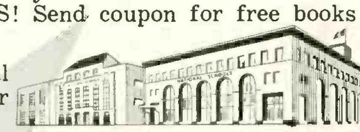

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the Radio month

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.

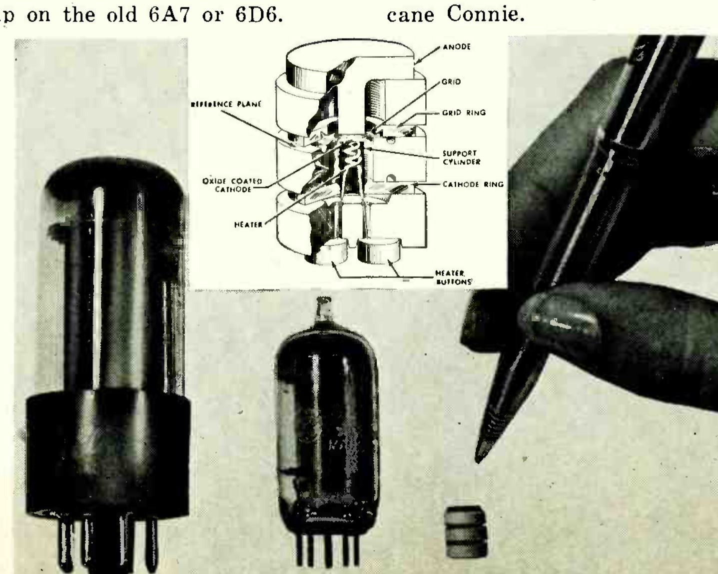
The show was a followup of a similar successful demonstration in London and featured the playing of records in conjunction with live performances of the same works by the same artists. The conclusion reached by a majority of the audience was that, though recorded music has not yet reached the point where 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. Interelectrode spacings within the tubes are measured in microns. Size of the tube is almost the same as that of the grid cap 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.



Comparative size of General Electric's microminiature ceramic tube, type 6BY4.

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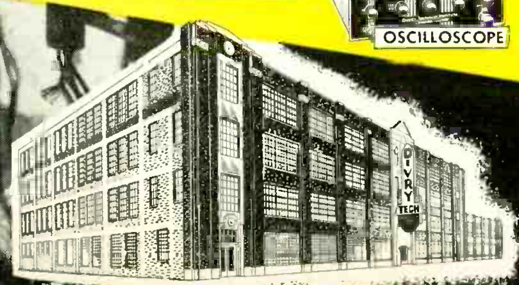

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ELECTRONIC TOLL SYSTEM has been installed at all toll booths on the new 241-mile superhighway, the Ohio Turnpike. The equipment, recently developed by International Business Machines Corp., consists of a combination of devices that permits weighing 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 treadle built into the traffic lane pavement separately 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 Janszen 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
KBMB-TV	Bismarck, N. D.	12
WOSU-TV	Columbus, Ohio	34
WORA-TV	Mayaguez, P. R.	5
KDLO-TV	Florence, S. D.	3
WDBJ-TV	Roanoke, Va.	7
WHTN-TV	Huntington, W. Va.	13

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 semi-automatic 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 controlled 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

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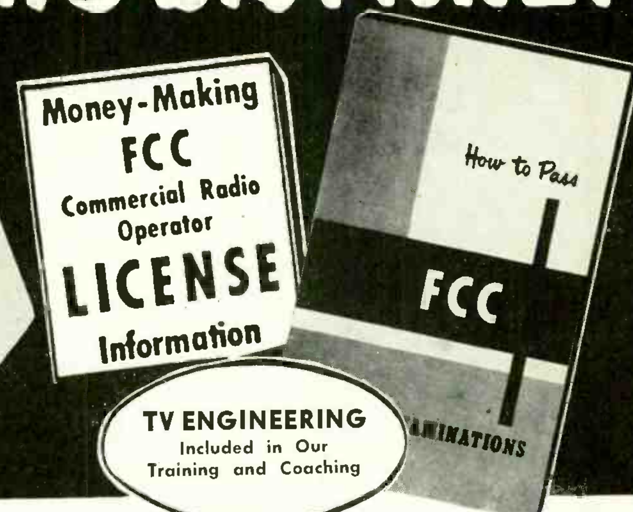

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Correspondence

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

Mr. Augspurger 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 ≤ -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:

$$\text{Damping ratio} = \frac{R_L}{R_L + R_O}$$

where R_L = load resistance; R_O = output resistance of amplifier and where both R_L and R_O are referred to the same side of the transformer.

The following table is for $R_L = 15$ ohms and is purely as an example:

R_O ohms	R_L+R_O ohms	Damping factor $=R_L/R_O$	Damping ratio $=R_L/(R_L+R_O)$
+75	+90	+0.2	0.167
+3	+18	+5	0.83
+1.5	+16.5	+10	0.91
+0.15	+15.15	+100	0.97
+ 0	+15.0	∞	1.0
−0.15	+14.85	−100	1.01
−1.5	+13.5	−10	1.11
−5.0	+10.0	−3	1.5
−12.0	+3.0	−1.25	5.0
−13.6	+1.4	−1.1	10.7
−14.3	+0.7	−1.05	21.4
−15.0 on verge of instability	0	−1.0	∞

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

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Here are just a few letters received from CREI students:

"In this time of less than two years, I have almost doubled my salary and have gone from wireman to engineering assistant and now to junior engineer. I have CREI to thank."—Frank A. Eckert, 22 Clover Lane, Levittown, Pa.

"I chose CREI training upon recommendation of two top engineers. Before I completed the course I became transmitter chief of a 5KW station. I am now employed as a technician at a 100 KW TV station and in spare time have a good TV sales and service business."—Arlie D. Patton, 203 Burke Ave., San Antonio, Tex.

CREI TEACHES YOU WHAT INDUSTRY WANTS

Industry recognizes this, by choosing and paying CREI to train their own technical staffs. Among them: United Air Lines, Canadian Broadcasting Corporation, Sears, Roebuck & Co., Bendix Products Division, All America Cable and Radio, Inc., Radio Corporation of America.

CREI GRADUATES GET TOP JOBS

. . . as electronic engineering technicians. Employers contact us regularly for graduates to fill good jobs. Our placement bureau cannot keep up with the demands. Typical recent requests: "Openings will occur in the GS-10 grade, starting salary $5500 per year, for men who can qualify for the servicing of 35 mm. motion picture sound and projection equipment. Although some previous experience in this field is desirable, it is not essential if the individual has sufficient training in radio . . ."—Departments of the Army and Air Force, St. Louis, Mo.

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

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CREI training equips you to pass FCC exams, qualify for top jobs; or, start your own business—many a graduate has been launched on a successful, self-owned business career, thanks to CREI training.

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Accredited Technical Institute Curricula Founded 1927

Dept. 1412-B, 3224—16th St., N.W., Washington 10, D. C.

Please send me your course outline and FREE illustrated Booklet "Your Future in the New World of Electronics" . . . describing opportunities and CREI home study courses in Practical Electronics Engineering.

CHECK FIELD OF GREATEST INTEREST
- ☐ Practical Radio Electronics Engineering
- ☐ Broadcast Radio Engineering (AM, FM, TV)
- ☐ Practical Television Engineering
- ☐ Aeronautical Electronics Engineering

D

Name ....

Street ....

City .... Zone ...... State ....

CHECK: ☐ Home Study ☐ Residence School ☐ Korean Veteran

To help us answer your request intelligently, please give the following information:

EMPLOYED BY ....

TYPE OF PRESENT WORK ....

SCHOOL BACKGROUND ....

ELECTRONICS EXPERIENCE ....

IN WHAT BRANCH OF ELECTRONICS ARE YOU MOST INTERESTED? ....

CORRESPONDENCE *(Continued)*

available function with all the desired qualities.

F. LANGFORD-SMITH
Amalgamated Wireless Valve Co.
Sydney, N. S. W., Australia

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 1614 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. CORDERMAN
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 Cabinart 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.

PAUL W. KLIPSCH
Klipsch & Associates
Hope, Ark.

END

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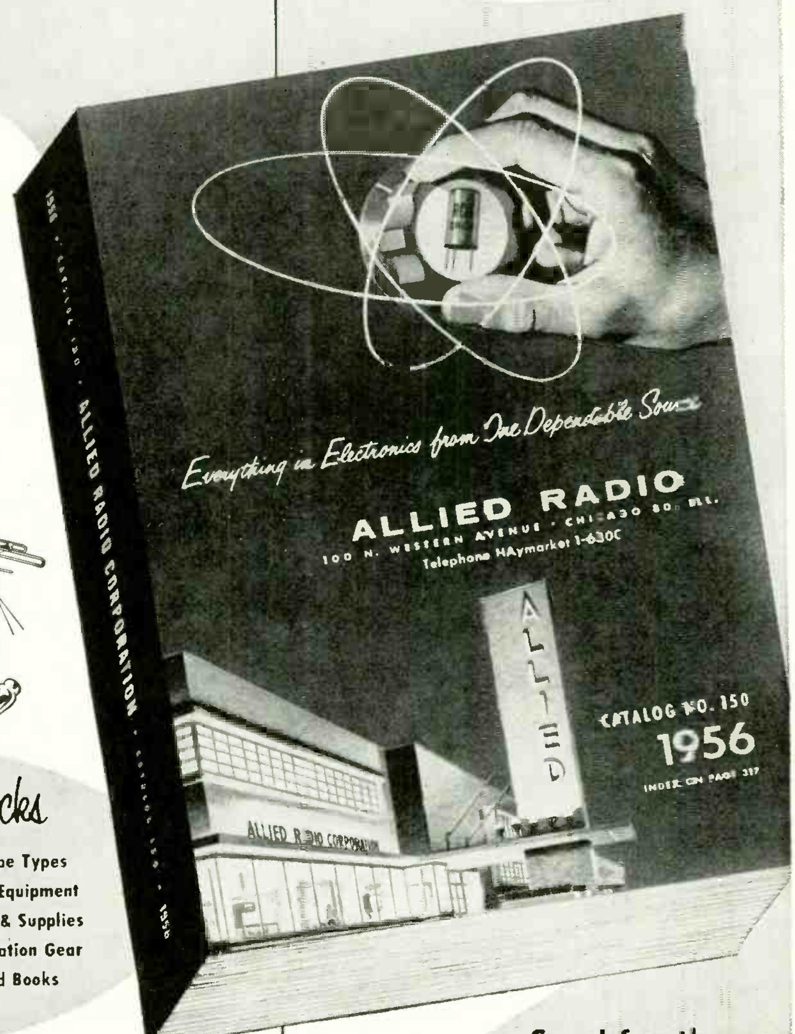

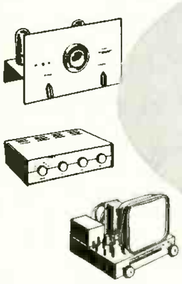

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Features the highest front-to-back ratios ever recorded for any TV antenna:

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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.

Ends co-channel interference!
Knocks out "Venetian Blinds"!

Channel Masters "K.O." puts an INVISIBLE BARRIER in the path of rear signals, preventing co-channel interference. The "K.O." is completely preassembled with time-saving "Snap-Lock" Action. 100% aluminum.

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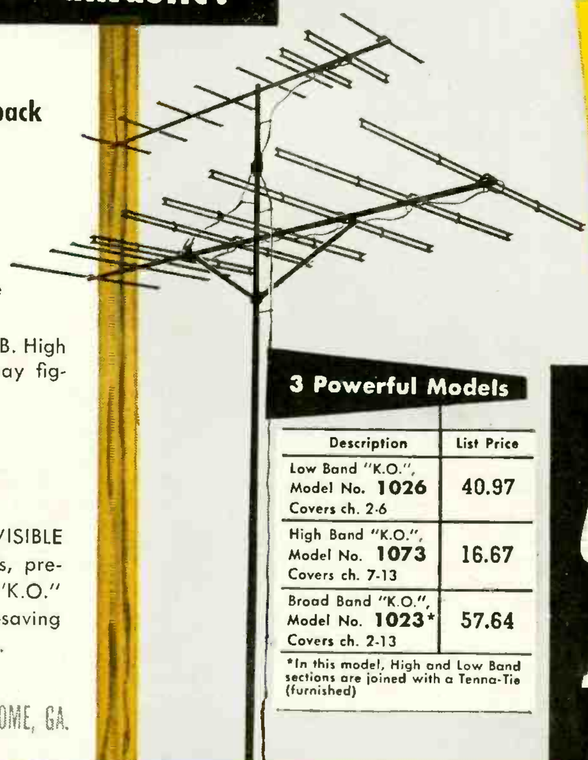

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CHANNEL MASTER now provides you

New expanded ACCESSORIES program! Channel Master now becomes the first and only manufacturer in the industry that can supply you with every*thing* you need for an antenna

new The *Super Fan*

- ***"Super-Sembled"!***
- ***Re-designed!***
- ***Better than ever!***

	Seamless		Butted	
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Channel Master's Super Fan is the original fan antenna. Famous for its superb quality, it has been in continuous demand for six years. *Millions* are in current use.

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- **Massive, heavy-duty, molded fan head. Unaffected by moisture and extreme temperatures.**
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FIRST IN PREASSEMBLED ANTENNAS

CHANNEL MASTER CORP. ELLENVILLE, N. Y.

the world's largest manufacturer of television antennas and accessories

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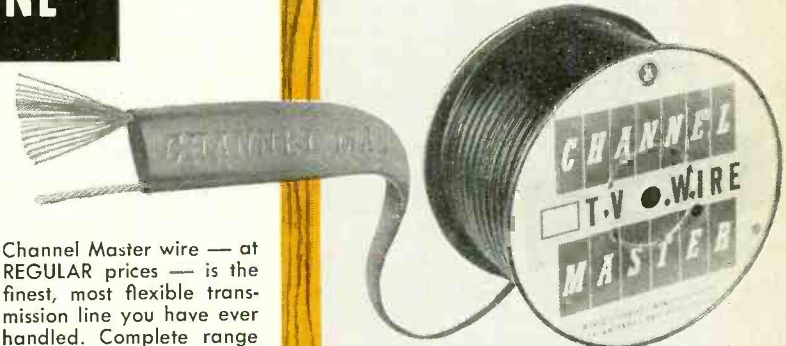
TV TRANSMISSION LINE

The first TV wire to give you the benefits of **20** strands per conductor (20/33 pure copper).



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Two outstanding lines:
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"TWIN TWENTY"

- Marked every 10 feet. Saves time, ends waste.
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"CHALLENGER"

Fine quality transmission line at today's VERY LOWEST PRICES.

installation. From now on, guarantee customer satisfaction with a *COMPLETE CHANNEL MASTER INSTALLATION — FROM TOP TO BOTTOM.*

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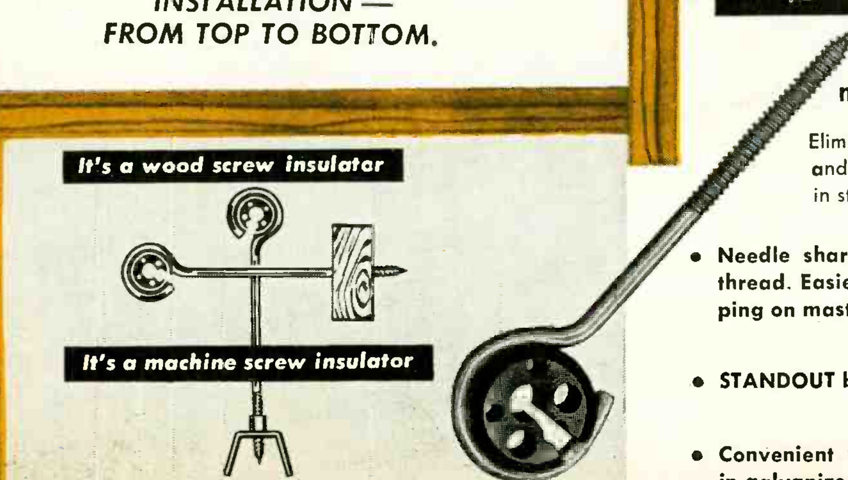
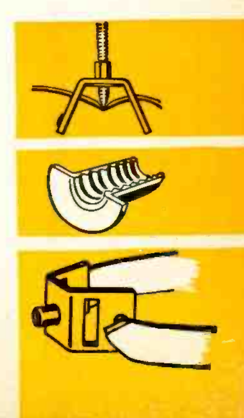
STANDOUT *insulators*



Featuring this revolutionary new 2 in 1 screw thread design!

Eliminates the need for stocking separate machine and wood screws. Cuts your inventory investment in standoffs by more than 65%.



- Needle sharp point, made possible by finer thread. Easier to work in wood. Prevents slipping on mast.
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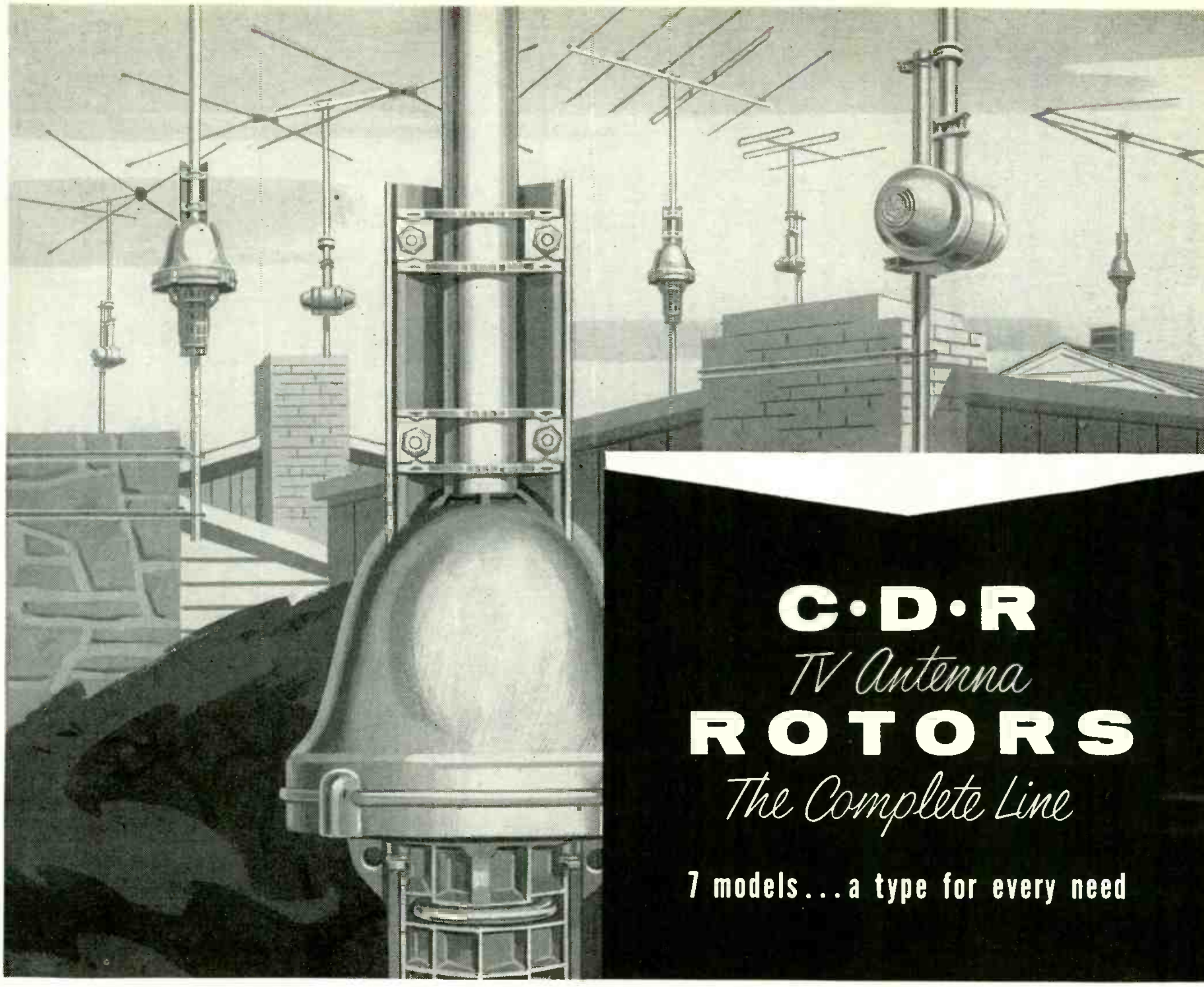

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TR-12 Complete rotor INCLUDING thrust bearing. Handsome modern cabinet with meter control dial, uses 4 wire cable.

TR-4 The heavy duty rotor complete with handsome new, modern cabinet with METER control dial, uses 4 wire cable.

TR-11 Same as model TR-12 without thrust bearing.

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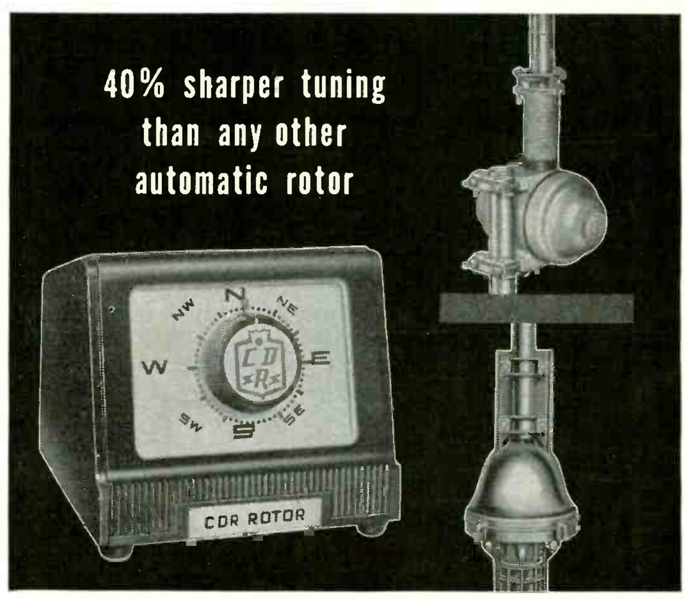
PRE-SOLD to millions with the greatest concentration of TV Spots in our history.



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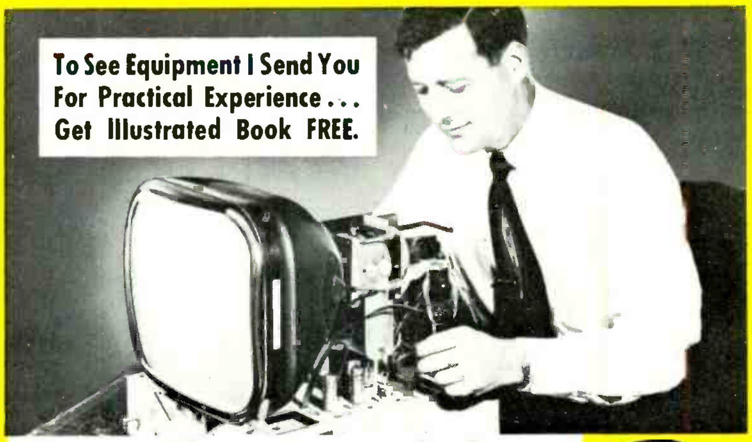

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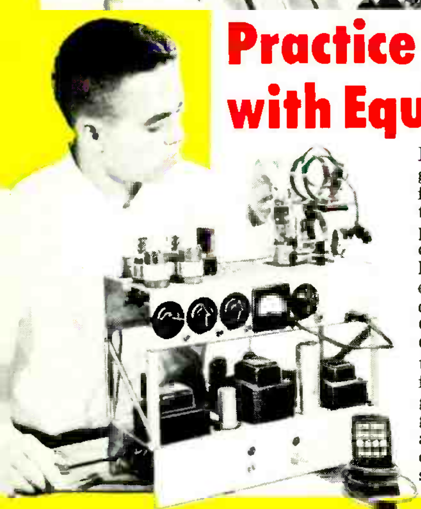
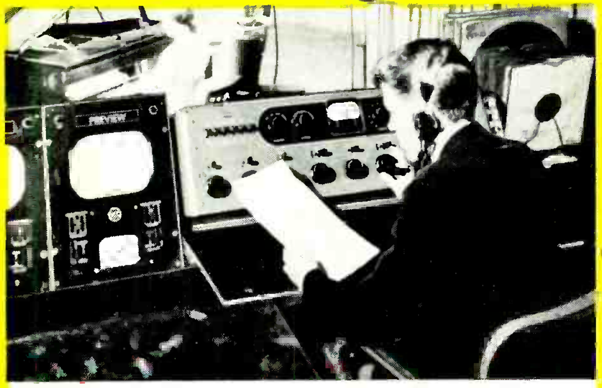


Practice Broadcasting with Equipment I Send

It's practical to train at home for good Radio-TV jobs and a brighter future. As part of my Communications Course I send you kits of parts to build the low-power Broadcasting Transmitter shown at the left. You use it to get practical experience performing procedures demanded of Broadcasting Station Operators. An FCC Commercial Operator's License can be your ticket to a better job and a bright future; my Communications Course gives you the training you need to get your license. Mail card below and see in my book other valuable equipment you build. Get FREE sample lesson.

Practice Servicing with Equipment I Send

Self-confidence, security, earning power come from knowing-how and from experience. Nothing takes the place of PRACTICAL EXPERIENCE. That's why NRI training is based on LEARNING BY DOING. You use parts I furnish to build many circuits common to Radio and Television. With my Servicing Course you build a modern Radio (shown at right). You build a Multitester, use it in conducting experiments, fixing sets in spare time starting a few months after enrolling. All equipment is yours to keep. Card below will bring book showing other equipment you build. Judge for yourself whether you can learn at home in your spare time.



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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This card entitles you to Actual Lesson on Servicing, shows how you learn Radio-Television at home. You'll also receive my 64-page Book, "How to Be a Success in Radio-Television." Mail card now!

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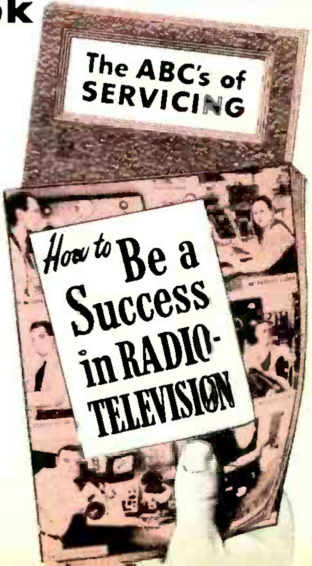

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Get a Better Job—Be Ready for a Brighter Future in America's Fast Growing Industry

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, Radio is 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. Use of Aviation and Police Radio, Micro-Wave Relay, Two-way Radio communication for buses, taxis, trucks, etc., is expanding. New uses for Radio-Television principles coming in Industry, Government, Communications and Homes.

Start Soon to Make $10 to $15 a Week Extra Fixing Sets

Keep your job while training. Many NRI students make $10, $15 and more a week extra fixing neighbors' Radios in spare time, starting a few months after enrolling. The day you enroll I start sending you special booklets that show you how to fix sets. The multitester you build with parts I furnish helps discover and correct troubles.

SEE OTHER SIDE

My Training Is Up-to-Date You Learn by Doing

Get the benefit of our 40 years' experience training men. My well-illustrated lessons give you the basic principles you must have to assure continued success. Skillfully developed kits of parts I furnish "bring to life" the principles you learn from my lessons. Read more about equipment you get on other side of this page.

More and more Television information is being added to my courses. The equipment I furnish students gives experience on circuits common to BOTH Radio and Television.

Find Out About this Tested Way to Better Pay

Read at the right how fellows who acted to get the better things of life are making out now. Read how NRI students earn $10, $15 a week extra fixing Radios in spare time starting soon after enrolling. Read how my graduates start their own businesses. Then take the next step—mail card below.

You take absolutely no risk. I even pay postage. I want to put an Actual Lesson in your hands to prove NRI home training is practical, thorough. I want you to see my 64-page book, "How to Be a Success in Radio-Television," because it tells you about my 40 years of training men and important facts about present and future Radio-Television job opportunities. You can take NRI training for as little as $5 a month. Many graduates make more than the total cost of my training in two weeks. Mailing postage-free card can be an important step in becoming successful. J. E. Smith, President, National Radio Institute, Washington 9, D. C. Training Men for Over 40 years. Approved Member, National Home Study Council.

J. E. Smith, *President*
National Radio Institute

The men whose messages are published below were not born successful. Not so long ago they were doing exactly as you are now . . . reading my ad! They decided they should KNOW MORE . . . so they could EARN MORE . . . so they acted! Mail card below now.

I TRAINED THESE MEN

Lots of Spare-Time Jobs
"I do a lot of spare-time Radio and TV servicing. It was fun learning and I don't know how to thank you." B. Goede, Plainview, Minn.

Now TV Trouble Shooter
"I had only gone to 7th grade when I started course. Now have job as TV trouble shooter, also fix sets spare time." M. R. Lindemuth, Fort Wayne, Ind.

Engineer with WHPE
"Thanks to NRI, I operated a successful Radio repair store. Then I got a job with WPAQ and now am an engineer for WHPE." V. W. Workman, High Point, N. C.

NRI Course Can't Be Beat
"Am with WCOC. NRI Course can't be beat. No trouble passing 1st class Radio-phone license examination." Jesse W. Parker, Meridian, Mississippi.

Quit Job for Own Business
"I decided to quit my job and do TV work full time. I love my work and am doing all right financially." William F. Kline, Cincinnati, Ohio.

Extra Money in Spare Time
"I am a police captain and also have good spare-time service business. Just opened my new showrooms and shop." C. W. Lewis, Pensacola, Fla.

My Training Leads to Jobs Like These

BROADCASTING: Chief Technician, Chief Operator, Power Monitor, Recording Operator, Remote Control Operator. **SERVICING:** Home and Auto Radios, P.A. Systems, Television Receivers, Electronic Controls, FM Radios. **IN RADIO PLANTS:** Design Assistant, Transmitter Design Technician, Service Manager, Tester, Serviceman, Research Assistant. **SHIP AND HARBOR RADIO:** Chief Operator, Assistant Operator, Radiotelephone Operator. **GOVERNMENT RADIO:** Operator in Army, Navy, Marine Corps, Coast Guard, Forestry Service Dispatcher, Airways Radio Operator. **AVIATION RADIO:** Plane Radio Operator, Transmitter Technician, Receiver Technician, Airport Transmitter Operator. **TELEVISION:** Pick-Up Operator, Voice Transmitter Operator, Television Technician, Remote Control Operator, Service and Maintenance Technician. **POLICE RADIO:** Transmitter Operator, Receiver Serviceman.

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Garry Moore

NOW SELLING

CBS TUBES ON THE

CBS TELEVISION

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"Women! . . . bless 'em, catch on to *good* things fast. So I'm telling them on my Friday morning show . . . there are no better tubes made than CBS tubes . . . the tubes with the Good Housekeeping Guaranty Seal. *More and more women will be asking you for CBS tubes.*"

Garry Moore

REPLACEMENT OR REFUND OF MONEY
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IF NOT AS ADVERTISED THEREIN

Be sure YOU have
CBS tubes in your tube caddy.

"I'll be on the CBS Television Network selling CBS tubes and your expert service every other Friday, 10:30 to 10:45 a.m., E.S.T."

CBS-HYTRON, Danvers, Massachusetts . . . A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.


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Adjustable UHF & VHF...Channels 2-83.
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Adjusts to any V angle; VHF-UHF.
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Series fil. and continuity tester.
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TAKES ALL UHF VHF LINES
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Adjustable to peaks, flat roofs.
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Use anywhere; masts to 2".
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UL approved; UHF and VHF.
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Fast-drying outdoor-indoor use.
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For 300-450-ohm open line; UL.
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For all types TV lines, VHF & UHF.
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Smart wrought black finish.
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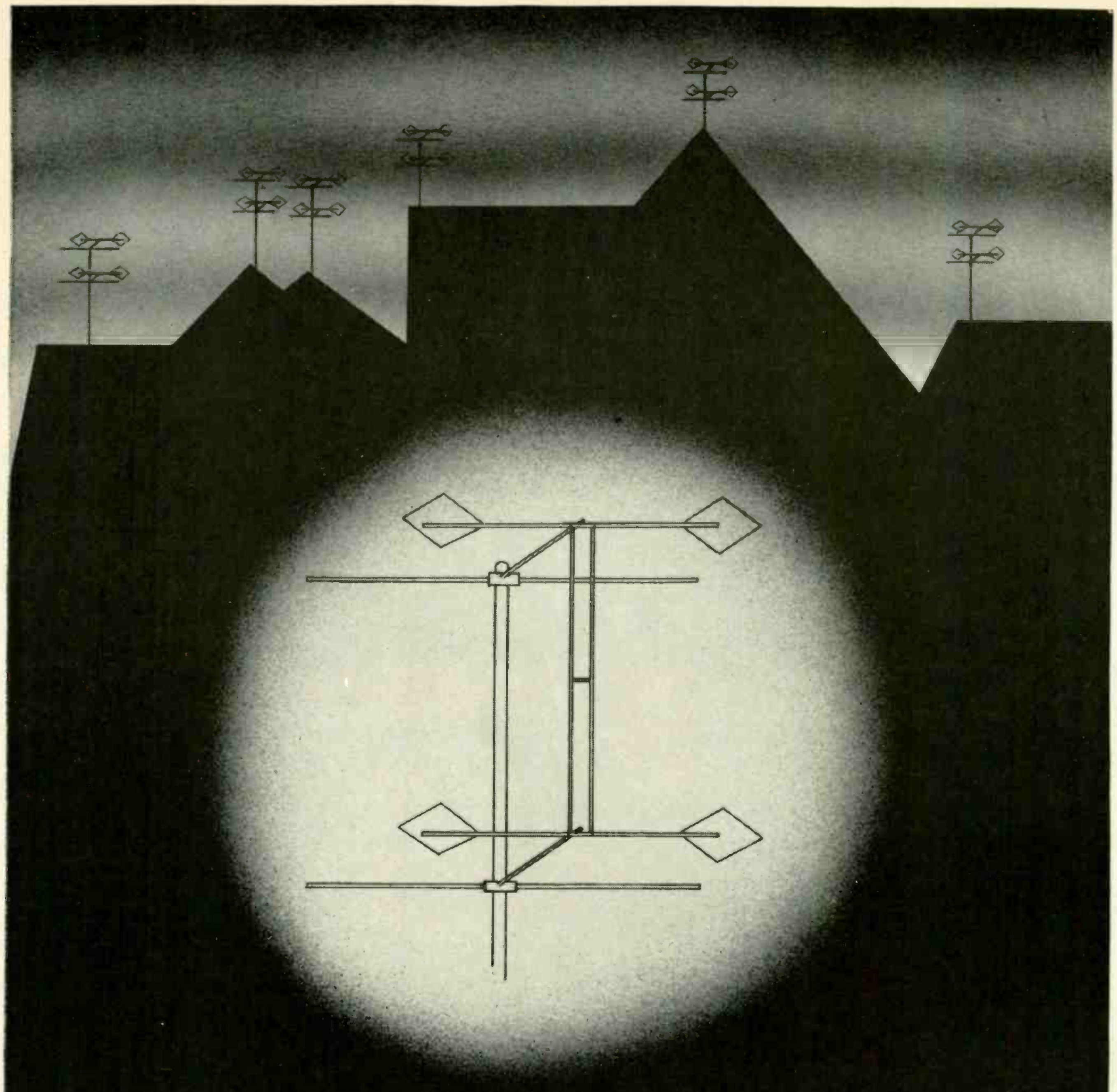

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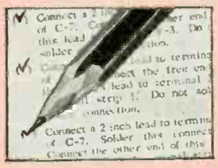

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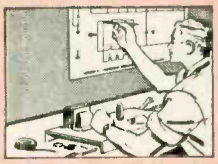

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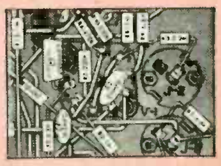

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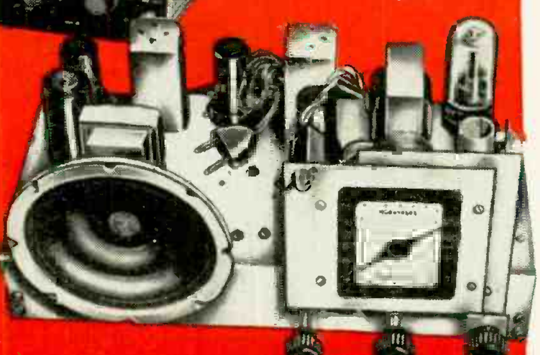

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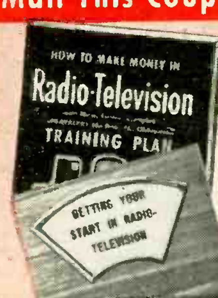

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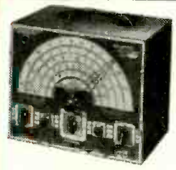

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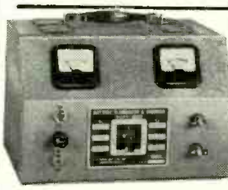

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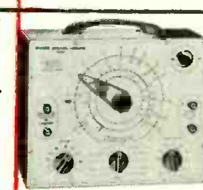

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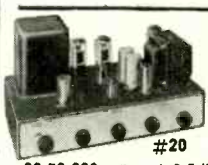

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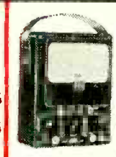

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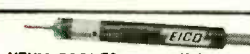

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One has only to step into the cockpit of a modern four-motored plane and see the bewildering array of the more than a hundred meters, indicating dials and controls to realize that nowadays no large aircraft could possibly navigate and land without 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, now 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 instantly and automatically 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 planes 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 even now 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 nonmetallic 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.*

* "Radar Possibilities," May, 1945; "Needed Electronic Inventions," May, 1951.

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

Panel view of the engine analyzer.

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-

* Research and Development Department, Socony Mobil Oil Company, Inc., Paulsboro, N. J.

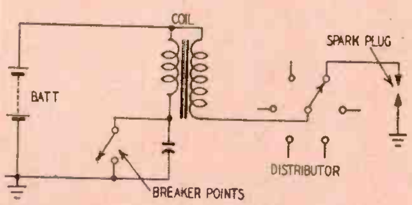


Fig. 1—Basic auto ignition system.

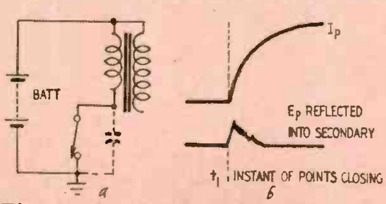


Fig. 2—Breaker points are closed

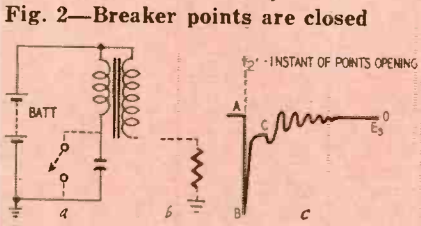


Fig. 3—Ignition circuit—points open.

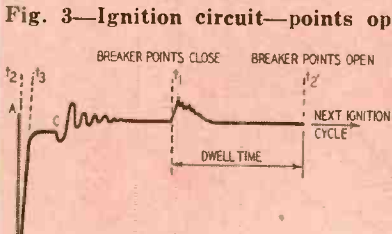
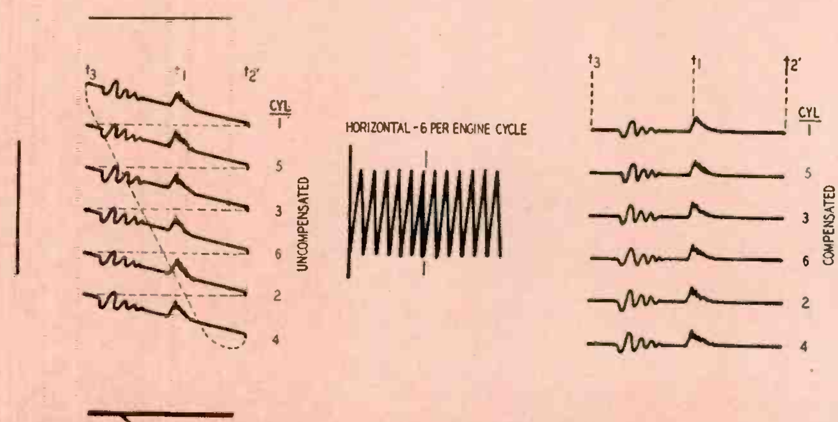


Fig. 4—The complete ignition cycle.



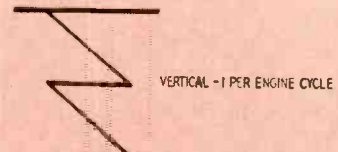


Fig. 5—Appearance of the raster, showing the sweep voltages applied to the four deflecting plates (left) before and after tilt compensation.

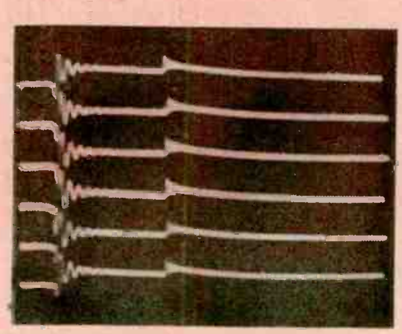


Fig. 6—Normal six-cylinder pattern.

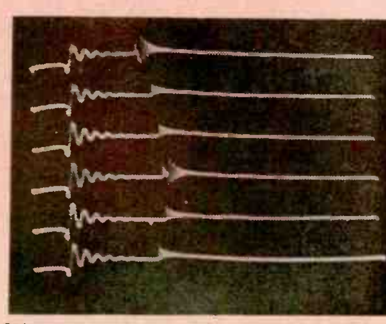
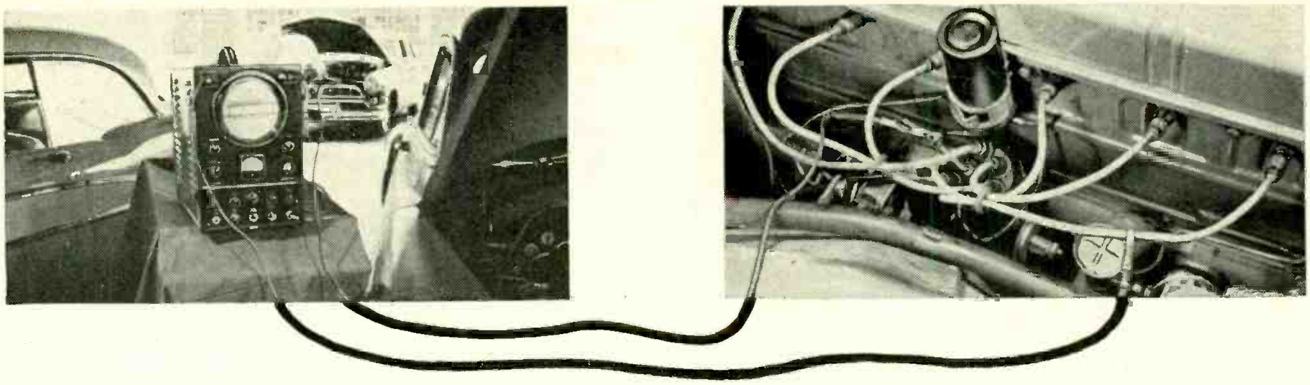


Fig. 7—Defective distributor points.



Closeup shows electrical connection to engine—capacitive clips are used.

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_p 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_p reflected into the secondary. Time t_1 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:

$$e = N \frac{d\Phi}{dt} \times 10^{-8}$$

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 the large negative pulse coincident with the opening of the points, t_2. Time t_2' 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-

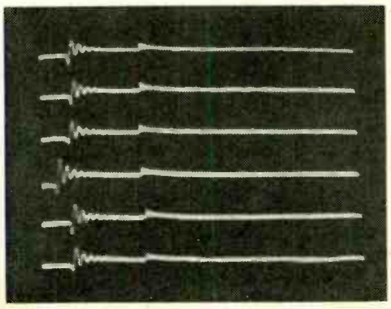


Fig. 8—Pattern shows large spark gap.

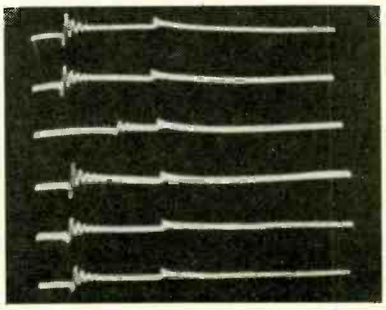


Fig. 9—Pattern shows a shorted plug.

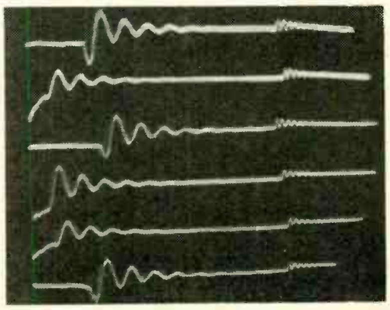


Fig. 10—Deposit-fouled spark plugs.

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_2) 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_3 instead of time t_2. 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-cycle 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_3 for cylinder No. 1 to t_3 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.

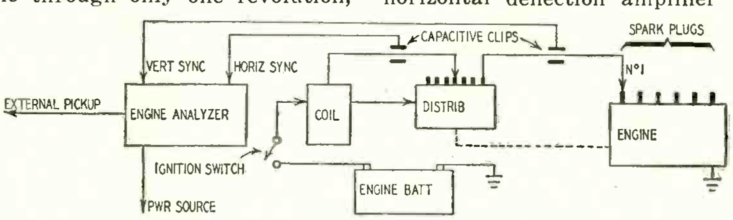
A front-panel control adjusts the amount of vertical sweep fed to the vertical deflection amplifiers so that the line spacing may be controlled. Continuous adjustment is possible from zero spacing—all lines superimposed on one another—to maximum spacing which allows for practically individual observation. 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-μa 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



Block diagram of the cathode-ray analyzer installed on an engine.

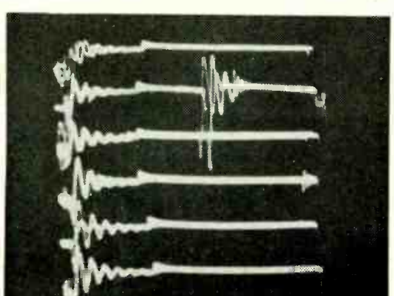


Fig. 11—Poor secondary voltage waveform caused by distributor point bounce.

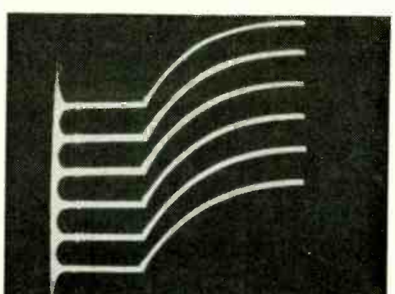


Fig. 12—Normal coil charging current.

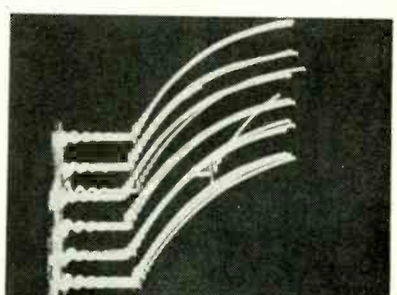


Fig. 13—Poor primary current waveform caused by distributor-point bounce.

by deposits 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. 13 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. END

SEARCHING FOR OIL with ELECTRONICS

Exploring for underground deposits with seismic waves

By JAMES A. McROBERTS

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 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 mountains; the innermost are valleys filled with ocean water. Down through the ages, some wrinkles have been removed, valleys have become mountains or vice versa. In this wrinkling process the U. S. A. has been out of the water and under it numerous times, as has the rest of the world. Whenever the surface of the ground has been covered by water, mud and other deposits have settled. These sediments usually come from some part of the Earth above water. Most of these sediments turn into rock.

The climate of our Earth was much warmer in its past history than today. Partly due to this, great forests and jungles of plant life covered many parts of the Earth's surface. Eventually these plants, trees, etc. died — partly due to change of climate — and

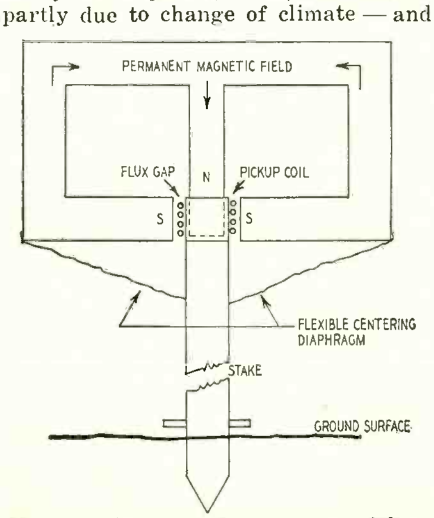


Fig. 1—Diagram of geophone pickup.

their remains (dead tree trunks, for example) were buried along with other sedimentary deposits. These dead plant remains or carcasses are said to be the source of our coal. Most geologists believe that some of the dead plant life became oil. To be accessible, these deposits must be available from dry land — not under the ocean, except in very limited areas. All exploration for oil is made in localities having sedimentary rocks or near such rocks.

Fig. 3 represents a cross-section of some part of the Earth's crust to illustrate how the shape or structure of the rock layers — sedimentary rocks are usually deposited in layers — may differ from the surface of the Earth. Note how the surface level varies. In places there are mountains; elsewhere there are areas that have been eaten away by running water. By this erosion, "old" mountains become rounded; new mountains are sharp cornered. Our Rocky Mountains are new or young mountains.

Consider the rock layers below ground. They do not follow the shape of the surface of the ground; their structure is different. Note what seems to be an old ground surface at layer D (Fig. 3) which was dropped below water and had sedimentary layers A, B, C deposited on it. Another action that shifts rock layers is called "faulting." Faults are simply rock layers that have broken and shifted. Sometimes this is due to weight; sometimes to bending back and forth.

Almost all crude or natural oil floats on water. Underground oil floats on water too — on underground water. If

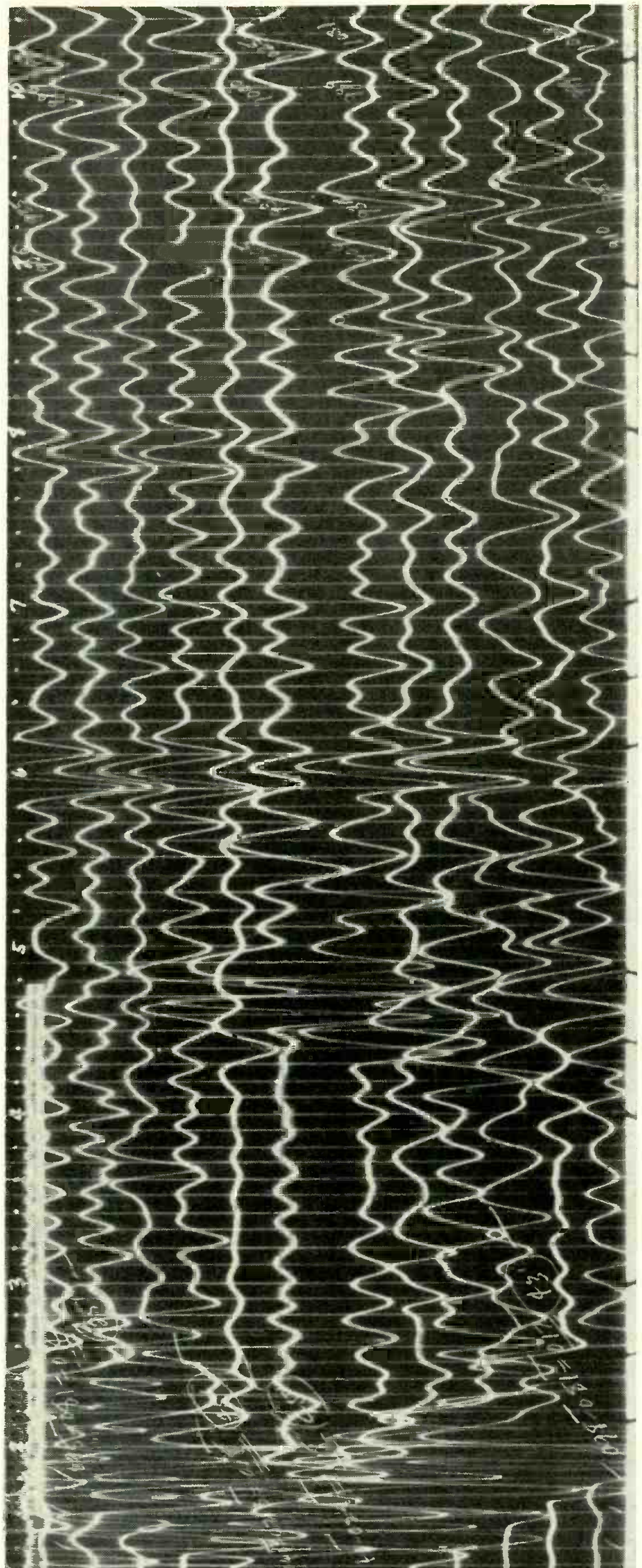


Fig. 2—Typical seismic recording.

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 "anticlinal" 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.

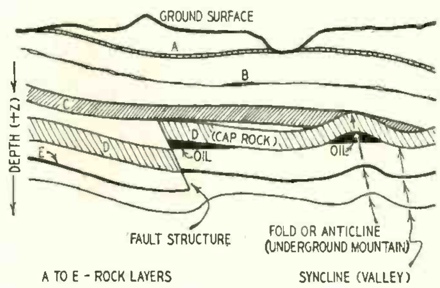


Fig. 3—Cross-sectional view shows structure of the Earth's crust.

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

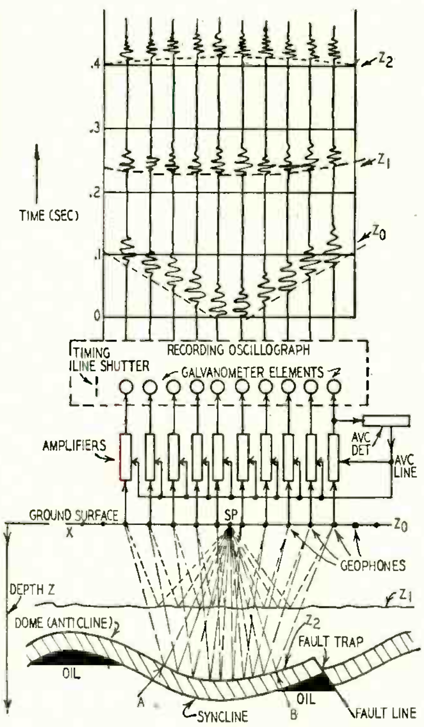


Fig. 4—Diagram shows relation of the Earth and components of seismic system.

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_0 of the seismic waveforms on the moving seismic record. Seismic waves traveling downward strike layer Z_1 with some reflection due to different physical characteristics which comes back to be recorded as Z_1 on the moving seismic record. Of the seismic energy hitting the Z_1 layer or rock bed, some is transmitted downward to hit Z_2 and is partially transmitted and partially reflected. The partially reflected wave reaches the surface to form the "reflection incident" labeled Z_2 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 Z_2. 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 taken over 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 Z_2, 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 .500 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 runs, 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 a 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 pushed 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 oscillograph has one element for each channel, but a common magnetic field for up to 36 elements. Timing lines are put 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.

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 link momentarily broke or interrupted the trace, making 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 to reach 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 deposits of oil around their sides.

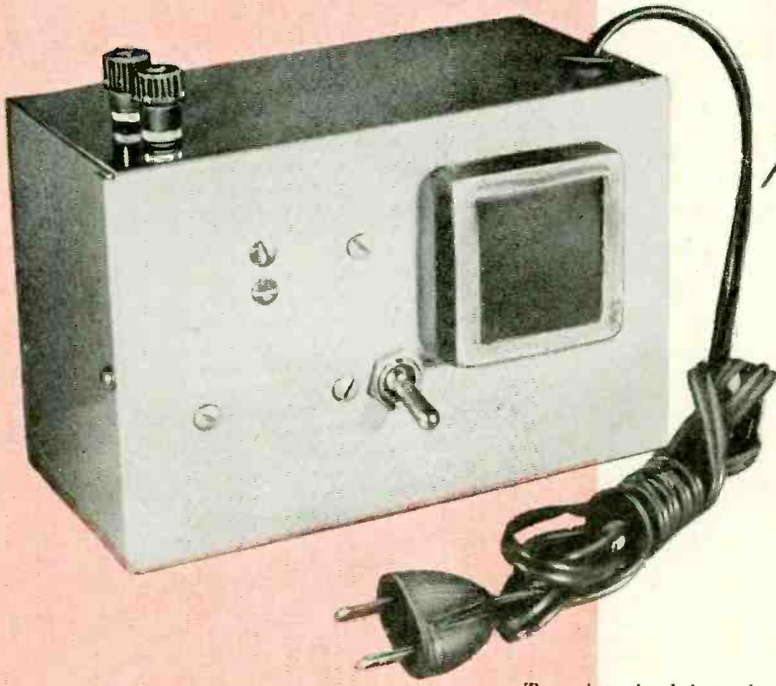
The length of the record in reflection work is about 2½ to 3 feet long. This length corresponds to a time of travel of the seismic wave of about 2.5 seconds both down and up. The speed of seismic waves increase with depth. Usually 2 seconds of travel represent a depth of about 12,000 feet but as the 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!

Refraction records are somewhat longer. 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. Despite 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. END

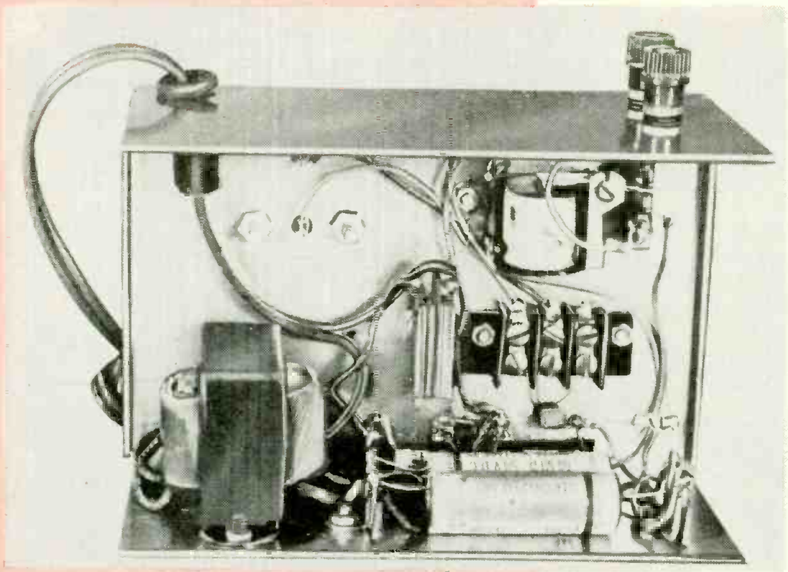
Transistorized Photocell ALARM

All-semiconductor unit is sensitive and fast-operating

By RUFUS P. TURNER*



Transistorized intruder alarm.



Components layout in the equipment.

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 milliampere 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.

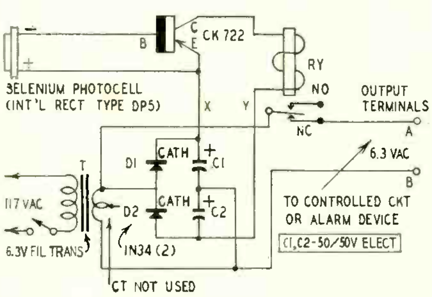
Normally, the d.c. output current of the transistor, only a few microamperes, is too low to operate the relay through whose coil it flows. But when the photocell is illuminated, the direct current it generates flows into the transistor input and causes an amplified transistor output current high enough 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 distance between a lamp bulb and the photocell 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



Schematic of the transistorized alarm.

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. Simply omit the power supply components (C1, C2, D1, D2 and T) and connect a single 22.5-volt battery to leads X and Y. Connect the positive terminal of the battery to X and the negative terminal to 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 pivot 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.

Parts for burglar alarm

2—50-μf 50-volt electrolytic capacitors; 2—1N34 germanium diodes; 1—sensitive d.c. relay, approximately 1 ma (Sigma type 4F or equivalent); 1—CK722 transistor; 1—self-generating photocell (International Rectifier Corp. type DP5 or equivalent); 1—s.p.s.t. switch; 1—filament transformer, 6.3 volts @ 1 amp (Merit P-2944 or equivalent); 1—line cord; 2—output terminals with insulating washers; 1—transistor socket or 3-terminal block (Cinch-Jones 3-141 or equivalent); 2—mounting strips; 1—cabinet, approximately 6 x 4 x 3 inches.

The transistor "socket" is a Cinch-Jones type 3-141 three-screw terminal block; the transistor pigtails 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.

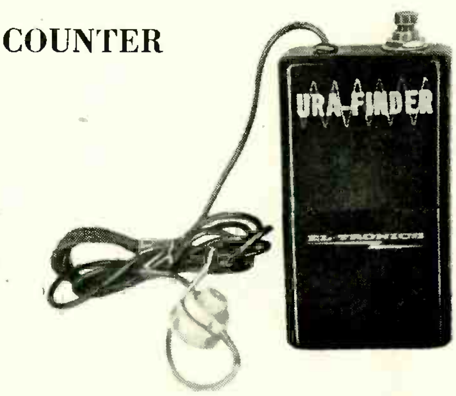
The output binding posts are mounted with insulating washers to prevent contact with the metal box. Neither is connected to the box.

Observe carefully the polarity of the diodes, electrolytic capacitors, photocell and transistor. Connect these components *exactly* as shown in Fig. 1.

After the wiring has been checked, the unit may be tested. Connect an a.c. voltmeter (or a buzzer or electric bell) to the output terminals. Place a lighted 60-watt lamp about 2 feet from the photocell. Plug the unit into the power line and close the switch. The meter should not read nor the bell sound. If either operates, move the lamp closer or adjust the relay pivot screw (to loosen the spring) until operation ceases. Now pass your hand between the light and the cell. If this causes the meter to read or the bell to sound, the device is ready for use.

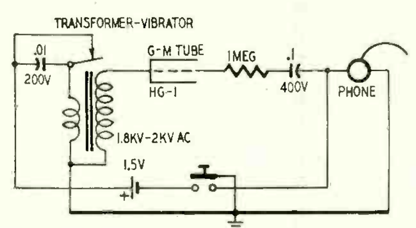
This photoelectric alarm is satisfactory for any of the uses to which such a light-operated relay can be applied—counting objects, opening doors, stopping a machine when a hand or arm approaches, turning lights on and off, etc. It operates quietly, without hum or chatter. Its light weight (2 pounds) makes it easy to install. END

COMPACT GEIGER COUNTER

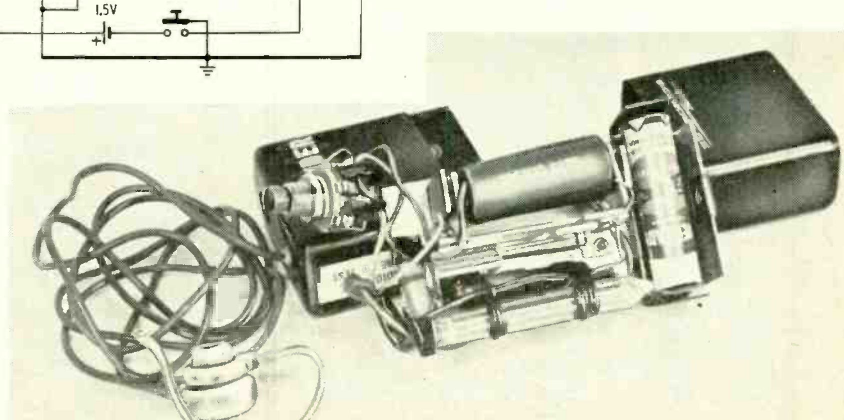


In keeping with the expanding demands in the field of uranium prospecting, a small Geiger counter capable of measuring tiny increases in radiation over normal background count has been introduced. The Ura-Finder (see photo) is powered by a small penlight cell. Extremely compact, the instrument is about 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.



HIGH-POWER williamson amplifier for HI-FI

50-watt unit uses 6550 output tubes and larger output transformer

By DAVID HAFLER*

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 *cleaner* 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 convert 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 proportions 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 5V4-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 basing arrangement as KT-66's or 5881'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

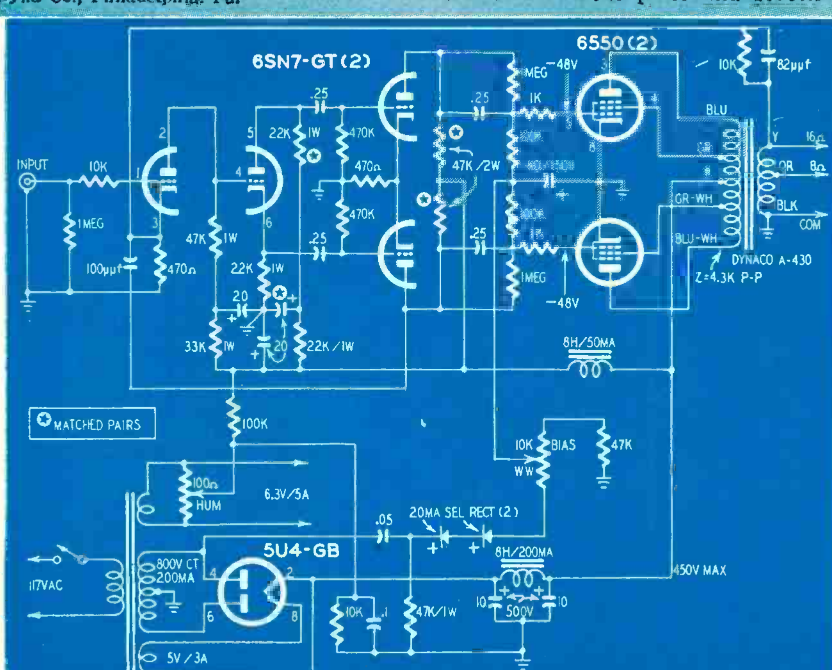
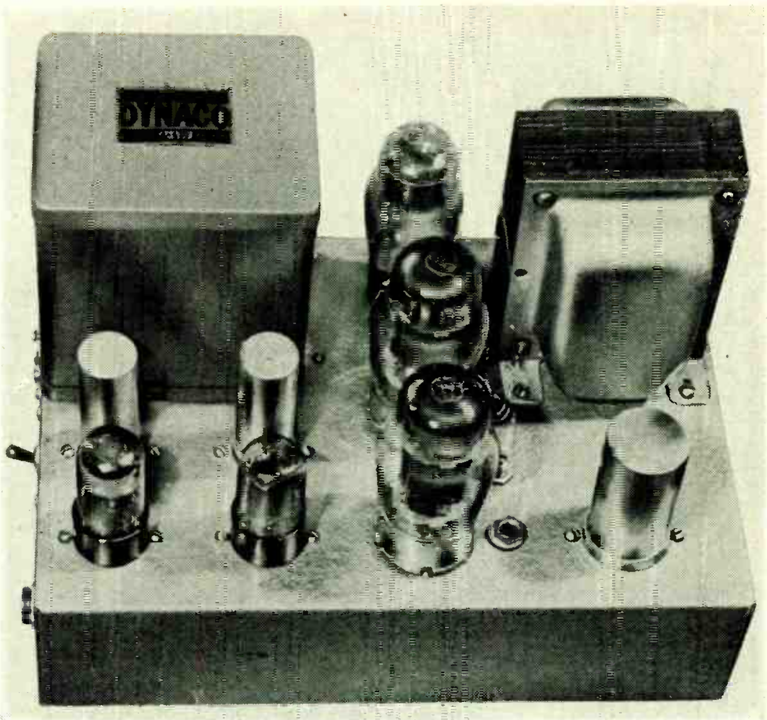


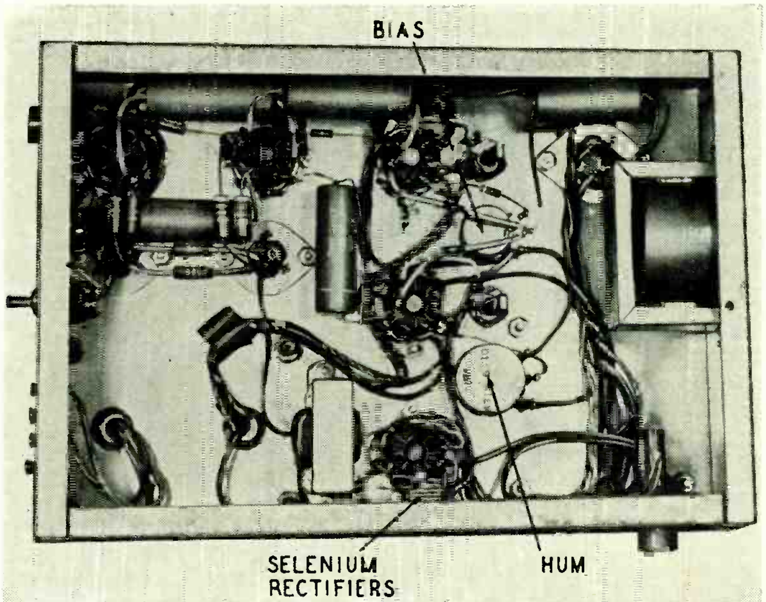
Fig. 1—Schematic diagram of the 50-watt modified Williamson amplifier.

* Dyna Co., Philadelphia, Pa.



Top view of the Ultra-Linear amplifier after conversion to 50-watt output.

Underchassis view after conversion. The jacks are for metering plate current.



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-μf 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-μf 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 shock-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 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 5V4-G'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 IM 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_2 or -B operation—either of these types of operation create minimum low-level distortion components of 0.25% or even higher.

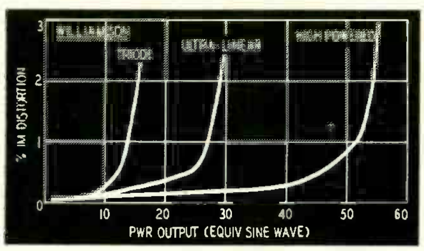


Fig. 2—Amplifier distortion curve.

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 kc 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.

Parts for high-power amplifier

Resistors: 2—470, 2—1,000, 3—10,000, 1—39,000, 3—100,000, 2—470,000 ohms, 3—1 megohm, ½ watt; 3—22,000, 1—33.000, 2—47,000, 1 watt; 2—47,000, 2 watts; 1—100-ohm potentiometer; 1—10,000-ohm potentiometer.

Capacitors: 1—50, 1—82 μμf, mica; 1—.05, 1—0.1, 4—0.25 μf, 400 volts; 2—10 μf, 500 volts, electrolytic; 1—20 μf, 150 volts, 3—20 μf, 450 volts, electrolytic.

Tubes: 2—6SN7-GT, 2—6550, 1—5U4-GB.

Transformers and chokes: 1—output transformer, primary impedance 4,300 ohms plate to plate, secondary impedance 8 and 16 ohms (Dynaco A-430 or equivalent. Acrosound's TO 330 is a very close equivalent; Stancor is bringing out an equivalent for use with 6550's.); 1—power transformer, 800 volts ct @ 200 ma, 5 volts @ 3 amps, 6.3 volts @ 5 amps; 1—choke, 8 henries @ 200 ma; 1—choke, 8 henries @ 50 ma.

Miscellaneous: 2—selenium rectifiers, 20 ma; 5—octal sockets; 1—line cord; 1—input jack; 1—output terminal.

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-kc 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. END

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 ads 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.

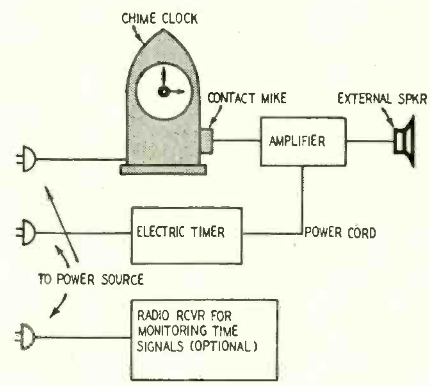
It wasn't long coming. Instead of the soft mellow chime, there was the thunderous roar of a gigantic gong. Turning the gain down I again restored the soft mellow chime, but with enough volume so that it could be heard over a radius of several blocks.

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.

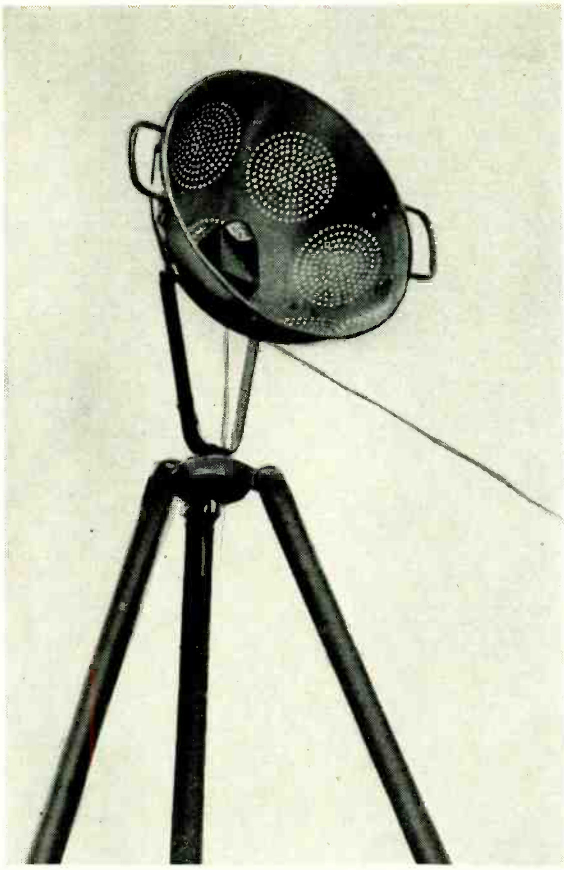
To get the correct time we used a shortwave radio tuned to WWV at 2.5, 5, 10, 15 and 20 mc, and set the chime clock by this at least once a day.

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 Washington, 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 correct 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 business as much as if you had given shoddy service or sold inferior merchandise. END



The preamp mounted in a colander.

Remote Transistor Preamp

Self-powered unit is versatile listening-in device

By EDWARD M. NOLL

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.

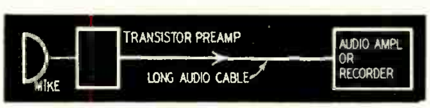


Fig. 1—Cable and terminal units.

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.

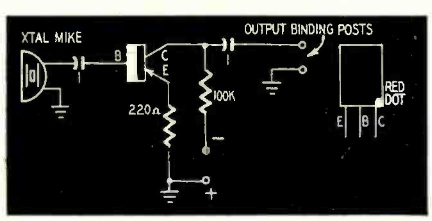


Fig. 2—Schematic of transistor preamp.

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-audio-frequency loss. Inasmuch as a battery powers the amplifier, there is no hum pickup. The signal is therefore amplified before it reaches the line and possible 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

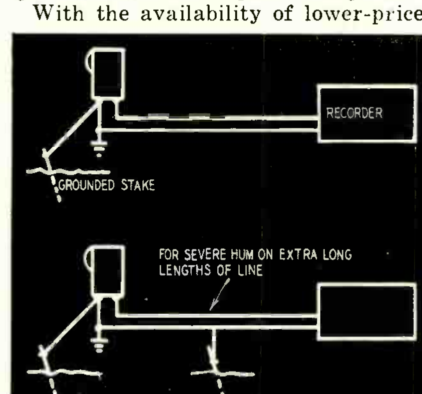
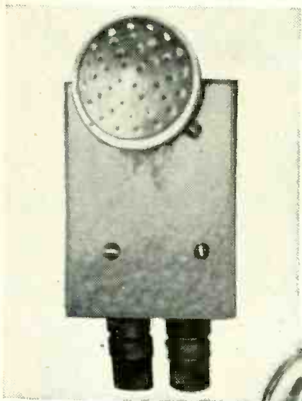
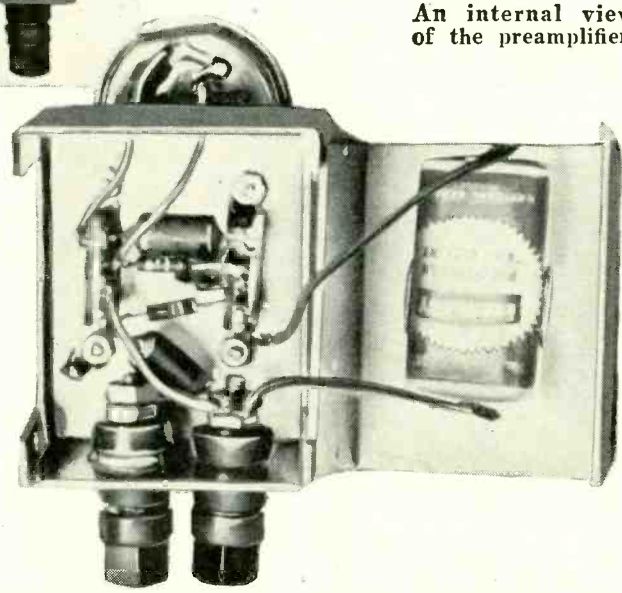


Fig. 3—Connections for hum reduction.



The transistor pickup—the crystal microphone is cemented to the case.



An internal view of the preamplifier.

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, without 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. END

Parts for transistor amplifier

1—220, 1—100,000 ohms, ½-watt resistors; 2—1-µf capacitors, metalized tubulars; 1—CK722 transistor; 1—crystal microphone cartridge; 1—22.5-volt battery (Eveready 412 or equivalent); 2—binding posts (Superior or equivalent); 1—box, 2¾ x 2⅛ x 1⅝ inches (Bud Minibox CU2100 or equivalent); 2—terminal strips.

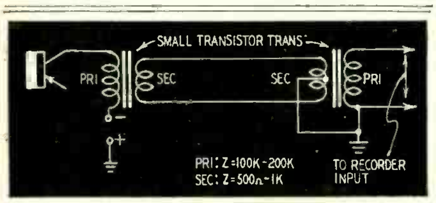


Fig. 4—Using transformer coupling.

Add Bias–Erase Indicator to Tape Recorder

HAVE 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 bias indicator to your tape recorder at a cost of less than a dollar.

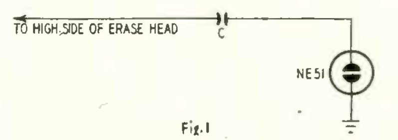


Fig. 1

Figs. 1 and 2 show the circuits that can be added to almost any tape recorder. 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-µµf unit on a Pentron 9T3C. Values as high as 50 µµf may be necessary on other tape recorders. The leads to C and the neon lamp should be as short as possible. Fig. 1 is used when one side of the erase head is grounded, Fig. 2 when both sides of the erase head are balanced to ground.

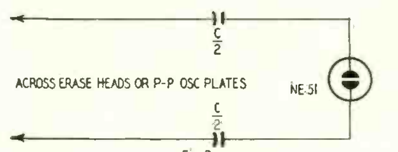


Fig. 2

If 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 erase circuits.

UNBALANCED

Dukane	11A55FF, 11B55
Masco	52, 52C, 52CR, 52L, 52LR, 52R
Pentron	9T3C
Revere	T-70153, T-70157, T-70163, T-70167, T-70253, T-70257, T-70263, T-70267, T-77153, T-77157, T-77163, T-77167, T-77253, T-77257, T-77263, T-77267
Tapemaster	PT125 unbalanced head only

BALANCED

Brush	BK-437, BK-437S, BK-439, BK-441, BK-442, BK-443P
Pentron	PRE-7
Tapemaster	PT125 balanced oscillator only

—*Frank J. DiElsi*

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 bourdon 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 *vibrato* 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 waggling 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

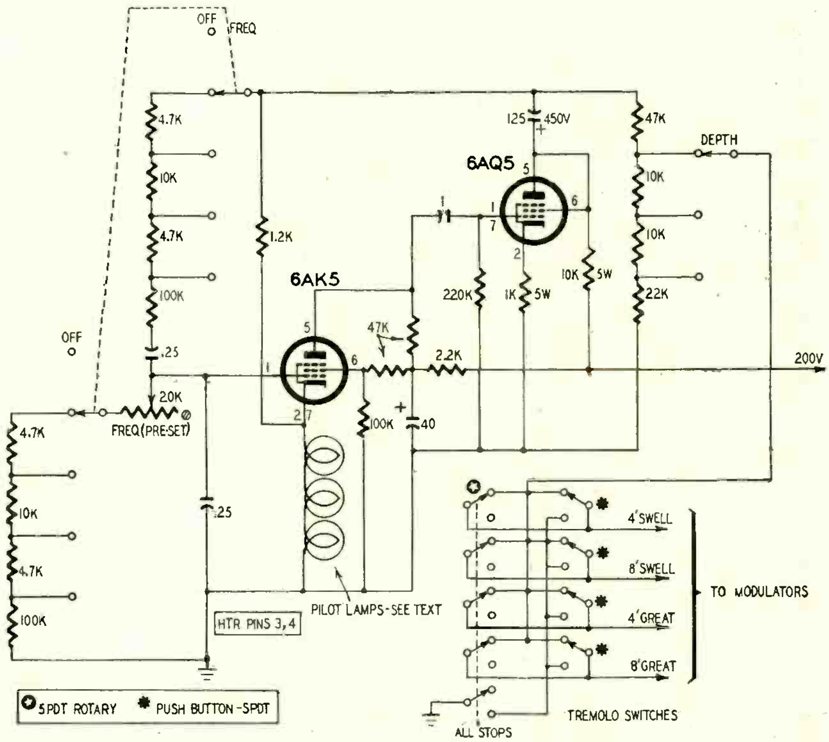
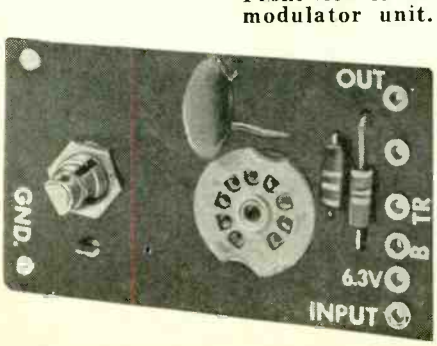
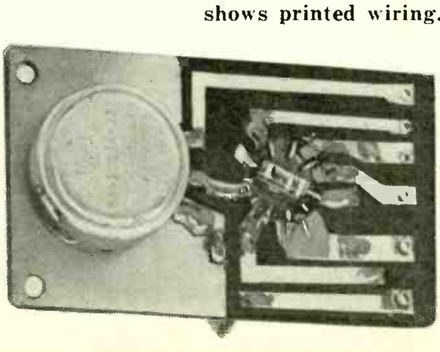


Fig. 1—Schematic shows circuit of a 4- to- 8-cycle tremolo oscillator.



Front view of the modulator unit.



Modulator rear shows printed wiring.

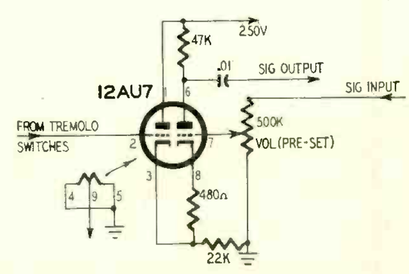
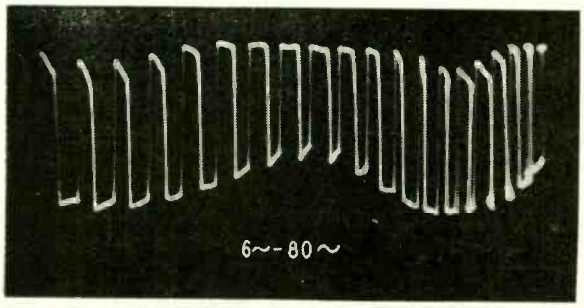
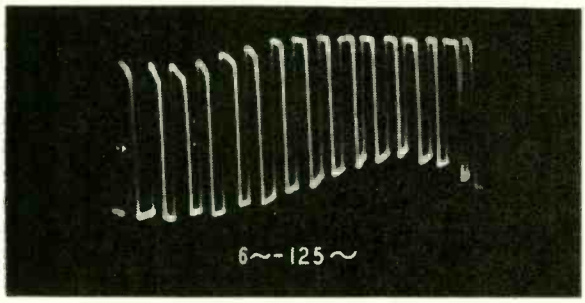


Fig. 2—Cathode-follower modulator.

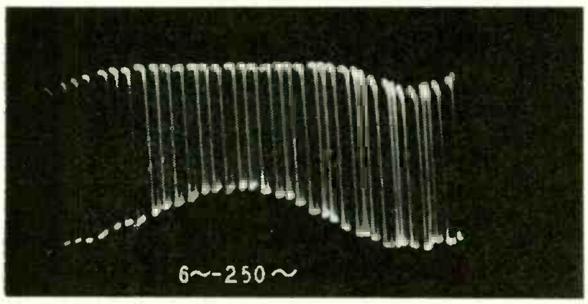
Fig. 3—Notes with 6-cycle tremolo



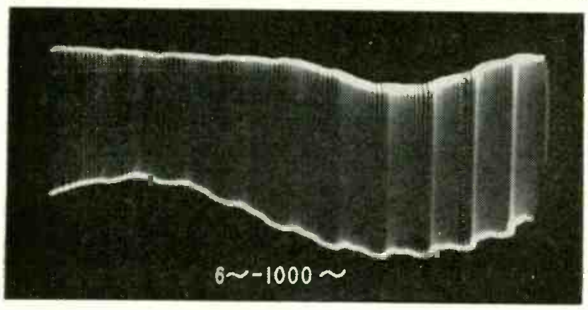
3-a—80 cycles



3-b—125 cycles



3-c—250 cycles



3-d—1,000 cycles

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, 1950—September, 1952).

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 bellow 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 klavier. 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

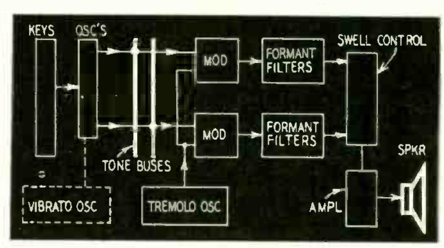


Fig. 4—Block diagram shows tremolo oscillator feeding two modulators.

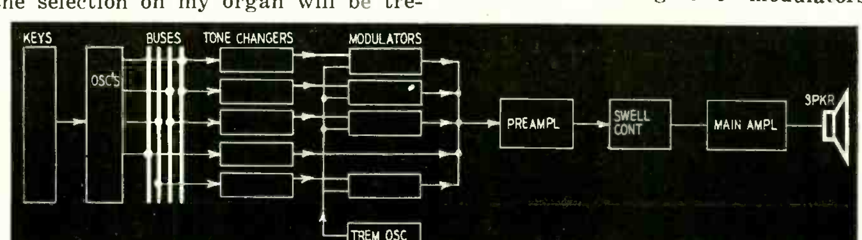


Fig. 5—Tremolo oscillator can feed several modulators without strain.

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 3S6/5 115-volt 3-watt indicator lamp may be used instead) are mounted on a piece of heavy fishpaper. By cutting in the paper an I slot, about ¾ inch long and ½ 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—1,200, 1—2,200, 4—4,700, 4—10,000, 1—22,000, 3—47,000, 3—100,000, 1—220,000 ohms, ½ watt; 1—1,000, 1—10,000 ohms, 5 watts; 1—20,000-ohm potentiometer.

Capacitors: 2—0.25, 1—1 µf, 200 volts; 1—40 µf, 350 volts, electrolytic; 1—125 µf, 450 volts, electrolytic.

Switches: 1—2-pole 5-position rotary; 1—1-pole 3-position rotary; 4—s.p.d.t.; 1—5-pole double-throw.

Miscellaneous: 1—6AK5 and socket; 1—6AQ5 and socket; 3—lamps, Westinghouse 55C or 1—G-E 3S6/5 115 volts, 3 watts; 1—chassis; 1—panel; 1—power supply socket; 1—output socket.

Parts for tremolo modulator

1—480, 1—22,000, 1—47,000 ohms, ½-watt resistors; 1—500,000-ohm potentiometer; 1—.01-µf capacitor; 1—12AU7 and socket; 1—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-organlike 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. END

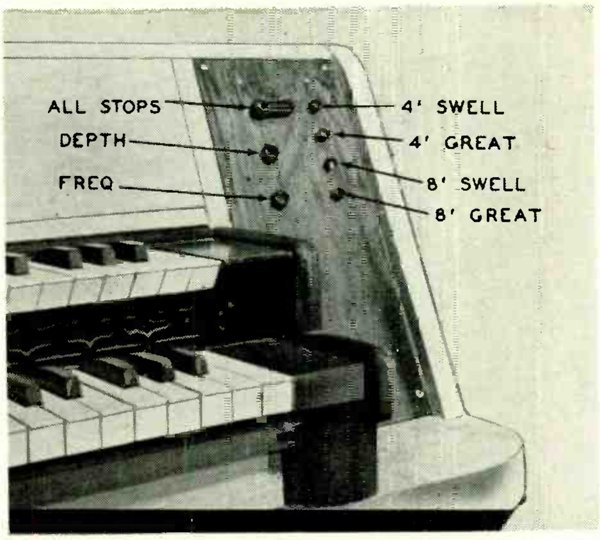


Fig. 6—The tremolo control panel.

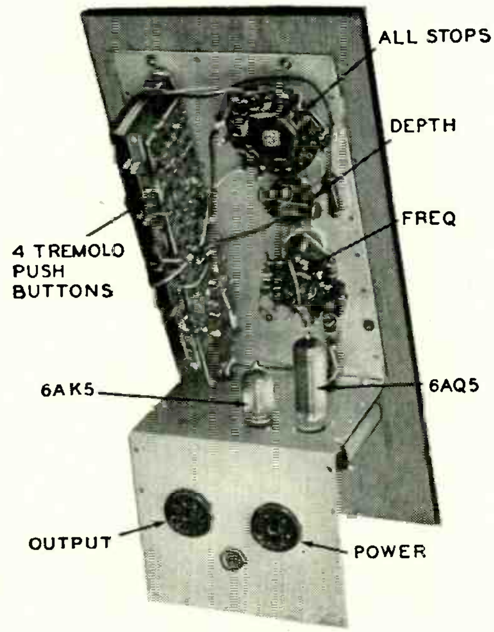


Fig. 7—Rear of the tremolo panel.

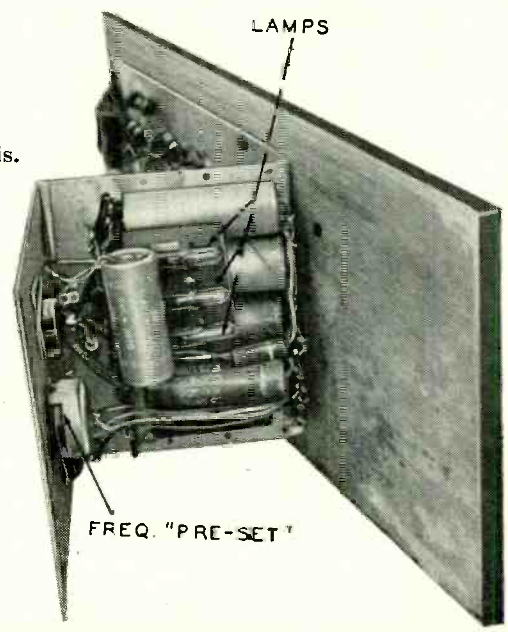


Fig. 8—Tremolo oscillator chassis.

FOR GOLDEN EARS ONLY

The Pilotrol PA-913 preamplifier-equalizer; Miracord XA 100 record changer and XM 100 turntable; new records review

By MONITOR

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 disenchant. 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.

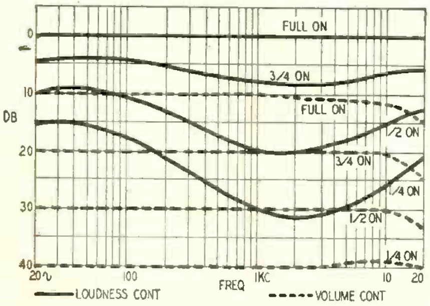


Fig. 1—Response of Pilotrol PA-913.

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 25 combinations

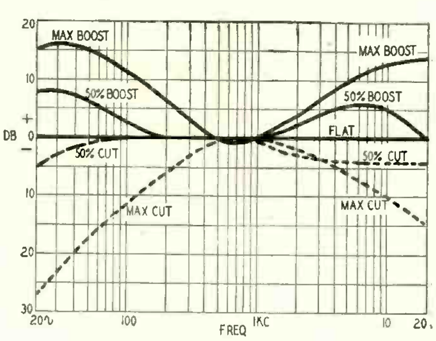


Fig. 2—Pilotrol tone control curves.

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

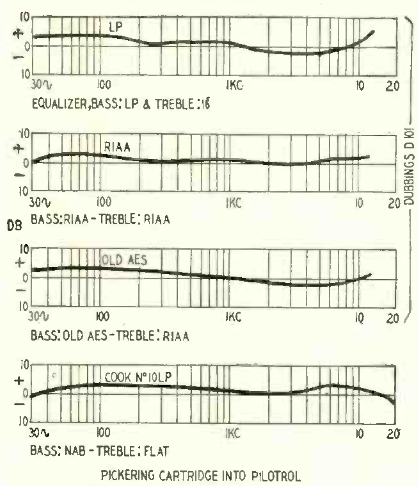


Fig. 3—Pilotrol equalization curves.

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.

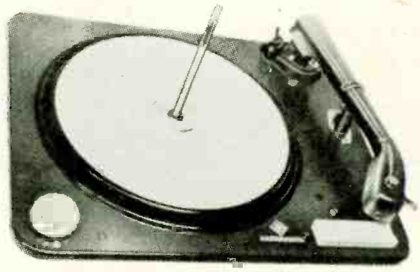
There is a microphone channel with a separate preamp and an independent compensated volume control so the mike can be mixed with any input channel. A tape output ahead of both the tone and loudness controls provides an unequalized input if desired. If the program needs some equalization for proper balance 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 phono 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 worse. 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—on 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

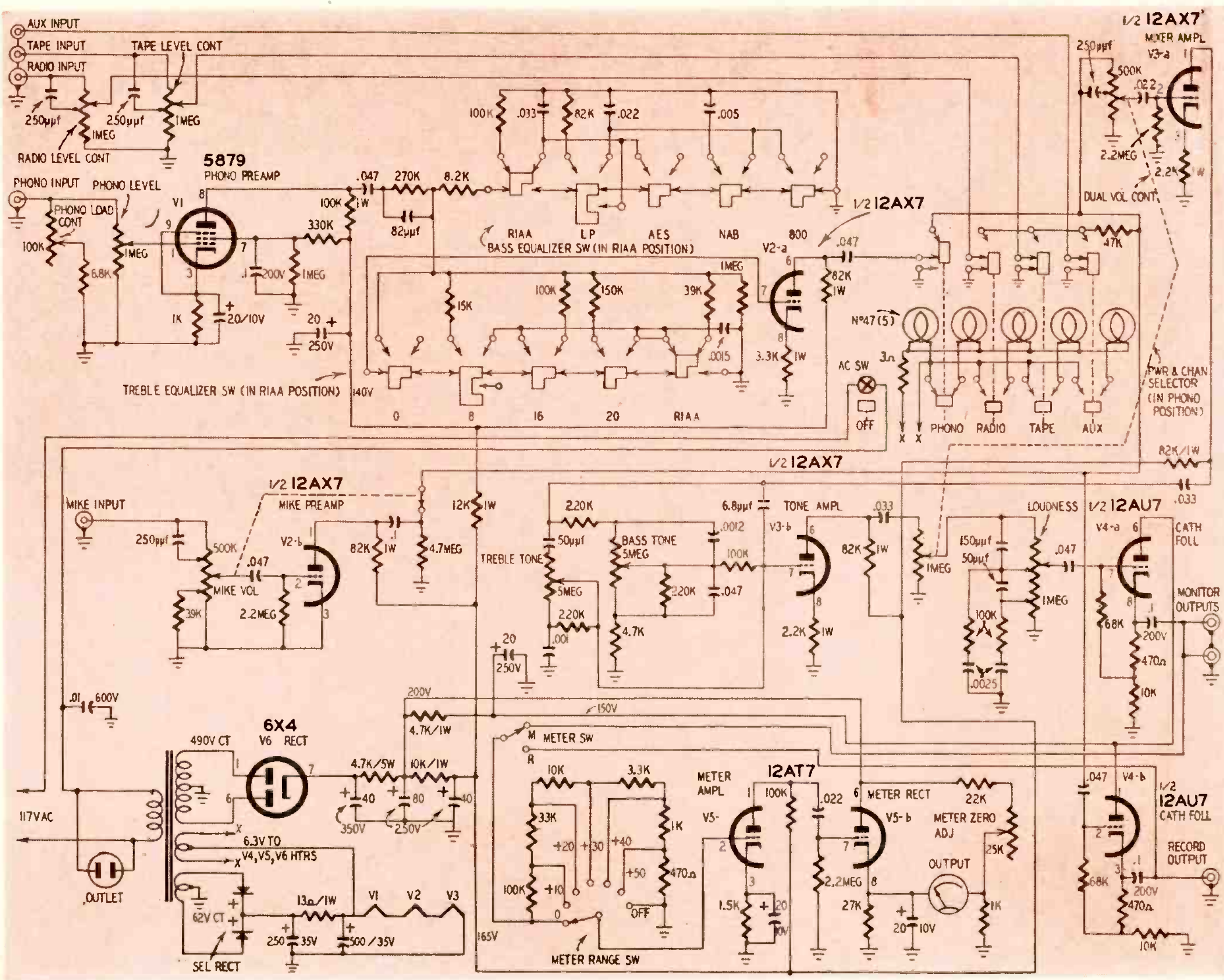


Fig. 4—Schematic diagram of the Pilotrol PA-913 hi-fi preamplifier–equalizer.

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 which follows 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.

The Pilotrol comes in a wood cabinet with a sloping panel. However, the chassis can be removed and mounted in a rack or an equipment cabinet. For such mounting the panel can be adjusted by changing the position of the screws to provide the normal 90° panel. The workmanship looks excellent.

Miracord XA 100 changer

This very clever product of Western German ingenuity will not take your records out of their jackets or wipe off the dust and static. But it will do just about anything else you could ask a changer to do and several things you never thought of.

The important qualities of a changer from the standpoint of listening are noise level, wow and tracking ability. The American distributor advertises "no rumble, no wow." This is an exaggeration; but it will take a lot of bass boost and a speaker system of very high efficiency below 40 cycles to show the rumble up. Thus, in this respect, the XA 100 (see photo) can stand up to the better professional type single-play turntables. As near as I can determine, the rumble is some figure between 45 and 50 db down from the level of a G-E cartridge and with the average speaker system, even a fairly large horn, it will not be a significant factor. The wow is also low, at least when the changer is new. And the fact that the speed switch has neutral positions between all speeds, in which the idler is disengaged from the turntable rim, ought to contribute to maintaining this fine condition—provided you make a habit of placing the switch in the neutral position. Merely turning off the turntable will not automatically disengage the idler.

Tracking will depend on the cartridge. Unfortunately cartridges differ in the overhang they provide when mounted in a given arm—the G-E produces excellent results. Needle pressure is easily varied with a knurled nut underneath the arm, but above the chassis, where it is always accessible. It permits a wide range of adjustment sufficient to obtain optimum pressure with all of the half-dozen cartridges I tried. I had no trouble obtaining good tracking over the full width of normal records. However, as is the case in other changers, you may be reluctant to play the last half-inch or so of such extended-play recordings as some released by Vox because the trip mechanism is often engaged before the arm reaches the end of the recorded grooves. Moreover, the pressure of the trip lever against the arm has a tendency to cause groove-locking on such records. This occurs also in the manual-play position and caution is recommended when playing these "longer-playing" records.

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 cable.

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 jams 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 or playing cycle. 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, a very nice feature is that the arm can be adjusted so that if 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 following the 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 5½ minutes for 33'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 four pushbuttons inserts a low-resistance load across the pickup to roll off highs and thus reduce scratch on noisy records. As it comes, 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 cycles 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 manual or semiautomatic. That is, having put 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—engaging the on switch—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 ½-inch mounting centers. Needle pressure is adjustable as in the changer.

Both changer and turntable use a rubber mat with concentric raised ridges 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 bases already cut; it takes scarcely 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 RIAA 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 want to hear it and it would be a discussion-provoking item in any hi-fi concert. RCA takes both sides of the jacket and one of the record—in the voice of overdone ham without which the record would be much more impressive—to tell what it is all about. I will not attempt to summarize except to say that this is the first recorded example of completely synthetic music, produced by completely electronic means, without any performers and direct, as it were, from the pen of (in this case) an arranger. There is nothing especially notable on it from a hi-fi point of 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 audiophile may find it very helpful for its simple 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 most useful addition to available technical test records with some absolutely unique material including, for the first time, 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 presenting frequencies from 15.6 to 22,500 cycles. Optical examination proves the sweep is excellently flat and even the 22.5-kc tone is captured solidly and flatly. Unfortunately, the response of LP cartridges when played back at 78 r.p.m. is not accurately representative of their 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 1 also provides an excellent test for translation loss and tracking distortion by offering identical frequencies on the outermost and innermost bands. A translation loss of much over 6 db will indicate either a poor needle or poor tracking or both. Finally, there are three bands giving the three standard pitches for A—444, 435 and 440. 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 a speed adjustment.

Side B is at 33 r.p.m. but can be played also with both needles. The first two bands offer the 100- and 1,000-cycle square waves. Much to my surprise the better pickups do an extremely good job of reproducing them although there is always a ripple on the top which I presume is at least partially recorded. Aside from a measure of transient response and stability these give a quick check of equalization.

There are two bands for checking IM: a 16-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 hear only the carrier tone for the same reason that the ear hears nothing when an r.f. wave modulated with a sound wave is fed into an audio amplifier. (The modulation on the two sides is out of phase and as long as both sides are passed without distortion, cancellation occurs.) But if the symmetry is disturbed by rectification or distortion the modulation will become audible to some extent. I have some reservations about the sensitivity of the method. My quick and perhaps inadequate checks appear to indicate that the distortion has to exceed 5% before it is evident to the sharp ear and 10% before it is at all obvious. But, though this may limit the usefulness of the bands for absolute measurement, there is no gainsaying that it is a simple method and provides the audiophile without instruments a means of keeping check on his equipment and spotting trouble at a fairly early stage.

There is another frequency sweep at the 33.3-r.p.m. speed but this time from 31.3 to 16,000 cycles. Unfortunately this sweep is equalized to the "Bartok" curve which uses a 630-cycle bass turnover, requires a 23-db boost at 30 cycles, a 1,590-cycle treble turnover and a 16-db slope at 10 kc. The old NAB equalizer or NAB bass and LP treble will do a fair but not exact job of reproducing it. Finally, there are three bands of music intended to show that the Bartok curve is superior to both the ancient 78-r.p.m. and RIAA curves. This special pleading takes away from the usefulness but the first band will give a good check of tonal balance of 78-r.p.m. equalizers and the RIAA of RIAA equalizers.

La Danza

Carmen Dragon and Hollywood Bowl Orchestra — Capitol P-8314

A top-notch demonstration and showoff recording with emphasis on beautifully sharp and clean high-highs, not especially notable bass but a nice presence and liveness despite the fact that it was recorded in an outdoor shell. The music which will please all but the most blasé includes the *Mexican Hat Dance, Tico-Tico, Siboney, Cielito Lindo* and other Spanish or Spanish-American dances in lush orchestrations. 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 records and systems. The presence of the voices is startling although a little artificial since it represents what the conductor rather than an audience would hear. Clarity and definition are absolutely topnotch, and the selections are a baker's dozen of favorite American folk songs—*Cindy, Blue Tail Fly, Streets of Laredo, Skip to Mah Lou*, etc. Folksong purists may decry the "modern" choralization and I raise a small criticism to the out-of-dynamic scale of the occasional solo voices. But I'm sure any system which does this disc justice will impress the hearers mightily and favorably.

PROKOFIEFF: *Sonata in D Major, Op. 94*
HANDEL: *Sonata No. 4 in D Major*
VITALI: *Chaconne*

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 incidental test value for those who do like the music. Capitol in these Millstein discs has been doing a fine job reproducing the fiddle in all its rosiny realism when heard close up. Improper equalization or a peak in the cartridge will distort the harmonic structure, however, producing an unpleasant shrillness with a boost or peak and an unnatural mellowness with a slope or hole. I find it very useful for quick checks on pickups, equalizers, poor needle condition, etc.

BIZET: *L'Arlésienne Suite*
FAURE: *Pelléas et Mélisande*

Orchestra of Radio Paris conducted by Le Conte — Capitol P-8311

Very felicitous recordings of these popular works with a nice liveness, excellent definition and very clean except for a touch of stridency in the strings and distortion in the finale of the *Pelléas*. There are excellent drums in the *Farandole* of *L'Arlésienne* whose complication makes an excellent test for definition and tracking distortion. The *Pelléas* has an excellent string bass and its *Sicilienne* one of the loveliest melodies in the library of classics.

STARLIGHT ENCORES

Hollywood Bowl Orchestra
John Barnett, conductor — Capitol P-8296

This is almost as good demonstration material as Capitol's *Studies in High Fidelity*. The overall quality is not as good as on those specially cut discs but the music here covers a wider range of interest, is pleasanter to listen to and should be more popular than the classical side of the *Studies*. The selections are: Ponchielli's *Dance of the Hours*, Liszt's *Second Hungarian Rhapsody*, Tchaikovsky's *Andante Cantabile* and *Marche Slave* (quite spectacular), Saint-Saen's *Danse Macabre* and Offenbach's *Orpheus in the Underworld*.

BACH: *Partita No. 2 in D Minor*
Sonata No. 1 in G Minor

Nathan Milstein, unaccompanied violin — Capitol P-8298

Capitol gives us another startlingly realistic recording of the violin in the expressive hands of Milstein. Though the music is principally for Bach fans, there are portions of hi-fi interest. One of the things the fiddler hears but his audience almost never does is the peculiar low-frequency transient produced as his fingers release the strings. Here, especially in the gigue of the *Partita*, these transients are beautifully reproduced. The presence is phenomenal; Milstein appears to be right at your side.

RIVERBOAT SHUFFLE

Preacher Rollo and His Five Saints — MGM E-220 (10-inch LP)

Very good revival Dixieland and sounds good on hi-fi systems. Just about worth the price alone is *Chimes Blues*, a seldom heard slow blues in which a piano, tuned for a chime tone, backed by a bass bowed in its lowest register to imitate the beat notes produced when several bells are rung, produces a beautiful and novel effect. The other selections are *Riverboat Shuffle, Muskrat Ramble, Livery Stable, Tap Me, Jazz Me* and *Royal Garden Blues*.

LATIN AMERICAN DIXIELAND

Panama Francis and his Dixie Don Juans
MGM X-1128 (extended play 45 r.p.m.)

A novelty for afficionados of Dixieland, consisting of the rhythm of some kind of Caribbean drums underneath the double bass. 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 *Fidgety Feet*.

BELL RECORDS

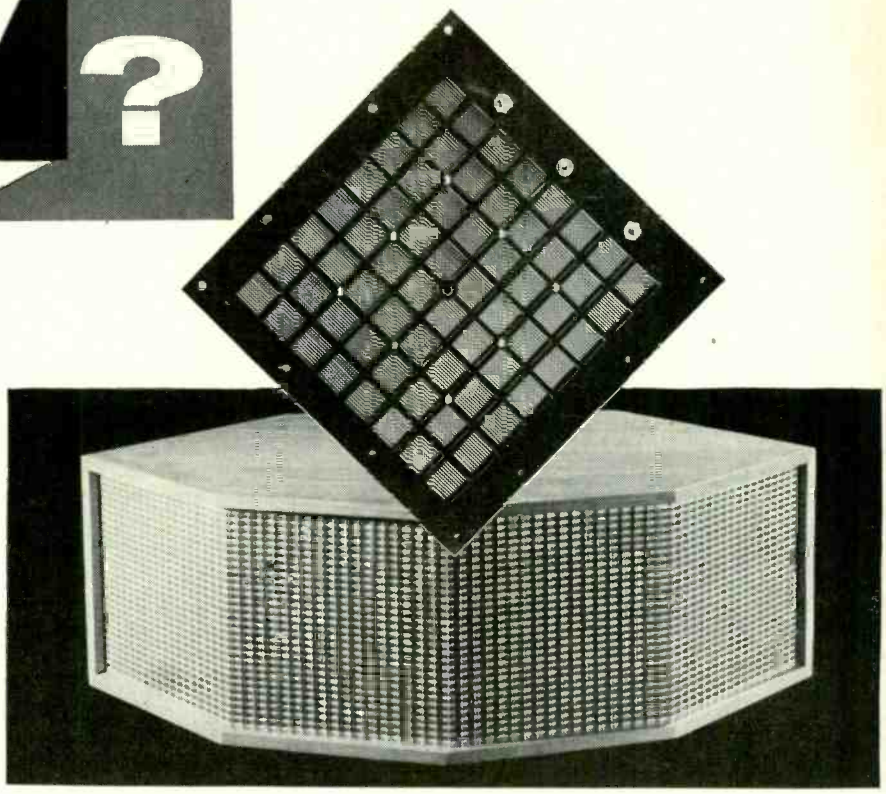
You may have noted in your corner drugstore or newsstand a bank of 7-inch recordings at the low price of 39c each, labeled *Bell* and distributed by Pocket Books, Inc. In case you've wondered if they're worth the money, I can assure you that they are. There is little of hi-fi interest in them except that the voices often have a pleasantly closeup naturalness. For the most part they are vocal renderings of hit-parade tunes. Technically they are of considerable interest because they are available not only in 45 r.p.m. with the big hole, but also in 78-r.p.m. microgroove with the small hole, a type of recording technique hitherto used almost exclusively by the superb Audiophile. If your changer or player can play these 78-r.p.m. 7-inch discs with the small hole and microgrooves, I recommend them over the 45 r.p.m. The quality seems to be slightly better at both extremes of the range, especially in the last portion of the record. END

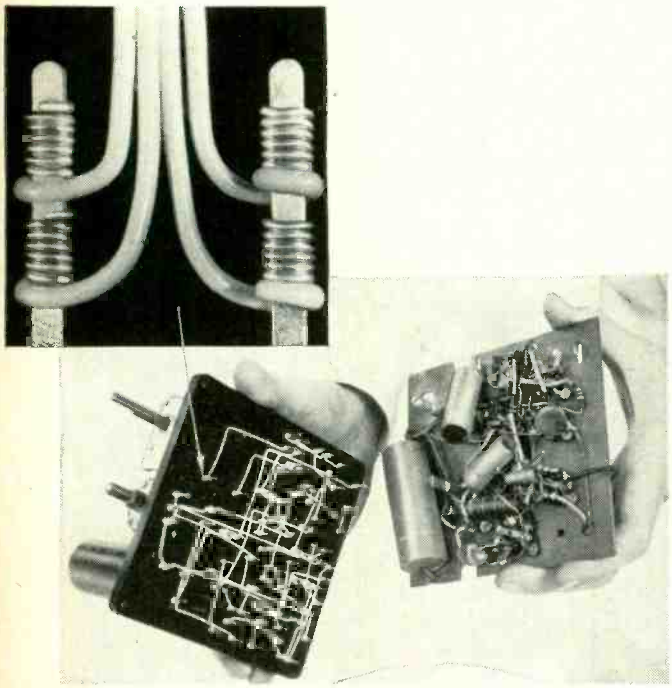
Names and addresses of manufacturers of any items mentioned in this column may be obtained by writing Monitor, RADIO-ELECTRONICS, *25 West Broadway, New York 7, N.Y.*

what's new?

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.



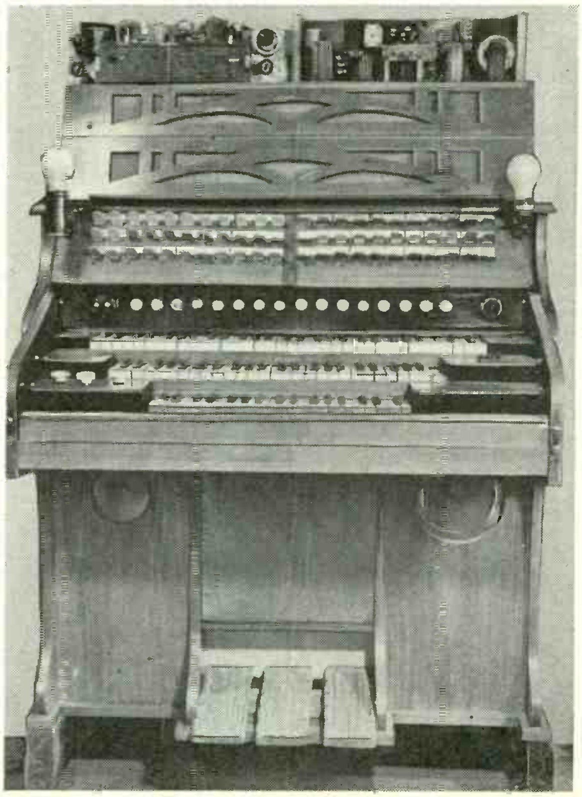


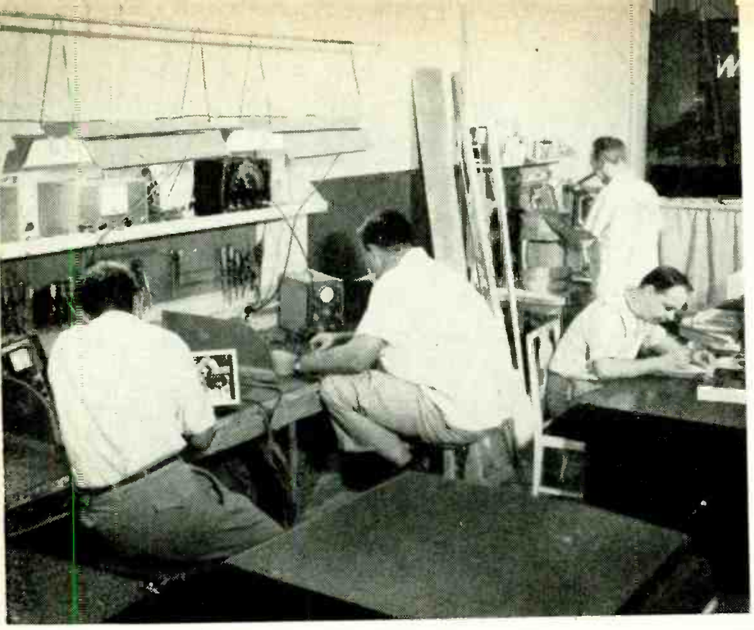
Circuit Connections

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

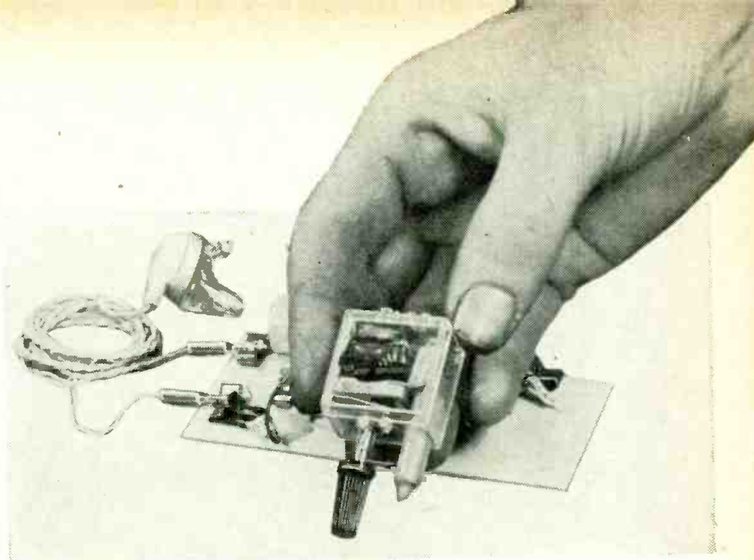
The organ at the right was conceived, designed and constructed by H. Meijer, Jr., of Amsterdam, Holland, who has followed the articles on electronic music in this magazine with great interest, and to which he gives credit for inspiration and a great deal of help in the details of design. Mr. Meijer informs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





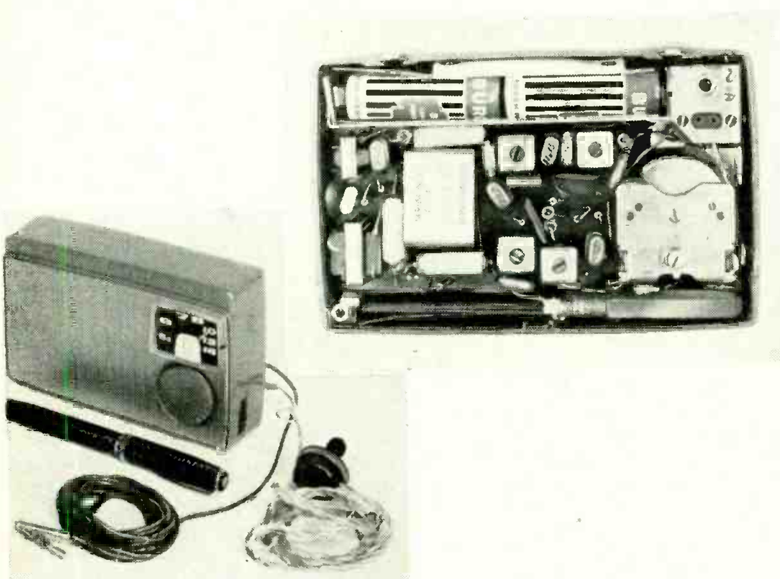
Hi-Fi Do It Yourself

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."



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.



Japanese Transistor Portable

New Nipponese five-transistor radio compares very favorable 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.

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-logth 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.

MAKING PHOTOETCHED CIRCUITS IN YOUR WORKSHOP

Part I: Process permits simplified construction; making drawing and negative

By RICHARD H. DORF*

THE printed circuit shown in Fig. 1 was made in my own laboratory. Any electronics worker—professional or hobbyist—can make his own printed circuits in the same way without any special industrial equipment and without any more space requirement 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 dollars 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 individual cost for each experimental panel of much less than $1.

Almost any electronic device produced in any kind of quantity can be made more cheaply with etched circuits because of the vastly shorter time required 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 troubleshooting and servicing. All wiring and component leads are immediately accessible for test and measurement. 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 operation 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 ordinary 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 located quickly—note the R and C numbers 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 projected onto a foil-clad panel coated with a light-sensitive acid resist. Those areas struck by light harden and remain 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 practical for any printed-circuit work. It can be carried out for small quantities—even for single panels—in any workshop or laboratory at very low cost and without any special training or equipment, even to the making of the negative from the drawing.

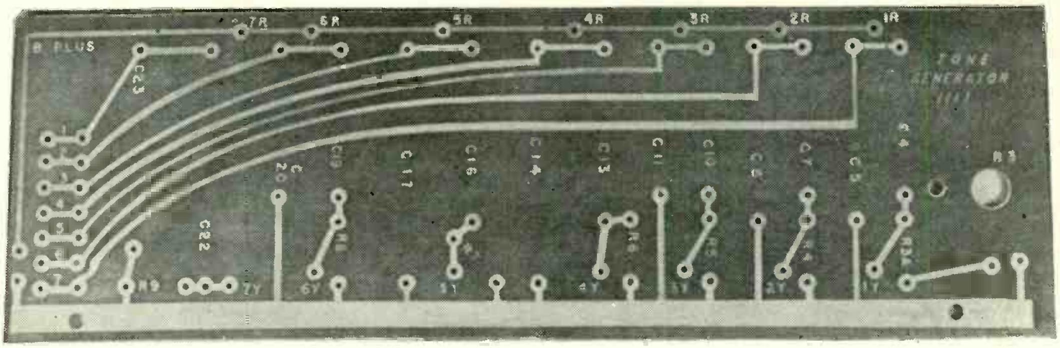
Making the drawing

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 correctness and such small points as making sure the lines are wide enough—1/16 inch is enough for almost anything—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.

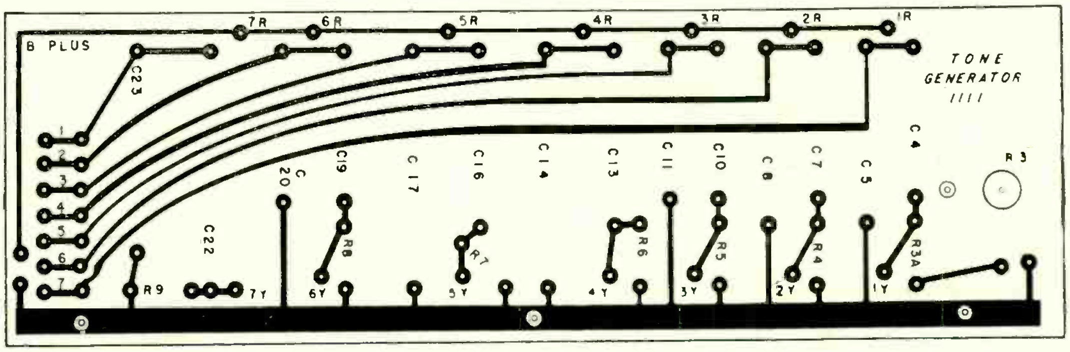
Provide a ground bus if one is required. A good trick is to carry it to at least one point where the screw or bracket fastening the panel to the metal chassis, if any, will make ground automatically. At each point where a component or other lead is to be connected to the panel make a pair of concentric 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 original drawing from which the tone generator panel was made. If any holes for mounting or such purposes are to be made in the panel, draw two concentric 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 component 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 operation.

Making the drawing requires thought in layout so that the circuit will be compact, yet complete. Usually it is necessary to make several pencil drawings as trials before obtaining a satisfactory scheme. When the final pencil drawing looks good, fasten it on top of the Bristol with drafting tape. Then, using the finest-pointed tool available—usually the steel point on the nonbusiness-end leg of a drawing compass—prick holes through the penciled paper into the Bristol. When you re-

* Electronics consultant, New York.



Above—Fig. 1—Author's etched circuit panel. Coding of parts simplifies assembly. Below—Fig. 2—The original panel drawing—India-inked on Bristol board.



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

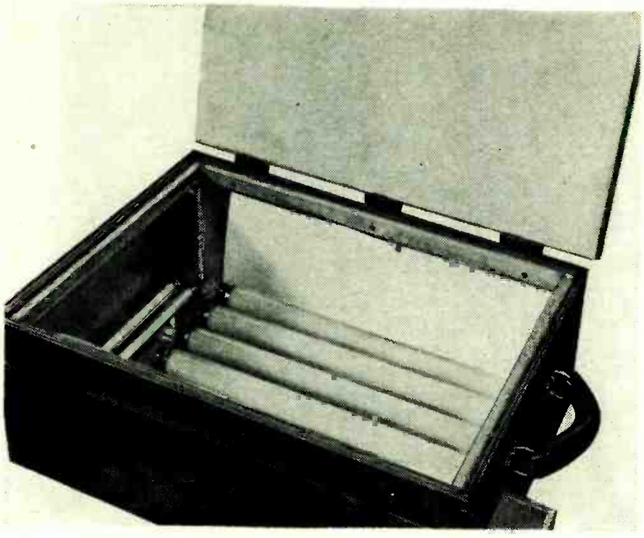


Fig. 3—A simple exposure device.

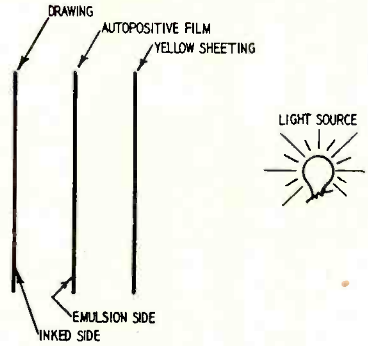


Fig. 4—Making a positive from original drawing.

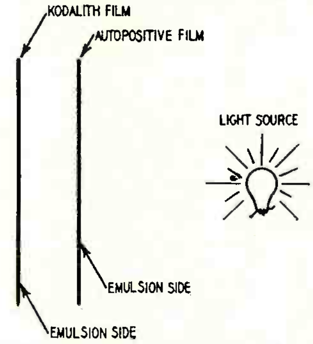


Fig. 5—Materials in making the final negative.

black where there has been no light.

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 developed film 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 interpose 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 overexposure.

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

it's reactance that counts

By H. P. MANLY

TRACING 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-µµf 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 16,000,000 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 straightedge 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 straightedge 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; *e*, tone compensation; *f*, voltage division; *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_c 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), 43 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 signal currents but their reactances oppose the signals to a greater or less extent.

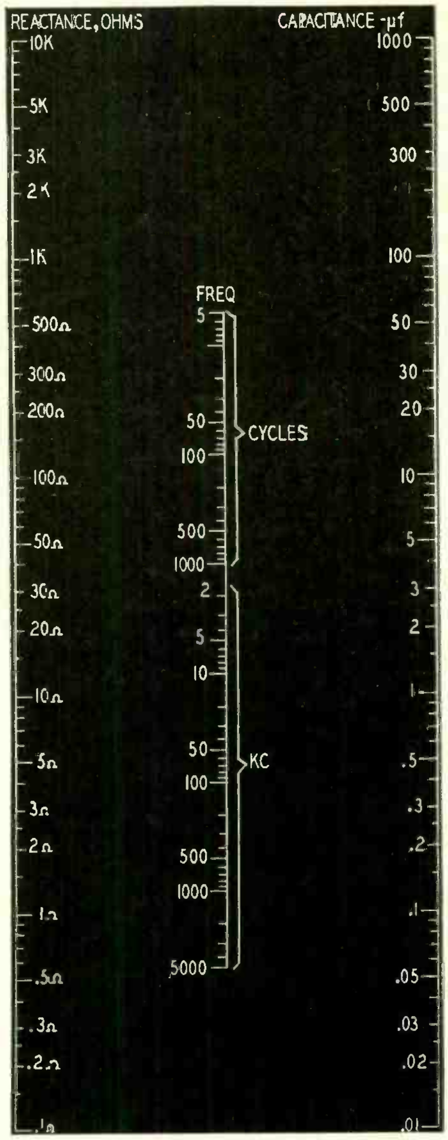
Blocking capacitors reduce low-frequency gain in audio amplifiers. The capacitor at C_a of Fig. 1 opposes 100-cycle signals with about 160,000 ohms of reactance, but opposes 5,000-cycle signals with only about 3,200 ohms.

Blocking capacitors (C_a) in i.f. amplifier and tuner circuits (Figs. 2, 3) usually have reactances too small to attenuate signals seriously. Approximate reactances for the two diagrams are:

5 µµf, 43 mc	=740 ohms
22 µµf, 70 mc (low band)	=100 ohms
22 µµf, 195 mc (high band)	= 37 ohms
12 µµf, 70 and 195 mc	=190 and 68 ohms

B. Bypassing

A capacitor for bypassing allows a large fraction of signal current to flow around a resistance or impedance whose opposition is not wanted in the signal path. The most familiar bypasses are around cathode resistors. Signal cur-



Reactance chart for 0.1 to 10,000 ohms.

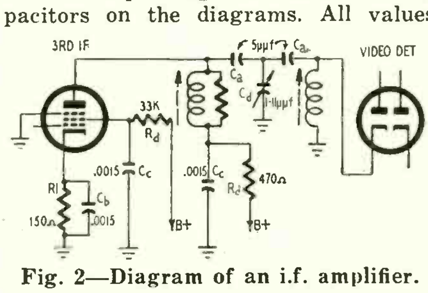


Fig. 2—Diagram of an i.f. amplifier.

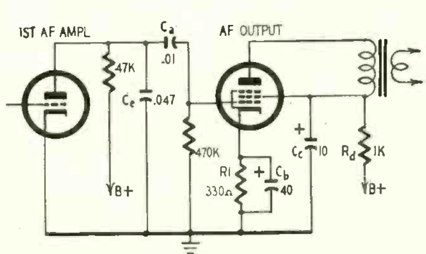
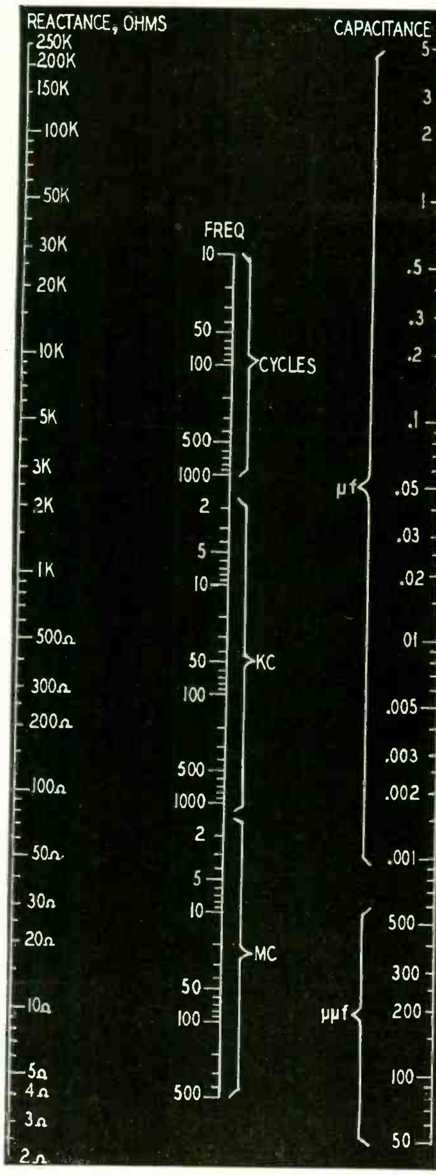
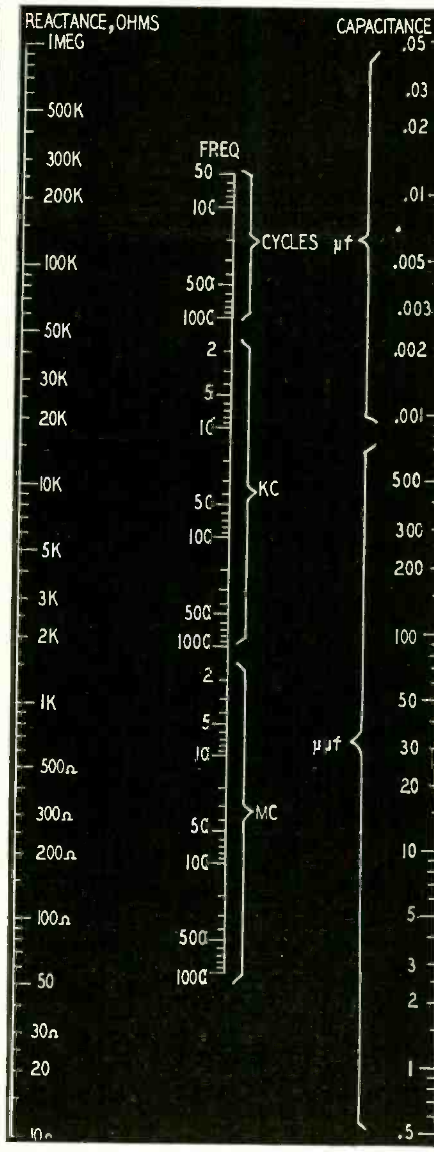


Fig. 1—Diagram of audio amplifier.



Reactance chart for 2 to 250,000 ohms.



Reactance chart for 10 ohms to 1 megohm.

rents not bypassed and flowing through the resistor cause degeneration and reduction of gain. Degeneration may be desired to improve wide-band frequency response or reduce distortion.

In Figs. 1 and 2, note the following:

Frequency	C_b (μf)	X_c (ohms)	R1 (ohms)	Not bypassed
100 cycles	40	40	330	11%
5,000 cycles	40	0.8	330	0.2%
43 mc	.0015	2.5	150	1.6%

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 R_d 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:

Frequency	C_c (μf)	X_c (ohms)	R_d (ohms)	Signal through C_c
100 cycles	10	160	1,000	86 %
5,000 cycles	10	3.2	1,000	99.7%
43 mc	.0015	2.5	33,000	99.9%
43 mc	.0015	2.5	470	99.5%

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.

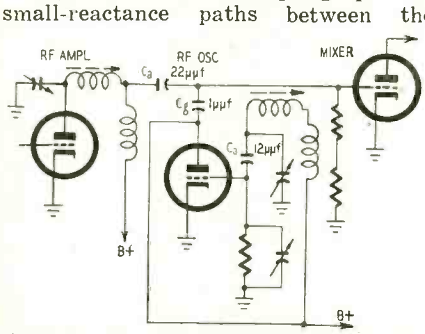


Fig. 3—Simplified oscillator circuit.

D. Coupling

Coupling capacitor C_d 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 $\mu\mu f$ provides a reactance of about 3,700 ohms for maximum coupling; maximum capacitance of 11 $\mu\mu f$ 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 C_e. The plate load increases when the opposition of blocking capacitor C_a increases.

F. Voltage division

Capacitors in series divide an applied alternating voltage proportionately to the reactances. Capacitors C_f1 and C_f2 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:

Drive	C_f2 ($\mu\mu f$)	Reactance of C_f2 (ohms)	Reactance of C_f1 (ohms)	Grid Input
Max.	40	250,000	22,000	92%
Min.	450	23,000	22,000	51%

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

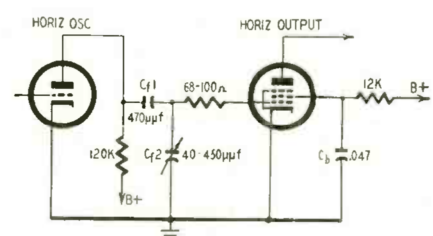


Fig. 4—Simplified horizontal drive—parts not needed in example left out.

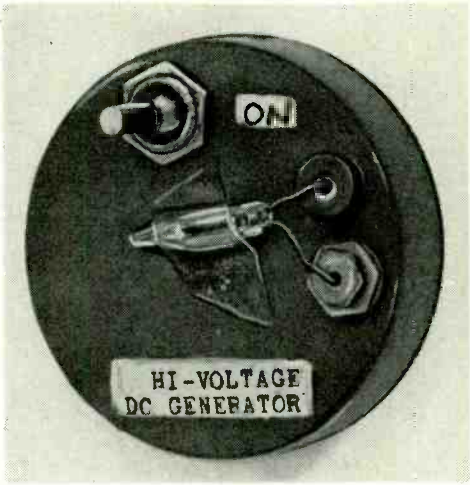
some for only 100. If a small-capacitance low-voltage unit is in series with a relatively large capacitance, the small one may get too much voltage. Should there be any doubt, determine the reactances. Then divide the larger reactance by the sum of the reactances to find the fraction of total applied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

G. Signal injection

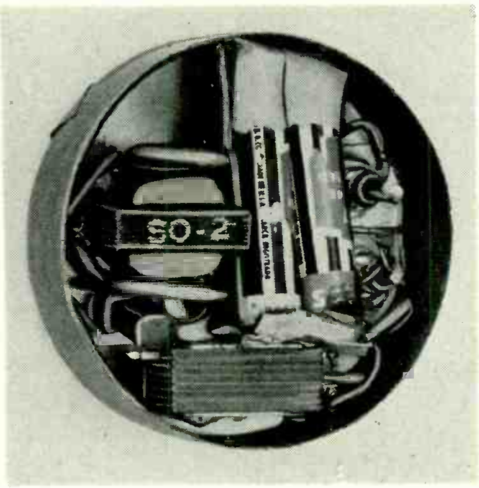
The 1-$\mu\mu f$ capacitor C_g of Fig. 3 allows oscillator voltage to enter the mixer grid circuit, at the same time blocking the oscillator d.c. plate voltage. Reactance at the middle of the low band is about 2,300 ohms and for the high band about 820 ohms. This voltage is strong enough that these reactances cause no serious attenuation. The very small capacitance avoids upsetting tuning of the high-frequency circuits. END

By I. QUEEN
EDITORIAL ASSOCIATE

A TRANSISTOR d.c. TRANSFORMER



Front view—neon lamp acts as indicator.



Inside view—components are miniaturized.

A BATTERY is a low-impedance source of power. It is most efficient and economical when supplying low voltage at high current. For example, a single No. 6 dry cell may be discharged at a rate of 2 watts or more, yet have a reasonable life span. Compare this with a penlight cell which has a recommended discharge rate of only 35 mw. Sixty penlight cells produce the same power output as a single No. 6 cell which costs about 66c. The 60 cells cost $6.60.

The cost of battery power could be drastically cut with the aid of a "d.c. transformer." Such a device should have a low-impedance input to match the battery source and a high-impedance output to match a high-impedance load. For example, we might take 1 ma from a single size-N cell. With a 1:10 d.c. transformer (and no losses) the output would be 15 volts at 100 μa. The N cell would hardly feel its light load and it would last many hundreds of hours. Yet it would provide the equivalent of a small 15-volt battery. The N cell costs 6c. The smallest 15-volt battery listed in the catalogs (size Y10) sells for 72c. If our load required only the 100 μa assumed above, the single N cell would be sufficient.

A d.c. transformer has other advantages. The circuit, having limited power input, cannot produce dangerous voltage or current peaks. Short circuits or wiring errors cannot blow out delicate filaments or endanger instruments in associated circuits. Furthermore, in many cases one or two dry cells are already available for other purposes, such as energizing a filament, and can be used to furnish power.

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-$\mu\mu$f capacitor which has been multiplied more than 10 times and fed it to the voltage doubler.

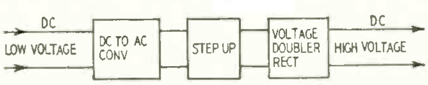


Fig. 1—Functions of d.c. transformer.

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.

Load	Output		
(megohms)	*volts*	*μa*	*mw*
0.12	17	150	2.6
0.18	23	130	3.0
0.22	28	125	3.5
0.27	30	110	3.3
0.33	32	95	3.0
0.62	40	74	2.9
1.10	45	50	2.3

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

(.01 or 0.1 μf) across the output terminals will also help. If the frequency is above audibility, it cannot cause difficulty in any audio circuit.

Most diodes pass considerable current in the reverse direction. For example,

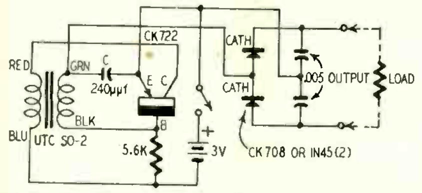


Fig. 2—Schematic of the transistor d.c. transformer—a CK722 unit is used.

they may permit several hundred μa to flow at 50 volts. Since this instrument is a low-power affair, even the smallest drain lowers the output voltage considerably.

The output power of this circuit can be raised by using *two* diodes for each one shown in Fig. 2. Evidently this lowers the power lost through the rectifiers, for it permits higher output. If you have several rectifiers on hand, try them all—choose those that provide greatest output. You may find a considerable difference even among diodes of the same type.

Applications

This d.c. voltage multiplier is a low-power source but it has many applications. It can ignite a neon lamp, even though the power input is supplied by two tiny dry cells. Use either a NE-2 or NE-51 neon lamp. This gives just about the smallest, most economical source of illumination. The cells cost 12c a pair and will last 200 hours or more. The neon glow can be used for signaling, indicating, testing high insulation, etc.

Parts for d.c. transformer

1—5,600-ohm resistor; 1—240-μμf capacitor (see text); 2—.005-μf disc capacitors; 1—CK722 transistor and holder; 2—penlight cells; 2—CK708 or IN45 diodes; 1—miniature audio transformer, 1:3 turns ratio, 10,000-ohm primary impedance, 90,000-ohm secondary impedance (UTC SO-2 or equivalent); 2—pin jacks; 1—s.p.s.t. switch.

The neon circuit is also useful for stroboscopic work since the lamp flashes on and off quickly and repeatedly as a result of the high d.c. potential breaking down the neon gas. Then the lamp begins to draw so much current that the voltage drops below the ignition point. The lamp is extinguished and ready for the next cycle.

The circuit has sufficient power for phototubes. Most gas types (like those used for movie sound) require approximately 70 volts at about 5 μa. If the phototube is used for audio work, the ripple should be kept very low.

I have used this circuit to power a transistor r.f. oscillator. The CK722 transistor would not function with less than 10 volts. It took off immediately when connected to the d.c. voltage multiplier. Still another application is as a voltage source to calibrate and test vacuum-tube voltmeter instruments and scopes. END

ELECTROLYSIS PROBLEM

By J. PERKINSON, JR.

I WAS recently called upon to service 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 grounding plates had not improved the situation—the 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 these 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.

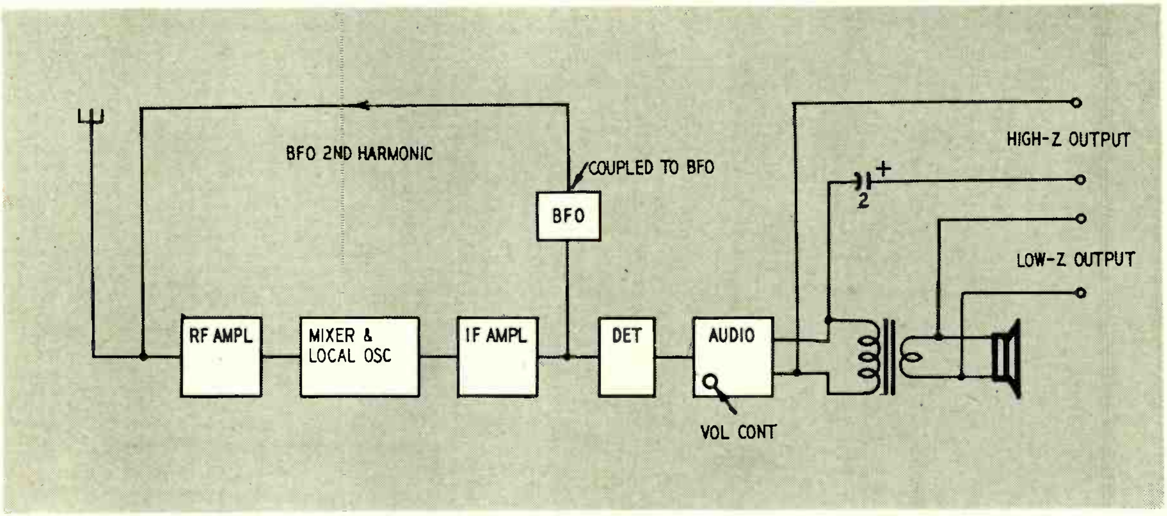
My final speculation was that a battery action was being set up somewhere between the port propeller shaft and its housing, and that iron was somewhere in the system. But both shaft and housing were brass. I asked a buddy of mine who had worked on boats about the metallic parts installed in the propeller-shaft 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 dissimiliar 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



Block diagram of a receiver set up to operate as an audio oscillator.

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 can. 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.

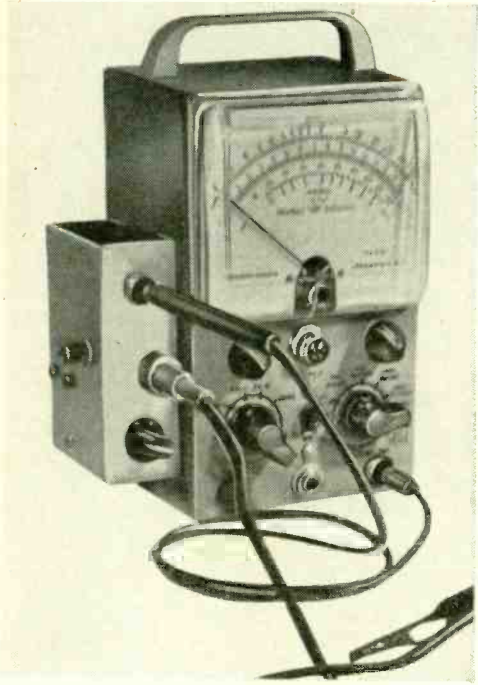
If the main tuning dial is used to adjust the signal, the approximate frequency can be determined from the dial markings of the receiver. For example, if zero beat is obtained at exactly 906 kc on the receiver tuning dial, then at the 911-kc mark the output will be 5,000 cycles, at 916 kc it will be 10,000 cycles, etc. This is based on a 453-kc 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 0, 1,000, 2,000 and 3,000 cycles of audio will also be obtained at the 906-, 905-, 904- and 903-kc 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-μf 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 mounted on a v.t.v.m.

The MILVAMP

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

By FORREST H. FRANTZ, SR.*

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 perches 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 *millivolt 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,

*Physics Department, Mississippi State College.

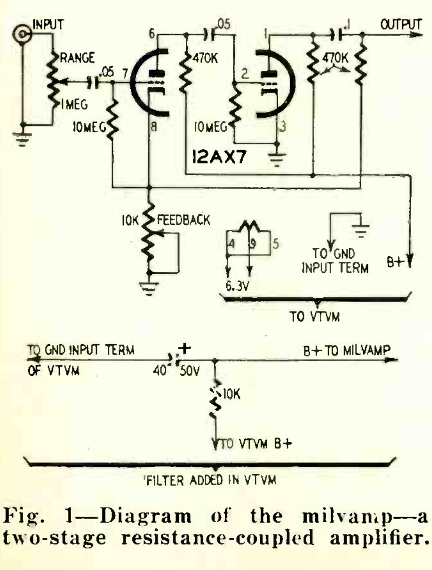


Fig. 1—Diagram of the milvamp—a two-stage resistance-coupled amplifier.

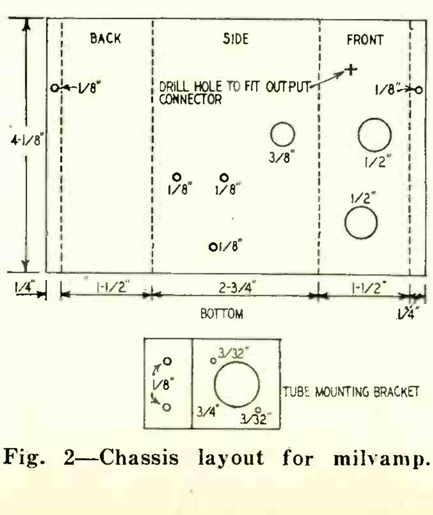
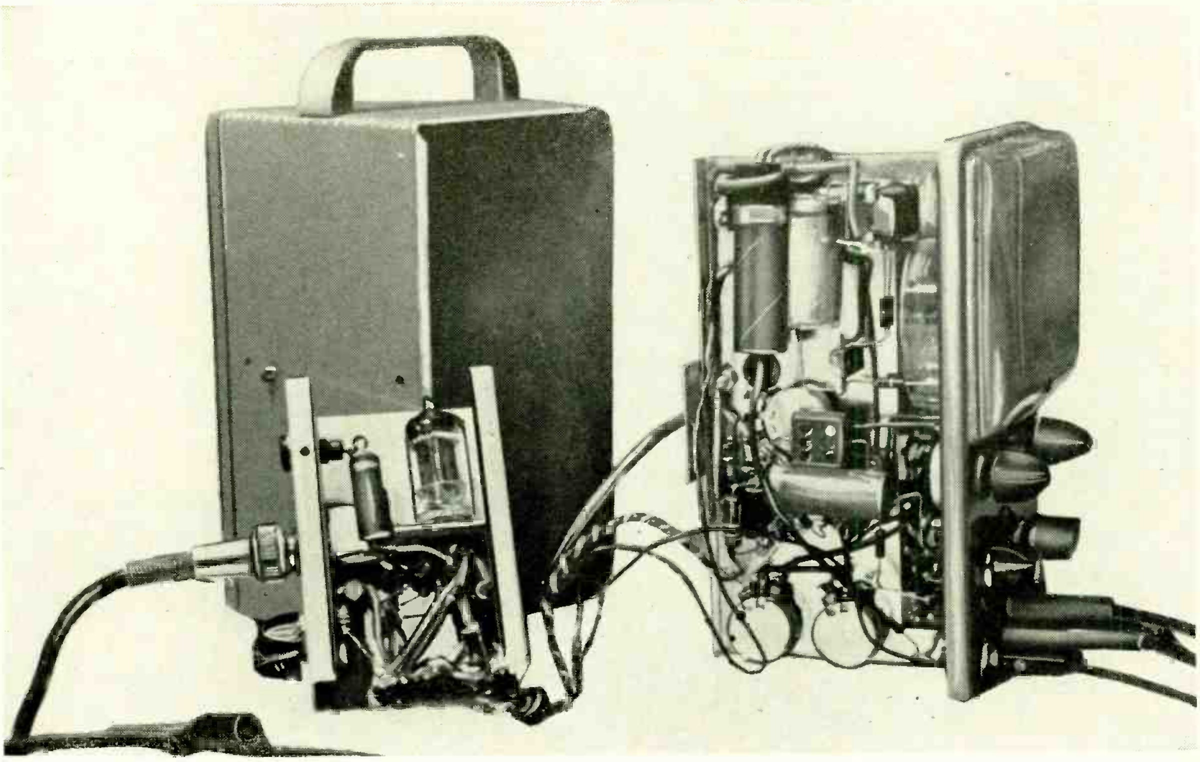


Fig. 2—Chassis layout for milvamp.



Underchassis view of the milvamp shows connection to the v.t.v.m.

the B plus voltage should be limited to 75 by using a larger filter resistance 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 milvamp, 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 measureable extent.

The voltage divider for the milvamp 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 1/100 of the voltage required for full-scale deflection on the lowest v.t.v.m. range is applied to the milvamp. (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 1/100 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 milvamp output jack and connect the milvamp 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 milvamp 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 milvamp 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 milvamp input lead should be shielded. Return all ground leads to a common point on the milvamp 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 milvamp chassis. It may be necessary in some cases to reverse the milvamp 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 the vacuum-tube voltmeter is placed in the cabinet.

The milvamp 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. END

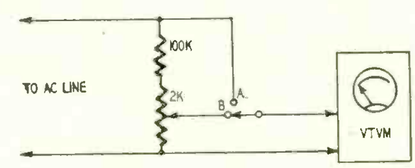


Fig. 3—Simple calibration circuit.

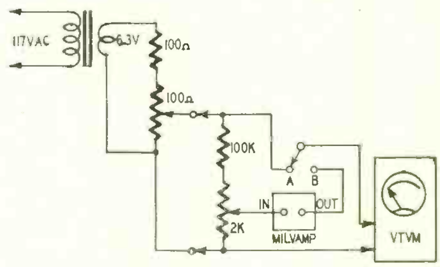


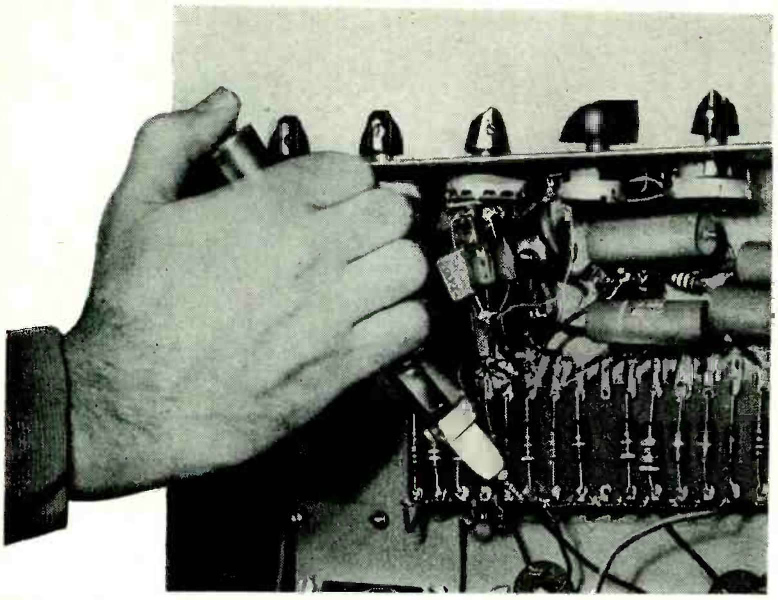
Fig. 4—Adjusting the amplifier gain.

Parts for the milvamp

Resistors: 1—10,000, 3—470,000 ohms, 2—10 megohms, 1/2 watt; 1—10,000-ohm potentiometer; 1—1-megohm potentiometer (audio taper).

Capacitors: 2—.05, 1—0.1 μf, 4—volts (Aerovox P-82 or equivalent); 1—40 μf, 150 volts, electrolytic.

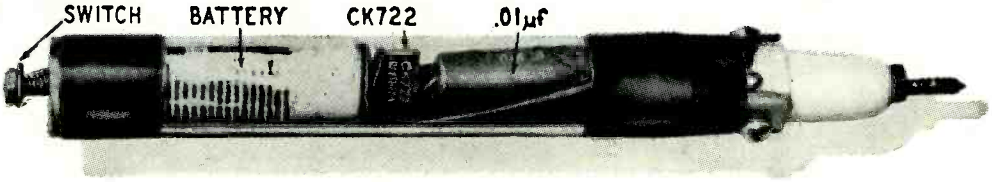
Miscellaneous: 1—12AX7 and socket; 2—connectors (input and output); 1—chassis 1 1/2 x 4 1/8 x 2 3/4 inches (ICA 29078 or equivalent); 2—terminal strips.



Using the signal injector probe

Miniature audio oscillator serves as test instrument

Transistor Signal Injector PROBE



By HOMER L. DAVIDSON

CONSISTING of a CK722 Raytheon transistor, 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 SO-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.

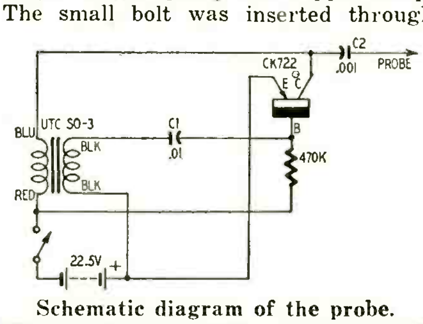
The only components left to mount are the hearing-aid battery and homemade switch. Solder the bias resistor return lead to the negative terminal of the battery and push the battery in place. The battery was inserted about ⅜ inch inside the plastic tube. Then the switch was soldered into place.

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 into 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 washer 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



Schematic diagram of the probe.

Parts for signal injector

1—CK722 transistor; 1—miniature transformer, primary impedance 10,000 ohms, secondary impedance 200 ohms (UTC SO-3 or equivalent); 1—22.5-volt hearing-aid battery (Eveready 505E or equivalent); 1—.01-µf capacitor, 200 volts; 1—.001-µf capacitor, ceramic; 1—470,000-ohm ½-watt resistor; 1—switch (see text); 1—plastic tube, 5½ inches long, ¾-inch diameter; 1—pointer (see text).

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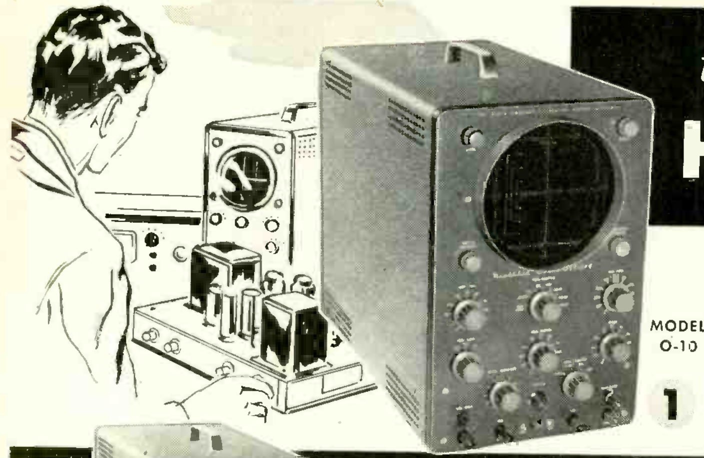

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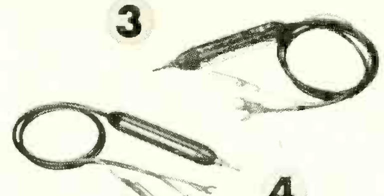

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This deluxe quality oscilloscope has proven itself through thousands of operating hours in service shops and laboratories. Features the best in components--and the best in circuit design.

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 3.58 Mc. Vertical sensitivity is 0.025 volts, (rms) per inch at 1 Kc. 11 tube circuit employs a 5UP1 CRT.

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Features built-in peak-to-peak calibrating source—retrace blanking amplifier—push-pull amplifiers and step-attenuated input.

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This compact little oscilloscope measures only 9½″ H. x 6½″ 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 3GP1 Cathode Ray Tube.

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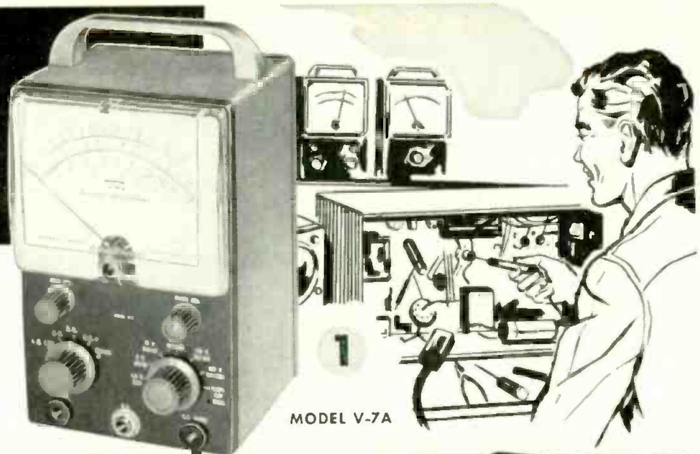

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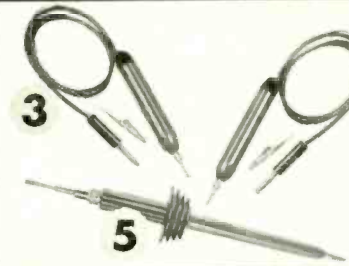

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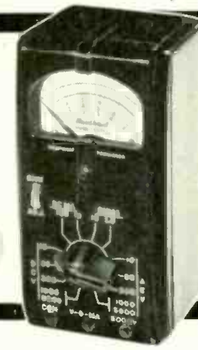

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Besides measuring AC (rms), DC and resistance, the modern-design V-7A incorporates peak-to-peak measurement for FM and television servicing.

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 μa 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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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 carton. Tests 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.

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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.

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The SG-8 covers 160 Kc to 110 Mc on fundamentals in 5 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 uv. 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

❶ *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. ½% resistors and ½% silver-mica capacitors especially selected for this instrument. A 100-0-100 microammeter provides null indications. Two-section CRL dial provides 10 separate "units" with an accuracy of .5%. Fractions of units read on variable control.

MODEL IB-2 $59.50
Shpg. Wt. 12 Lbs.

2

❷ *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. Indispensible 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.

MODEL QM-1 $44.50
Shpg. Wt. 14 Lbs.

3

❸ *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.

MODEL BE-4 $31.50
Shpg. Wt. 17 Lbs.

❹ *Heathkit* DECADE RESISTANCE KIT

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

MODEL DR-1 $19.50
Shpg. Wt. 4 Lbs.

4 5 6

❺ *Heathkit* VIBRATOR TESTER KIT

Tests vibrators for proper starting and indicates the quality of the output on a large "GOOD-BAD" scale. Checks both interrupter 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.

MODEL VT-1 $14.50
Shpg. Wt. 6 Lbs.

❻ *Heathkit* DECADE CONDENSER KIT

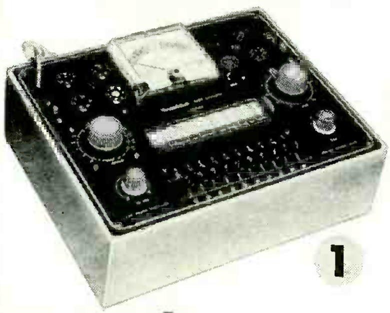
Provides capacity values from 100 mmf to 0.111 mfd in steps of 100 mmf. ± 1% precision silver-mica condensers used. High quality ceramic switches for reduced leakage. Polished birch cabinet. Extremely valuable in all electronic activity.

MODEL DC-1 $16.50
Shpg. Wt. 3 Lbs.

HEATH COMPANY
A SUBSIDIARY OF DAYSTROM INC.

BENTON HARBOR 20, MICHIGAN

Heathkit TUBE CHECKER KIT



1 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.

MODEL TC-2
$29.50
Shpg. Wt. 12 Lbs.

2 *Heathkit* PORTABLE TUBE CHECKER KIT

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.

MODEL TC-2P
$34.50
Shpg. Wt. 15 Lbs.

3 *Heathkit* TV PICTURE TUBE TEST ADAPTER

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.)

MODEL 355
$4.50
Shpg. Wt. 1 Lb.

4 *Heathkit* . . . CONDENSER CHECKER 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 mfds. 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 megohms. 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.

MODEL C-3
$19.50
Shpg. Wt. 7 Lbs.

5 *Heathkit* VISUAL-AURAL SIGNAL TRACER KIT

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 locater circuit for DC noise checks, and a built-in calibrated wattmeter (30-500 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 6½" high x 5" deep. A real test equipment bargain.

MODEL T-3
$23.50
Shpg. Wt. 9 Lbs.

HEATH COMPANY
A SUBSIDIARY OF DAYSTROM INC.
BENTON HARBOR 20, MICHIGAN

Heathkit HARMONIC DISTORTION METER KIT

MODEL HD-1

Shpg. Wt. 13 Lbs. **$49.50**

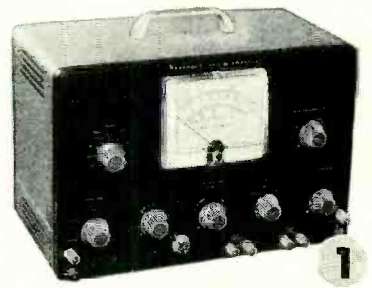
Used with a sine wave generator, the Model HD-1 will check the harmonic distortion output of audio amplifiers under a variety of conditions. Reads distortion directly on the meter as a percentage of the input signal. Operates between 20 and 20,000 cps. High impedance VTVM circuit for initial reference settings and final distortion readings. Ranges are 0-1, 3, 10, and 30 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.

❶ *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 loads 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 mw. to 150 w. in 7 steps. IM scales are 1% to 100% in 5 steps.

MODEL AA-1 **$59.50** Shpg. Wt. 13 Lbs.



❷ *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-.003, .01, .03, .1, .3, 1, 3, 10 volts. Step-tuning provides rapid positive selection of the desired frequency, and allows accurate return to any given frequency.

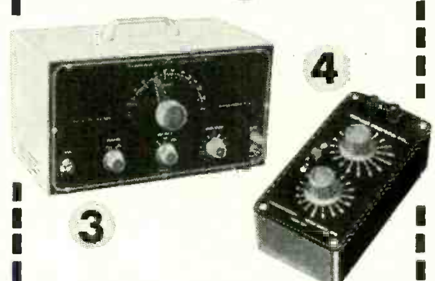
MODEL AG-9 **$34.50** Shpg. Wt. 8 Lbs.

❸ *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 **$24.50** Shpg. Wt. 10 Lbs.



❹ *Heathkit* RESISTANCE SUBSTITUTION BOX KIT...

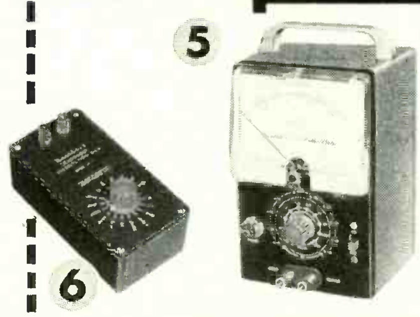
Provides switch selection of 36 RTMA 1 watt standard 1% resistors ranging from 15 ohms to 10 megohms. Numerous applications in radio and TV work, and essential in the developmental laboratory.

MODEL RS-1 **$5.50** Shpg. Wt. 2 Lbs.

❺ *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 **$29.50** Shpg. Wt. 5 Lbs.



❻ *Heathkit* CONDENSER SUBSTITUTION BOX KIT...

Very popular companion to Heathkit RS-1. Individual selection of 18 RTMA standard condenser values from .0001 mfd to .22 mfd. Includes 18" flexible leads with alligator clips.

MODEL CS-1 **$5.50** Shpg. Wt. 2 Lbs.

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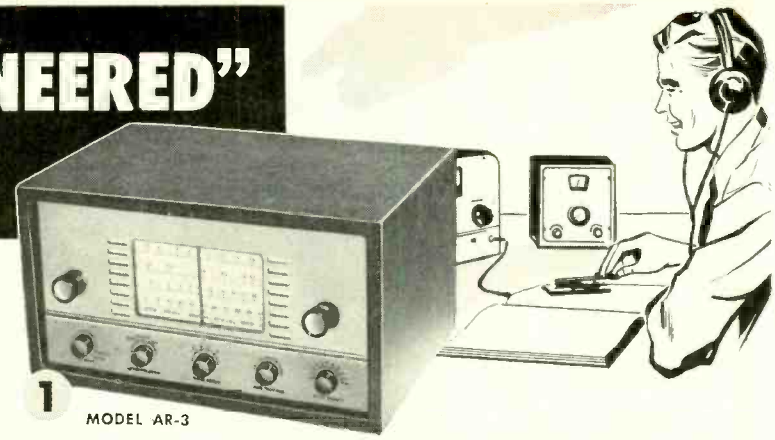
BENTON HARBOR 20, MICHIGAN

"AMATEUR-ENGINEERED"

Equipment For The Ham



1 MODEL AR-3

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.*

2 3 4 5

❶ *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 sensitivity 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—5½" PM speaker and illuminated tuning dial.

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

MODEL AR-3
$27.95
Shpg. Wt. 12 Lbs.
(Less Cabinet)

❷ *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.x7⅜"W.x4⅛"D. A really valuable addition to the receiving equipment in your ham shack.

MODEL QF-1
$9.95
Shpg. Wt. 3 Lbs.

❸ *Heathkit* VARIABLE VOLTAGE REGULATED POWER SUPPY 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
Shpg. Wt. 17 lbs.

❹ *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 0-600 ohms. An instrument of many uses for the amateur.

MODEL AM-1
$14.50
Shpg. Wt. 2 lb.

❺ *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-1B 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
Shpg. Wt. 4 lbs.

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

Heathkits PROVIDE THE "CONSTRUCTIVE" APPROACH TO HIGH-FIDELITY

EASY TO BUILD: *The assembly instructions supplied with Heathkits are so complete and detailed that anyone can assemble the kits without difficulty. Plenty of pictorial diagrams and step-by-step instructions. Information on resistor color codes, soldering, use of tools, etc. Build-it-yourself with confidence!*

1 *Heathkit* ADVANCED-DESIGN HIGH FIDELITY AMPLIFIER KIT

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.

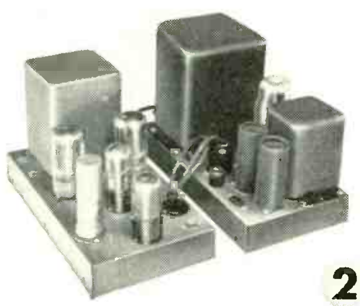
Features a new-design Peerless output transformer, and KT66 output tubes handle power peaks up to 42 watts. The unique "tweeter-saver" suppresses high frequency oscillation. A new type balancing circuit results in closer "dynamic" balance between output tubes. Features improved phase shift characteristics and frequency response, with reduced IM and harmonic distortion. Color styling harmonizes with the Heathkit WA-P2 Preamplifier and the FM-3 Tuner.

Frequency response—within ± 1 db from 5 cps to 160 Kc at 1 watt. Harmonic distortion only 1% at 25 watts, 20-20,000 cps. IM distortion only 1% at 20 watts, using 60 and 3,000 cps. Output impedance 4, 8, or 16 ohms. Hum and noise—99 db below rated output. Uses two 12AU7's, two KT66's and a 5R4GY.

KIT COMBINATIONS:

W-5M Amplifier Kit: Consists of main amplifier and power supply, all on one chassis. Complete with all necessary parts, tubes, and comprehensive manual. Shpg. Wt. 31 lbs. Express only. **$59.75**

W-5 Combination Amplifier Kit: Consists of W-5M Amplifier Kit listed above *plus* Heathkit Model WA-P2 Preamplifier Kit. Complete with all necessary parts, tubes, and construction manuals. Shpg. Wt. 38 lbs. Express only. **$79.50**



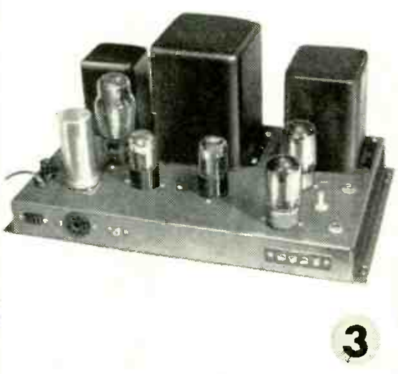
2 *Heathkit* DUAL-CHASSIS WILLIAMSON TYPE HIGH FIDELITY AMPLIFIER KIT

This is a very popular high fidelity amplifier kit that features dual-chassis type construction. The resulting physical dimensions offer an additional margin of flexibility in installation. It features the famous Acrosound TO-300 "ultra-linear" output transformer, and has a frequency response within ± 1 db from 6 cps to 150 Kc at 1 watt. Harmonic distortion only 1% at 21 watts. IM distortion at 20 watts only 1.3% at 60 and 3,000 cps. Rated power output is 20 watts. Output impedance 4, 8, or 16 ohms. Hum and noise—88 db below 20 watts. Uses two 6SN7's, two 5881's, and a 5V4G.

KIT COMBINATIONS:

W-3M: Consists of main amplifier and power supply for separate chassis construction. Includes all tubes and components necessary for assembly. Shpg. Wt. 29 lbs., Express only. **$49.75**

W-3: Consists of W-3M Kit listed above *plus* Heathkit Model WA-P2 Preamplifier described on opposite page. Shpg. Wt. 37 lbs., Express only. **$69.50**



3 *Heathkit* SINGLE-CHASSIS WILLIAMSON TYPE HIGH FIDELITY AMPLIFIER KIT

This is the lowest priced Williamson type amplifier ever offered in kit form, and yet it retains all the usual features of the Williamson type circuit. Main amplifier and power supply combined on one chassis, and uses a new-design Chicago output transformer. Frequency response—within ± 1 db from 10 cps to 100 Kc at 1 watt. Harmonic distortion only 1.5% at 20 watts. IM distortion at rated output, 2.7% at 60 and 3,000 cps. Rated power output is 20 watts. Output impedance 4, 8, or 16 ohms. Hum and noise—95 db below 20 watts. Uses two 6SN7's, two 5881's, and one 5V4G.

Instructions are so complete that the kit may be assembled successfully even by a beginner in electronics.

KIT COMBINATIONS:

W-4AM: 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. **$39.75**

W-4A: Consists of W-4AM Kit listed above *plus* Heathkit Model WA-P2 Preamplifier described on opposite page. Shpg. Wt. 35 lbs. Express only. **$59.50**

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ATTRACTIVELY 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.*

enjoy....

THE VERY BEST IN AUDIO WITH "BUILD-IT-YOURSELF"

HEATHKITS

❶ *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.

MODEL WA-P2
$19.75
Shpg. Wt. 7 Lbs.

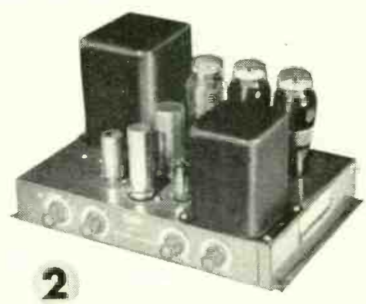
1

❷ *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!

MODEL A-9B
$35.50
Shpg. Wt. 23 Lbs.



2

❸ *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 ± 1½ 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-7D
$16.95
Shpg. Wt. 10 Lbs.

3

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.

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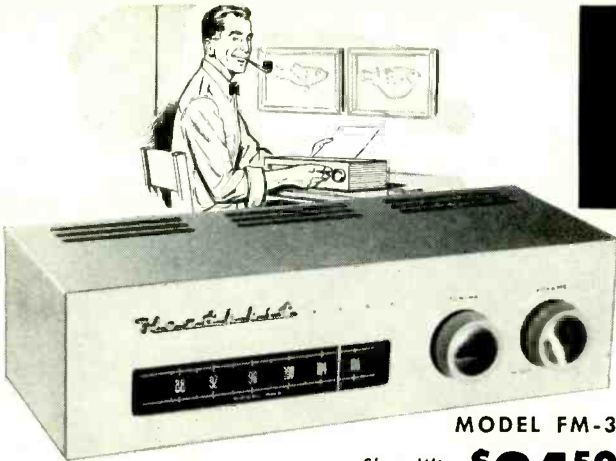

MODEL FM-3

Shpg. Wt. 7 lbs. **$24.50** (with cabinet)

Brand New HEATHKIT HIGH-FIDELITY FM TUNER KIT

Features

- *Brand New, Modern FM Circuit Using Latest Type Miniature Tubes.*
- *Low-Noise Cascode 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 Preamplifier.*
- *Compact Physical Dimensions for Most Pleasing Appearance and Increased Circuit Efficiency.*

The new Heathkit Model FM-3 features tremendous circuit improvements and brand new physical design. Sensitivity is better than 10 uv. 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 Preamplifier 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 *prealigned*, and the front-end tuning unit is pre-assembled and aligned. Uses 6BQ7A 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.

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 phono 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

$17.50 *Less Cabinet*

Shpg. Wt. 10 lbs.

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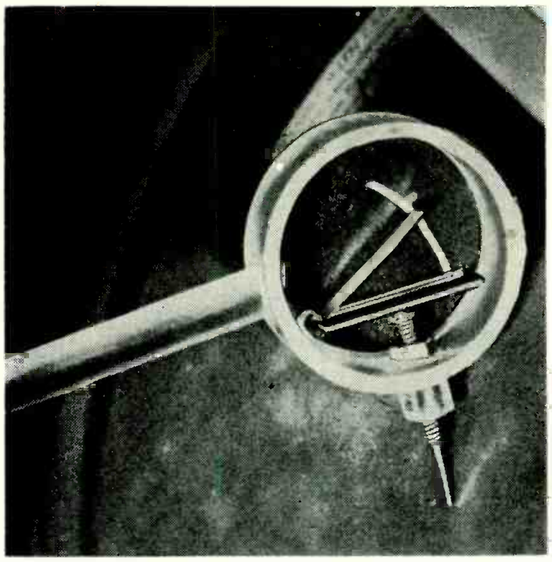
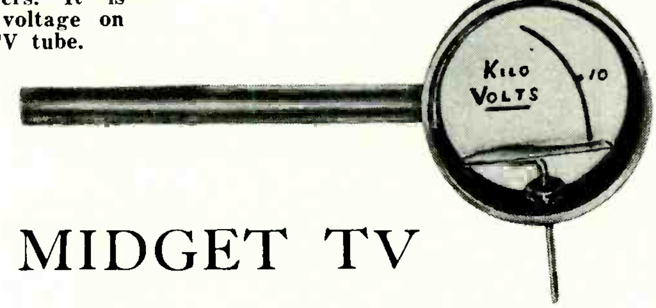


This kilovoltmeter is made from a plastic ring with transparent plastic covers. It is measuring voltage on metal TV tube.

Kilovoltmeter made in plastic bottle cap.



MIDGET TV KILOVOLTMETER

By ELLIOTT A. McCREADY

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.

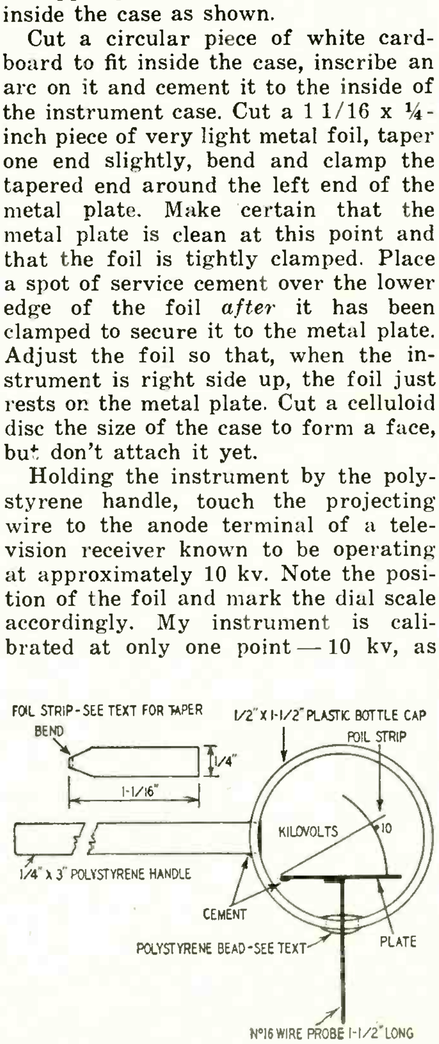
The midget TV kilovoltmeter was inspired by a home-made electroscope and pretty well fills the bill in so far as size, weight, ruggedness and accuracy are concerned. It can be constructed in an hour or so. The instrument operates on the electroscope principle — a high voltage is applied to a metal plate 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 1½ x ½-inch plastic or Bakelite medicine bottle cap is used as the case of the instrument. Two ¼-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 ¼-inch polystyrene rod. In the other hole insert a ¼-inch length of ¼-inch polystyrene rod having a 1/16-inch hole through the center. Bend a ⅛-inch hook in a 1½-inch length of No. 16 tinned copper wire and insert the wire in the ¼-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 ¼-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 ¼-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.



Construction of the TV kilovoltmeter.

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.

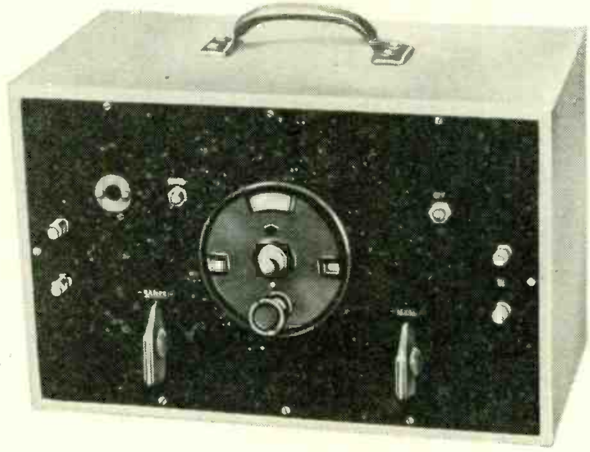
Two things are very important in the construction of this instrument — use polystyrene to insulate the wire probe from the case; be sure the foil strip makes good contact at the end of the metal plate.

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



Front view of R–C controlled oscillator

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.

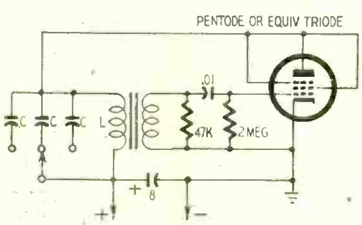


Fig. 1—An audio-frequency oscillator.

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.

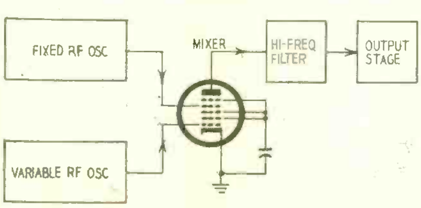


Fig. 2—The beat-frequency principle.

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 multivibrator which, however, suffers from exceedingly poor waveform (poor because rich in harmonics).

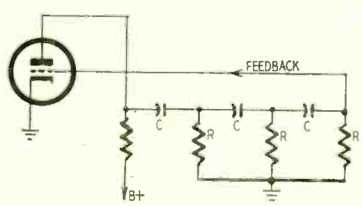


Fig. 3—Diagram of Nichols oscillator.

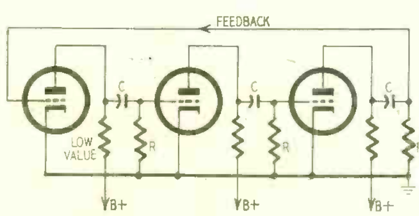


Fig. 4—Van der Pol oscillator circuit.

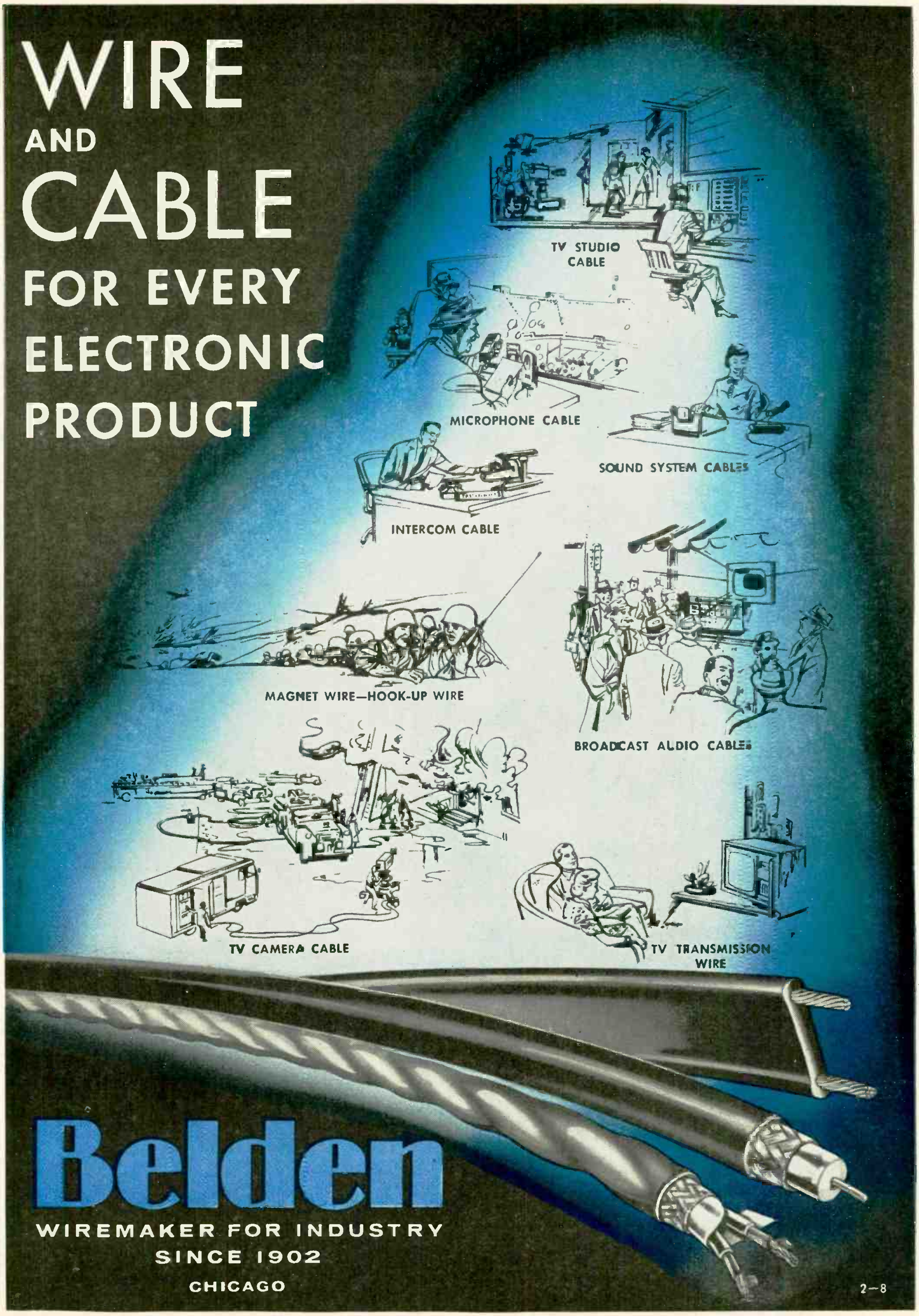
Other examples are the Nichols (Fig. 3) and van der Pol (Fig. 4) oscillators. The Nichols uses a three-stage phase-shifting network with a single high-gain tube. In the van der Pol the single tube is replaced by three—inserted between the sections of the resistance–capacitance network.

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 interelement and interlead capacitances become troublesome, so each range is limited at its high-frequency end by providing a fixed capacitor in parallel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with each tuning capacitor (Fig. 6). One of the fixed capacitors is 150 $\mu\mu$f, the other is made up of a trimmer in parallel with a 100-$\mu\mu$f 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.

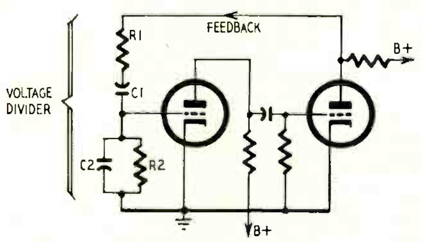

Fig. 5—Schematic of Willans circuit.

(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 6B8-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 6SV7 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 230-volt 10-watt unit —G-E 10S6/10 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 once the bias passes a low voltage.

The waveform is also improved by fitting a shunt capacitor across the output—this removes 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 6B8-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 25-volt electrolytic, the other a 0.1-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 730-$\mu\mu$f 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-

Parts list for R-C oscillator

Resistors: 1—150, 1—1,000, 1—39,000, 1—47,000, 2—100,000, 1—150,000, 3—270,000, 1—470,000 ohms, ½ watt; 2—1, 1—1.5, 2—3.3 megohms, ½ watt; 2—1,000 ohms, 3 watts; 2—39,000, 2—180,000, 2—390,000 ohms, 2—2, 2—10 megohms, ½ watt, 1%; 1—500,000 ohms, 1—1 megohm, potentiometers.
Capacitors: 1—100, 1—150 $\mu\mu$f; 1—.001, 1—.003, 1—.005, 1—.01, 1—.02, 1—.05, 2—0.1, 2—0.25, 4—0.5, 1—1 μf; 1—50 $\mu\mu$f, trimmer; 1—4-gang variable, 365 $\mu\mu$f per unit.
Electrolytics: 1—20-20 μf, 350 volts; 1—10-10 μf, 450 volts; 1—100 μf, 25 volts.
Miscellaneous: 1—lamp LM (see text); 1—power transformer, 700 volts c.t. @ 40 ma, 6.3 volts @ 2 amps; 1—6J7-G, 1—6B8-G; 1—6V6-GT; 1—6X5-GT; 4—octal sockets; 1—output transformer, 10,000-ohm primary to 4-ohm secondary; 1—chassis; 1—3-gang 5-position rotary switch; 1—line cord; 2—jacks.

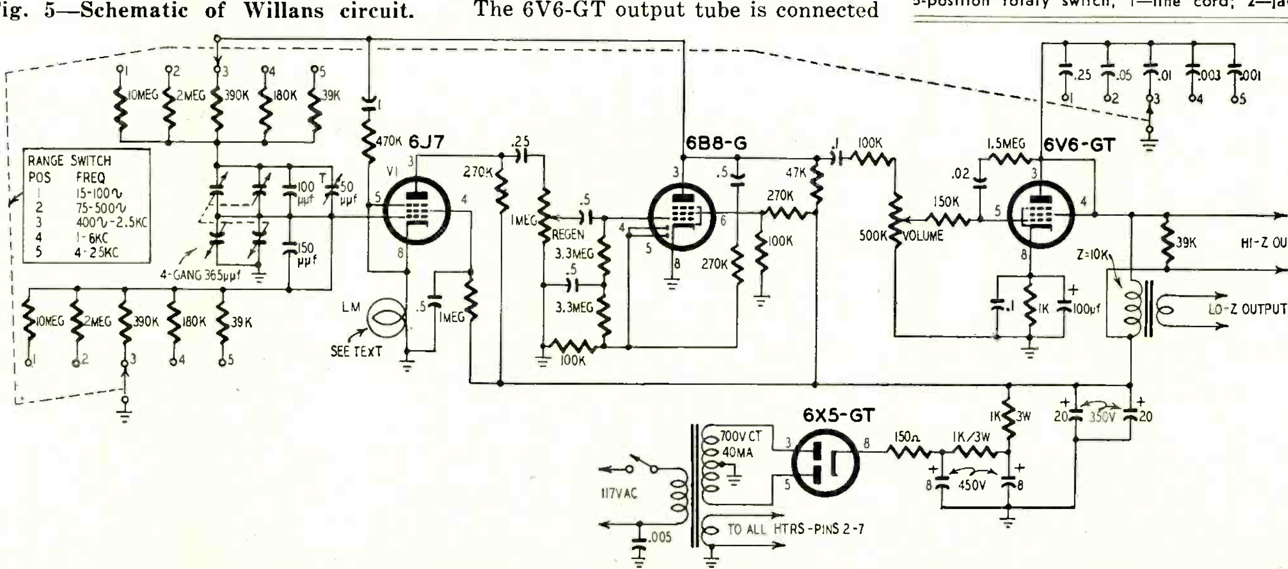

Fig. 6—Schematic of the resistance–capacitance controlled oscillator.

Remember This?

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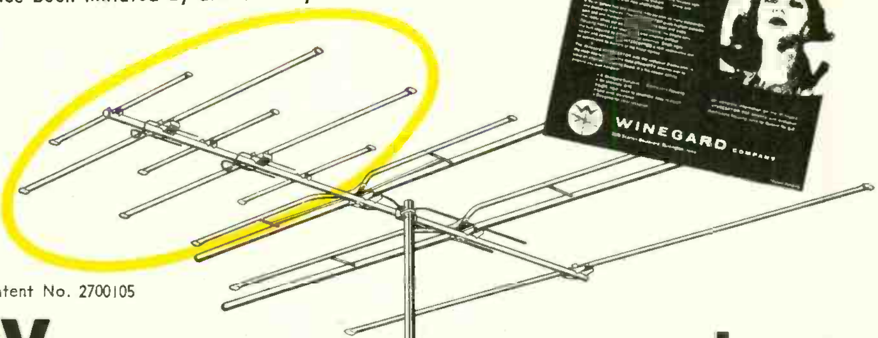

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line frequency and its harmonics. One side of the filament circuit is grounded.

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 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 $\sqrt[12]{2}$ (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. **END**

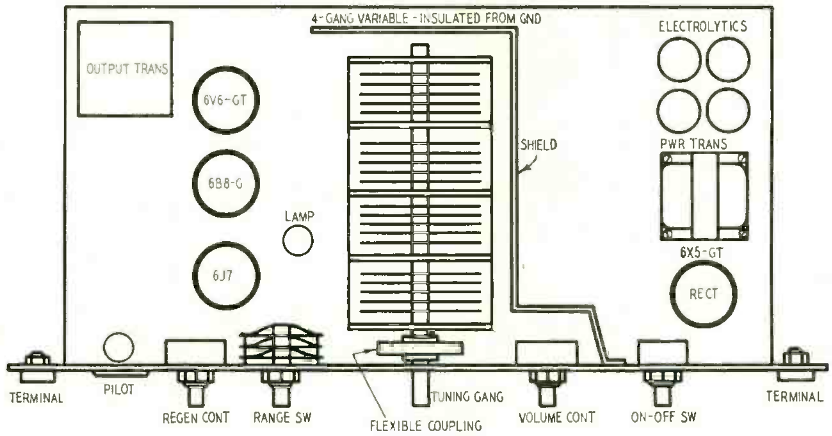
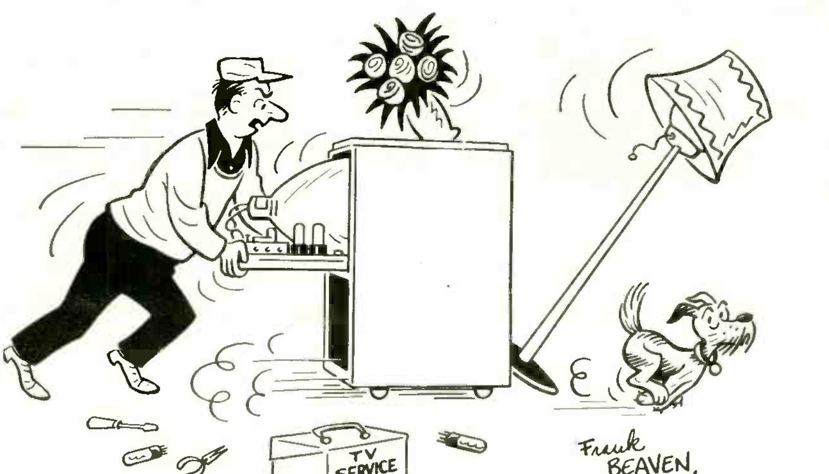


Fig. 7—Layout of the controlled resistance capacitance audio oscillator.



Suggested by: Bob Loynd, Waltham, Mass.

"Damn these sets on wheels!"

No. 1 in independent survey among servicemen

"Fewer returns" votes for "Silver Screen 85" were more than twice that of No. 2 and No. 3 brands combined

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

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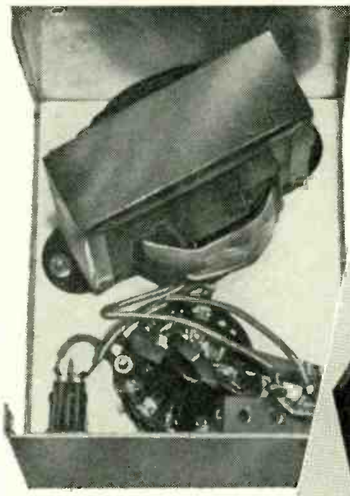
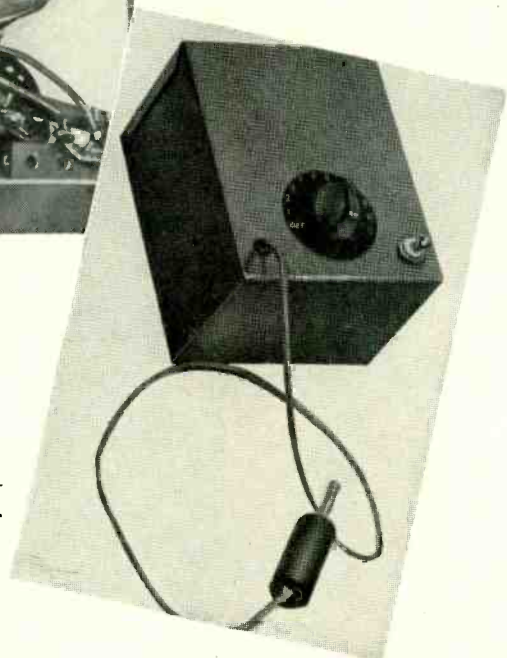
A 1,000 - *and* 100 - *cycle* FILTER

Simple device can be used for alignment and measurement

By JAMES FRED



An underchassis view of the filter.



Top view shows filter chassis and plug.

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-ma filter choke. This was used in the final model with a .003-μf capacitor for a 1-kc filter.

The signal generators in most radio laboratories use 1-kc 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 153L, 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-μf capacitors, you can get combinations from .001 to .01 μf in steps of .001 μf. The switch and capacitors permit you to adjust the frequency of your filter $\pm 10\%$. 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 $\pm 5\%$. 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-μf capacitor and a jack suitable for the

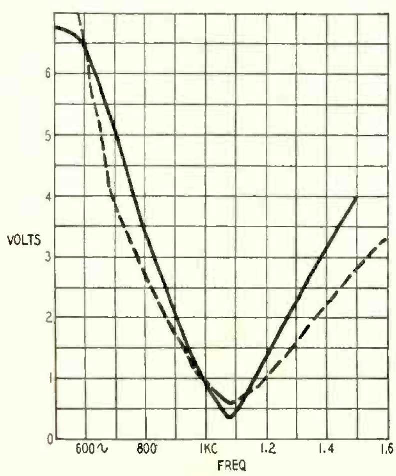


Fig. 1—Frequency response of filters.

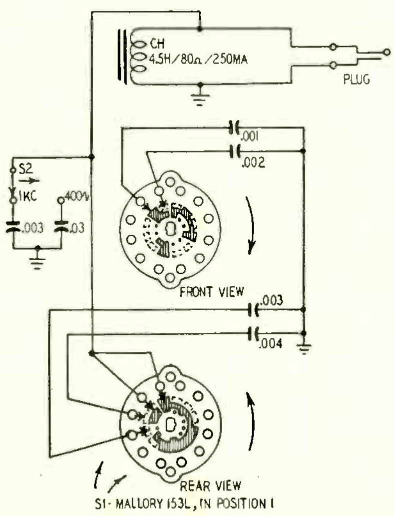


Fig. 2—Schematic diagram of filter.

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, con-

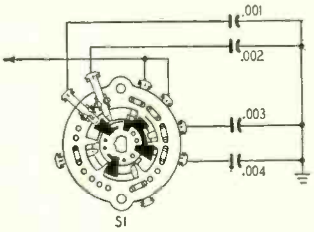


Fig. 3—Wiring diagram for switch S1.

nect 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

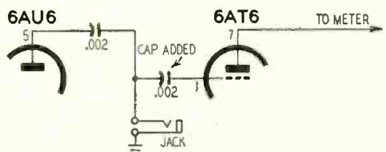


Fig. 4—Modifying v.t.v.m. for filter.

1,000 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.

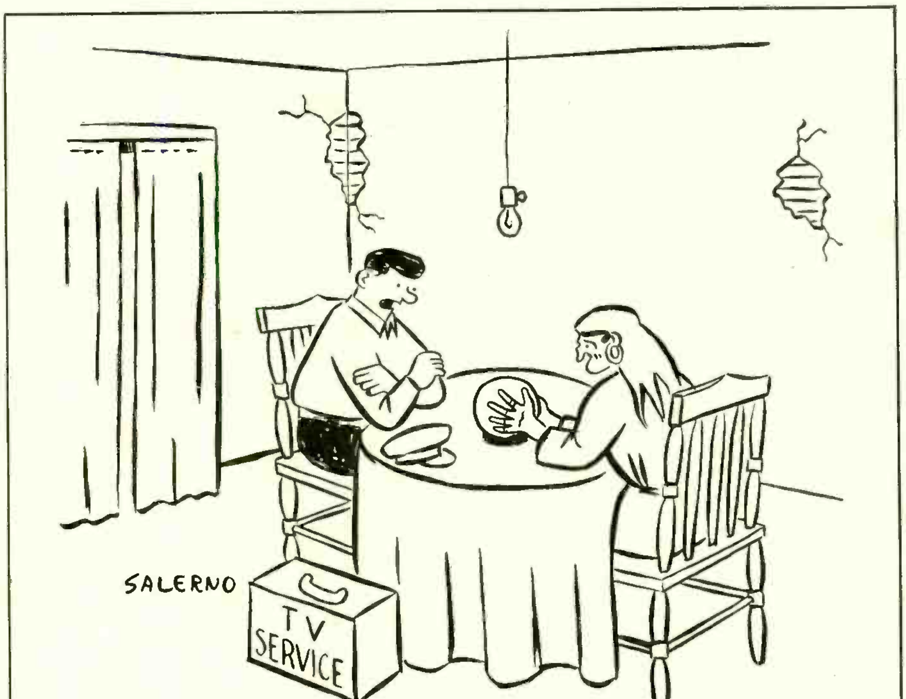
When making r.f. measurements on receivers, u.h.f. converters or TV sets, an audio filter should be used. The output of the signal generator, modulated at 1 kc, is connected to a u.h.f. converter. The output of the converter goes to a diode probe which removes the r.f. carrier and gives us the 1,000-cycle 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

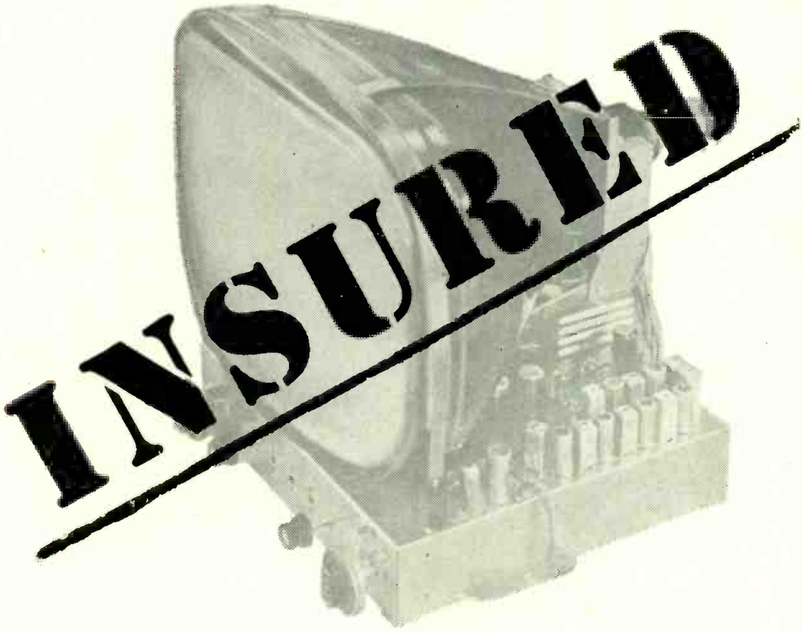
Capacitors: 1—.001 µf, 1—.002 µf, 1—.003 µf, 1—.004 µf; 1—.003 µf, 1—.03 µf, silver mica 5% (if unavailable in these values, parallel smaller units); 1—.002 µf (for meter).

Miscellaneous: 1—phone plug and jack; 1—choke, 4.5 h (Stancor C1411 or equivalent); 1—s.p.d.t. switch; 1—decade type switch (Mallory 153L); 1—chassis.



"Madam Zerbona, to-day I want to ask you about an Admiral 321 DX 15"

SERVICE INSURANCE THAT WORKS!



By RALPH W. HALLOWS

FULL maintenance insurance systems for TV receiving sets have been operating successfully here 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 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 hadn't 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 viewers. 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 whatver 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 £16 ($46.20) a year or £1.11.6 ($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 £1.2s.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 £1.6.3 ($3.70) by monthly payments.

Well, there's the scheme. Viewers like it; dealers like it and, let me assure you, IT WORKS. END

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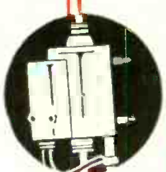
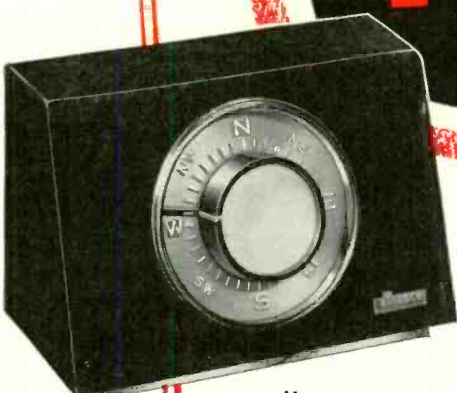
biggest, longest TV SPOT CAMPAIGN

30,000,000 TV VIEWERS

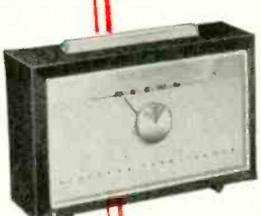
week after week





New

MODEL U-98—fully automatic—incorporates 32 distinct improvements—eliminates all arcing and consequent picture distortion—points directly, positively, instantly to target station—*"just set it and forget it"!* . . . . List Price, **$39.95**



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MODEL T-12—fingertip electrical operation. Rocker switch on top controls turning. Has direction indicator dial. Compact and smartly styled. Highly accurate! . . . . List Price, **$29.95**

When you sell Alliance Tenna-Rotor, you sell the pace-setter—the favorite for *seven solid years!*

30,000,000 folks see Alliance TV spots week after week . . . newspapers and magazines run hard-hitting Alliance ads all over the country . . . that's promotion—***sends sales your way!***

Alliance is *sold the most*, because it's *seen the most. You* profit most, coast-to-coast, with Alliance.

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THE ALLIANCE MANUFACTURING CO., INC
Alliance, Ohio

Post-Acceleration Tube

By FRED SHUNAMAN
MANAGING EDITOR

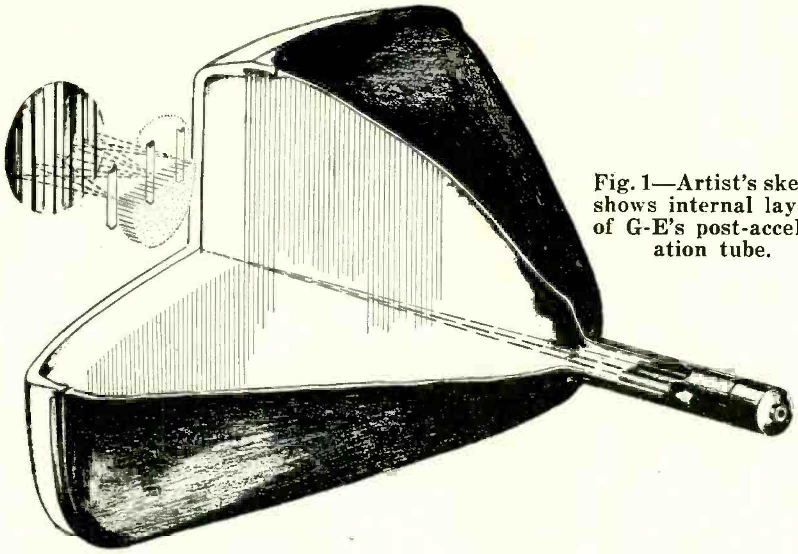


Fig. 1—Artist's sketch shows internal layout of G-E's post-acceleration tube.

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 0.8 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.

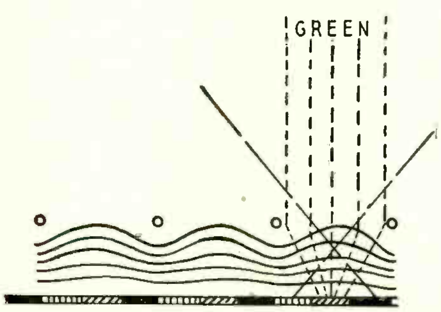


Fig. 2—Lines of equal potential make a sine-wave type pattern that flattens out as the screen is approached.

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—to cross 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 of 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 only 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.

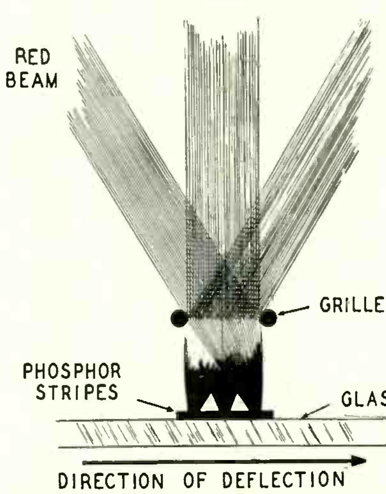


Fig. 3—Electron beams enter grille.

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 dealer's floor. 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 grille and those released from 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 bright 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 earth's 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 fairly constant over the United States and can be compensated for in the design of the equipment. Thus there is no need for heavy and expensive magnetic shielding.

Considering all the advantages of the post-acceleration tube, one is tempted to ask: "Why is it not immediately placed on the market?" The answer is that this is a developmental tube and problems of manufacture are still to be solved. Putting the phosphor on the face of the tube under production conditions is a feat still to be achieved. The tubes demonstrated were made up in "sandwich" form, with the grille and a flat phosphor-covered plate as a unit and inserted in the front of the tube. Incidentally, this caused some confusion in evaluating the tube's performance as one set gave noticeably better pictures than another of larger size, due not to any difference in the color sandwich but to a difference in the quality of the glass in the external faceplates.

The job of installing grille frames by factory mass-production methods has not been resolved as yet, but three approaches are being evaluated. END

THE ATOM-BOMB EFFECT

By JAMES A. McROBERTS

PART of the picture on an intermittent RCA KCS72 chassis so resembled the now familiar cloud (see photo) of an atomic explosion that this particular trouble was dubbed "The Atom Bomb Effect" in the shop in which it occurred. All intermittents are service lemons; but this dog was particularly troublesome because it would "intermit" for only several seconds to about a minute at a time. Sometimes the trouble could be caused or cured by jarring or shaking the chassis. If the set was left 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 particular 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 vestigial 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 reoccurred. A 0.1-μf 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.t.v.m. across the B supply at the focus coil takeoff. 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.

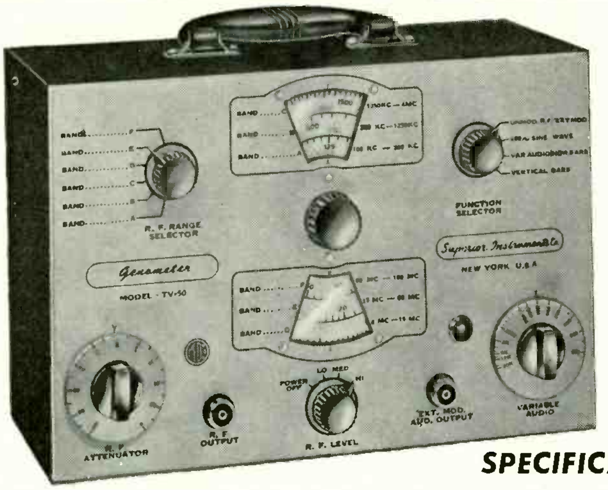
The plate of the vertical oscillator did have about 10 volts on it (through the high-resistance joint), which accounted for the failure of the vertical scan. During the intermittent the B feed to the 6AU6 a.g.c. tube and the grid of the 6SN7 horizontal sync separator was open. Likewise, the feed to the 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. END

The Model TV-50

GENOMETER

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A. M. Radio F. M. Radio Amplifiers Black and White TV Color TV



7 Signal Generators in One!

- R. F. Signal Generator for A.M.
- R. F. Signal Generator for F.M.
- Audio Frequency Generator
- Bar Generator
- Cross Hatch Generator
- Color Dot Pattern Generator
- Marker Generator

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.

CROSS HATCH GENERATOR:

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.

DOT PATTERN GENERATOR *(For Color TV)*:

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: 189 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.)

The Model TV-50 comes absolutely complete with shielded leads and operating instructions. Only .... **$47.50 NET**

SHIPPED ON APPROVAL

NO MONEY WITH ORDER—NO C.O.D.

Try it for 10 days before you buy. If completely satisfied *then* send $11.50 and pay balance at rate of $6.00 per month for 6 months. **No Interest or Finance Charges Added!** If not completely satisfied return unit to us, no explanation necessary.

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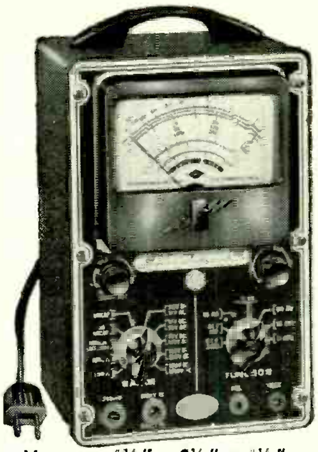

Measures 6¼" x 9½" x 4½"

Superior's new Model 670-A

SUPER METER

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 15/30/150/300/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 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
INDUCTANCE: .15 to 7 Henries 7 to 7,000 Henries
DECIBELS: −6 to +18 +14 to +38 +34 to +58

ADDED FEATURE:
Built-in ISOLATION TRANSFORMER reduces possibility of burning out meter through misuse.

The Model 670-A comes housed, in a rugged crackle-finished steel cabinet complete with test leads and operating instructions.

$28.40 NET

Superior's new Model TV-11

TUBE TESTER

SPECIFICATIONS:

- ★ Tests all tubes including 4, 5, 6, 7, Octal, Lock-in, Peanut, Bantam, Hearing Aid, Thyratron Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse type, etc.
- ★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because *all elements are numbered according to pin-number in the RMA base numbering system*, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-11 as any of the pins may be placed in the neutral position when necessary.
- ★ The Model TV-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus *it is impossible to damage a tube by inserting it in the wrong socket.*
- ★ Free-moving built-in roll chart provides complete data for all tubes.
- ★ Newly designed Line Voltage Control compensates for variation of any Line Voltage between 105 Volts and 130 Volts.
- ★ NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRA SERVICE — The Model TV-11 may be used as an extremely sensitive Condenser Leakage Checker. A relaxation type oscillator incorporated in this model will detect leakages even when the frequency is one per minute.

The model TV-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover

$47.50 NET

About Testing Picture-Tubes . . .

Of course you can buy an "adapter" which theoretically will convert your standard Tube Tester into a picture-tube tester. Sounds fine—but—it simply doesn't work out that way!

We do not make nor do we recommend use of C.R.T. adapters because a Cathode Ray Tube is a very complex device and to properly test it, you need an instrument designed exclusively to test C. R. Tubes and nothing else. As compared to a make-shift adapter, which sells for about five dollars, our Model TV-40 C.R.T. Tube Tester sells for $15.85. But, if you believe that Television is here to stay, then you must agree that the difference in price is more than justified by the many years of valuable service you will get out of this indispensible instrument.

Incidentally, the Model TV-40 is the ONLY low-priced C.R.T. Tube Tester, which includes a real meter. Neons are fine for gadgets and electric-line testers, but there is no substitute for a meter with an honest-to-goodness emission reading scale.

Superior's New Model TV-40

C.R.T. TUBE TESTER

Tests ALL magnetically deflected tubes . . . in the set . . . out of the set . . . in the carton ! !

- Tests *all* magnetically deflected picture tubes from 7 inch to 30 inch types.
- Tests for quality by the well established emission method. All readings on "Good-Bad" scale.
- Tests for inter-element shorts and leakages up to 5 megohms.
- Test for open elements.

EASY TO USE: Simply insert line cord into any 110 volt A.C. outlet, then attach tester socket to tube base (Ion trap need not be on tube). Throw switch up for quality test . . . read direct on Good-Bad scale. Throw switch down for all leakage tests.

Model TV-40 C.R.T. Tube Tester comes absolutely complete —nothing else to buy. Housed in round cornered, molded bakelite case. Only

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Try any of the above instruments for 10 days before you buy. If completely satisfied *then* send down payment and pay balance as indicated on coupon. **No Interest or Finance Charges Added!** If not completely satisfied return unit to us, no explanation necessary.

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Please send me the units checked. I agree to pay down payment within 10 days and to pay the monthly balance as shown. It is understood there will be no finance, interest or any other charges, provided I send my monthly payments when due. It is further understood that should I fail to make payment when due, the full unpaid balance shall become immediately due and payable.

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By H. L. MATSINGER

Slight changes in resistor and capacitor values raise havoc in TV receivers. So . . .

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.

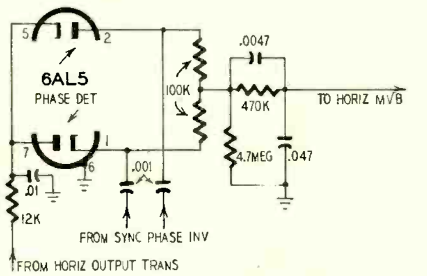


Fig. 1—Schematic diagram of the horizontal a.f.c. circuit in the Admiral 21W1.

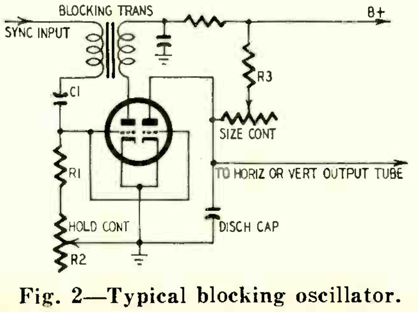


Fig. 2—Typical blocking oscillator.

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 called to correct 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.

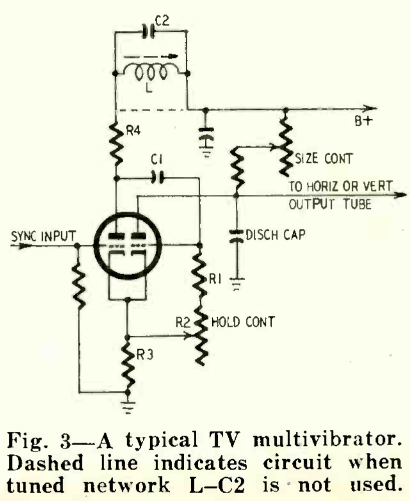


Fig. 3—A typical TV multivibrator. Dashed line indicates circuit when tuned network L–C2 is not used.

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.

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, however, may 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., i.f. and a.g.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 itself suspect. Even units that look good should be checked, but if there is any sign of blistering, bubbles or melting wax, be doubly suspicious. END

Rainbow Patterns with Conventional Generators

By ROBERT G. MIDDLETON*

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.

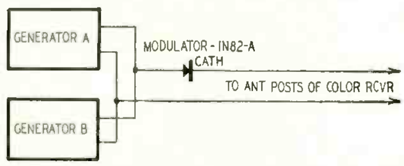


Fig. 1—Generators and diode provide rainbow patterns in color receiver.

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 supply 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.

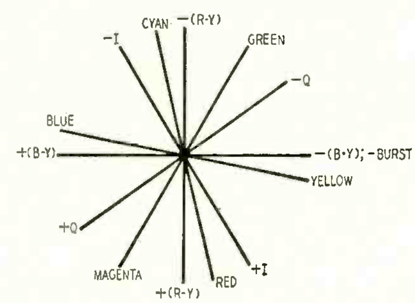


Fig. 2—Diagram shows phase relations of various hues defined in rotation of offset color subcarrier voltage vector.

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 89% 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 in such displays since only vertical bars are developed, and rolling is either invisible or appears only as a drift of the residual hum pattern.

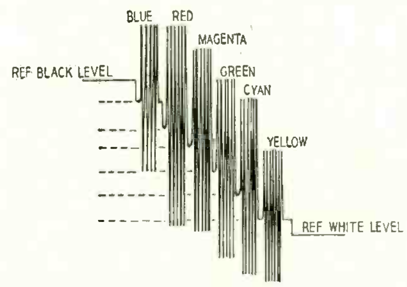


Fig. 3—Voltage relationships when true saturated colors are generated.

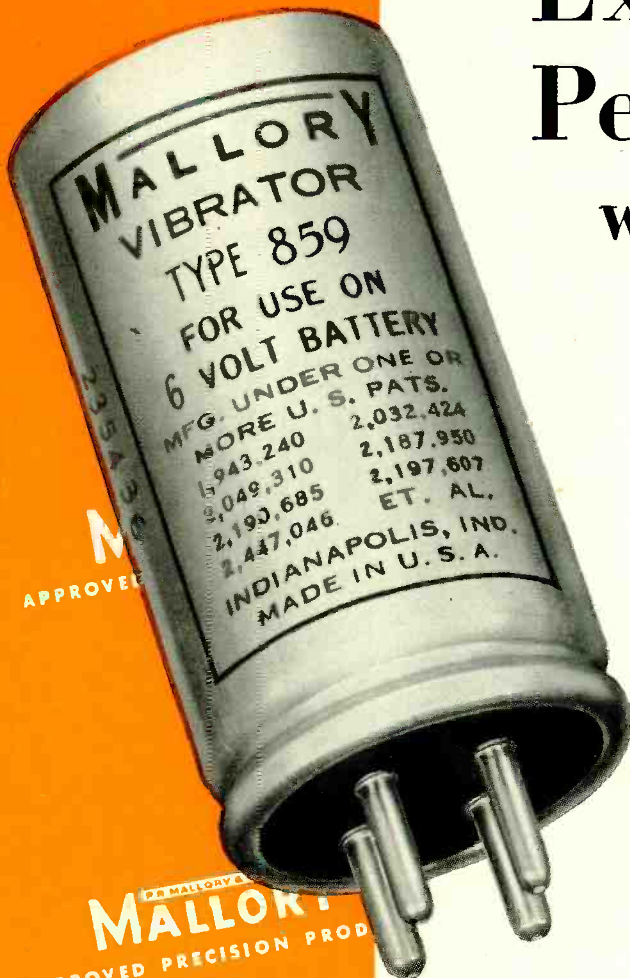
The lack of burst does not inhibit operation of the color sync circuits since the color subcarrier oscillator in the receiver will lock in on some average phase of the signal. But it would be a difficult matter to attempt to use this to adjust the color phase control of the receiver, since a reference 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 R − 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. END

*Chief Field Engineer, Simpson Electric Co.



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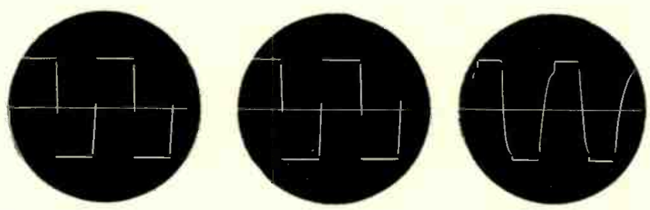

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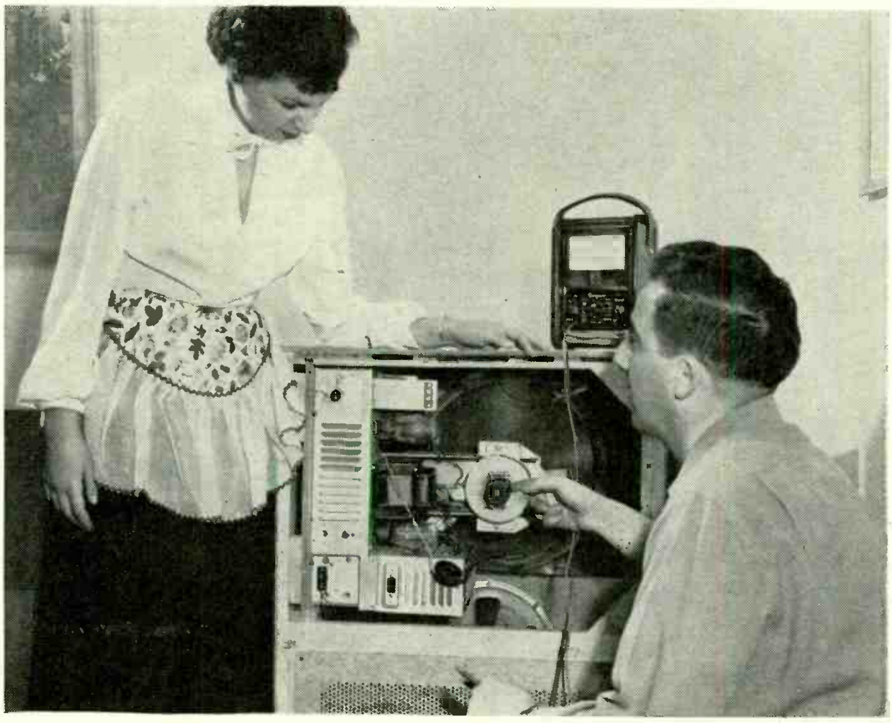
Those deadly intermittents

By ART MARGOLIS

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



". . . I reasoned it was the filament in the picture tube or the 6W6 damper."

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 6W4 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 Magnovox 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 about halfway. I turned into a glasspecker 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 struck gold. The customer who was watchdogging 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. It was acting fine 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 neck of the picture tube. The set owner frowned at this procedure. But I was dead right, for only two or three slight knocks 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 to part.

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. To avoid pulling the 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 as usual. 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 6S4 vertical output tube, instead of the high-priced chassis pulling and bench labor charges.

Another time a customer was being tormented by intermittent rolling 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 mixed 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 chassis 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-harboring chassis is pulled, dire circumstances are created. You have filched 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 favor us by going off. 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 on an inactive channel. 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 shop for instructions. They informed me that the last substitution of the .001-μf 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 capacitor 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 delivered the chassis. Actually though, I didn't need the policemen for the customer gladly paid his bill and returned my untouched tube caddy. All these melodramatics could have been avoided if this habitual viewer had been supplied with some form of TV. Since then we have found it highly profitable in keeping goodwill and reducing customer-waiting aggravation to have a few small-screen loanouts available.

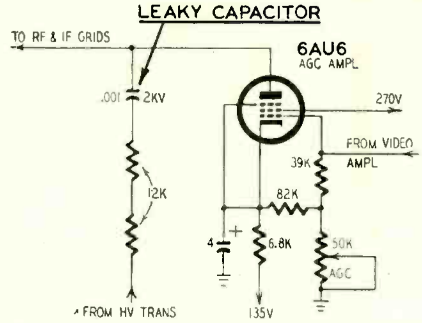


Fig. 1—Schematic of a.g.c. amplifier.

Clarifying the price

A thing we make crystal clear with the customer before hauling an intermittent into the shop is price. We painstakingly explain, as tactfully as possible, that an accurate estimate for this type job is well nigh impossible. And since it is a serious and difficult undertaking they should be prepared for a large repair bill. If the set owner won't go along with this, we won't accept the job. Only a fool works for nothing or does a job and loses money, and fools can't last in the TV service business very long. Here's how smooth such a difficult repair job can go:

One of the boys was dispatched to a complaint on a 19-inch Admiral. Naturally the set was performing like new when he arrived. He pieced together the symptoms — intermittent loss of raster. He informed the set owner he had a deadly intermittent that was going to be expensive, made arrangements for a loanout set and then pulled it into the shop.

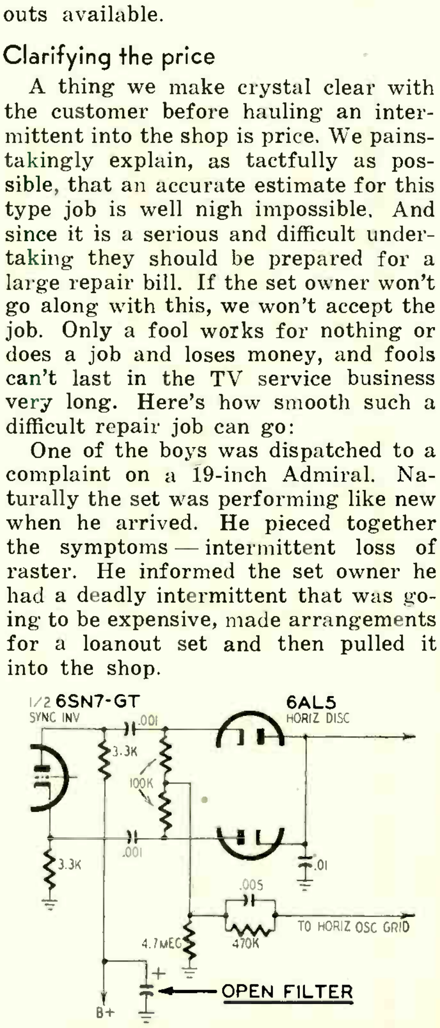


Fig. 2—Horizontal discriminator circuit.

The first seizure took place about 3 days later. Some frantic checks showed no high voltage and the horizontal oscillator way off key. 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

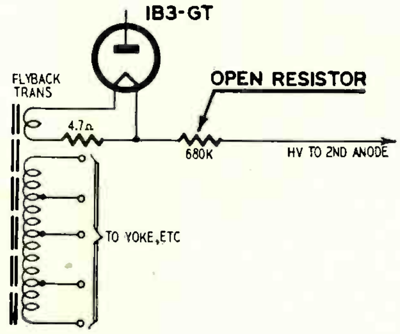


Fig. 3—High-voltage supply circuit.

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

"A couple of neighbors are having trouble with their sets—check these for me."

A simplified procedure for adjusting TV circuits

TV ALIGNMENT

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 his limited ability 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. Chances are, if a set has been serviced a number of times, somewhere along the way it has fallen into the hands of a screwdriver 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 streaky picture, unstable 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 and 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 generator output 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.

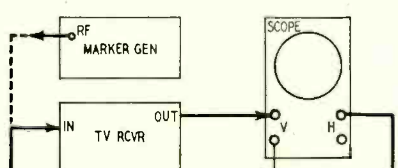


Fig. 1—Basic test equipment setup for aligning a television receiver.

Visual alignment

Knowledge and familiarity with the instruments involved—the oscilloscope, 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,

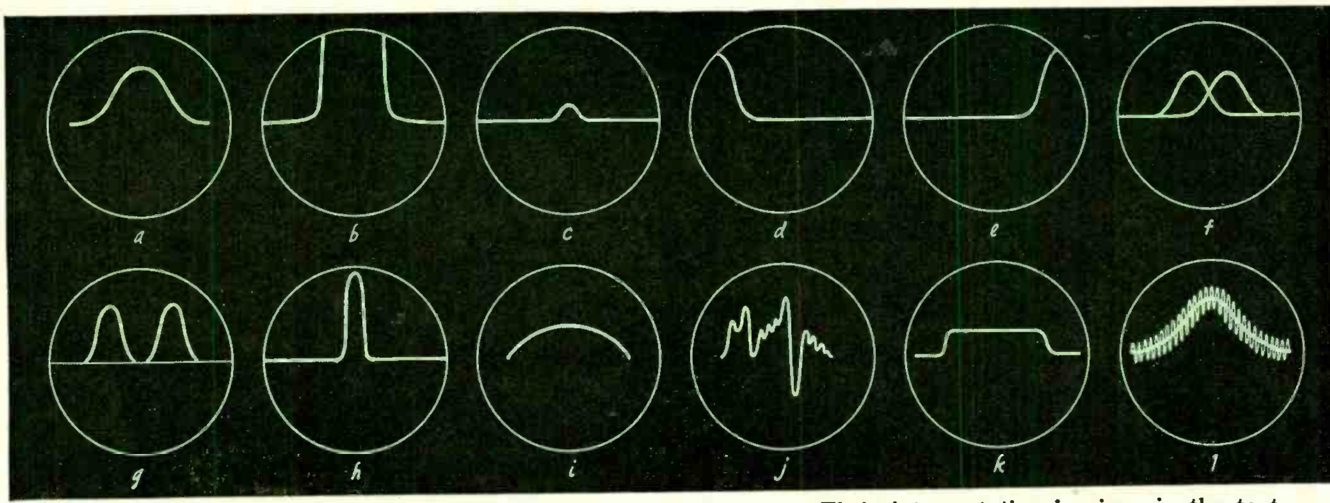


Fig. 2—A group of assorted response curves, as seen on the scope. Their interpretation is given in the text.

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 backing 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 pix 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 10% 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 overtune 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 best be aligned 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.

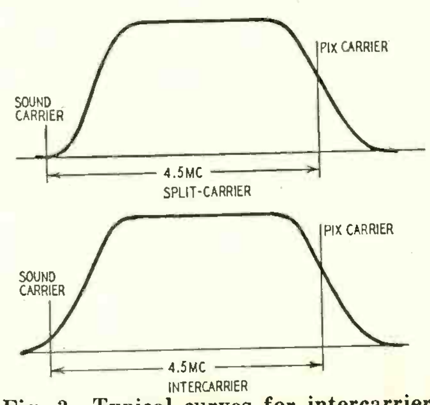


Fig. 3—Typical curves for intercarrier and split-carrier TV receivers.

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. slugs 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 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. slugs 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 slugs 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 slugs. 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 slugs 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. slugs in the tuner for maximum meter reading. Tune the generator to the sound carrier and adjust the mixer slugs for greatest deflection. If the two readings differ by more than 25%, alternately adjust each until they are nearly equal. Air-check reception on all channels and, if necessary, make a compromise touch-up in favor of the weakest one. END

TROUBLESHOOTING THE VIDEO DETECTOR

By JAMES A. McROBERTS

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-mc 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.

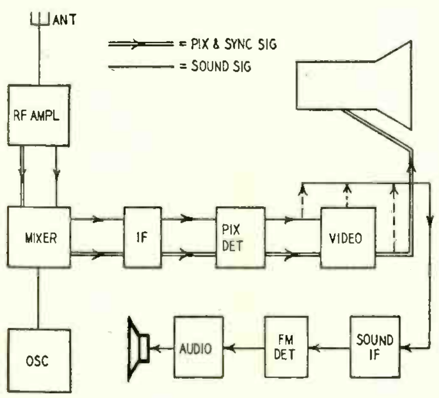


Fig. 1—Path of the audio and video signals in an intercarrier receiver.

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 120168D (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 or 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-μμf blocking capacitator need not be low; up to 100 μμf 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 indi-

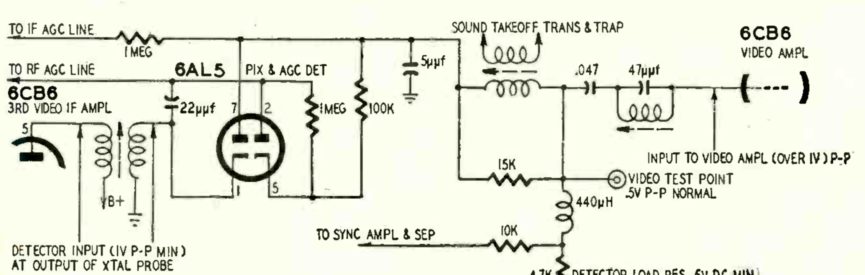


Fig. 2—Schematic diagram of the video detector in Emerson chassis 120168-D.

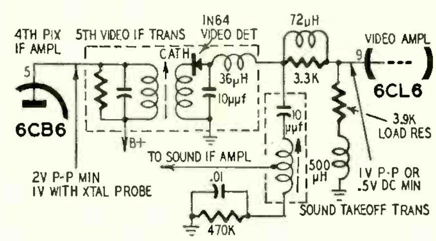


Fig. 3—Schematic diagram of the video detector circuit in RCA chassis KCS81-B.

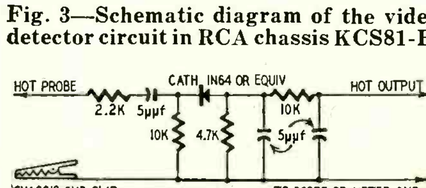


Fig. 4—A demodulator probe circuit.

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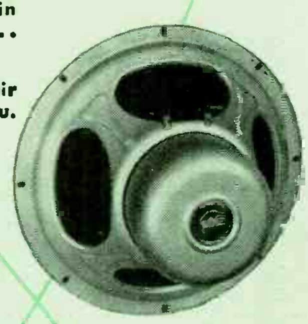

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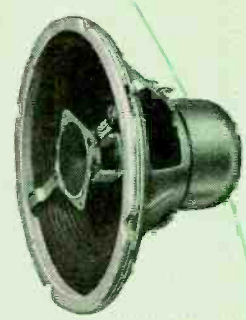

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cation. The reading will be somewhat less than the reading at the output of the video detector. Voltage-divider action of the isolation resistor and the shunt impedance across the input to the probe's crystal detector will cause about a 10% loss; the amount may be checked on a set in good operating condition.

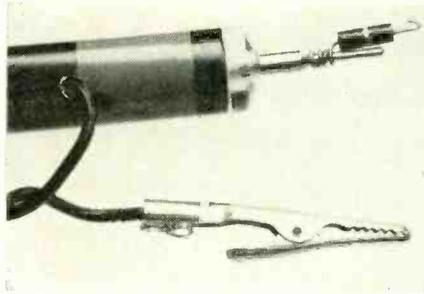


Fig. 5—Typical commercial probe.

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.

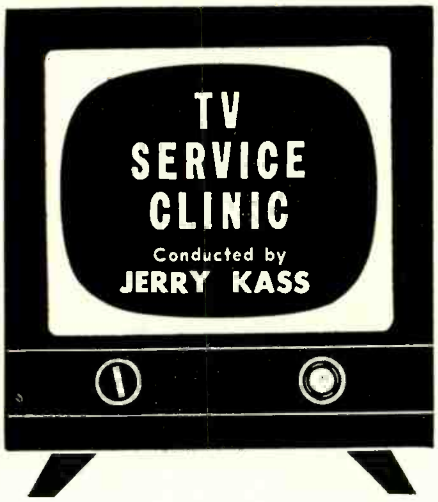
If no scope is available, the voltmeter may be connected across the output of the probe. The readings will be about one-third those obtained with the scope. When using a voltmeter, switch to an unused channel to determine whether the indicated reading is due to a signal or to hum or some other voltage.

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-μμf 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 pheonomenon 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. END



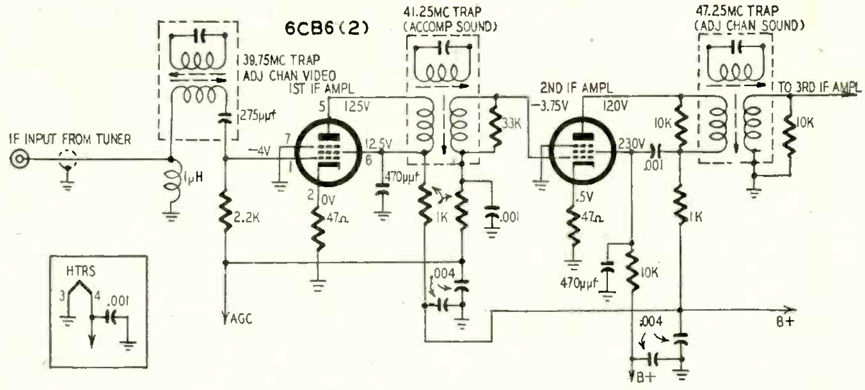


Fig. 4—Absorption type i.f. traps in Stromberg Carlson models K-KH21-22.

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 beat 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.

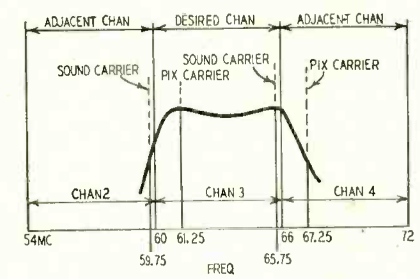


Fig. 1—Broad response of TV tuner admits adjacent-channel interference.

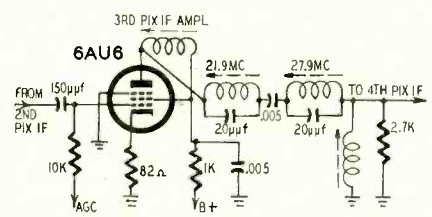


Fig. 2—The parallel-tuned traps are inserted in series in the signal path.

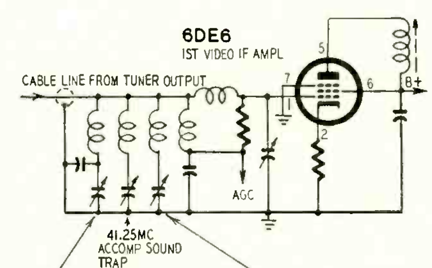


Fig. 3—Series-tuned traps shunt signal path and attenuate interference.

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 the frequency 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 flow takes 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, 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

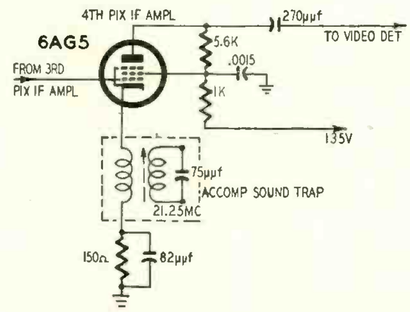


Fig. 5—A cathode absorption trap.

frequency. Fig. 5 shows such a circuit in the fourth video i.f. stage of the RCA 8TS30. 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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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.

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HELPS YOU EARN MORE DAILY

esting 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

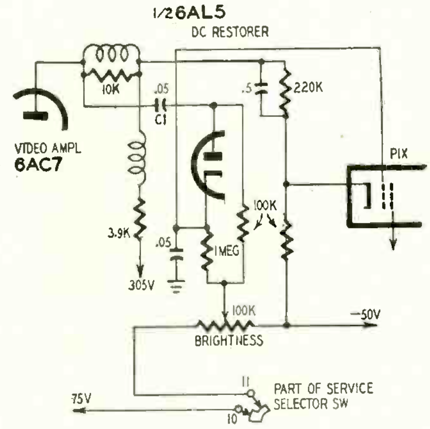


Fig. 6—Picture tube input circuit.

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 extensive 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

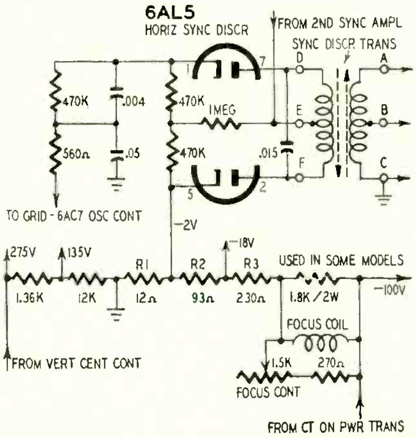


Fig. 7—Bleeder and a.f.c. circuits.

very critical. Anything below about −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, ½-volt differences are usually not noticed.

Split picture

I recently replaced a horizontal output transformer in a Sentinal 1U-446 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 isolate 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.

Noisy channel switch

A Motorola chassis in the shop has an extremely noisy channel-selector switch. This set uses the TT-15 tuner with a 6CB6 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 tet 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 rotor plate or the contact friction spring. 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 rotor plate and the friction spring. Then rotate the channel selector switch at least twice through its complete range.

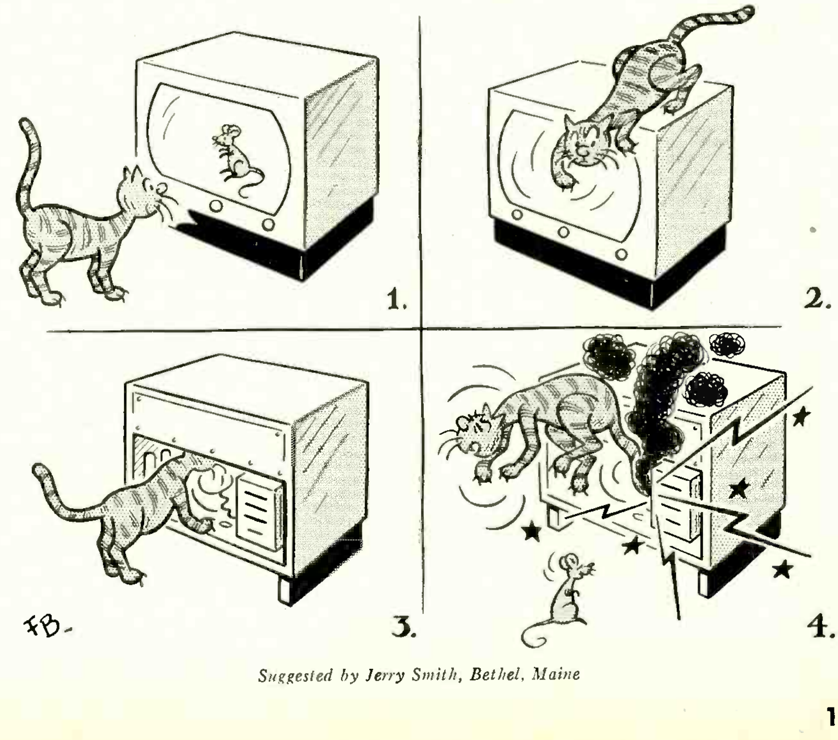
As an added precaution tighten the nuts that hold the switch contacts and coils in place. This will give you a good connection between the contact friction spring and the contact rotor plate. Don't use too much muscle on the nuts because the insulating washer under one of them breaks rather easily —tighten 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. F., 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. END



Suggested by Jerry Smith, Bethel, Maine

TELEVISION

V.T.V.M. Orients TV Antenna

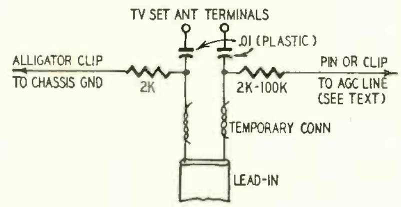
YOU can adjust your antenna direction for optimum reception of any v.h.f. or u.h.f. station, using a v.t.v.m. and a simple adapter.

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*

Technicians News

INDIANAPOLIS UNITY MEET

Delegates from widely separated parts of the country met at Minneapolis on Oct. 9 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 chairman, 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. Barg then 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.

Al Bernsohn, 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 Bert Bregenzer objected 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. Al 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 qualified association 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, however, 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 ESFETA (Empire State Federation of Electronic Technicians 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 in part:

"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 300 service dealers and technicians, 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 price between different purchasers of commodities of like grade and quality.

"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 NATESA 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 NATESA 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 credit ratings; 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. END

THE FUND REACHES $11,816.73

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 toward 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-mechanical—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.

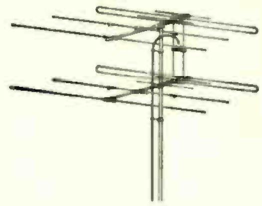
Won't you do your bit to help? No contribution is too small to receive our sincere thanks and acknowledgment, and you will know that every penny of your donation is put to good use in a worthy cause. *Make out all checks, money orders, etc., to Herschel Thomason.* Send all contributions to

Help-Freddie-Walk Fund
c/o RADIO-ELECTRONICS Magazine
25 West Broadway
New York 7, N. Y.

RADIO-ELECTRONICS Contributions as of July 5, 1955	$11,078.86
FAMILY CIRCLE Contributions	602.50
Anonymous, San Francisco, Calif.	50.00
Anonymous, Hartford, Conn.	1.00
Anonymous, Amherst, Mass.	1.00
Anonymous, Brooklyn, N. Y.	25.00
Anonymous, Philadelphia, Pa.	1.00
Columbia Broadcasting System, Inc., for account Jose Manuel Flores	7.37
A. H. Danter, St. Louis, Mo.	5.00
Philip R. Dodge, Pittsburgh, Pa.	2.00
Van H. Ferguson, Tallahassee, Fla.	5.00
H. Goldstein, White Plains, N. Y.	15.00
G. T. Harris, Richmond, Va.	5.00
Lizzie K., Dayton, Ohio	3.00
Karl W. Koenig, New York, N. Y.	2.00
Margaret Morrissey, Worcester, Mass.	1.00
J. R. Simpson, Rockville, Md.	2.00
Steven Warhol, Saint Paul, Minn.	5.00
Anthony J. Zugel, Washington, D. C.	5.00
TOTAL CONTRIBUTIONS as of Oct. 10, 1955	$11,816.73

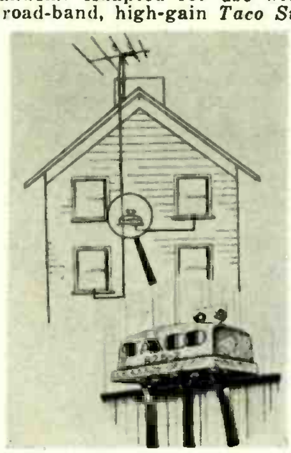
new Devices

FRINGE-AREA ANTENNA, *Poweray,* 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 50, Ill.

MULTISET TV COUPLER, *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 Trapper model 1890* antenna.

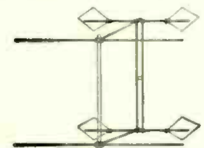


—**Technical Appliance Co.,** Sherburne, N. Y.

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

increases mechanical and electrical efficiency, cuts down installation time. Extra dipoles, harnesses, phasing stubs completely eliminated.—**Walsco Electronics Corp.,** 3602 Crenshaw Blvd., Los Angeles 16, Calif.

ANTENNA, *Wayco Master,* uniform high gain on channels 2–13. Functions as phased collinear array on channels 7–13 and as end-loaded broad-band



dipole with reflector for low-band operation. Standard and deluxe models; deluxe carries full 5-year guarantee.—**Wayco Inc.,** Waynesboro, Tenn.

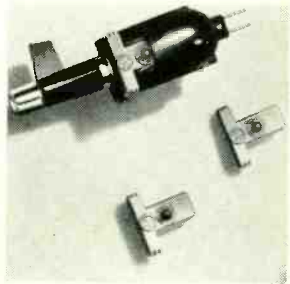
MAGNETIC TAPE RECORDER, *model 360 Crestwood Concerto,* table unit with accessory legs which screw into base for conversion to armchair-height consolette. Woofer and tweeter speaker system baffled to reproduce full music range. Push-button control, printed circuit preamplifier, 10-watt power amplifier. Ample space for storage of microphones,

cords and 4 7-inch reels of magnetic tape. Mahogany or blondwood.—**Daystrom Electric Corp.,** 753 Main St., Poughkeepsie, N. Y.

30-WATT AMPLIFIER, *model 80-AZ,* features Fisher *Z-Matic* circuitry, *PowerScope*—peak-power indicator calibrated in

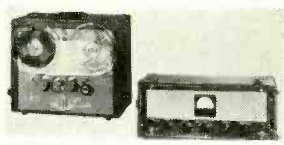
watts to show peak load on speaker system—and positive indicator to help prevent voice coil damage.—**Fisher Radio Corp.**, 2121 44th Drive, Long Island City 1, N. Y.

WIDE-RANGE MAGNETIC PICKUP, *Fluxvalve*, turnover type cartridge. Replaceable styli has high compliance for low tracking force (2–5 grams). Frequency response absolutely flat well beyond 20 kc; negligible IM distortion; output of 25 mv at normal recording level. Entire magnetic circuit,



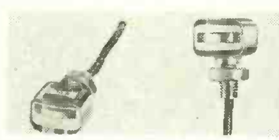
encapsulated in tough plastic. Mounting clip for use with all standard arms acts as bearing for turnover action.—**Pickering & Co., Inc.**, Oceanside, N. Y.

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, play back tape on standard 7-inch reels at 7½ or 15 i.p.s. Single control lever for record, play-



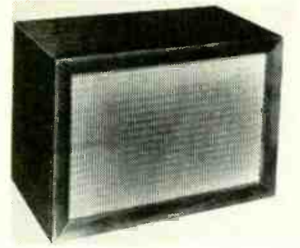
back or fast-speed operation. Amplifier contains microphone, playback preamplifiers, 2 small speakers for low-level monitoring. Microphone inputs of 50 or 250 ohms. Maximum output power 10 watts. At 15 i.p.s., frequency response up to 15,000 cycles, signal-to-noise ratio 50 db, flutter 0.15% r.m.s.—**Presto Recording Corp.**, P. O. Box 500, Paramus, N. J.

PRECISION MAGNETIC RECORDING HEAD, *Micro-Gap*, designed for specialized indus-



trial applications and professional-quality tape recorders.—**Shure Bros.**, 225 W. Huron St., Chicago 10, Ill.

HI-FI LOUDSPEAKER ENCLOSURE, *Karlson 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. *Karlson 8* kit parts precut, step-by-step account of assembly. Only hammer and glue neces-



sary. 15 pounds; 17¼ x 11¾ 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 215* nonresonant speak-

ers. 30 x 18 x 16 inches, in blond or mahogany.—**Hartley Products Co.**, 521 E. 162 St., New York 51, N. Y.

LOUDSPEAKER SYSTEM, *Shorthorn*, now available assembled and finished. Dark mahogany or light primavera wood. May be purchased with *Klipsch*

Ortho-15 3-way system with 15-inch bass driver, *Klipsch Ortho-12* 3-way system with 12-inch bass driver, or without drive system. Unfinished utility model available with same choice of drive systems. Cornerhorn back loading. Coordinated acoustic elements, including filters.—**Klipsch & Associates**, Hope, Ark.

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

TOP performance for TV anywhere!

Federal's "ALL-STAR" LEAD-IN TEAM

Urban, fringe or distribution system . . . heat, rain, dust, snow, ice, salt spray, polluted air . . . whatever the conditions you'll find a winner in these dependable Quality-Controlled Cables by "FTR"

North, East, South, West . . . wherever there are TV customers . . . Federal's "All-Star" Lead-in Team can be depended upon to deliver *championship performance* . . . !

These six popular types are outstanding examples of the quality, ruggedness, efficiency and long life built into every foot of Federal Cable. Whatever the run requirements or local weather conditions the Federal "All-Stars" will score high in satisfaction . . . with you and your TV customers.

Federal lead-ins can be installed with utmost confidence, because they are engineered and manufactured by a *pioneer* cable maker . . . and "Certified by a World of Research" . . . through the International Telephone and Telegraph Corporation.

Check the high points of Federal's "All-Star" Lead-in Team . . . then get in touch with your Federal Distributor. Always specify "Federal" . . . *keep* those TV installation profits instead of *paying them back in call-backs!*

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Federal

A DIVISION OF IT&T

TV-1190

Economical and Efficient

TV-1190—300-ohm heavy-duty lead-in with 90 mil. web. Has 7/#28 copper strands. Economical and highly efficient. Insulated with Federal-developed "silver" polyethylene for rugged service and long life.

TV-2000

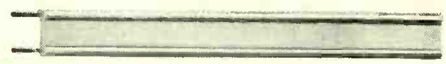
Another Low-cost Leader

TV-2000—300-ohm dumbbell-shaped lead-in with 55 mil. web. Has 7/#30 copper strands. A high-value, low-cost type for the average installation. Cinnamon-brown color is protection against ultra-violet.

TV-1182

Heavy-duty Type

TV-1182—300-ohm deluxe type heavy-duty lead-in with 90 mil. web, insulated with Federal's "silver" polyethylene. Resists weather, heat and sun. Very low line loss in fringe areas. Outstanding for long life.



TV-1184

Quality *plus* Economy

TV-1184—300-ohm dumbbell-shaped, standard, economy type lead-in for installations in urban areas where there are no unusual conditions. Cinnamon-brown color is highly effective in resisting ultra-violet.

RG-11/U

C-TV Primary Lead-in

RG-11/U—75-ohm shielded low-loss coaxial. One of the best small-diameter cables. Tops as a Community TV primary lead-in. Also can be used with unbalanced input TV receivers in low signal strength areas.

59/U Type

C-TV Secondary Lead-in

59/U Type—73-ohm coaxial lead-in Highly efficient as a Community TV pole-to-house tap-off. Meets all needs wherever a high-grade installation is a must. Ideal for use with unbalanced input TV receivers.

For data on other types, write Dept. D-463

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In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, P. Q.
Export Distributors: International Standard Electrir Corp., 67 Broad St., New York

bags.—**United Motors Service**, Div. of General Motors Corp., General Motors Bldg., Detroit 2, Mich.

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 multiplier. Less than 1% distortion. Frequency accurate to within ±5%. Output monitored on a large 4½-inch meter that reads voltage or db. Variable

and step type attenuation provided. Zero-to-maximum reading at each attenuator position. Output (and meter) ranges: 0–.003, .01, .03, 0.1, 0.3, 1, 3, 10 volts. Rapid selection of desired frequency; accurate return to any frequency.—**Heath Co.**, Benton Harbor, Mich.

LABORATORY TYPE OSCILLATOR, *type 347*, 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 level 3 mv or 60 db below signal; power supply 117 volts, 50 to 400 cycles.—

Technical Products Div., Allen B. Du Mont Labs., Inc., 760 Bloomfield Ave., Clifton, N. J.

5-INCH OSCILLOSCOPE, *EICO 460*, 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-mv-per-inch vertical sensitivity; sweep frequencies 10 cycles to 100 kc, plus lower sweep frequencies with external capacitor; re-

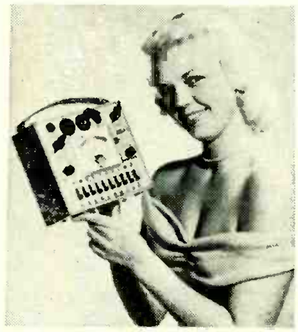
trace blanking.—**Electronic Instrument Co., Inc.**, 84 Withers St., Brooklyn 11, N. Y.

FILAMENT CHECKER, *SENCO model FC 4*, for finding open filament in series-string TV sets. Checks all octals, loctals,

(Continued)

7- and 9-pin miniature tubes, picture tubes. To use as continuity checker and neon voltage indicator insert standard test leads in pins 1 and 12 of picture-tube socket. Pocket-sized.—**Service Instruments Co.**, 171 Official Rd., Addison, Ill.

PRECISION TUBE TESTER AND REJUVENATOR, *EMC model 209*, checks all types of vacuum tubes by emission.



Wired and tested in hammertone case, in oak carrying case or in easy-to-assemble kit form. 3½-inch meter with 3-color good–bad scale. Rejuvenates and repairs all monochrome picture-tube types by using EMC *model CRA* picture-tube adapter.—**Electronic Measurements Corp.**, 280 Lafayette St., New York 12, N. Y.

FM WAVE TRAP, *MWT-1*, precision tunable, eliminates FM interference in master TV systems and individual TV sets. Mounted on antenna mast, at

Watch for . . .

SPECIAL TV ISSUE
JANUARY RADIO-ELECTRONICS

STATEMENT OF THE OWNERSHIP, MANAGEMENT, AND CIRCULATION REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) of RADIO-ELECTRONICS published monthly at Mt. Morris, Illinois, for October 1, 1955.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Gernsback Publications, Inc., 25 West Broadway, New York 7, N. Y.; Editor, Hugo Gernsback, 25 West Broadway, New York 7, N. Y.; Managing Editor, Fred Shunaman, 25 West Broadway, New York 7, N. Y. Business Manager, none.

2. The owner is: Gernsback Publications, Inc., 25 West Broadway, New York 7, N. Y.; H. Gernsback, 25 West Broadway, New York 7, N. Y.; M. Harvey Gernsback, 25 West Broadway, New York 7, N. Y.

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

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

H. GERNSBACK, Publisher

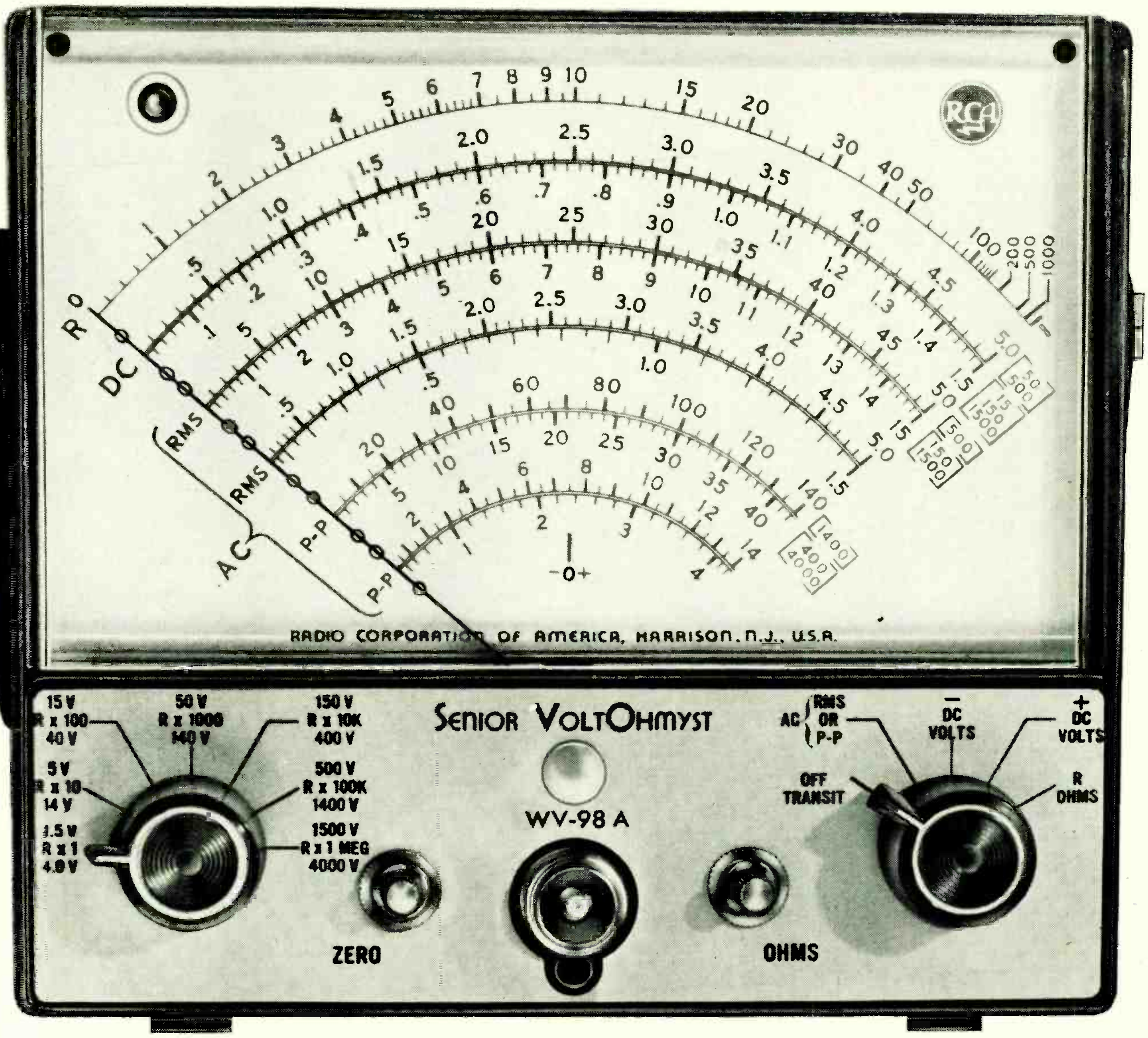
Sworn to and subscribed before me this 16th day of September, 1955.

[Seal] Irving Abramson, Notary Public

(My commission expires March 30, 1956)

Speed-Up Your Work with the *All-New*

RCA SENIOR VOLTOHMYST®



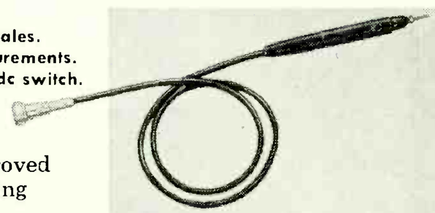
Senior VoltOhmyst, RCA WV-98A, only $75.00 User Price* including probe and cable, instruction booklet, complete and ready-to-use . . . Shown slightly smaller than actual size.
*Optional

New!

You can work faster, more accurately—when you own and use the new RCA WV-98A SENIOR VOLTOHMYST with the extra-large full-vision meter-face. "Speed-up" in your service work—without the slightest sacrifice in quality—means a "build-up" in your profits. Look at the easy-to-read expanded scales. Then look at some of the other advanced features you also get.

- Large, easy-to-read, wide-vision meter (6½" w).
- Expanded meter scales . . . separate peak-to-peak voltage scales.
- Accuracy of 3% full-scale on *BOTH* ac and dc voltage measurements.
- Sturdy, single-unit streamlined probe with built-in ac-ohms/dc switch.
- Rugged die-cast aluminum case.
- Compact design: 7" wide, 3¾" deep, 6½" high, 6 lbs.

The all-new WV-98A has all the important, time-proved performance features of earlier VoltOhmysts including direct reading of peak-to-peak voltages of complex waveforms. See this highly accurate, versatile, service instrument at your RCA Distributor! Order now.



NEW! WG-299A slim, single unit DC/AC-Ohms Probe and Shielded cable is provided with the RCA WV-98A. Probe has handy built-in switch permitting instant selection of dc or ac/ohm operation.

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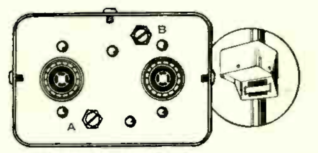
amplifier or TV inputs. 2 trimmer screws tune out interfering frequency. Rejection from 35 db at channel center to less

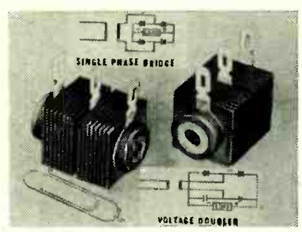


than 3 db 1.5 mc on either side.—**Blonder-Tongue Labs., Inc.,** 526 North Ave., Westfield, N. J.

GEIGER COUNTER, *model AE100,* completely wired, includes all batteries and tube. Supersensitive, has 900-volt halogen quenching type Geiger tube to protect against burnout. Detects presence of ura-

nium or other radioactive ores, minimum radiation harmful to health. *Model AEK100* (kit) includes batteries and tube, headphone and shoulder carrying strap.—**General Electronics Equipment Co.,** 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 connected as single-phase full-wave bridge circuit delivers approximately 180 volts d.c. at 0.1 amp for r.m.s. voltage input of 230. Output of 350 volts d.c.

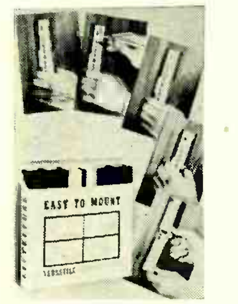


obtainable. For remote TV tuners where hum is objectionable; solenoids, variable-speed controls, field supplies for small d.c. motors, etc. 21/32 x 1/16 x ¼ inches overall. Mountable with No. 8 machine screw through hollow brass eyelet.—**International Rectifier Corp.,** 1521 E. Grand Ave., El Segundo, Calif.

VARIABLE CAPACITOR, *MS-215,* for builder of transistorized and miniature equipment. Variable from 10 to 365 $\mu\mu f$. 3/16 inch thick by 1½ inches

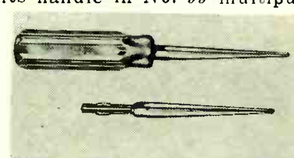
square. Bushing and shaft extend ⅞ inch; 180° rotation.—**Lafayette Radio,** 100 Sixth Ave., New York 13, N. Y.

FUSE DISPENSER, double or multiple channels. Single-channel dispensers available in 10-channel package. Each channel can dispense 2 types of fuses, from middle and bottom. One 20-box channel with most popular selling fuses, 10 boxes



each of ¼-amp and ½-amp 3 AG's.—**Littelfuse, Inc.,** 1865 Miner St., Des Plaines, Ill.

HAND REAMERS, ½ to ⅜ inch in wood, plastic and sheet metal. Chrome finish keeps cutting edges sharp and rust-free. *No. 38* (top) fixed in 1 x 3⅞-inch plastic handle. *No. 99-38* fits handle in *No. 99* multipur-

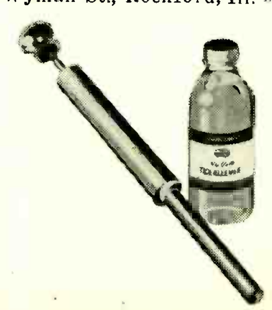


pose tool kit. Kit *No. 99* has 13 detachable nut-driver and screw-driver bits. Extra pocket stores *No. 99-38* reamer.—**Xcelite, Inc.,** Orchard Park, N. Y.

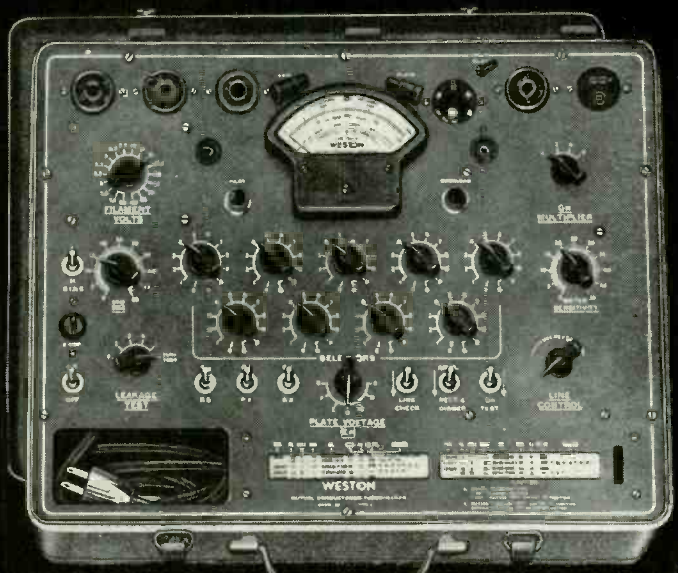
PREAMPLIFIER - AMPLIFIER, *Prelude model PC-200,* uses printed circuits. 10 watts output. Preamplifier inputs for phono and tuner, tape input for

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



All specifications given on these pages are from manufacturers' data.



Weston Model 981
Proportional Mutual Conductance Tubechecker

FILTERED D-C POTENTIALS

for accurate G_m measurements

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.

GRID BIAS, SCREEN GRID AND PLATE VOLTAGE: Filtered d-c potentials of 90, 130, and 220 volts are available for plate and screen potentials. A variable filtered d-c voltage in two ranges of 0-5 and 0-20 volts are used to obtain better resolution of Grid Bias settings. *Far greater accuracy is obtainable with filtered d-c potentials than previously possible in portable tubecheckers.*

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.

TWIN SECTION TUBES—Three toggle switches make it possible to rapidly check and compare the respective sections of twin section tubes at only one setting of the selector switches.

WESTON *980 LINE TEST EQUIPMENT*

THE

980

LINE

PROPORTIONAL MUTUAL CONDUCTANCE

TUBECHECKER

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Weston Electrical Instrument Corporation
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Please send literature on the new 981 Tubechecker.

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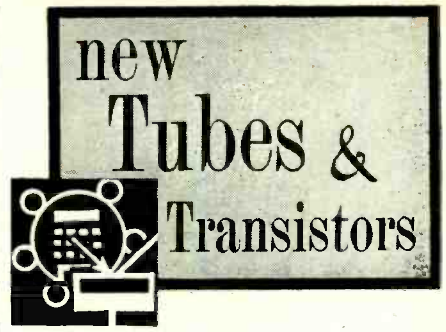
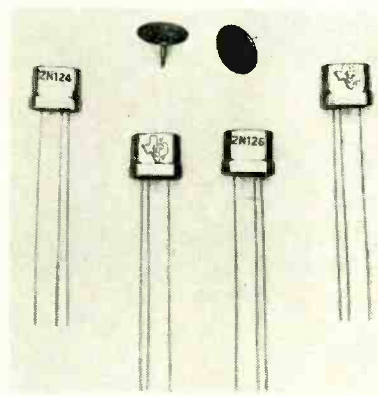


Germanium transistors

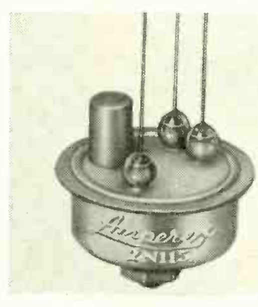
Four new types of germanium n-p-n transistors have been announced by Texas Instruments. The 2N124, 2N125, 2N126 and 2N127 are especially designed for general-purpose switching and computer applications. The units feature a beta spread of 2 to 1: 12 to 24, 24 to 48, 48 to 100 and 100 to 200, respectively. 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.



The absolute maximum ratings of these transistors at 30° C are as follows: collector voltage, 10; emitter reverse voltage, 5; collector current, 8 ma; emitter current, −8 ma; collector dissipation, 50 mw.

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



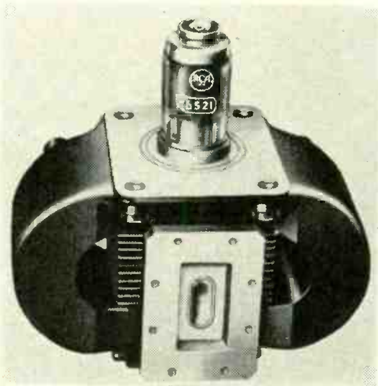
for a 5-ohm speaker voice coil to be used directly as the collector load in an audio output stage and is ideal for operation in car radios having 6-volt systems.

6521 Magnetron

Intended for use as a pulsed oscil-

NEW TUBES & TRANSISTORS *(Continued)*

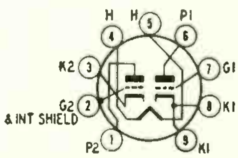
lator at 5,400 mc in weather radar equipment, the 6521 (see photo) operates with high efficiency at pulse durations to 2.2 microseconds and has a maximum peak input power rating of 256 kw, a maximum peak anode voltage rating of 16 kv and a peak anode current rating of 10 to 16 amperes.



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

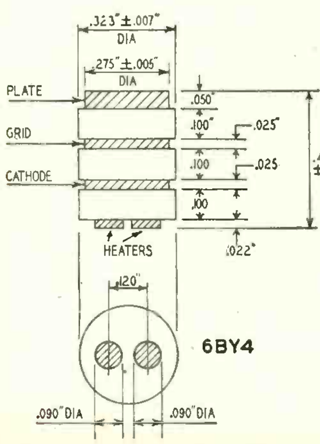


6CH7

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-



6BY4

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 900 mc, the 6BY4 provides a power gain of approximately 15 db and a noise factor of approximately 8.5 db with a 10-mc 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 milliamperes.

Operating as a typical class-A_1 amplifier the 6BY4 has an amplification factor of 100, a plate resistance of 16,700 ohms, a transconductance of 6,000 micromhos. 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 Elnora, 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 Electrics	1908
Wireless Association of America	1908
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Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
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*)

A New Color-Music Instrument, by Edwin Haynes.
Perfectly Synchronized Talking Movies, by Joseph H. Kraus.
Learn and Work While You Sleep, by H. Gernsback.
Invisible Ray Signaling.
Radio in a Nutshell.
The World's Series by Radiophone, by Arthur H. Lynch.
A Short-Wave Regenerative Set, by William H. Grace, Jr.

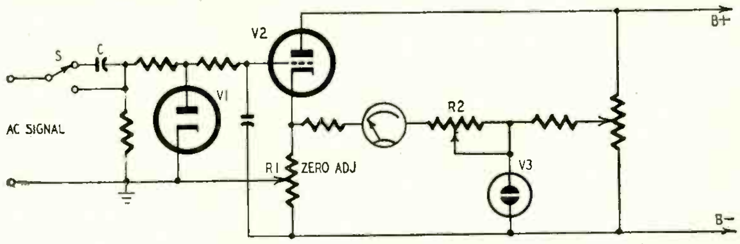
Patents

V.T.V.M.

Patent No. 2,713,663

John R. Crabbe, Bayside, N. Y. (Assigned to Servo Corp. of America)

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 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 voltmeter tube). If the input also has a d.c. component, switch S is thrown to cut in a blocking capacitor C.

V2 is a cathode follower with load R1. This resistor develops a potential equal to that across the neon lamp V3. 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

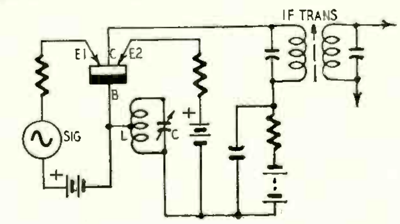
Patent No. 2,713,117

Rowland W. Haegele, Bayside, N. Y. (Assigned to Sylvania Electric Products, Inc.)

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 beat is passed by the collector into the output i.f. transformer.

As usual, each emitter is biased to a fraction of a volt positive. The collector battery may be about 22–40 volts negative.

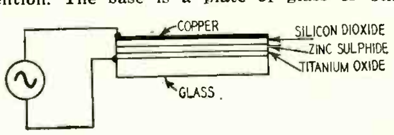


COLD LIGHT

Patent No. 2,709,765

Lewis R. Koller, Schenectady, N. Y. (Assigned to General Electric Co.)

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 expotentially with the a.c. voltage.

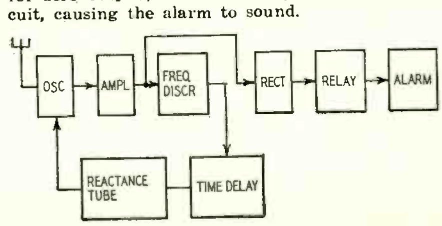
INTRUDER ALARM

Patent No. 2,708,746

Joseph D. Shaw, Cincinnati, Ohio

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.



PATENTS (*Continued*)

Voltage also reaches the reactance 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 unbalanced 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.

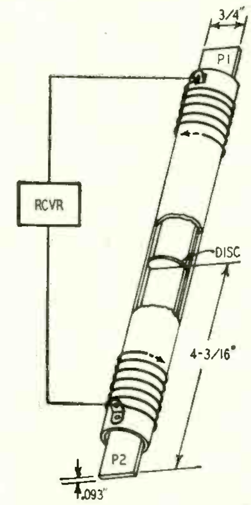
COMPACT LOOP ANTENNA

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 89 turns of litz wire, with maximum inductance 265 μh. END

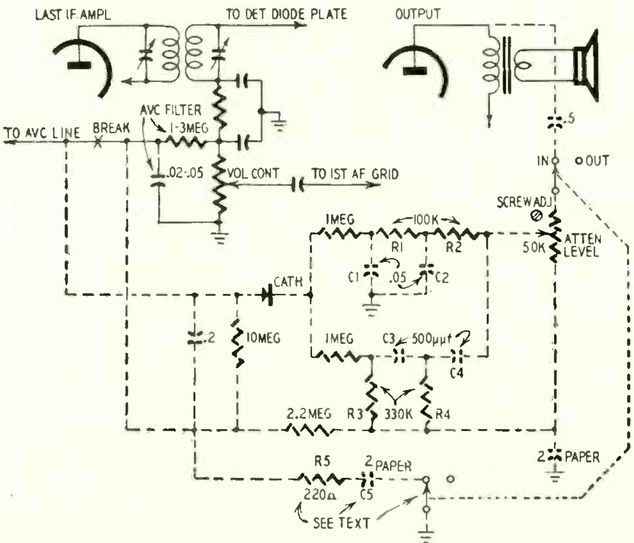
My card, Madame!"

radio-electronic Circuits

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 highpass filter (C4–R4 and C3–R3) 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.

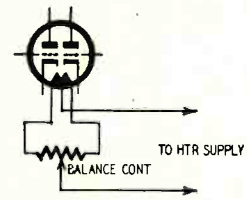
This diode rectifies the signal and charges the 0.2-μf capacitor to a negative voltage that depends on the amplitudes of the signals passed by the filters. This voltage is applied to the a.v.c. line in series with the a.v.c. voltage obtained by rectifying the carrier. Most speech power is in frequencies 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 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

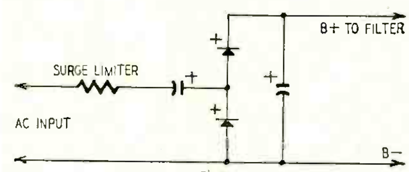


Fig. 1

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

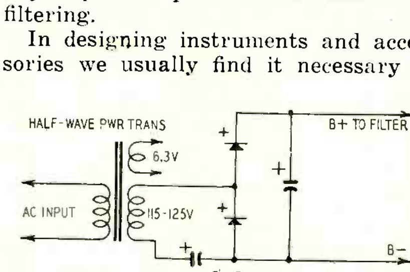


Fig. 2

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.

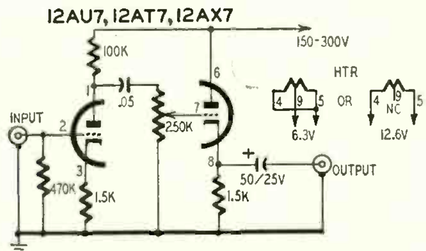
The circuit can then be rearranged as in Fig. 2, at considerable advantage.

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.

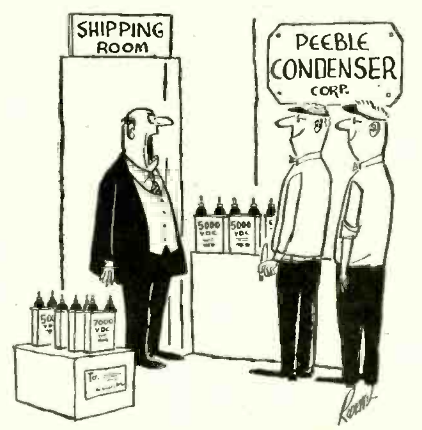
This arrangement has the minor disadvantage that the transformer secondary is placed off ground by a d.c. voltage equal to its own peak charge on the input capacitor. This may be neglected in ordinary applications, however, as the transformer contains a tremendous margin of safety in its insulation.—*Donald 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 volume 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-μf capacitor in the output presents a low reactance.—*Quentin J. Evans* END



"Which one of you guys has been shipping high-voltage condensers charged?"

Question Box

CONTROL CIRCUIT

Please publish a circuit of a simple and reliable carrier-current remote control circuit for starting and stopping a distant motor over existing power lines. — D. W. P., Hialeah, Fla.

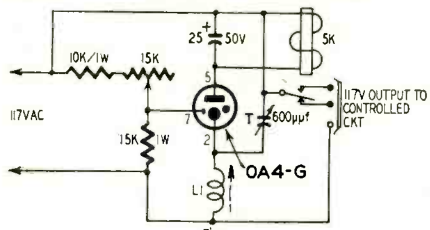


Fig. 1

center-tapped on a 1½-inch form. L3 is 8 to 10 turns of plastic-insulated hookup wire around the center of coil L2.

The receiver and transmitter must be tuned to the same frequency. The tuning range extends from the high-frequency end of the broadcast band down to around 400 kc. Do not operate on a frequency that causes interference in the r.f. or i.f. circuits of nearby receivers.

Several remote devices can be controlled individually by using separate receivers tuned to different frequencies

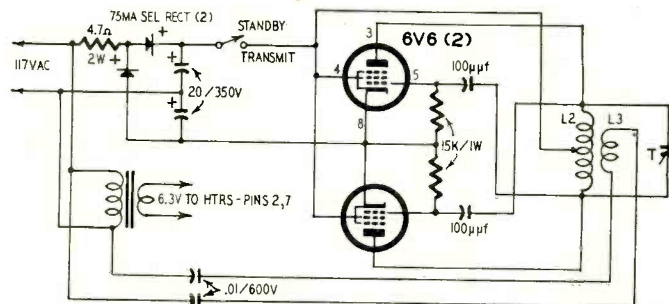


Fig. 2

The circuit of the receiver is shown in Fig. 1. The 600-μμf mica trimmer capacitor tunes L1 to the r.f. control carrier. The incoming control signal fires the 0A4-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 0A4-G.

The transmitter circuit is in Fig. 2. The oscillator uses 6V6's in push-pull. The 600-μμf 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 enameled wire closewound and

and by suitable switching padders across L2.

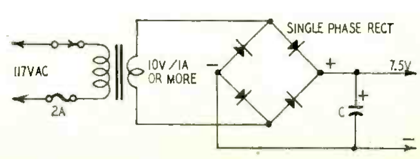
With the relay circuit shown in the receiver, the transmitter must remain on to maintain the desired operation at the remote point. Therefore, if you do not want to operate the transmitter continuously or if you plan to operate several devices, you can use pulse type control. One pulse turns the equipment 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 on 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 μf. The output voltage will drop and stabilize at a slightly lower voltage as the



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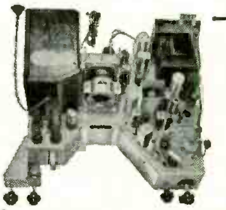

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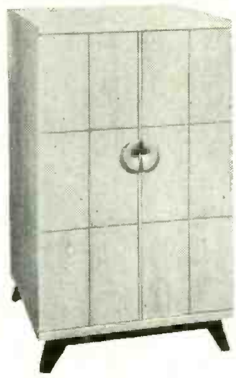

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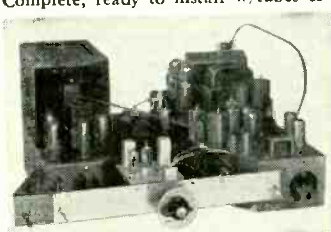

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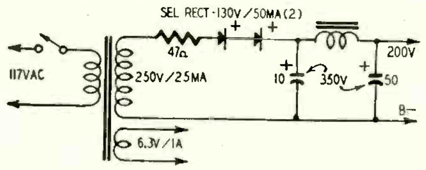
TELEPHONE COrtland 7-2359

rectifier ages. You can bring it back to the original value by increasing the capacitance of C. The rectifier may be a selenium or copper-oxide type. Its input voltage rating should be at least 15 volts r.m.s.

This circuit may be used for battery chargers and as a d.c. supply for electroplating. For currents up to around 10 amperes you can use a transmitting type filament transformer. For higher currents, use two or more such transformers with the windings in parallel. A Variac, Varitran or similar variable autotransformer can be used on the input side of the supply to vary the output voltage. However, take care that the a.c. applied to the rectifier does not exceed the manufacturer's ratings.

VERSATILE POWER PACK

Please print a diagram of a power supply that will deliver 200 volts d.c. at 25 ma and 6.3 volts a.c. at 1 ampere for a Granco HT-5 converter and other small equipment such as phono preamplifiers and mixer units.—W. J. F., East Springfield, Mass.

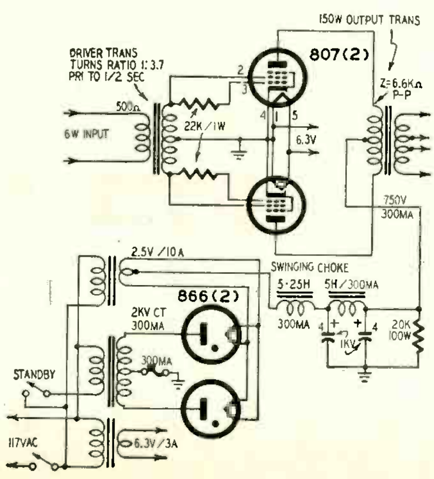


This circuit should meet your needs. The transformer is a Stancor PS-8416 or equivalent. Two 130-volt selenium rectifiers are connected in series to handle the a.c. input voltage. If the d.c. output voltage is too high, insert a suitable dropping resistor in series with the filter choke, an a.c.–d.c. 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 1:3.7.



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 866. 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-μf units rated at 1 kv. The power transformer secondary center tap is fused.

VARIABLE CAPACITORS

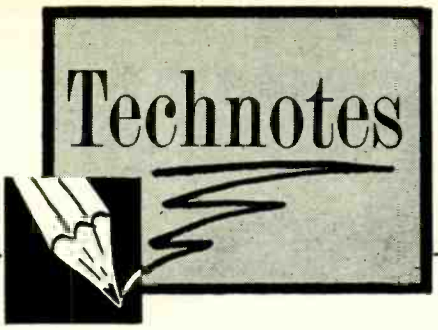
I plan to build the novice transmitter described in the September, 1953, issue but I've not been able to find the 325-μμf 1,000-volt variable capacitors nor the 135-volt 75-ma power transformer. Please recommend these components by brand and type number. In some instances transmitting type capacitors 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.

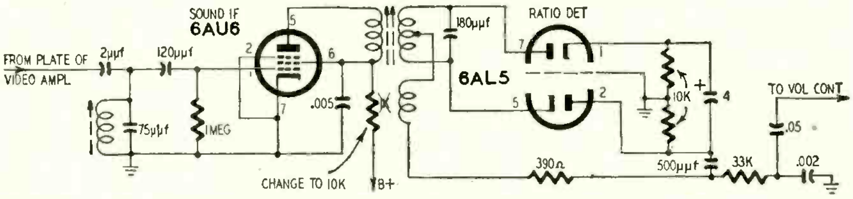
A capacitor with plate spacing of .024–.025 inch will handle peak voltages of 1,000–1,200; .034–.047 inch will handle 1,600 volts; .051–.065, 2,000 volts; .07–.078 inch, 3,000–3,600 volts. For the novice transmitter you can use Hammarlund MC-325-M, National STH-335 or Bud TMS-300 capacitors in the pi 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. END



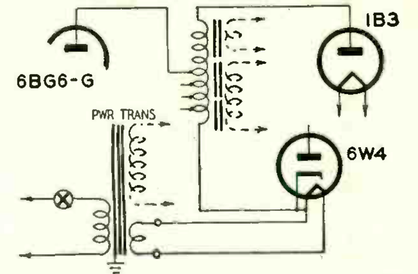
TV INTERFERENCE

In weak-signal areas or locations where an indoor antenna is used, cross-hatch interference in an Admiral 20Z1 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 6T7I 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*

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 covered 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 underside 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 shown in the photograph. 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.

Capacitor is touching Aquadag coating.

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 frying 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 metal 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*

TELETONE 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*

END

try This one

TESTING OF RECORDING TAPES

Magnetic recording tape comes in a wide variety of brands and price ranges, making it difficult to tell which brands of tape are worth using. But here is a comparative test which very simply demonstrates the relative output available from any two tapes.

Take sample lengths (3 to 5 feet) of any two tapes, give them identifying marks, and splice them together. Run this spliced sample through the recorder while applying a steady signal to the input. Then splice the free ends of this composite tape together to make one continuous loop. Insert this in the tape machine and play back.

When measured with a v.t.v.m. or oscilloscope, the relative outputs of the two tapes can be compared easily.

Even without a signal generator or measuring instruments, significant results can be obtained by whistling a steady note into the tape recorder microphone and listening to the playback. With just a little practice one can whistle a note that will be steady enough for the purpose. A good variation of this test is to use the voice or a musical passage as the signal. A general listening test can then be made.

If available, a sawtooth signal generator and oscilloscope are excellent instruments when making tests on a tape recorder. Not only can the relative outputs of different tapes be measured but also their frequency response and that of the tape recorder. This is so because any reproducing system that passes perfectly a sawtooth wave of a certain frequency will also be flat for a band of sine waves in the range of about 1/10 to 10 times the sawtooth-wave frequency. (See "Check Audio Response with a Neon Glow Tube," RADIO-ELECTRONICS, November, 1952, and "Testing with White Sound," *Audio*, October, 1954.) A tape system that reproduces a 600-cycle sawtooth without distortion will be flat from about 60 to 6,000 cycles.—*Charles Wolf*

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 (L4) as in Fig. 2. If the oscillator fails to work, reverse the connections to L4.

A *Vari-Loopstick* with 25 turns re-

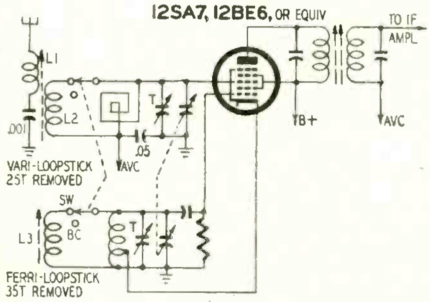


Fig. 1

moved 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 removing approximately 35 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

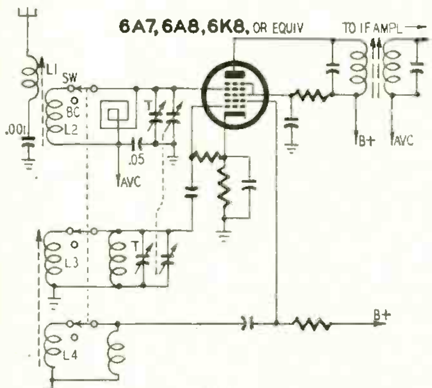


Fig. 2

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 i.f., and the antenna coil could be peaked at the signal frequency. However, the main drawback is that strong low-frequency signals may ride through.

The 100-turn antenna coil L1 works

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.

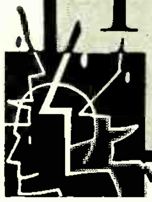
Since replacement contacts are not available on the market, a *new* socket of each type commonly used should be obtained. Removing the contacts is simple but use *extreme* care as they are easily broken or weakened. The technique varies slightly with different types of sockets, but if a careful examination is made the procedure will be obvious. In some sockets the projecting solder lug should be flattened for removal; in others it should be rolled 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.*

END

"This time I'm really going to tell the boss off."

People



Howard W. Sams, president of Howard W. Sams & Co., Indianapolis, was elected chairman of the board. **J. A. (Shine) Milling**, executive vice president and general manager of the company, succeeds Sams as president.

H. W. Sams

William W. Posey was appointed East Central district sales manager of CBS-Hytron with headquarters in Detroit, Mich. He was formerly with Fitzsimmons Associates and National Union Radio Corp.

W. W. Posey

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.

J. Solari

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 Centralab products engineering.

R. L. Wolff

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.

E. E. Wineblatt

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.

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-Hadley 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 Titanium Corp., 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., Malden, Mass. He comes to National from Magnavox.

. . . **Brig. Gen. David Sarnoff**, chairman of the board of RCA, was awarded the 1955 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 Walsco Electronics Corp., Los Angeles.

OPPORTUNITY ADLETS

Rates—45c per word (including name, address and initials). Minimum ad 10 words. Cash must accompany all ads except those placed by accredited agencies. Discount, 10% for 12 consecutive issues. Misleading or objectionable ads not accepted. Copy for February issue must reach us before December 15, 1955.

Radio-Electronics
25 W. Broadway, New York 7, N. Y.

ENGINEERING DEGREES earned through home study. American College of Engineering, Box 27724 (M), Hollywood 27, Calif.

HIGH-FIDELITY SPEAKERS REPAIRED. Amprite Speaker Service. 70 Vesey St., New York 7, N.Y.

BUY Surplus Radio. Electronic Equipment direct from Government. List $1.00. Box 169RAC, East Htfd 8, Conn.

EXPERIMENTERS—HOBBYISTS—BUILD PROJECTS IN THIS MAGAZINE. Parts available for most articles. Free price list of our Part-Paks. Write Box 481, Camden, N.J.

SPEAKER RECONING: Guaranteed workmanship. C&M Recone Co., 255 Tioga St., Trenton 9, N.J.

RCA, Motorola. Link, GE and Kaar new and used two-way radio equipment bought and sold. Communications Associates, 138-17 Springfield Blvd., Springfield Gardens, N. Y. Phone LA 7-2727.

DEFINITELY SUPERIOR, report television engineers everywhere, comparing the OCTO-TENNA with other antennas. Sample $3.50, Postpaid. DERR, 1018 Taylor, Vallejo. Calif.

DIAGRAMS FOR REPAIRING RADIOS $1.00. Television $2.00. Give Make, Model. Diagram Service, Box 672-RE, Hartford 1, Conn.

BIG MAILS—ALL TYPES OF OFFERS: Your name in our Directory. Once 10c; 3 listings 25c. DON ENTERPRISES, Box 186-A. Hialeah. Fla.

NEW printed circuit Television antenna, Ekeradio Electronic Developments, 646 N. Fair Oaks Ave., Pasadena, Calif.

SPECIAL: New English COLLARO RC-54 changer, mounting board, plug-in-head, $38.75 prepaid. Guaranteed: DIAMOND-SAPPHIRE Stylus RPX-050, $10.75. Simulated base-cover for all changers, $9.75. 3¾ – 7½ – 15 Ips Dual Tracks. 30–15,000 cps English High Fidelity Tape Deck. Three 4 pole motors. Best buy $79.50 prepaid. WRITE TODAY. Dept. RE, FIDELITY UNLIMITED, 63-03 39th Ave., Woodside 77, N.Y.

TUBES—TV, RADIO, TRANSMITTING, AND SPECIAL PURPOSE TYPES BOUGHT, SOLD AND EXCHANGED. Send details to R. E. Gensler W2LNI, 512 Broadway, N.Y. 12, N.Y.

ALL MAKES OF ELECTRICAL INSTRUMENTS AND TESTING equipment repaired. Write for free catalogue on new and used instruments at a savings. Hazelton Instrument Co., 128 Liberty Street, New York, N. Y.

TRADIN TV SETS $14, Jones TV, 1115 Ramber, Pottstown, Pa.

TAPE RECORDERS, tapes: Wholesale prices. KARSTAN, 215 E. 88 St., New York 28, N.Y.

WANTED: AN/APR-4, other "APR.", "TS-", "IE-", ARC-1, ARC-3, ART-13, BC-348, etc. Microwave Equipment. Everything Surplus. Special tubes. Tec Manuals. Lab Quality Equipment. Meters. Fast Action. Fair Treatment. Top Dollar! Littell, Fairhills Box 26, Dayton 9, Ohio.

YOUR choice $1.35 postpaid: T49C radiosonde transmitter less tube. 25 assorted mica capacitors. 100 insulated carbon resistors. 10 assorted switches or 20 wirewound resistors. All five for $4.95; bargain list on request. PALMER, 1440 Las Salinas Way, Sacramento 21, Calif.

DIAGRAMS: Professional Model Timers, Counters, Intercoms, Organs, etc. $1.00 each. List free. Parks, 101 S.E. 57th. Portland 15. Oregon.

PRINTING—Letterheads, 6¾ envelopes, statements. 250 for $2.50, Postpaid. POOR BOY RE, Box 1055, Little Rock, Ark.

RADIO, RADAR, TELEVISION instruction leading to Licenses. Port Arthur (Texas) College.

GERMANIUM DIODES, new, large quantities, suitable for crystal set manufacture, etc. Sample 100 package $10.00. DOUGLAS PRICE, Claybrooke Grange, Rugby, England.

RADAR—Correspondence course, including Loran, Sonar, and Mirrowave now being offered. Inquire, Progressive Electronics Institute, P.O. Box 27764, Los Felez Station, Los Angeles 27, Calif.

SPLICES in a wink! NO SCISSORS! NO RAZOR BLADES! with GIBSON GIRL TAPE SPLICERS. Diagonal cuts tape ends and trims splice edges with the "Gibson Girl" shape. Model TS-4 $8.50 list. Model TS-4 Deluxe, $11.50 list. At your dealer or write: ROBINS INDUSTRIES CORP., Dept. RE, 41-08 Bell Blvd., Bayside 61, N. Y.

CODE speed information free. DON ROGERS, Dubois Ave., Ivyland, Pa.

DO-It-Yourself Geiger Counter Kit complete with Meter. Neon Headset. Best 3-range sensitivity. Write SIERRA SCIENTIFIC, Dept. 5, 5415 York Blvd., Los Angeles 42, Calif.

25-50% DISCOUNT, guaranteed. Factory Fresh LP records; 69c and up; pre-recorded tapes. Send 20c for catalogue. SOUTHWEST RECORDS, 1108 Winburn, Houston, Texas.

TAPE RECORDERS WHOLESALE. Free bargain catalog. TOWERS, Box 155, Philadelphia 5, Pa.

TV FM ANTENNAS. ALL TYPES INCLUDING UHF. Mounts, accessories. Lowest prices. Wholesale Supply Co., Lunenburg 2. Mass.

. . . **Richard L. Beam** was elected vice president in charge of engineering for Hazeltine Electronics Corp., Little Neck, N. Y. He was formerly an assistant vice president. **Webster H. Wilson**, also an assistant vice president, was elected vice president in charge of the Government and Commercial Dept.

. . . **Gramer Yarbrough**, sales manager of American Microphone Co., was appointed head of the committee for the 1956 Los Angeles High-Fidelity Music Show.

. . . **R. M. Macrae**, Northeastern region manager of RCA, was appointed vice president in charge of distribution for RCA Victor Co., Ltd., Montreal, Canada. **Raymond W. Saxon**, formerly general sales manager of the RCA Victor Television Division, succeeds him. **Joseph P. Bannon**, field manager of the division, advances to Saxon's former position.

. . . **Raoul Du Chatellier** was promoted to export manager of Sola Electric Co., Chicago. Prior to this appointment he had been assistant export manager.

. . . **Morris Harris** was appointed resident counsel of Allen B. Du Mont Labs., Clifton, N. J. He had been production control manager of the Technical Products Division.

. . . **Wayne Cargile** of Permo, Inc., was named chairman of the Industry Relations and Publicity Committee of the Association of Electronic Parts and Equipment Manufacturers. Other chairmen and their committees include: **Ted Rossman**, Pentron Corp., Industry and Conference Coordinating; **Ernie Necker**, Argos Products, Program; **Norman Ackerman**, Perma-Power, Membership and Attendance; **Robert Reigel**, Chicago Standard Transformer, Educational; **Vic Machin**, Shure Bros., Survey; **Robert E. Jacobsen**, Rauland Corp., Credit, and **Bill Halligan, Jr.**, Hallicrafters, Social.

. . . **Dr. W. R. G. Baker**, General Electric Co., was reappointed chairman of the RETMA Television Committee and the Special Committee on Spurious Radiation. He was also named to head the group appointed to study TV frequency allocation problems. **J. A. Milling** of Howard W. Sams & Co. was reappointed chairman of the RETMA Jobber Relations Committee and **Ellis L. Redden** of Magnavox was named head of Public Relations and Advertising.

. . . **Col. Richard H. Ranger**, Rangertone, was elected president of the Audio Engineering Society.

. . . **Dr. Elmer W. Engstrom**, RCA, received the Progress Medal Award of the Society of Motion Picture and Television Engineers at its recent Convention in Lake Placid, N. Y. Others honored included **Dr. Harry F. Olson**, RCA, the Samuel L. Warner Memorial Award, and **Bernard D. Laughlin** of Hazeltine Corp., the 1955 David Sarnoff Gold Medal Award.

. . . **Gene Gold** joined Granco Products, Long Island City, as merchandising manager. He comes to the company from Audio & Video Products. END

Merchandising and Promotion

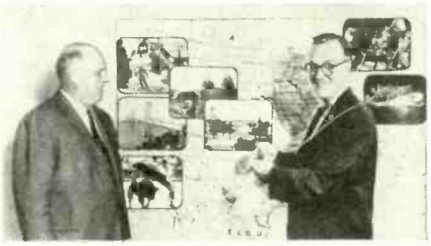
Weller Electric Corp., Easton, Pa., launched a fall and winter promotion on its soldering guns and power sanders. The program includes an advertisement in *Life* magazine, backed by space in hobby and trade magazines including RADIO-ELECTRONICS. The company also designed a display rack for point-of-sale promotion.

Westinghouse Electric is sponsoring a "Don't do it yourself" campaign to discourage TV set owners from doing their own repairs. Commercials on the TV program "Studio One" headline the campaign which is being followed through by direct mail at the dealer level.

International Rectifier Corp., El Segundo, Calif., designed a new *Bonus Pack* containing a pair and a spare pair of its TV replacement rectifiers. A premium, a nylon TV alignment tool, is included in the plan which is being backed up by an extensive direct-mail program.

General Electric, Syracuse, N. Y., has designed a special counter display card for its low-priced transistors for hobbyists.

United Motors Service Division of General Motors, Detroit, is co-sponsoring 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 6,478,351 TV picture tubes and 300,080,000 receiving tubes for the first eight months of 1955. This compares with 5,326,775 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.

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., Telco Electronics, Gee-Lar Manufacturing Co. and Wood Specialty 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 semiconducters 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-Neomatic, 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 Camillus, N. Y.

Telectrosonic 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 8,200,000 sets this year. Other industry leaders including Ross D. Siragusa, Admiral Corp.; John S. Coleman, Burroughs Corp.; Frank Stanton, CBS, and Frank M. Folsom, RCA, predicted 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 were admitted to the association: American Electronics Co., New York; Eltran 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 circuits 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; S. B. Marantz Co.; Fenton Co.; Precision Radiation of California; National Co. and the Grommes Division of Precision Electronics Inc.

. . . **Columbia Wire & Supply Co.**, Chicago, is now backing its 300-ohm *Permaline* 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.

. . . **ORRadio 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. END

1955 ANNUAL INDEX

Vol XXVI RADIO-ELECTRONICS

(Key to abbreviations on pg 156)

ANNUAL INDEX *(Continued)*

ANNUAL INDEX *(Continued)*

KEY TO SYMBOLS AND ABBREVIATIONS

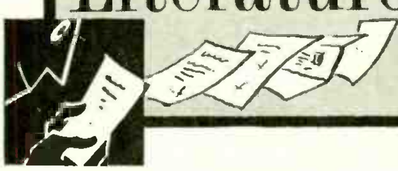
* Construction Articles
† Section of full-length article

Clinic .... Television Clinic
Pat .... Patents
QB .... Question Box
REC .... Radio-Electronic Circuits
RM .... Radio Month
TTO .... Try This One

Items marked as above appeared monthly. Regular departments not indexed are Business, Technician's News, New Devices, People, Technical Literature, Book Reviews. In most entries author's name is included.

END

technical Literature



RECEIVING TUBES

RCA's 20-page booklet *Receiving Type Tubes for Industry and Communication* contains tabular data, tube base diagrams and photographs of special red tubes, premium tubes, pencil tubes and other types for u.h.f. applications; computer tubes, glow-discharge tubes, small thyratrons, low-microphonic amplifier tubes, etc.

Commercial Engineering Department, RCA Tube Div., Harrison, N. J., 20c.

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears.
UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

MASTER TV MANUAL

Blonder-Tongue's 12-page *Master TV Installation Manual* discusses all types of multiple TV systems, industrial TV systems and the proper use of *Masterline* equipment. Illustrated sections cover antenna and line installations, signal distribution, closed-circuit TV, system maintenance and troubleshooting procedures. Simplified charts and tables, with specific examples, show how to calculate signal levels at any point. Amplifiers, converters, tapoffs and accessories are also described.

Blonder-Tongue Labs., Inc., 526–536 North Ave., Westfield, N. J.

Nov. 25

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.

Henry Francis Parks Laboratory, 104 S. E. 57th Ave., Portland 15, Ore.

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

see pg. 155

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 116 TV manufacturers. One page contains a summary of all Stancor exact replacement flybacks.

Chicago Standard Transformer Corp., Addison & Elston, Chicago 18, Ill.

CABINART FOLDERS

Folder 1 contains information on wood cabinets and assembled, ready-to-finish equipment cabinets. *Folder 2* is concerned with Cabinart kits. *Folder 3* details the latest Rebel horns and the new Rebel Ortho speaker systems. *Folder 4* contains a dissertation on wall storage cabinets and cabinet kits and their many uses.

Cabinart, Div. of G & H Wood Products Co., Inc., 99 N. 11 St., Brooklyn 11, N. Y.

CAPACITORS

Capacitors for the Electronics Industry, GED-2620, 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.

Tantalytic capacitors are detailed in *Pamphlet GEA-6258* and specifications given in *Pamphlets GET-2513, GET-2502* and *GET-2333G.*

Capacitor pulse-forming networks are described in *Pamphlet GEA-49962.*

General Electric, Schenectady 5, N. Y.

RESISTORS

The following bulletins 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, insulation, voltage ratings, charts and graphs of type HFR high-frequency resistors.

Bulletin B-2a: gives data on construction, tolerances, power ratings, humidity, adaptability, frequency characteristics, and detailed charts and graphs on MW wirewound resistors.

Bulletin B-8a: ½-watt molded boron-carbon Precistors 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 Resistor Engineering Guide.* Data given includes JAN or MIL equivalents, rated wattages, standard tolerances, temperature rises, 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 Repl Guide and Catalog Form 408* 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., 4427 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; effect of weather on radiation; etc., in layman's terms.

Precision Radiation Instruments, Inc., 4223 W. Jefferson Blvd., Los Angeles 16, Calif. END

Books

SECOND THOUGHTS ON RADIO THEORY, by "Cathode Ray." Published for *Wireless World* by Iliffe & Sons Ltd., London SE 1, England. 6 x 8½ pages, 409 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, "j" 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*

AMPLIFICATION AND DISTRIBUTION OF SOUND, 3d Edition, Revised, by A. E. Greenlees. Chapman & Hall, Ltd., 37 Essex St., London WC2, England. 5½ x 8½ inches, 300 pages. 35 s.

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.

Introductory chapters start with Ohm's law, decibels, power calculation. There is special emphasis on transformers, leakage inductance and capacitance effects at audio frequencies. Feedback, volume expansion and compression and performance measurements are described in the chapters on amplifiers and radio receivers. There are separate chapters on microphones, recording (optical, magnetic, disc) and loudspeakers. Necessarily some of this information is not too detailed, but all the fundamental principles are clearly explained.

Considerable space is given to the installation of sound equipment and the distribution of sound (including impedance matching). After reading these chapters you will know how to match multiple speakers of different impedance and power ratings to a single source, how to arrange speakers and mikes for minimum echo, how to operate, maintain and test audio circuits and components.

Useful wire tables, a chart for matching speakers, filter design, are among the many topics found in the appendix.—*IQ*

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 equipment on frequencies adjacent to amateur bands.

ELECTRONICS FOR YOUNG PEOPLE, by Jeanne Bendick. Whittlesey House, McGraw-Hill Book Co., New York. 189 pages. $2.75.

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.

DICTIONARY OF MECHANICAL ENGINEERING TERMS (7th Edition), by J. G. Horner. Philosophical Library, Inc., New York. 537 pages. $6.50.

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. END

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4	3.50	6.45	11.35	14.35	21.75
6	4.00	7.75	12.85	17.30	29.75
10	5.90	11.45	19.50	24.80	41.35
12	7.25	14.35	22.10	29.75	44.25
20	13.05	25.05	37.25	48.75	78.50
24	14.25	28.75	44.50	57.65	81.00
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4 Amps.........	.07 Hy........	.6 ohm........	7.95
12 Amps.........	.01 Hy........	.1 ohm........	14.95
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Capacity	W. Voltage	Each
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1000 MFD	15 V.	.35

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GT	(6SN7, 6W4, etc.)	1.25
Large GT	(1B3, 6BQ6GT, etc.)	1.50
Large G	(5U4G, 6BG6G, etc.)	2.00

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ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

RADIO SCHOOL DIRECTORY PAGE 161

TROLMASTER

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Now you can completely clean and lubricate volume, tone, brightness and contrast controls without removing chassis or back from cabinet.

Simply remove knob at front of control, screw solvent-loaded TROLMASTER onto control, push the plunger in, remove TROLMASTER, work the control back and forth and the job is done—in 60 seconds or less!

TROLMASTER thoroughly cleans either single or dual controls. Constructed of solid brass, TROLMASTER will not corrode when used with any chemical normally used in the electronics industry. User's Net, **$3.95**

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KT-76 Complete Kit (Less Earphones)........Net 9.95
MS-16 Telephone Pick-Up ....Net 2.95
MS-111 Miniature Crystal Ear Receiver .... Net 1.49
MS-260 New Super Power Dynamic Earphone. Ideal for Transistor Circuits........ Net 3.95

3 TRANSISTOR PUSH-PULL AUDIO AMPLIFIER FOR SPEAKER OPERATION

NOTE: Input impedance 1000 ohms. For high impedance inputs matching transformer is needed (AR-100); for magnetic input use preamp (KT-71)

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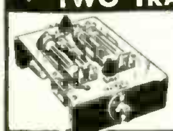
KT-69 Complete with batteries....Net 17.95

TWO TRANSISTOR PREAMP KIT



With the Lafayette KT-71 you can now build a simple Transistor preamp in a matter of hours. The overall result will be a noiseless, humless and virtually distortionless amplifier. The complete unit is mounted on an aluminum chassis size 3"x4"x1". The Kit comes complete with two transistors, condensers, resistors, battery holders, batteries, etc., and schematic diagram.

KT-71 Complete Kit ....Net 8.95

2 TRANSISTOR POCKET RADIO KIT

Packed into a 2½"x3½"x1¼" plastic case. This Two Transistor plus crystal diode radio kit offers many surprises, utilizing a regenerative detector circuit with transformer coupled audio stage, gives you high gain and excellent selectivity. Pulls in distant stations with ease with more than ample earphone volume. Kit comes complete with two transistors, crystal diode, loopstick, Argonne transistor audio transformer, resistors, condensers, plastic case, etc. including schematic and instructions.

KT-68A Complete Kit less earphones. Net 11.80
MS-260 New Super Power Dynamic Earphone, ideal for Transistor Circuit Imp. 8000 ohm, D.C. 2000 ohm 3.95

LAFAYETTE GEIGER COUNTER KIT WITH HIGH SENSITIVITY VICTOREEN TUBE 1B85

Lafayette Geiger Counter Kit with High Sensitivity Victoreen 1B85 tube, makes this one of the most outstanding kit buys in the country. This tube is used only in the most expensive equipment. Easy to build, at only a fraction of the price, of commercial instruments of this type. Just turn it on, flip the high voltage switch and listen to the clicks. Kit includes all parts, tube, carrying case, 22½" and 1½" volt Batteries. Complete instructions for quick assembly. Shpg. wt., 1½ lbs.

KT-75 .... Net 14.95

TRANSISTOR 455 KC I.F.

Specially designed for transistor circuits, only ½" square by ¾" high.
MS-126—
In lots of 10, each 79¢
Single, Each ...... 89¢

RAYTHEON TRANSISTOR

TYPE CK722
P-N-P
99¢

IMPORTED BINOCULARS

All have coated lenses — clamped in prisms — light weight all metal bodies. Complete with case and straps.
Fully guaranteed for 6 mos. against mechanical and optical defects.

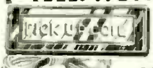
Includes Hard Pigskin case

F-182	— 6x,15	I.F.	NET	10.75
F-105	— 8x,30	I.F.	NET	17.95
F-15	— 7x,35	I.F.	NET	17.95
F-183	— 7x,35	C.F.	NET	20.95
F-184	— 7x,35	C.F. Wide Angle	NET	29.50
F-103	— 7x,50	I.F.	NET	21.50
F-164	— 7x,50	C.F.	NET	24.95
F-117	— 10x,35	C.F.	NET	23.95
F-104	— 12x,50	I.F.	NET	27.95
F-118	— 16x,50	C.F.	NET	31.50
F-185	— 20x,50	C.F.	NET	37.50

MONEY BACK GUARANTEE

Add 10% Fed. Tax to Prices

TELEPHONE PICKUP



FOR RECORDING TELEPHONE CONVERSATIONS

Induction telephone pickup. Telephone conversations can now be picked up with no tapping of wires or special telephone circuits. Simply place the phone base, either cradle or upright type, on the pick-up platform and connect the leads to the high impedance input of any medium gain audio amplifier, or directly to any tape disc or wire recorder.

MS-16........ 2.95

SUPER POWER DYNAMIC EARPHONE

FOR TRANSISTOR CIRCUITS

SPECIAL HIGH OUTPUT FOR LOW POWER CIRCUITS

The answer to the problem of the low output inherent in transistor circuits! You'll be amazed at the difference in volume when you use this new dynamic earphone. Gives up to 3 times the volume of other dynamic earphones. AC impedance 8000 ohms, DC resistance 2000 ohms. Comes complete with 3 ft. detachable plug-in cord.

MS-260 .... 3.95

WEBSTER • GARRARD • COLLARO
3-SPEED—HI-FI RECORD CHANGER

Now Lafayette makes it possible for you to save money on the three most popular makes of 3 speed Record changers.

WEBCOR Diskchanger: It's completely automatic, 33⅓, 45 and 78 RPM, automatic shut off after last Record, balanced tone arm, etc. Size 13⅜ x 12 x 8¼". Shpg. wt., 16 lbs.
Stock No. **PK-49**—With Dual Turnover Cartridge 24.95
Stock No. **PK-46**—With G.E. RPX 050 Triple Play Cartridge 27.95

COLLARO, THE WORLD'S FINEST 3 SPEED INTERMIX CHANGER:
Collaro Model 3/532—3 speed **Intermix** changer designed and engineered to meet the most exacting requirements of the finest audio systems. While our stocks last. Shpg. wt., 23 lbs. with **G.E. RPX—050** Triple play cartridge ....Net 34.50
With **G.E. RPX—052A** Triple play latest **Golden Treasure cartridge with Diamond and Sapphire** styli installed ....Net 44.95
Collaro RC-54: Latest Collaro 3 speed Intermix less cartridge ....Net 47.77
With **G.E. RPX—050** Triple play cartridge ....Net 49.95
With **G.E. RPX—052A** Triple play **Golden Treasure cartridge with Diamond and Sapphire** styli installed ....Net 59.95
Garrard Model RC-80 3 speed Record changer less cartridge ....Net 48.51
Model RC-80 with G.E. RPX—050 Triple play Cartridge........Net 51.95
Model RC-80 with **G.E. RPX—052**—A latest triple play **Golden Treasure cartridge with Diamond and Sapphire** styli installed ....Net 62.53

TOP QUALITY CRYSTAL MICROPHONE

COMPARE IT WITH ANY MIKE AT 2 to 3 TIMES THE PRICE

A quality crystal Microphone for PA systems, house recorders, etc. Frequency response 30 to 10,000 cycles. Output level —52 db. Provides ample output for use with low gain amplifiers. Complete with 5 ft. of shielded cable. Shpg. wt., 3½ lbs.

PA-24 —in lots of 3 3.95 ea.
singly, each 4.25

High Output Dynamic Microphone

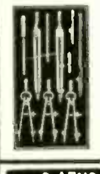
List Price ~~$47.00~~ **$12.95**

High quality Dynamic microphone exceptionally fine for Public address recording, etc. Flat response 60-10,000 cps. Impedance 40,000 ±15% at 1,000 cps. output level —55 db. Die cast metal case equipped with 6 ft. of shielded cable. Shpg. wt., 3 lbs.

PA-19 —in lots of 3... 12.45 ea
singly, each 12.95

PRECISION DRAFTING SET

2.59



11 Pieces — Fitted Felt-Lined Case. Made in Germany, of heavy brass, nickel plated and polished. Instruments include 5⅛" Compass with pencil and pen points and lengthening bar, 5⅛" Divider, three 3¾" sidewheel bow dividers with needle point, pen point and pencil point. 5" Ruling pen, extra handle for pen or pencil, capsule with extra leads. Your money back — if this set is not worth twice our price!

F-13 ....NET 2.59

3 LENS TURRET MICROSCOPE

100X-200X-300X **4.95**

Precision built for accuracy and long lasting service. Triple position turret holds 3 achromatic color-corrected objectives for magnification of 100X, 200X and 300X power! Dual knob focusing. High-grade micro-optics used throughout. Complete with fitted wood carrying case and slides. Shpg. Wt. 4½ lbs.

F-10 ....NET 4.95

TRANSISTOR TYPE 2N107

P-N-P
$1.25

TIMER-SWITCH SALE 3.95

Automatically turns on radio, television sets, toasters, coffee-makers, etc.—at any pre-set time within 12 hour period; also tells time. Requires 3½" diameter round hole. Depth behind dial face 2¼". Shpg. wt. 1½ lbs. MS-62, for 110V/60 Cy AC

Lafayette Greatest Tape Buy Ever!

1200 FT. REEL
HIGH FIDELITY
RECORDING TAPE
Shpg. Wt. 14 oz.

1.69 per roll plus postage
C.O.D.'s accepted

LAFAYETTE made a terrific deal with one of the leading manufacturers of recording tape to supply us with their regular tape which sells for almost twice our price. **WE GUARANTEE ABSOLUTE SATISFACTION OR YOUR MONEY BACK.** The finest, professional-quality recording tape obtainable. Highest performance for thousands of playings. Red Oxide Base in a smooth, uniform coating; greater signal strength; with maximum fidelity; uniform frequency response from 40-15,000 cps.

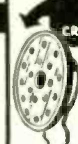
In lots of 10 rolls - 1.59 ea

A new light weight Dynamic Ear Phone.

Fits right into the ear. Excellent sensitivity of 65 db. Ideal for use with miniature sets, hearing aids, transistor pocket radios. DC resistance 2000 ohm, Impedance 5000 ohm with 3 ft. of plastic cord.

MS-72 ....Net **1.95**
MS-100 Impedance 8 ohm for Silent Radio or TV viewing.
Net........ **1.95**

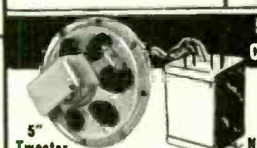
MINIATURE CRYSTAL MICROPHONE



Here's a typical Lafayette special for the experimenter, student or dealer. An extremely sensitive and small crystal microphone used in hearing aids and other small apparatus. Can be used as lapel mike—miniature transmitter mike for concealed locations, etc. Its size and performance gives it joint versatility. Brand new. Size only 1⅜" Diam. x 5/16" deep. Imported to save you money.

MS-108 ....Net **1.95**

5" Tweeter AND Crossover Network



5" Tweeter

Network

7.95

A specially designed 5" Tweeter and Crossover Network that will assure high frequency response when used with any speaker you now possess. You can now make your present speaker into a 2-way speaker system increasing the high frequency range up to 15,000 cycles. Diagram included. Shpg. Wt. 5 lbs.

STOCK NO. SY-14........................Net 7.95

DUAL STYLUS — TRIPLE PLAY

11.95

DIAMOND and SAPPHIRE
(LP) (78)
LIST ~~$31.00~~
Replacement for All G.E. RPX-050 Triple-Play Cartridges!
Stock No. PK-29 Net 11.95

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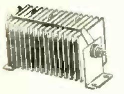
Include postage with order.

"TAB" THAT'S A BUY

NEW "TABTRON" SELENIUM BRIDGE RECTIFIERS
Dated



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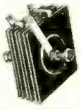
We mfg. Power Rectifiers to your specs. From 1 Amp up to and above 1000 Amps. Following list. Full Wave Bridge.

	18/14 Volts	36/28 Volts	52/42 Volts	130/100 Volts
1AMP	$1.60	$2.70	$4.30	$9.45
2AMP	2.40	3.40	6.15	11.50
3AMP	3.45	4.75	6.70	14.65
4AMP	4.25	8.45	13.05	28.45
6AMP	5.10	10.05	14.75	36.80
10AMP	7.50	14.35	22.40	47.55
12AMP	9.20	18.10	25.40	50.85
20AMP	15.00	28.80	42.80	90.25
24AMP	18.40	36.74	51.15	97.75
30AMP	22.70	38.50	64.95	125.35
36AMP	28.45	54.60	74.75	154.10
50AMP	33.90	62.50	115.95	200.10

SELENIUM IS WORTH $$
RETURN YOUR OLD DUD RECTIFIER
DEDUCT 5% FROM PRICE

TABTRON

HEAVY DUTY BATTERY "FAST" Charger Rectifier



13-0-13V(CT) 100 Amp Fan Cooled or 34 Amp Air Cooled—Repl'mt 6V Booster Charger. Model CR16.........$12
16-0-16V (CT) Fan Cooled. For 12V/60A and 6V/100A Booster Chargers. Model CR30.........$14

NEW HIGH CURRENT POWER SUPPLIES—ONE YEAR GTD

Variable 0-28VDC. Completely Built. Full Wave Selenium Rectifier, Transformer, Variac, Volt & Amp Meters, Switch, Terminals & Fuse. Housed In Heavy Duty Steel Cabinet. 115V/60cy Input. 110 or 220V† and 3 phase to order. Specify

Stk No	Cont. Rating	W-Meters
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T28V24A†	0-28 VDC at 24 Amp	$155
T28V50A†	0-28 VDC at 50 Amp	$285
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Write For New "TABTRON" Rectifier & Power Supply Catalog PR156

230 to 115V Autoformers

For 220-240 V/50-60 cy in. To 110-120 v or step-up.† w/ Cord, Plug & Receptacle.
TPA050/50W*.........$2.55
TPA075/75W†.........$3.65
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TPA200/200W†.........$5.75
TPA250/250W†.........$6.75
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Model TPA1000/1000W/1KW†.........$16.95
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$100 Order Take 10% Disc. *Less C. P&R

New Variable Voltage Xfmrs
Superior—Gr—Staco—Utc

0-132V 1.25 A.........$ 7.65
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Uncased 0-135V 7.5A......... 20.70
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New "TABTRAN" Rectifier Chokes
CR6001/1AMP/0.1HY/1.4R...$4.50; 2/$8
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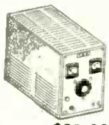
CR6003/5AMP/.07HY/.6R...$7.90; 2/$15
CR6004/12AMP/0.1HY/.1R..$14.50;2/$28
CR6005/24A/.004HY/.025R $29.50;2/$58

New Variable 0 to 6 & 12 Volt/12A DC Power Supply



Battery Eliminator, Charger, Model RR, Plater, Aircraft, Marine or any DC Req. Extra Hvy Dty Selenium Rectifier. 2 Meters V & A. Designed for Cont. Service & up to 20 Amps intermittent overload.
New Model T612V12AC......$33.00

New "TABTRAN" Rectifier Xfmrs
Sec Volts (Dual†) 18-15-9-0:0-9-15-18V
Primary 115V 60 Cyc

5 Amp†.....$8.65 2/$15.75
12 Amp†..$16.50; 2/$32.00
24 Amp†..$35.50; 2/$70.00
50 Amps*...$58.50; 2/$115
100 Amp*...$107.00; 2/$210
18 Volt, 2 Amps..$1.98; 2/3.50
†Wndgs in Series at ratings shown; Parallel 2xAmps, Voltage ½ max.* Dual Pri 115 & 220V 60 cy; Tapped 36VCT

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CE156M 6000 MFD 15V 98c; 2/$1.50; 10/$5
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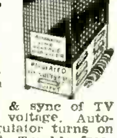
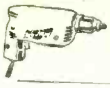
NEW! Quality VOLTAGE REGULATOR
$ $ Popularly Priced $ $
ONLY $16.98



LINE VOLTAGE STABILIZER
Stabilizes line voltage within plus or minus 3% on VOLTAGE & FREQ. shift. Insures full size, strength, & sync of TV picture regardless of line voltage. Automatically operated . . . regulator turns on & off with set or equipment. Trouble free, quiet, needs no adjustment. Universal use from 100 to 300 Watts. Input 100-125V/Output 115V ± 3% 50-60 cy.
SOLD WITH "TAB" MONEY BACK GTD. Order Six and Take 10% Discount

THOR ELECTRIC DRILLS



201J ¼" Electric Speed Drill w/Jacobs Chuck. 2400 RPM/115VAC . . . "TAB" @ $14.95
325 ⅜" Electric Speed Drill w/geared chuck. 1000 RPM/115 VAC.........Only $23.25
400 @ ½" J chuck....$28.95

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60 pcs #1 to 60 C.V....$5.95
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13 pcs set 1/64" to ¼" with Index.........$1.98
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NEW "LUGER" SOLDERING GUN

BEST balanced 180 Watts heat at your fingertips. For fine or heavy duty soldering. Non-corroding alloy, long & short tips, prefocused twin lights, rugged construction.
120V AC/60 cycles Input
Model DB-1 Single 180 Watt.........$6.95
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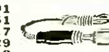
Esico Soldering Irons 115 VAC-DC



60W ¼" Tip.....$1.91
100W ⅜" Tip.....$2.51
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300W† ⅞" Tip....$8.18
†Industrial Constant Use 120 V AC-DC

Thor Bench Speed Grinder

Model 117—3450 RPM. 115 VAC motor; 2 wheels 4½"x⅜"x⅜"; (1-60 grit, 1-120 grit) Self-aligning, oilless 1 pc. Aluminum Body. Precision mfg. Special only $12.39.

TUBES
• 1st Quality •

0A2	.70	6AF6	1.18	6X5	.45
0A3	.90	6AG5	.45	6Z7	2.11
0B2	.60	6AG7	1.14	7A4	.78
0B3	.80	6AH6	.85	7A8	.65
0C3	.80	6AK5	.60	7AD7	1.41
0D3	.75	6AK6	.70	7B6	.70
0Z4	.45	6AL5	.40	7B8	.80
1A5GT	.60	6AL7	1.22	7C4	.26
1A7GT	.90	6AQ5	.45	7C7	.68
1AD4	3.95	6AQ6	.50	7E6	.70
1AE4	3.75	6AR6	2.74	7E7	.70
1AH4	1.07	6AS6	1.60	7F7	.75
1AX2	1.25	6AS7	3.48	7F8	1.18
1B3	.65	6AT6	.40	7H7	.70
1C6	.49	6AU6	.45	7N7	.85
1D8GT	.89	6AV5	.80	7S7	1.29
1E5	.65	6AV6	.45	7V7	1.06
1E7	.49	6AX4	.80	7X6	.85
1G4GT	.69	6B4	1.12	7Y4	.64
1G5	.69	6B5	1.18	10	.49
1G6GT	.70	6B7	.91	12A6	.45
1H4G	.45	6B8	.64	12A8	.75
1H5GT	.70	6BA6	.45	12AH7	.90
1H6	.65	6BD6	.70	12AL5	.50
1J6G	.75	6BE6	.45	12AT6	.40
1L4	.40	6BG6	1.24	12AT7	.65
1LA4	1.01	6BH6	.50	12AU7	.50
1LB4	1.09	6BJ6	.65	12AV6	.35
1LC6	.65	6BK7A	1.11	12AW6	.80
1LD5	.90	6BL7	.90	12AX7	.55
1LE3	.90	6BN6	1.19	12AY7	.65
1LH4	1.09	6BQ6	.90	12BA6	.50
1LN5	.65	6C4	.35	12BA7	.90
1P5	.78	6C5	.65	12BE6	.60
1Q5	1.19	6C8	.82	12BH7	.65
1R4	[illegible]	6CB6	.50	12C8	.60
1R5	.50	6CD6	1.08	12H6	.45
1S4	.85	6D6	.80	12J5	.45
1S5	.40	6D8	.80	12K8	.45

"TAB" TESTED GUARANTEED

1T4	.50	6E5	1.09	12SC7	.78
1T5	.90	6F6	.75	12SF7	.78
1U4	.45	6F8	.85	12SH7	.60
1U5	.45	6G6	.90	12SJ7	.50
1V2	.60	6H6	.60	12SK7	.45
1X2A	.60	6J4	4.59	12SL7	.56
2A4	2.37	6J5	.40	12SQ7	.50
2A5	.75	6J6	.45	12SR7	.45
2A6	1.49	6J7	.70	12Z3	.85
2A7	.89	6K6	.45	14A7	.85
2B7	.89	6K7	.45	19BG6	1.38
2E5	.92	6L5	1.09	19T8	1.49
2V3	2.90	6L6	.90	19V8	1.96
2X2A	1.15	6L7	.75	24A	.90
3A4	.48	6N7	.75	25A6	1.79
3B4	2.70	6P5	.99	25BQ6	.90
3B7	.56	6Q7	.81	25L6	.42
3Q4	.45	6R8	7.44	25Y5	.80
3Q5	.65	6S4	.45	26	.79
3S4	.45	6S7	1.30	28D7	1.29
3V4	.75	6S8	.92	34	.69
5AX4	1.22	6SA7	.50	35A5	.70
5AZ4	.96	6SC7	.70	35B5	.54
5R4GY	.96	6SF7	.70	35C5	.70
5T4	1.48	6SG7	.60	35Y4	.68
5U4G	.65	6SH7	.40	35Z3	.69
5V4	1.28	6SJ7	.65	35Z5	.45
5X4G	.75	6SK7	.50	39/44	.56
5Y3	.65	6SL7	.55	45Z3	.66
5Y4	.60	6SN7	.55	49	1.29
6A3	1.29	6SQ7	.55	50A5	.50
6A5	2.98	6SS7	.85	50C5	.52
6A6	.81	6T7	1.27	50L6	.55
6A7	1.09	6T8	.75	71A	.70
6A8GT	1.09	6U5	.90	75	.85
6AB4	.40	6U7	.60	76	.65
6AB7	.78	6V6GT	.55	77	.65
6AC5	1.19	6W4	.35	83V	1.22
6AC7	.65	6X4	.40	117Z3	.65

TRANSFORMERS

All 115 V 60 Cyc Input TV, & CR pwr Xmfr up to 20" tubes. Hi VOLTS to 20KV (w/quadrupler ckt.) ALL tubes, PL & FIL wndgs, 5000 VDC/5MA, 300 VDC/275 Ma Full-Wave, 6.4V/10.3A,5.4V/8A,2.5V/3A Hypersil Core, Oil Fill $4.98; 2 for $8.50; 6 for $22.00
2500V/20MA, 6.3V/.6A, 2.5V/1.75A for BC412 Scope Replmt.........$7.98
900V/35MA 2X2.5V/2A, XCLENT 1800V DBLR TWO 2X2 FIL WNDGS.........$1.98
778VCS/200MA, 5V/3A, 6.3VCT/5A $4.25
770V/2.5MA, 2.5V/3A, HVINS HMSLD includes FILTER PARTS, 4/scope.......$3.69

NEW MINIATURE METER
O-1 Milliamp

Precision Jeweled D'Arsonval Mvt. Better than 2% accy. Readable Long 1⅛" scale. 20 divisions, rugged, well damped bakelite cased, front sq. or rear round face mtg. Mounts 1½" hole, 4 screws, 1¼" ctrs. Not surplus. "TAB" $3.85; 2/$7
Data sheet for shunt current ranges.

PRECISION RESISTORS

W.E. — IRC — Wilkor
1% Accuracy Gtd.
10 of One Value......10c ea.
100 of One Value.........$8.00
10 Ass't'd Values.........$1.50
Write for Complete Listing

TERRIFIC OFFER!!
Sylvania Crystal Diodes

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"TAB" SPECIAL $1.25 ea. 9 for $10, 100 for $100
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NEW 212W/SEC PHOTOFLASH AC & Dry Battery Kit

Includes four-525 MFD/450V Condensers. Total 212W Secds. Resistors, capacitors, rectifier, flash tube in indicating flash gun, guide = 80 Daylight Kodachrome, 240 on Ektachrome. Less Batteries. "TAB" Special AC only.........@ $44.98
(5) 90V (N60) Batteries & Box @ $14.98
525MFD/450V/53W'Scds Cond. new low leakage famous mfr. $8; 2/$15.
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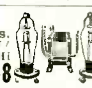
Trigger Coil for LO Volt Flash $1.47

866A KIT & XFMR



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"TAB" 60 **$21.95** Lots of 3
(Not A Kit)
A complete precision test instrument. 20,000 Ohms per Volt DC-10,000 Ohms p/v AC. 38 micro ampere movement, 8 easy to read scales: DC 0-6, 30, 120, 600, 1200, 6000 Volts. AC 0-6, 30, 120, 600, 1200 Volts. Current 0-60 ua, 6, 60, 600 ma. Resistance 0-8K, 80K, 800K, 8 megohms. Decibels Cal 600 ohm —20 to +6, 20, 34, 46, 60 DBS. Capacity 250 uufd to 10 mfd. Inductance 10 to 1000 millhys. Hi accuracy, versatile 1% Precision Resistors. Scale 3". Plastic engraved panel. Rugged metal case. Lgth. 4¼" x 6¼" x 2¾". Complete w/batteries & leads, RF Diode Probe included, for signal measurement. Shpg. wt. 4 lbs.
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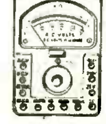
HV 30,000 Volt Probe. Special $5.95 ea.

Pocket AC-DC MULTITESTER "TAB" 27C
$7.85 ea.



Hi-accuracy precision VOM 1000 Ohms per V. Reads AC & DC Volts 0, 5, 25, 250, 1000 V DCMA: 0, 1, 10, 100 MA. Ohms 0, 10, 100 K, Size 1¼" D, 4⅝" L, 3¼" W. Test Leads (plus 40c ship in U.S.A.)

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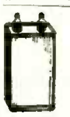

4 MFD 1200 VDC or 10 MFD 600 VDC **$1.25** LOTS OF 12
Or any Assortment of 12
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(as illustrated)

The 10 Way Wrench with 1001 Uses!
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COMPLETE LINE OF HI-FI
Speakers, Tuners, Amplifiers, Record Changers & Components
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Replc'ment Needles "TETRAD" Diamond†
RPJ010A Dual (S) .001 & .003 GE...$1.98
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Replc'mts for New A Cartridge Only
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RPJ01S or RPJ03S Single (S).........$1.35
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Complete Stock of Replc'mnt Needles
Send Cartridge Name and Number
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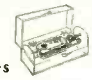
$1.55 ea. LOTS OF 6



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95% OF ALL 78 RPM'S
Sold Singly.........$1.65 ea.

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Finest, $, $, $, Back Gtd

PRECISION COATED & SLIT, Gtd Splice free. Quality Controlled. Plastic Base. Gtd Constant Output. Freq. 7½ IPS 40-15KC Oxide Wnd In 7½" reel; 1200 ft. per reel
Sold Singly **$1.80** Twelve Lot Special **$1.58 ea.**

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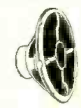

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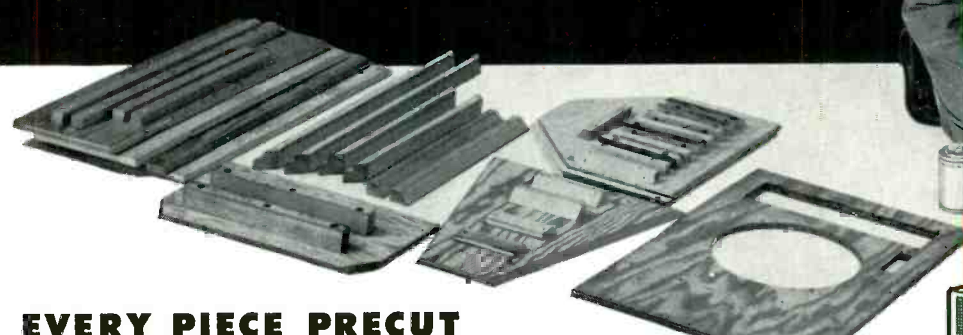

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THE ARISTOCRAT KIT. Folded-horn corner enclosure designed for 12-in. speakers and separate 2 and 3-way systems. For use with Electro-Voice SP12 or SP12B coaxial speakers, 12TRX or 12TRXB triaxial reproducers, and 108, 111 2-way and 108A, 111A 3-way systems. Smooth reproduction down to 35 cps, with remarkable purity and efficiency. Finished size: 29⅝ in. high, 19 in. wide, 15¾ in. deep. Shpg. wt. 37 lb.
Model KD6 Net, $36.00

THE BARONET KIT. Phenomenal reproducer for such small size. This folded-horn corner enclosure is designed for use with E-V Model SP8B 8-in. Radax speaker. E-V T35 or T35B Super Sonax UHF driver can be added for a separate two-way system. Finished size: 23 in. high, 14 in. wide, 13 in. deep. Shpg. wt. 24 lb.
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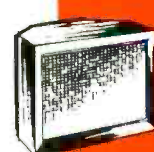
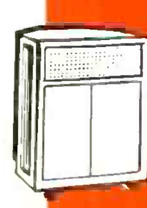


THE EMPIRE KIT. Economical, folded-horn enclosure for use in a corner or flat against one wall. Designed for 15-in. speakers and separate 2 and 3-way systems. Particularly effective when used with SP15B coaxial speaker, 15TRXB triaxial reproducer, or 116 2-way or 116A 3-way system. Recommended components for Regency kit may also be employed. Finished size: 29⅝ in. high, 32 in. wide, 16 in. deep. Shpg. wt. 45 lb.
Model KD5 Net, $48.00

THE REGENCY KIT. Most popular lowboy style folded-horn enclosure that can be used in corner or flat against one wall. Improves the bass range and response of any 15-in. speaker. Makes an outstandingly efficient reproducer when used with E-V SP15 coaxial speaker, 15TRX triaxial reproducer or 114A 2-way or 114B 3-way system. Finished size: 29⅝ in. high, 33½ in. wide, 19 in. deep. Shpg. wt. 70 lb.
Model KD4 Net, $69.00

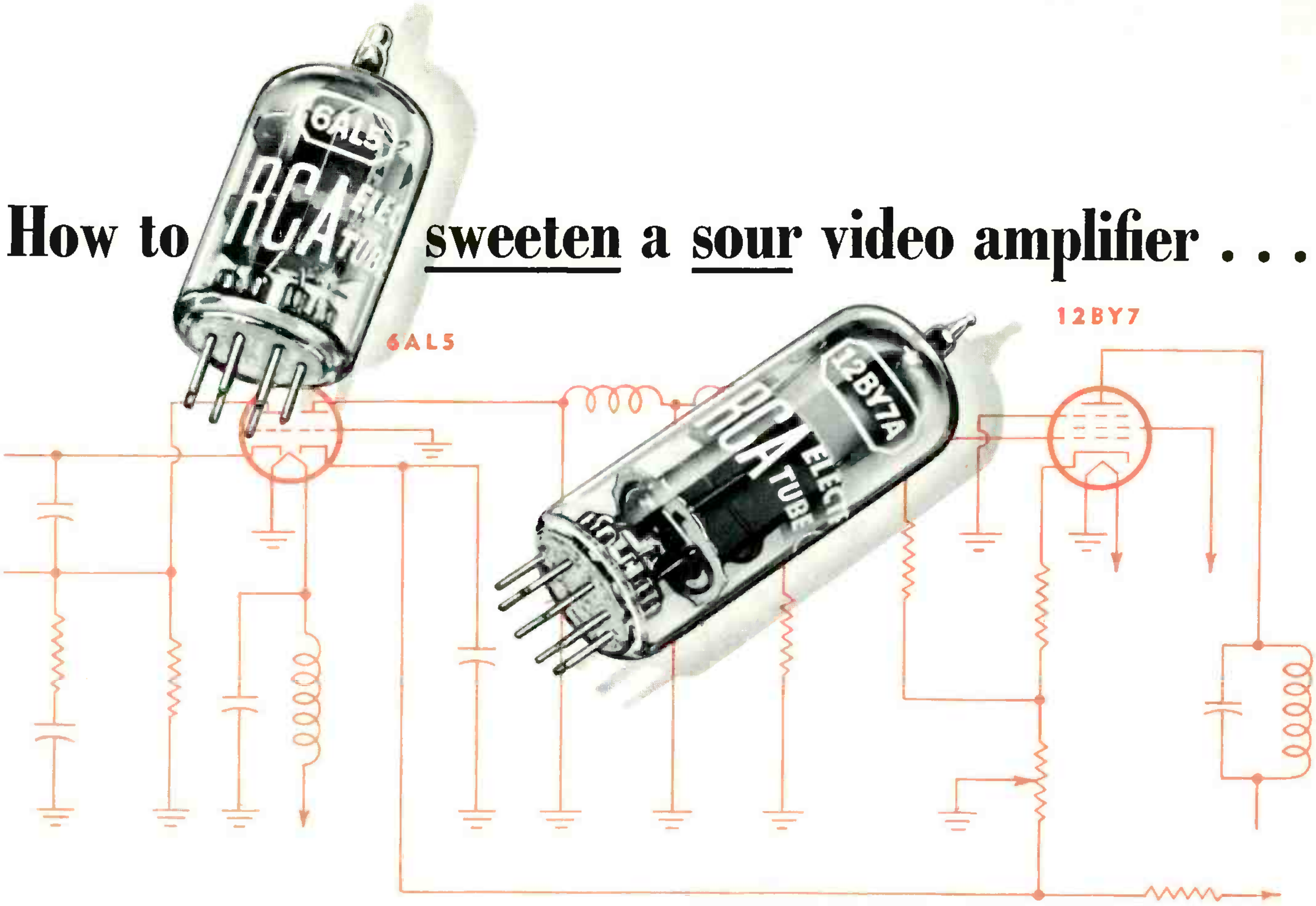
THE PATRICIAN IV KIT. An interior assembly kit for those desiring the finest. This augmented design of the Klipsch corner folded-horn bass section delivers an added full octave of bass. Designed for use with E-V Model 103C Patrician IV four-way driver components. For built-in installations or to be decorated as you choose. Finished size: 57½ in. high, 34½ in. wide, 26⅞ in. deep. Shpg. wt. 150 lb.
Model KD1 Net, $99.00

THE GEORGIAN KIT. An interior assembly kit that creates authentic Klipsch indirect radiator type corner folded-horn bass section for 15 in. 4-way speaker system. Exceeded in range only by the Patrician IV. For use with E-V Model 105 or Model 117 package of 4-way driver components. For built-in installations or to be decorated as you choose. Finished size: 38½ in. high, 26¾ in. wide, 22½ in. deep. Shpg. wt. 88 lb.
Model KD2 Net $58.00



THE CENTURION KIT. Four-way system folded-horn, corner enclosure. Uses exclusive E-V "W" type single-path indirect radiator for propagation of extended bass. Sealed cavity behind 15 in. low-frequency driver cone promotes superlative transient response, subdues cone excursions, lowers distortion. For use with E-V Model 105 or Model 117 package of driver components. Finished size: 42⅛ in. high, 29 in. wide, 22½ in. deep. Shpg. wt. 75 lb.
Model KD3 Net, $79.00

How to sweeten a sour video amplifier . . .



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