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JUNE, 1961

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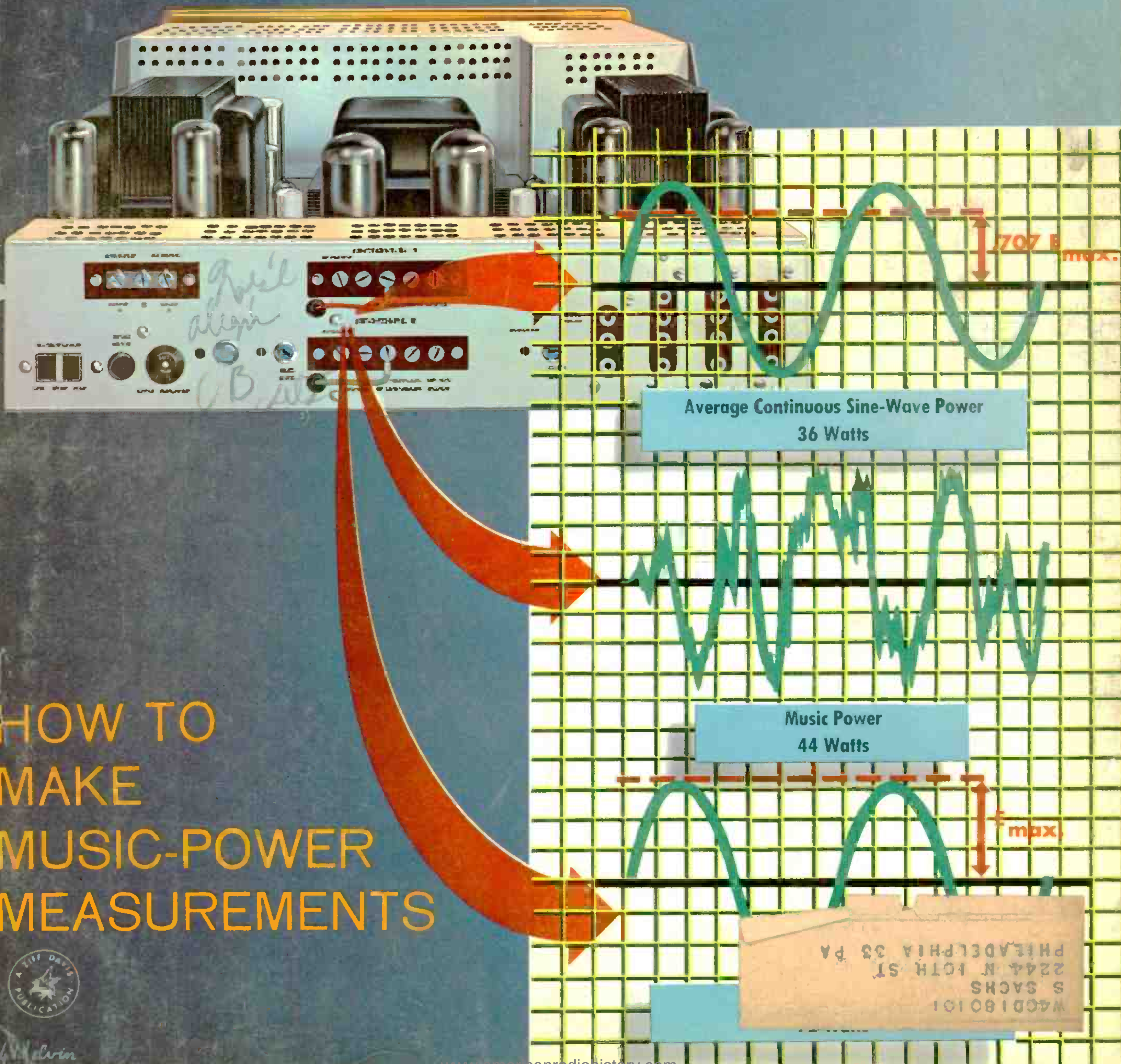

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JUNE, 1961

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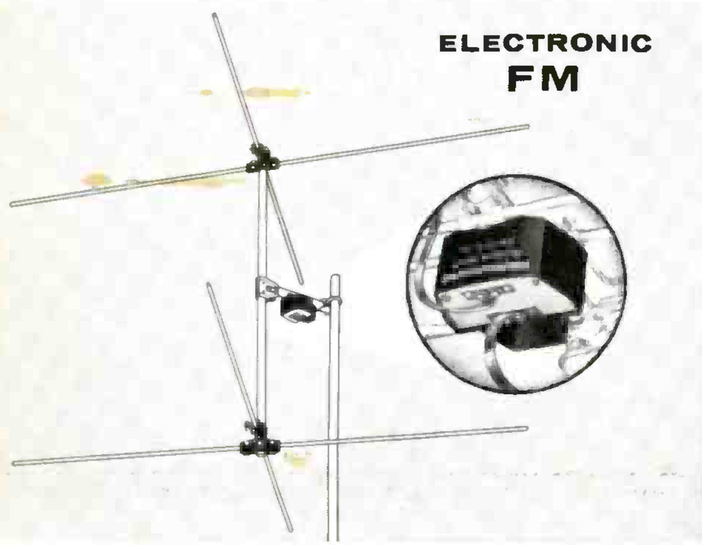


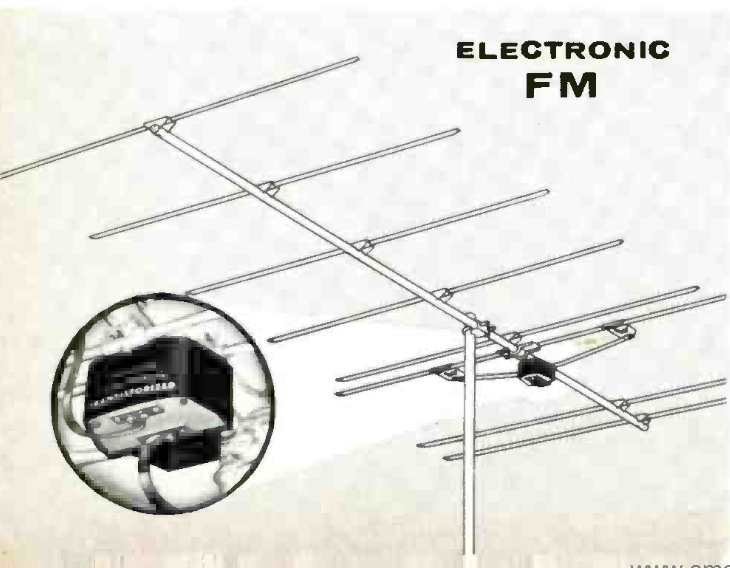
MODEL PF-T FM POWERTRON TURNSTILE Non-directional FM antenna with 16 DB gain in all directions over a folded dipole. Has unique offset mount and comes complete with built-in transistorized amplifier and TV-FM coupler.

NEW, POWERFUL TRANSISTORIZED FM POWERTRONS WITH FM-TV COUPLERS

For the first time, FM antennas with built-in transistorized amplifiers are available for long range FM reception. Winegard offers two models—FM Powertron Turnstile (omnidirectional) and the FM Powertron Yagi (directional). Both models have two 300 ohm terminals on the amplifier: one for down-lead connection to the set and one for connection to a TV Powertron antenna.

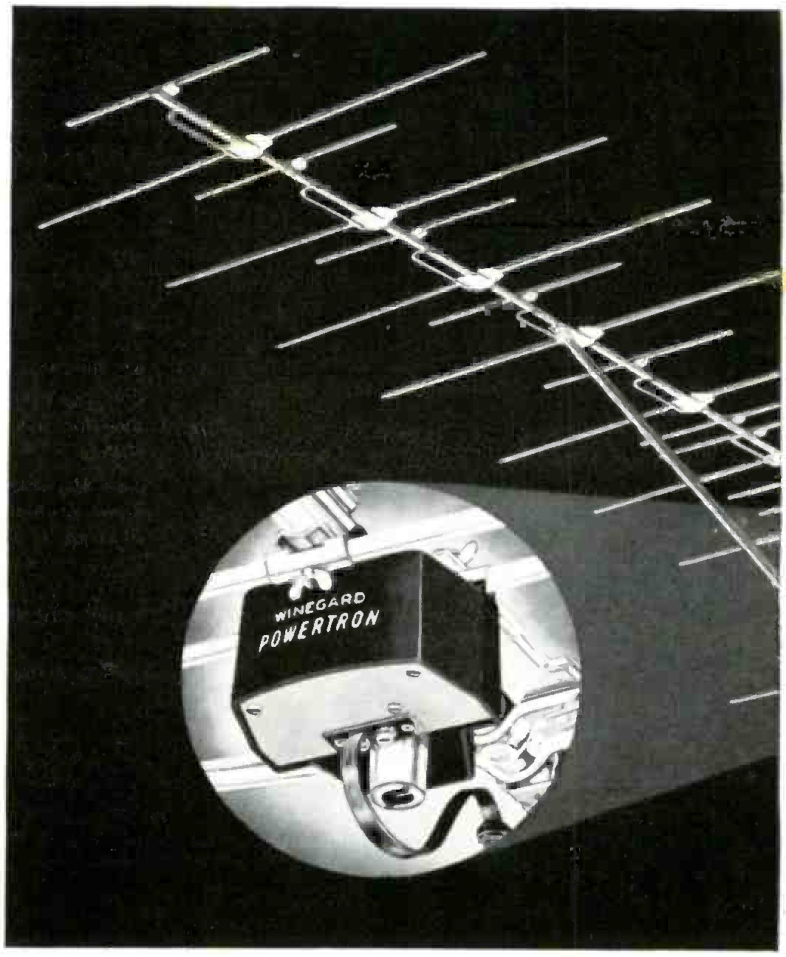
MODEL PF-8 FM POWERTRON YAGI This is the world's most powerful FM antenna. Makes weak signals come in like "locals". Has 25 DB gain over folded dipole. Eight elements with exclusive Winegard "tapered T" driven element. Built-in TV-FM coupler allows you to couple into TV Powertron with only one power supply. Complete with built-in transistorized amplifier.

ELECTRONIC
FM



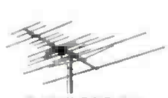
In addition to three all-channel (VHF) Powertron antennas, Winegard now offers you 14 cut-channel and broad band Powertron yagis and two FM Powertrons. Each of these high gain antennas has the following important features:

1. Electronic amplifier for unprecedented antenna gain.
2. Amplifier connected *directly* to the yagi "Tapered-T" driven elements for best possible signal-to-noise ratio.
3. Linear frequency response for crisp, clear black and white and brilliant, true color reception.

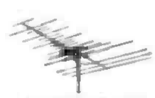


ELECTRONIC ALL-CHANNEL YAGIS

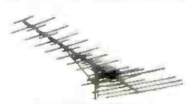
. . . will greatly improve every channel. Weak, faded pictures become crisp and clear. "Good" channels will be even better. In many areas you'll watch channels you couldn't possibly see before. Because Powertrons are powerful enough to drive up to 10 TV sets, you can have plug-in outlets in every room . . . and in many locations you can install a Powertron lower than other antennas.



POWERTRON MODEL P-44
14-Elements



POWERTRON MODEL P-44X
21-Elements



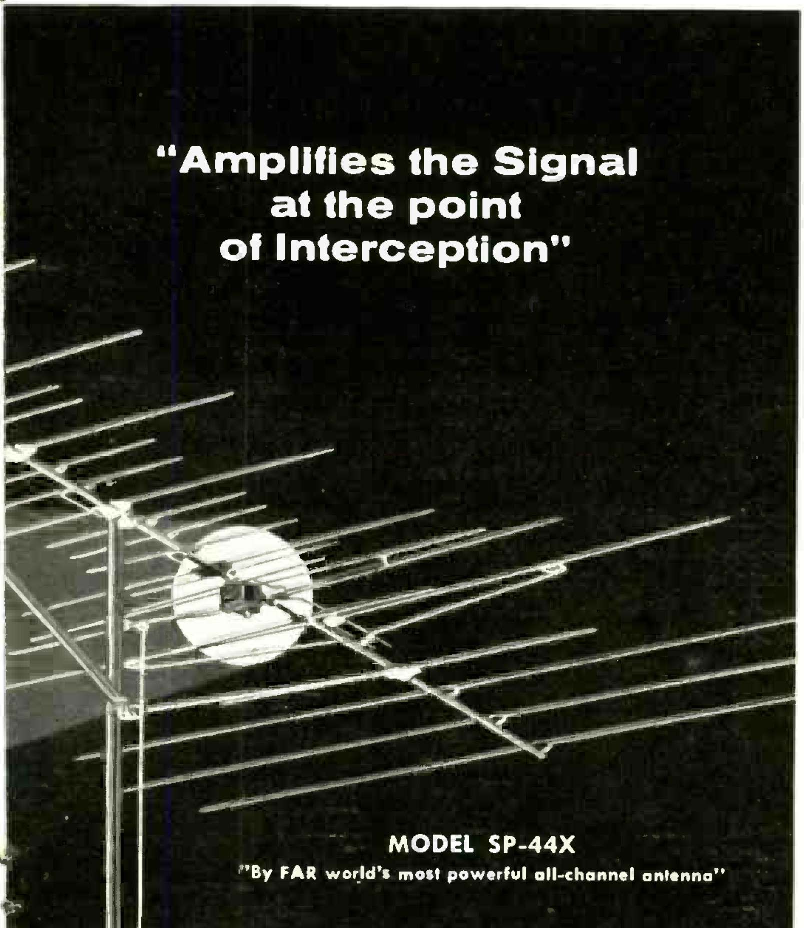
POWERTRON MODEL SP-44X
30-Elements

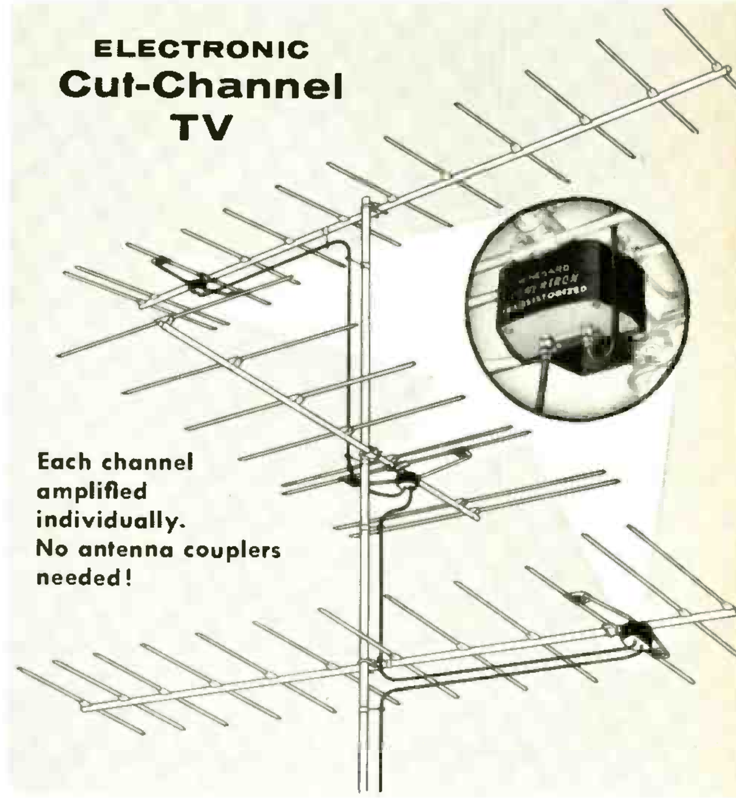
Winegard Electronic Antennas

contrast...gives you greater reception distance!

4. Gold Anodized finish for permanent corrosion protection and fine appearance.
5. Deluxe quality materials and workmanship.

Try a Powertron and see for yourself. Take a field strength meter reading with your present antenna and then take a Powertron reading. When you see the meter jump 5 to 10 times . . . and see the sharp, contrasty reception you get, you'll be convinced . . . and so will your customers.





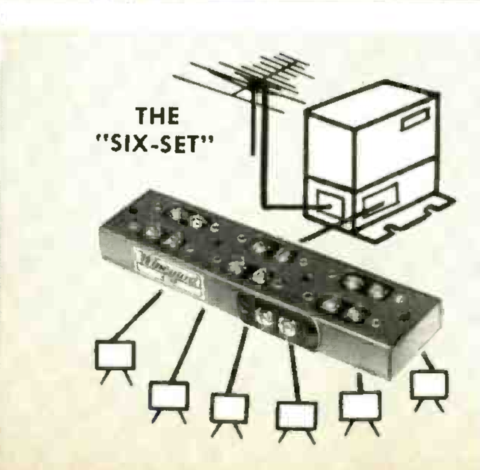
NEW, TRANSISTORIZED CUT-CHANNEL YAGI POWERTRONS FOR THE FINEST INSTALLATIONS

Here are the highest gain (28 db) TV antennas ever made! Each is powered by a *built-in transistorized* amplifier. Because TV signals are amplified right at the point of interception, you get the best possible signal-to-noise ratio . . . resulting in the ultimate in reception!

Each Powertron yagi amplifier has two 75 ohm coaxial connectors: one for the down-lead to the power supply and one from the built-in coupler for connection to another Powertron yagi.

Because of the built-in mixing coupler, they can be connected directly to each other without interaction. The negligible power consumption of these transistorized antennas (.05 watt each) means you can tie as many as 8 Powertron yagis together and run them all from one power supply on one down-lead.

There are six (8-element) cut-channel and broad low band models —eight (12-element) cut-channel and broad high band models. Ideal for hotels, motels, apartment buildings or wherever the finest installation is needed.



WINEGARD "SIX-SET" TV COUPLER

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. . . for the Record

By **W. A. STOCKLIN**
Editor

Los Angeles Hi-Fi Show

ALMOST as far back as we can remember, some of our staff have covered the major hi-fi shows across the country. We have seen shows in Los Angeles, San Francisco, Chicago, Toronto, Ottawa, New York, and Washington. In recent years, we've confined our efforts to the two major shows presented by the Institute of High Fidelity Manufacturers Inc.—either in Los Angeles or San Francisco in the Spring and in New York in the Fall.

We have just returned from the recent Los Angeles Show and it was one of the most interesting and informative presentations we have witnessed in many years. It was held in a group of small cottages on a 27-acre plot on the Ambassador Hotel grounds. The setting was ideal in that the cottages were considerably separated, eliminating the problem of the sound from one exhibitor interfering with another. It was relaxing in that there was no hustle and bustle because of the spaciousness of the grounds.

There were 68 exhibitors. If one were to spend four minutes in each exhibit, it would have taken approximately 4½ hours to see the complete show. The attendance was good; approximately 30,000 highly interested, intelligent individuals viewed the displays. No longer were we asked the question of whether "hi-fi or stereo is better."

One of the most discussed topics among the various manufacturers and the press was the status of FM multiplex. The FCC has been field-testing a number of FM multiplex systems, and all of us in the industry expected a final choice early this year. There is some disappointment that an announcement has not been made as yet. There is a feeling that an FCC decision has been made, but the announcement is being withheld until standards for broadcasting are completed. The feeling is that the decision will favor the system proposed by *General Electric* or *Zenith*, or a combination of the two. Both of these systems are similar. The industry, of course, is not asleep in that a lot of design work is being done at the present time and multiplex adapter units should be on the market shortly after the FCC choice is announced.

All of the hi-fi manufacturers had some new products on display. These were either new designs replacing older models or new products added to round out their lines of equipment. On all the new items we saw, it was a pleasure to note the advances made in cabinet styling and improved electronic performance providing better hi-fi reproduction.

Many of the kit manufacturers are becoming aware that some of their cabinet and panel designs are no longer attractive to the buyer. They are making great strides in improving appearance so that, in many cases, a kit no longer looks like a kit.

Another point one became aware of is that power ratings on integrated stereo units are getting higher and higher. In the early days of monophonic sound reproduction, we had low-power amplifiers and, as time went on, the power ratings on amplifiers increased steadily. Integrated amplifiers have also had their powers boosted so that now we have 60 to 70 watts per channel.

There were some items displayed that particularly attracted our attention. The *Harman-Kardon* "Citation" speaker systems, designed by Stu Hegeman, produced a good stereo effect throughout the entire room. This was no doubt due to the omnidirectional radiation from the vertically directed speakers. *Rek-O-Kut* also showed a new speaker system in a cabinet approximately 2 feet wide, 30 inches high, and a mere 4 inches deep. The sound was radiated equally from the front and rear. The sound is projected against the walls of the room and produces a somewhat omnidirectional pattern that gives a good stereo spread.

Transistors are beginning to appear in hi-fi equipment. *Transi-Tronics* displayed an all-transistor amplifier and tuner. The amplifier was of moderately low power but, in time, transistor circuits will have higher power outputs with good quality.

Superscope, marketing *Sony* products, displayed a new tape machine with a completely transistorized preamp and *Weathers* also featured a transistor preamp for their phono cartridge.

There were a good many other impressive products, too numerous to mention, that were of interest to us. All in all, it was a terrific show and congratulations are in order to the Institute of High-Fidelity Manufacturers Inc. for their presentation.—30—

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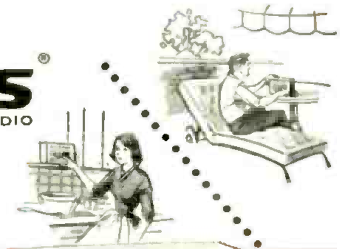

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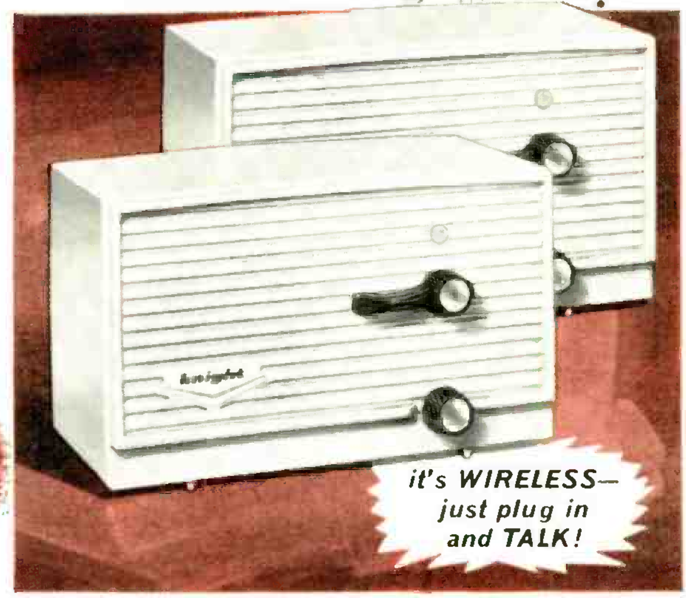

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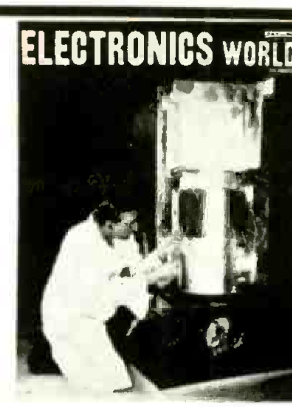

COMING NEXT MONTH

ELECTRONIC AIR PURIFIERS
Just how good are the "electronic" air purifiers being sold in supermarkets, drugstores, and appliance shops? Do they do the job for the allergic person? Here is a careful survey of their advantages and drawbacks as well as details on available electronic systems.

BREAKTHROUGH IN THERMOELECTRICITY
This important new method of energy conversion promises increasingly widespread applications for power generation and for heating and refrigeration in the home. A leading research engineer brings you up to date on the status of the art.

DON'T WASTE YOUR CB POWER
Your CB transceiver must be properly matched to its antenna for maximum range. Here is how to avoid power-wasting installations. Standing waves, their causes and cures, are thoroughly explained in this useful article for the Citizens Band operator.

HUM ELIMINATION IN OSCILLOSCOPES
Problems in interpreting and measuring waveforms that are modulated by hum are clearly presented, along with the techniques that may be used in eliminating or reducing this extraneous signal.

AUTOMATIC HEADLIGHT DIMMER
An inexpensive accessory for your car. It dims your headlights automatically upon the approach of another car—but is so designed that the circuit may be overridden by the driver in case of emergencies.

SIMPLE SQUARE-WAVE GENERATOR
An easy-to-build test unit for the service technician. Two resistors, a tube, and transformer are all the parts required.

ECONOMY HI-FI AMPLIFIER
Build this simple, inexpensive 10-watt monophonic amplifier and phono preamp for use with any high-efficiency speaker system.

SHOCKPROOF SUSPENSION SYSTEM
If your cartridge does a jig every time someone walks across the living room floor, here is a simple, inexpensive mechanical suspension system that will cushion such household shocks as well as vibrations from traffic.

ADD A.F.C. TO TV SETS
Build this small and simple adapter which can be mounted on the tuner of your TV set to eliminate the need for fine tuning. Circuit is adaptable to any tuner found in popular-brand TV receivers.

All these and many more interesting and informative articles will be yours in the July issue of ELECTRONICS WORLD . . . on sale

June 15th

WAVEFORM QUIZ

By **WILLIAM E. BENTLEY**

A WORKING knowledge of waveform theory is necessary for intelligent trouble-shooting of TV sets, industrial controls, and in most technical jobs. Employment tests for positions in many electronics plants include such material. Try your hand at these questions on waveforms. Chances are that you will miss a few, but you may learn some facts about those elusive wiggles on the scope screen.

1. A square-wave generator is set for 100-cps output. The signal is to be passed through a filter, the output of which must be a 100-cps sine wave. Since cost and space are always factors in filters, we wish to select the highest possible cut-off frequency that will still deliver a pure sine-wave output. What cut-off frequency would you specify?
2. A sine-wave generator is connected so that its output passes through a differentiator and an integrator, in that order. What is the waveshape at the integrator output?
3. When two sine waves are mixed, the output usually consists of four frequencies: the two original signals, their sum frequency, and their difference frequency. Can you think of a situation where the output would consist of only three frequencies?
4. A 100-cps sine wave is fed into a Schmitt trigger stage. What will be the waveshape at the trigger output?
5. Name the two most common means for inverting a waveform.
6. In general, one particular type of passive waveshaping circuit produces "spike" pulses when energized by square waves. Can you name it?
7. A square wave taken from a voltage divider has a base voltage of zero and a top voltage of plus one volt. This signal passes through a large coupling capacitor to the grid of an amplifier tube. What are the base and top voltages of the square-wave signal at the grid?

(*Answer on page* 73)

new COMPACTRON devices

TV sets ever

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TAPE-RECORDING AT 50 CPS

To the Editors:

My letter in your January "Letters" column received some harsh criticism from a reader who found fault with two portions of my original letter. This reader writes as follows: "Mr. Miller brings his tape home to 60-cycle current after having recorded it on a machine operating at 50 cycles. The tape, which had been recorded at 6.3 ips is now put through the tape machine at 7½ ips. The sound, which is 6/5ths of what it should be will be pulled through the recorder at about 9 ips according to his calculations. I can only conclude that: (1) Mr. Miller has never recorded with a 50-cycle current on a 60-cycle machine, or (2) he must be grossly tone deaf not to detect any difference in material recorded at 6.3 ips and then played back with his enlarged capstan at 9 ips."

I think the reader has overlooked one important step. It is necessary to copy from the standard tape recorder to one with the enlarged capstan. After this has been done, the copy is played on a standard machine.

The original recording made on a 60-cycle machine in Brazil on 50-cycle power ran at only ⅚ of 7.5 ips. Therefore it was recorded at an actual speed of 6.25 ips. I have no way to slow down my recorder at Fort Worth to play those tapes, but I can speed it up by increasing the diameter of the capstan which pulls the tape. I wound *Scotch* #41 splicing tape around the capstan to build it up sufficiently. Then I copied the tapes to the second machine (with the enlarged capstan) running at an actual 9 ips. The copying process was at a ratio of 7.5 to 9, which can be expressed also as 50 to 60 (same ratio). The resultant tape, the copy, has the signal corrected for speed and can be played on any standard 7.5-ips tape machine. It does work. The built-up capstan is used only once—for recording the copy.

Another point brought up by this reader is that he does not see how I can wind 12 inches of splicing tape around a ¼"-diameter capstan and do this evenly without the tape spiraling off or warping.

Actually, I found it necessary to wind the splicing tape by hand to get a smooth line. My secretaries do it without help. We use an *Ampex* 350 machine on which the exposed capstan is readily accessible.

WES MILLER, Chief Engineer
Southern Baptists' Radio
and Television Commission
Fort Worth, Texas

Mr. Miller is responsible for producing 11 radio programs and mailing out 1000 tapes a week of these programs. He assures us that the method works and would be glad to demonstrate it to anyone.—Editors.

* * *

PRINTED CIRCUIT TESTING

To the Editors:

The column "Mac's Service Shop" is excellent and the first thing I read in every issue.

In addition to Mac's recent suggestions for checking printed circuits, here is one which I found by accident. Simply trace the suspected sections with a soft lead pencil. The line made by the pencil will readily show up any cracks or breaks in the circuitry.

RICHARD J. WELLS
Syracuse, New York

Mac suggested the use of an illuminated magnifier to spot hairline cracks and shining a light through the board from the other side. He also suggested the gentle flexing and tapping of the board with the volume full on to locate the break.—Editors.

* * *

HAM-RADIO CONSTRUCTION

To the Editors:

Letters by Howard S. Pyle and Leslie E. Wright anent the construction from scratch of ham radio equipment are interesting and provocative. I am one of the old boys, having started in 1919 (without a license even) and having held one since 1921. I was old W3AOT and when the redistricting started things anew I then received the call W4KBW.

Well do I remember the trouble of making condensers, coils, even tube sockets and assembling the whole business on a breadboard and later on panels. I even made one vacuum tube that lasted for a very short time. There was not enough vacuum for it to live very long.

I would say that amateur construction has improved, even in scratch-built equipment. Personally I never owned anything but home-made apparatus until quite recent years. I know that every self-respecting ham watched the factory products and tried to copy them. They also were happy when assembled variable condensers came along. The first ones I ever had were bought knocked down. One purchased as many stator and rotor plates as he wanted, also end pieces and the shaft and made his own.

Amateurs today have it much easier because of the kits. Many of them are superior products when assembled and do give that finished look. The old timer seldom even had a meter. He used a neon lamp to indicate r.f. and watched

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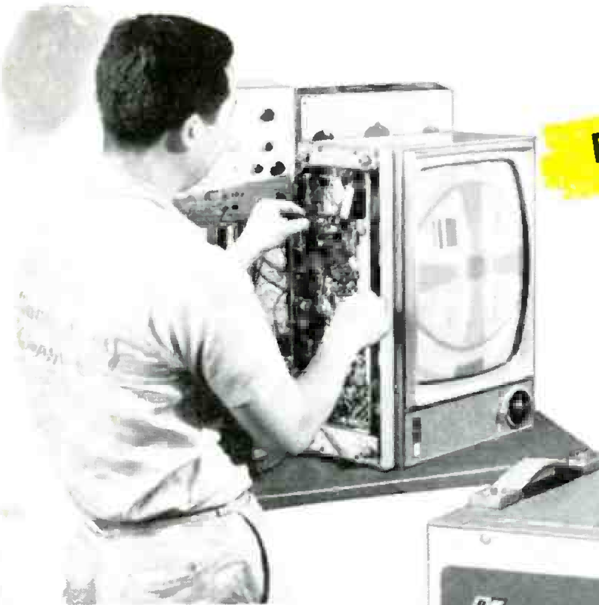

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the tube plates to see that they did not turn white hot and that was it.

Construction has improved. It was bound to get better when there were better models. Hams always have built their equipment, even when the circuit was their own idea, to resemble factory-made equipment. As it improved, the amateur improved.

The "good old days" taught us old timers much that the newcomer will never need to learn but we did not turn out the finished apparatus that the years have made possible.

H. G. Turner
Colonial Heights, Va.

* * *

SOUND SYSTEM FUNDAMENTALS

To the Editors:

Several members of our Sales Department involved in the Commercial Sound Division have read through the first of your series entitled "Commercial Sound System Fundamentals" published in Electronics World for February. The reaction was universally one of great satisfaction in seeing some good fundamental and factual information in print. In the past, so much very broad information has been printed both in the form of articles and case histories that it appeared no one would ever get back to fundamentals and the facts which are so highly useful in planning a public-address system. The first of your series is certainly a complete reversal and we hope it continues in this same vein. The results can only be that it will help us all do a better job of selling and installation.

George R. Riley
Manager, Commercial Products
Electro-Voice, Inc.
Buchanan, Michigan

We have received quite a few letters on this series both from companies as well as interested individual readers. This is certainly evidence of renewed interest in the very important p.a. system field. We are also working on another series on p.a. systems which will contain much practical and useful information.—Editors.

* * *

METRIC SYSTEM

To the Editors:

I know that your readers will be interested in knowing that at long last a bill has been introduced in the House of Representatives to study the practicability and desirability of the United States adopting the metric system of weights and measures.

The bill has been referred to the Committee on Science and Astronautics and is H.R. 269 by Congressman James Roosevelt.

As an engineer I have always felt our scientists and engineers have been under a handicap in using the present U.S. system of measurements.

Lewis J. Miller
Los Angeles, Calif.

Of course, many of our scientific measurements do use the metric system and there would be many problems in changing our system of measurment, but it does sound like a good idea.—Editors.

* * *

LOUDSPEAKER PHASING

To the Editors:

I see by a recent Electronics World that EIA has issued a new standard "Phasing of Loudspeaker." This is about 15 years late.

In April, 1945 Radio News (as you were known then) published a comprehensive article by me titled "Phasing of Loudspeakers." The procedures there recommended were important then and are doubly important now. Why did it take the industry so long to catch up?

Looking through my files I find that the manuscript was mailed to you in Chicago on September 25, 1944. Acceptance was dated four days later. It must have been love at first sight.

Nicholas B. Cook
Paterson, N.J.

Stereo, of course, has made speaker phasing doubly important.—Editors.

—30—

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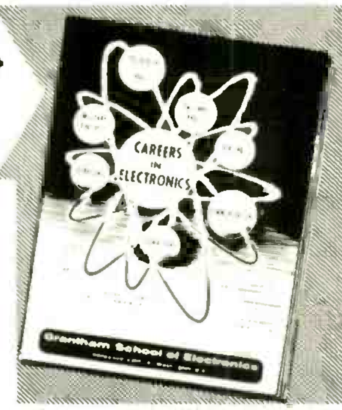

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Within the Industry

MILTON S. KIVER has resigned his post as Editor of *Electrical Design News* to form his own publishing and consulting organization, *Milton S. Kiver Publications, Inc.* with headquarters at 222 W. Adams Street, Chicago 6, Illinois.

He will publish a new magazine in the electronics field as well as offer specialized services in the form of counsel and guidance for the development of new products and techniques.

Mr. Kiver has been active in the electronics field for twenty-five years and is the author of nineteen books on many phases of the subject. He is a Senior Member of the IRE, a member of AIEE and New York Academy of Sciences; vice-chairman of the Professional Group on Engineering Writing and Speech and a member of the education committee of the Professional Group on Radio Frequency Interference, both of the IRE.

* * *

EIA has announced that factory sales of transistors scored another healthy advance during 1960, following the yearly growth pattern which has characterized this industry since its inception.

According to the Association's Marketing Data Department, a total of 127,928,586 transistors valued at $301,-432,285 were sold at the factory during the past year. Figures for 1959 were 82,294,120 units for a total of $222,009,-722.

* * *

NEWTON COOK is the new sales director of *Astatic Corp.*, Conneaut, Ohio manufacturer of phonograph cartridges, microphones, phono needles, and other electronic equipment.

Before joining the firm, Mr. Cook was general sales manager of *Chicago Standard Transformer Corp.*, a position he had held since 1955. He joined the company in 1946. Prior to this he was associated with *P. R. Mallory and Co.* for twelve years.

Mr. Cook is a member of the industry relations committee of EP&EM and a graduate of DePauw University.

* * *

JAN BLEEKSMA has been upped to the post of vice-president in charge of manufacturing of *Amperex Electronic Corp.* . . . The appointment of **GOODWIN G. MILLS** as executive vice-president and general manager has been announced by *National Radio Co., Inc.* . . . *University Loudspeakers, Inc.* has named **STAN NEUFELD** to the post of distributor sales manager. . . . **ABE KOSAKOWSKY** is the new distributor sales manager for *Silicon Transistor Corp.* . . . **LARRY B. MEYERSON** has been named assistant director of sales promotion for *World Radio Laboratories* of Council Bluffs, Iowa. . . . **RONALD ENDRESS** has been appointed assistant chief engineer for *Sherwood Electronic Laboratories, Inc.* . . . *Radio Shack Corp.* of Boston has appointed **GAYLORD RUSSELL** to the newly created post of director of engineering . . . **MORRIS SHULTZ,** controller and a director of *Arco Electronics, Inc.*, died recently at his home. He had been with the firm since 1952.

* * *

WILLIAM W. GARSTANG has been named manager, special products, at *Centralab*. In his new post Mr. Garstang will be responsible for sales, manufacturing, and engineering supervision of new products and processes acquired by the firm as a result of cross-licensing arrangements with various foreign companies.

A veteran of 30 years' experience in the electronic industry, he was formerly chief engineer of the electronics division of *Allen-Bradley Company*. Prior to that time he was associated with *Raytheon*, *P. R. Mallory*, and other electronic firms in both sales and technical positions.

He is a Senior Member of the IRE and holds a degree in physics from the University of Wisconsin.

* * *

SERVICE INSTRUMENTS CORPORATION has changed its name to **SENCORE, INC.** to take advantage of the wide public acceptance of its tradename. The firm manufactures a line of service test equipment . . . **THE MAGNAVOX COMPANY** has announced its entry into the electronic organ field. The first unit in the line will be a transistorized instrument in the popular-price range . . . **SPRAGUE ELECTRIC CO.** has consolidated all of its transistor manufacturing, engineering, and marketing activities in a new division to be headed by Robert L. Parrish with headquarters at Concord, N.H. . . . **HARMAN-KARDON, INC.** has been acquired by **JERROLD ELECTRONICS CORPORATION** and will operate as a separate subsidiary with headquarters in Plainview, New York . . . **AMPHENOL-BORG ELECTRONICS CORP.** has agreed to a merger with **FXR, INC.** with the Illi-

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nois firm the surviving corporation. The Woodside, N.Y. company will be operated as a separate unit with present management, organization, and personnel . . . **HAMMOND ORGAN COMPANY** has established a special products division which will be responsible for all reverberation activities as well as for the production and marketing of non-organ products developed by the firm. The company also acquired **GIBBS MANUFACTURING AND RESEARCH CORPORATION,** a Janesville, Wisconsin electronics manufacturing and research organization . . . **LOWELL MANUFACTURING COMPANY** has acquired **VAN SICKLE RADIO COMPANY,** a St. Louis radio supply firm, which will operate as a wholly owned subsidiary of the speaker baffle and enclosure manufacturer.

* * *

ROBERT H. BEISSWENGER has been named general sales manager of *Jerrold Electronics Corporation* and will coordinate the rapidly expanding activities of the firm's four sales divisions which cover markets in community antenna systems; government, educational and industrial communications; consumer products; and test instrumentation equipment.

He was formerly vice-president and general sales manager of *Whitney Blake Co.* and sales manager of *Indiana Steel and Wire Company.* During World War II he was a Major in the Signal Corps.

* * *

AIREX RADIO CORPORATION has opened a new 10,000-square-foot store and high-fidelity showroom at 85 Cortlandt Street, New York City . . . **SPECIALTY ELECTRONICS DEVELOPMENT CORP.** has broken ground for a modern two-story plant in Flushing, N.Y. The 70,000-square-foot facility is expected to be ready for occupancy by late summer . . . **ULTRASONIC INDUSTRIES INC.** has relocated to Engineers Hill, Plainview, New York, occupying a new 18,000-square-foot plant. National sales headquarters of the company as well as engineering and manufacturing departments are located in the new building . . . The Electron Tube Division of **RCA** has opened a new microwave engineering laboratory at 6801 East Washington Blvd., Los Angeles. It will be operated in conjunction with facilities at Harrison and Princeton, N.J. . . . **MILO ELECTRONICS CORP.** of New York City has opened a new sales office at 1140 N.E. 163rd Street, North Miami Beach, Fla.

* * *

CHARLES W. McCLURE, an electrical engineering graduate student at the University of Wisconsin, is the recipient of the 1961 National Electronics Conference Fellowship Award.

A second lieutenant in the Signal Corps Reserve, Mr. McClure received his B.S. in Electrical Engineering in 1960 and his M.S. in February. He is now studying for his doctorate.

(*Continued on page 94*)

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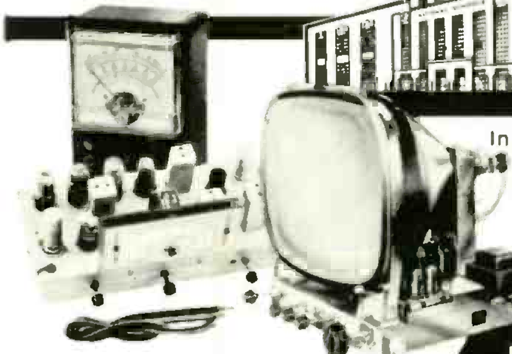

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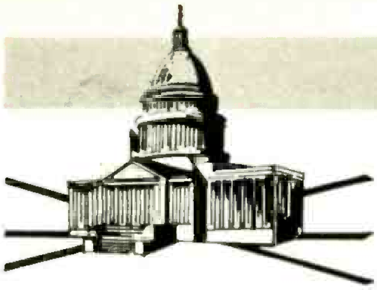

Spot News

Latest Information on the Electronic Industry

By ELECTRONICS WORLD'S WASHINGTON CORRESPONDENT

RADIO SIGNALS MAKE 6½-MINUTE ROUND TRIP TO VENUS—Reception of strong, clear radio signals, reflected to earth from Venus in a 6½-minute, 70-million-mile round trip, was reported recently by the National Aeronautics and Space Administration. Received at the Goldstone tracking station in the Mohave Desert, 50 miles north of Barstow, California, the signals were, for the first time, immediately detectable without elaborate analysis and processing. The unusual reception was made possible by the use of a pair of 85-foot dish antennas and a receiver employing a ruby maser and parametric amplifier. The ruby crystal, heart of the maser, was maintained at the temperature of liquid helium (4.2° F degrees above absolute zero) to reduce the receiver's generated noise power to a small quantity. The transmitting antenna, located seven miles from the receiving site to minimize interference, beamed a 10-kw., 2388-mc. signal with a conical beamwidth of but .4 of a degree to Venus.

TRANSIONOSPHERIC NRL SATELLITE COMMUNICATIONS CITED AS MILITARY BOON—Striking results obtained by the Naval Research Laboratory's LOFTI (low-frequency ionospheric) satellite have, it is believed, opened a whole new field of scientific possibilities which could lead to major advancements in military communications and manned and unmanned space vehicle navigations. By receiving very-low-frequency signals from a ground station, the satellite has provided scientists with its first data on the degree of v.l.f. penetration into and through the ionosphere. From the data telemetered back to earth, it has been possible to confirm the belief that the ionosphere is not nearly as opaque at these frequencies as generally assumed and also that v.l.f. waves do pass through the ionosphere into the exosphere with relatively little attenuation. Thus it was demonstrated that while the ionosphere reflects v.l.f. waves back to earth to a large degree, it also permits very substantial penetration of these waves to outer space. In the LOFTI experiment, signals from NBA, the Navy's station in the Panama Canal Zone, were picked up by a receiver in the satellite and re-transmitted from the sphere over v.h.f. telemetry channels to special NRL mobile and NASA ground observation stations.

FIRST COMPUTER COMPLETES TENTH YEAR OF CENSUS WORK—The world's first commercial electronic computer system recently celebrated its tenth year of active service at the Bureau of Census in Washington. Since March 31, 1951, the computer, "Univac I," is estimated to have performed more than 510-billion basic arithmetic operations. First used during the final stages of the 1950 census tabulations, the computer has been in almost constant use, usually 24 hours a day and seven days a week. Today the Bureau not only uses "Univac I," but scores of electronic systems for the sorting and re-arranging of hundreds of millions of items of statistical information and for complex mathematical computations.

ENGLAND AND FRANCE TO PROVIDE SATELLITE GROUND STATIONS—A 1962-1963 tri-nation cooperative program (involving this country, England and France) for the trans-atlantic testing of experimental satellites, provided and launched by NASA, has been announced. The British General Post Office and the French Center for Telecommunications Studies have agreed to provide stations in Europe for the transmission of multi-channel telephone, telegraph, and TV signals using satellites in projects "Relay" and "Rebound." Project "Relay," a low-altitude active repeater satellite, weighing 100 pounds and to be launched in 1962, will contain instruments to detect radiation damage and other environmental effects on critical components, as well as communication experiments. Project "Rebound" will be a follow-up to the passive reflector communication satellite program "Echo."

1000 LOCATIONS TO SCREEN U.H.F. RECEPTION IN NEW YORK CITY—As part of the FCC program to study the practicability of the ultra-highs in large metropolitan areas, TV receivers will soon be installed in 1000 locations in New York City to evaluate coverage. And at 5000 sites, hand-carried equipment will be used to appraise the technical and economic feasibility of the high bands. Tests will be made within dwellings and on house tops. Target date for the beginning of the survey has been set for early Fall and tests are expected to continue until the Summer of 1962.

-30-

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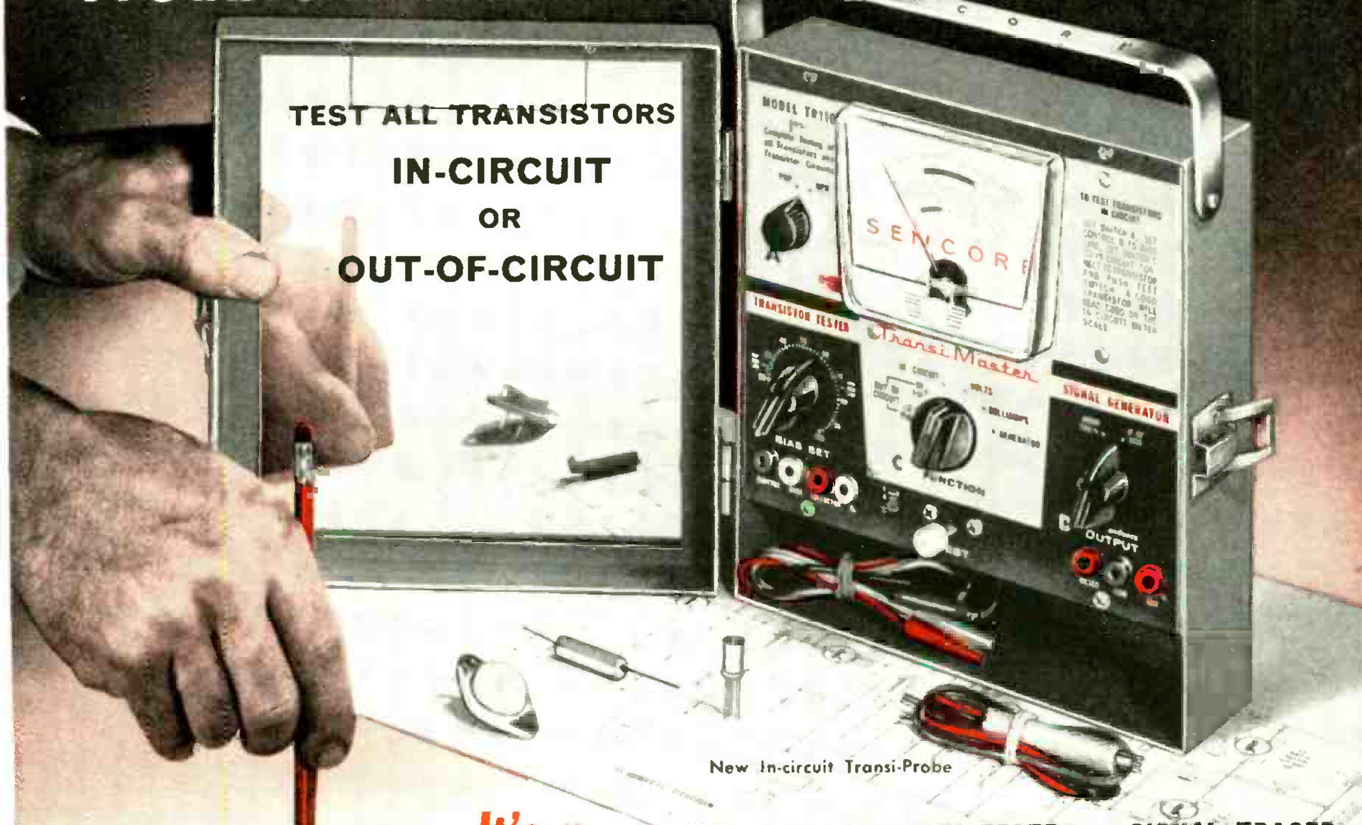

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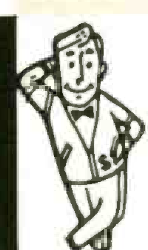

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A summary of the techniques to follow in making music-power measurements on high-fidelity amplifiers, along with reasons why short-cut methods lead to inaccuracies.

HOW TO MAKE MUSIC-POWER MEASUREMENTS

By **DANIEL R. von RECKLINGHAUSEN**
Chief Research Engineer, H. H. Scott, Inc.

AMPLIFIERS used in home high-fidelity systems and in phonograph consoles have been rated by their manufacturers many different ways. Such terms as sine-wave power, steady-state power, music power, tone-burst power, peak power, and instantaneous peak power have been used. Some of these terms mean the same thing although some give values twice as large as others. Standardization of rating and measurements has been sorely needed. Recognizing this need, both the Institute of High Fidelity Manufacturers and the Electronic Industries Association have established standards of measurement which fulfill this requirement. They both have adopted "music-power output."

What is Music Power?

The Institute of High Fidelity Manufacturers states[1] that sine-wave measurements be made with all significant supply voltages maintained at the same values as under "no-signal" conditions. The Electronic Industries Association defines[2] music-power output as a "single frequency power obtained at 5% total harmonic distortion or less, when measured immediately after the sudden application of a signal and during a time interval so short that supply voltages within the amplifier have not changed from their 'no-signal' values."

Both standards, in essence, have defined the same performance aspect of an amplifier, *i.e.*, the power output at a given distortion level for signals of short duration such as exist in music. The only significant difference is that the EIA specifies a 5% distortion value whereas the IHFM sets no such parameter. In another portion of the IHFM Standard, however, the distortion level at which music-power-output is measured is taken as the amount of total harmonic distortion as specified by the manufacturer. This rated distortion is usually on the order of ½% or 1%.

What is significant about a music-power measurement? First, an amplifier used in the home is designed to do its job in the reproduction of music. Music is not a single-frequency sine wave and is better described as a series of tone bursts at a number of different frequencies which depend upon the musical content. The amplifier processes and amplifies this signal while adding a minimum amount of distortion, hum, noise, and other undesirable characteristics. When music is played through an amplifier whose power-supply voltages are monitored by a number of voltmeters, it is found that these voltages change imperceptibly as the music changes from loud to soft. For the measurement of output power to show a significant performance aspect of the amplifier all supply voltages must be maintained as they were at "no-signal" conditions, when sine-wave measurements are made. The supply voltages in an amplifier, particularly one that has a class AB or class B output circuit, may vary considerably when the amplifier is operated with a sine-wave signal. Since a sine-wave signal is the only practical means of measuring harmonic distortion or intermodulation distortion, it means that the supply voltages within an amplifier will have to be maintained by external means in order for a music-power measurement to be made.

What is the cause of the voltage change in the amplifier? Any examination of output tube data will supply a good portion of the answer. For example, a pair of 6CA7 tubes in a class B push-pull circuit with a supply voltage of 425 volts, control grid bias of −38 volts, a common screen-grid re-

[1]IHFM-A-200 "Standard Methods of Measurement for Amplifiers"
[2]EIA-RS-234 "Power Output Ratings of Packaged Audio Equipment for Home Use"

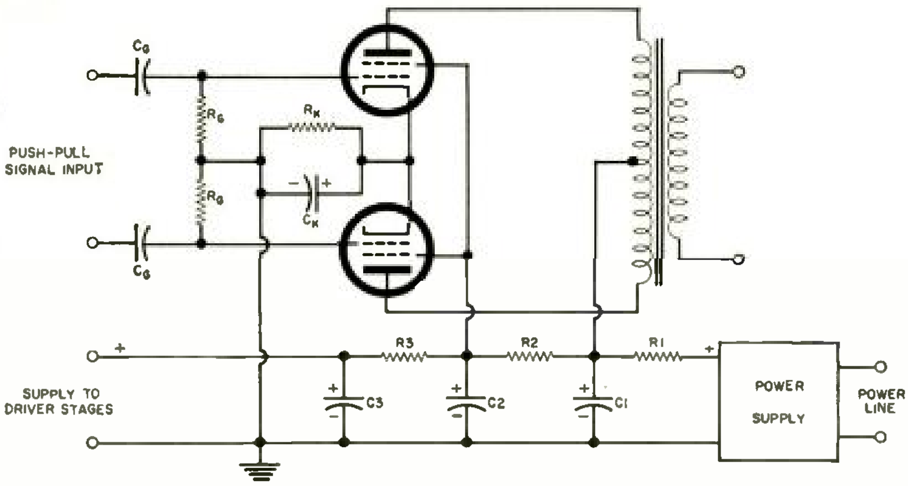


Fig. 1. The output circuit of a typical push-pull pentode or tetrode amplifier. The voltages across capacitors designated C_1, C_2, C_3, and C_K must be maintained at their normal no-signal values in order to make measurements of music power.

sistor of 1000 ohms, and a load resistance of 3400 ohms plate-to-plate will show a total plate current under "no-signal" conditions of 60 ma. and a screen-grid current of 10 ma. The full power output, according to the tube manufacturer is 55 watts, but at this power the plate current has increased to 240 ma. and the screen-grid current to 50 ma.

Under steady-state sine-wave measurements, this increased current consumption is supplied by the power supply of the amplifier. Since this power supply may have a significant internal resistance, the plate-supply voltage and the screen-grid supply voltage will have decreased from their "no-signal" value. A total steady-state power output of less than 55 watts will be obtained. Depending upon the characteristics of the supply the power output may be only 40 watts. Under tone-burst or music conditions, the increase in current for a very short duration would be supplied by the filter capacitors of the power supply and the music-power output of the amplifier would remain at 55 watts (neglecting the losses of the output transformer).

It is very difficult to make power-output and distortion measurements of an amplifier under extremely short tone-burst conditions because all measurements would have to be made instantaneously and accurate results would not be obtained. Better results can be had if the value of the filter capacitors in the amplifier is increased tremendously. Here measurement time would be lengthened from perhaps a few milliseconds to, say, a second. Even this is not sufficient to permit the acquisition of accurate data.

However, if external means are used to maintain a power supply at its "no-signal" voltage then measurements can be performed carefully, limited only by test equipment accuracy.

Significant Supply Voltages

What are the significant supply voltages, and how can these voltages be maintained?

One of the important voltages to be maintained is the filament voltage. This can be done by using a regulated power line either with a constant-voltage transformer or a variable power transformer. This voltage should be 117 volts at the a.c. input.

Second, the plate-supply voltage for the output stage would have to be at its "no-signal" value. The place to measure this voltage is at the center-tap of the output transformer and not the plates of the output tubes. The d.c. resistance of the output transformer has an essential place in determining the power of an output stage.

Third, if the amplifier output stage uses pentodes or tetrodes the screen-grid supply voltages would have to be maintained. If the screen supply is taken directly from the center-tap of the output transformer this is already done. If a separate filter resistor and filter capacitor are used to supply these screen grids, then the voltage at the filter capacitor would have to be maintained. If the screen grids are supplied through an unbypassed resistor, the voltage at the supply-end of the resistor (not the tube end) would have to be maintained.

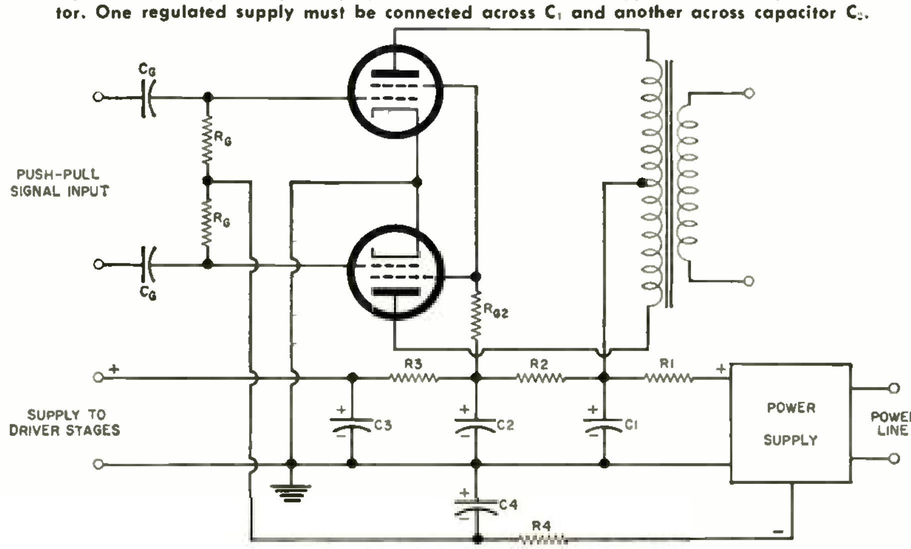
Fourth, the bias voltage of the output stage would have to be maintained. If the bias voltage is obtained in the amplifier with a separate rectifier power supply, this voltage should be monitored. However, it is expected that this voltage is not likely to change because under normal conditions the output-tube grids will not draw any current. If the bias voltage is developed across a common cathode resistor which is bypassed, the voltage across that cathode resistor would also have to be maintained.

From the foregoing it should be obvious that if there are any resistances in the amplifier where signal voltages or their harmonics develop in the normal course of operations, only the voltages at the supply ends of the resistors shall be maintained. If by some means the voltages on the tube-ends are maintained, then the characteristic of the amplifier would be changed because these resistors or resistances serve an essential function in the performance of the amplifier.

Maintaining the Voltages

What means can be used to maintain these voltages? It might be possible to connect a high-power potentiometer in parallel with one of the filter resistors in the power supply and vary this potentiometer so that the "no-signal" voltages are maintained. This is possible in many cases. However, since a power-supply filter resistor performs an essential function in maintaining the hum level of the amplifier at its specified value an additional filter capacitor may have to be connected in parallel with the filter capacitor already provided within the amplifier. A danger still exists in this because this filter resistor may also perform the function of keeping the instantaneous peak currents within the rectifier circuit to a tolerable value. Connection of a variable resistor across a cathode resistor of an output stage generally will not cause rectifier difficulty, for such a resistor will not have any filtering function. It is still necessary, however, to increase the value of the cathode bypass capacitor for this measurement.

Fig. 2. This output stage employs fixed bias and an unbypassed screen-grid resistor. One regulated supply must be connected across C_1 and another across capacitor C_2.



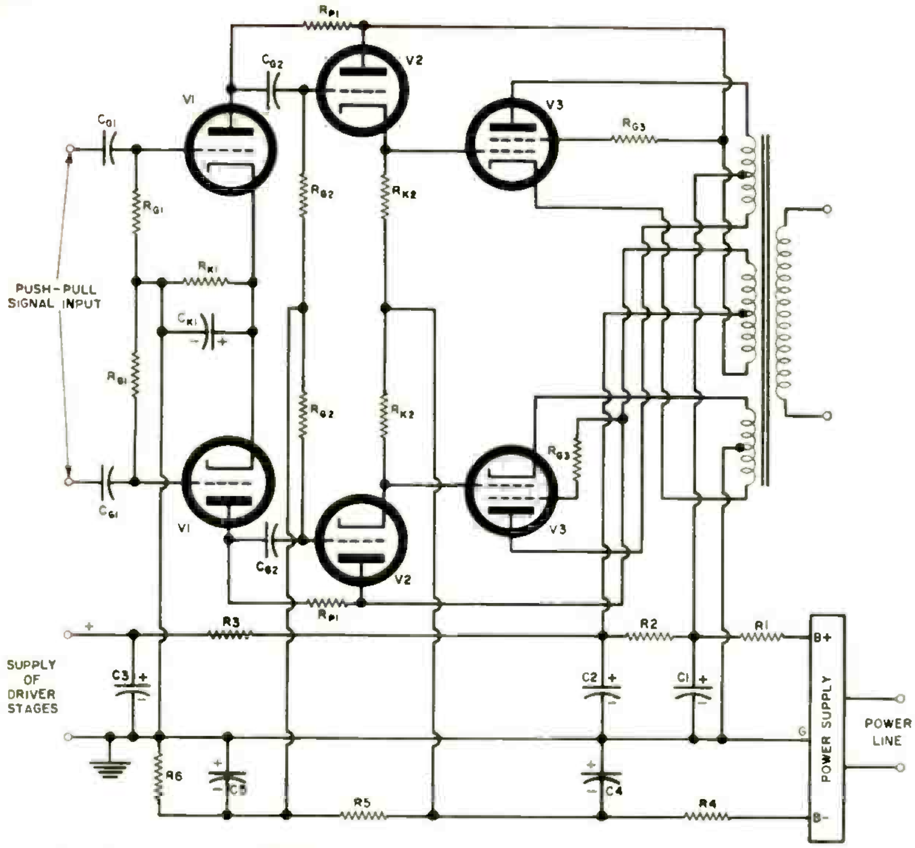


Fig. 3. A more sophisticated output circuit is shown here. Two power supplies would be required across capacitors C_1 and C_2, and the negative supply would have to be maintained. In addition, the C_1 voltage should be maintained and several other voltages in other parts of the circuit would have to be carefully monitored.

Perhaps a simpler means of maintaining supply voltages within an amplifier is to use one or perhaps several external power supplies which are connected in parallel with the appropriate "B+" or screen filter capacitors. These regulated power supplies of low internal impedance would then be adjusted in voltage so that these supplies deliver no current under "no-signal" conditions and supply the additional current requirement of the output stage as the input signal is increased. This is perhaps a more expensive method of doing the job, however, the time saved in making adjustments is well worth it, especially if many measurements have to be made.

As in any measurement technique, there are a few ways to make a correct measurement and many more ways to make incorrect ones. These incorrect ways should be avoided if at all possible. One of the wrong ways, for example, is to just go ahead and increase the line voltage so that the proper plate-supply voltage is obtained. With this method the filament voltages and the bias voltages have changed and a false reading results. Another wrong way is to fail to monitor all the supply voltages and to measure only a few of them. It is necessary that *all* supply voltages be monitored; not simply those for the output stage, but also those for the preamplifier and driver stages as these voltages may be affected by the operation of the output stage. Only when it has been established that these voltages have not changed after the output-stage voltages are maintained is it possible to eliminate the external supply for these portions of the amplifier circuit.

The foregoing are general rules to be followed when making music-power measurements. Of course, a calibrated output meter, calibrated load, and low-distortion audio oscillator are as necessary for these measurements as they are for steady-state measurements. It is not possible to treat the amplifier as a black box with a line cord and a set of inputs and a set of outputs for music-power measurements. It is necessary to make connections to the internal circuitry of the amplifier. For this purpose the amplifier circuit must be examined carefully to determine the purpose of each component in the power supply and in the output stage. It is not quite as necessary to make an analysis of all the other circuit components. It is of course necessary to have a circuit diagram of the particular amplifier available for examination.

Typical Circuits

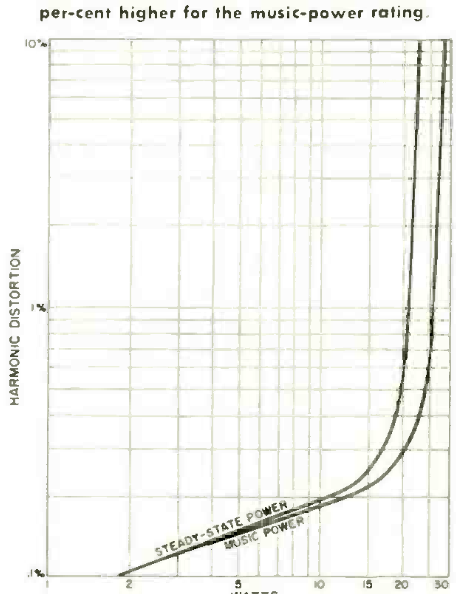
The output circuit of a typical push-pull pentode or tetrode amplifier is shown in Fig. 1. The circuit of the driver stages has been omitted as has been the feedback circuit. From an examination of the circuit, it can be determined that this amplifier is supposed to operate without grid current. Bias for the output stage is developed across the cathode resistor R_K, bypassed with capacitor C_K. Voltages for operation are obtained from the power supply which has an internal impedance R_1 and is also filtered by resistors R_2, R_3, and capacitors C_1, C_2, and C_3.

For the purposes of music-power measurements it would be necessary to have four voltmeters connected across capacitors C_1, C_2, C_3 and C_K. These voltages would have to be maintained at the "no-signal" conditions. In addition, the power line would have to be maintained at 117 volts. It is most likely that in this amplifier the driver stages will not require any additional current during power-output conditions. Therefore it would be necessary to connect two regulated power supplies, one across capacitor C_1 and the other across capacitor C_2. By these means, the plate- and screen-supply voltages are maintained. To maintain the bias voltage for the output stage it would be necessary to connect a resistor in parallel with R_K and adjust its value so that the voltage across C_K is maintained. If this amplifier were even simpler, *i.e.*, had no separate filter for the screen supply, then of course only one regulated power supply would be needed for music-power measurements.

Fig. 2 shows a more complicated amplifier. This one is similar to the one in Fig. 1 except that the output stage operates with fixed bias which is filtered through resistance R_4 and capacitor C_4. There is also an unbypassed screen resistor R_{G2}. It is again unlikely that the driver stages will require any increased current during music-power conditions and it is also quite unlikely that the bias voltage will change if the power line is maintained at 117 volts. Therefore only two regulated power supplies would be required. One of them should be connected across capacitor C_1 and the other one across capacitor C_2. Here again music-power measurements could be performed at leisure.

Going from amplifiers of rather simple construction to an amplifier with more sophisticated circuits, as required to obtain class AB_2 operation, careful

Fig. 4. Distortion versus power for a typical amplifier. For the .8 per-cent distortion level, the power output is about 20 per-cent higher for the music-power rating.



circuit analysis is required. Fig. 3 shows what is perhaps an extreme example of such circuit design. This particular amplifier shows a push-pull output stage (V_3) which is operated in class AB_2. This stage is driven by a bootstrap cathode-follower (V_2) for each grid which, in turn, is driven by a bootstrap amplifier (V_1). For the purpose of music-power measurements, these six tubes would have to be considered as the output circuit and the supply voltages for these tubes maintained. As expected from this rather complicated circuit, a more elaborate power supply is required. Here both a "B+" and a "B−" supply are required. The supply for the output plates is filtered by resistor R_1 and capacitor C_1. This supply also delivers the current for the screen grids through the filter R_2 and C_2. The driver stages are supplied from the screen-grid supply point through a filter R_3 and C_3. The voltages across C_1, C_2, and C_3 would have to be maintained, although by past experience it *may* not be necessary to connect a separate power supply across C_3. However two power supplies, across C_1 and C_2, would be required. In addition to that, the negative supply would have to be maintained. From this circuit it would be expected that tubes V_3 will not draw any grid current during normal operation. However, their cathode current may vary considerably and it would be necessary to maintain the voltage across C_1 and perhaps monitor the voltage across C_3. A third regulated power supply would have to be connected across C_1. In addition, it is possible that the current from tubes V_1 is likely to change. Therefore, the voltage across capacitor C_{K1} would have to be monitored and perhaps a resistor connected in parallel with resistor R_{K1} to maintain the supply voltage on the bootstrap driver stage.

As can also be seen from this circuit the output tubes have screen supply resistors which are not bypassed. No attempt should be made to maintain the voltage drops constant across resistors R_{G3} because these resistors play an essential role in maintaining proper screen-grid operation in this particular stage.

Fig. 4 shows the distortion *vs* power output curve for a typical amplifier. It can be seen that for the .8% distortion level the power output has increased approximately 20% over that obtained under steady-state conditions. This value is perhaps typical of that obtained with a well-designed amplifier. It is the author's experience that music-power output of an audio amplifier is generally 10 to 30% higher than that obtained for steady-state conditions. It is also possible to design amplifiers which will have lower distortion at all power output levels of "music-power" conditions than under steady-state conditions. However, this possibility should not be taken as a license to design amplifiers which are completely useless for steady-state operation. After all, it may be more difficult to design a poor amplifier than to design a good one. —30—

COVER STORY

ONE of the most important specifications applied to a hi-fi amplifier is its output-power rating. But there are many ways of measuring power, several of which are quite valid. This means that the prospective buyer may be confronted with two, three, or even more numbers, all of which purport to specify its output power at a given distortion level. To simply state that the output power of a given amplifier is so many watts is meaningless unless the manufacturer also states definitely just what power he is referring to.

The two most widely used power ratings are the continuous, steady-state average sine-wave power and the music power. Our own feeling is that if the manufacturer wants to quote a music-power rating, he should also include a steady-state average sine-wave power as well for the guidance of buyers. A rating composed of both these figures will be helpful in comparing amplifiers.

Our cover symbolizes the measurement and use of a number of different output-power ratings on a given amplifier, in this case an H. H. Scott Model 272 stereo unit. When a steady-state average sine-wave power measurement is to be made, a dummy load is connected across the output terminals of each channel, an a.f. sine wave is applied to the input, and the output voltage is measured at a given distortion level. Since most a.f. or a.c. voltmeters are calibrated in r.m.s. values (top cover waveform), it is merely necessary to square this voltage value and divide it by the load resistance to obtain average sine-

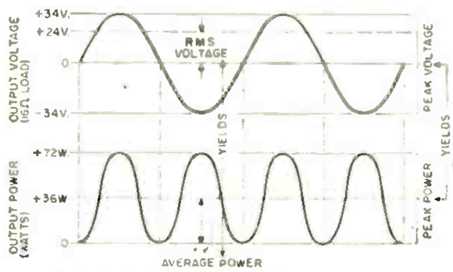


Fig. 1. Sine-wave voltage and power.

wave power. In the case of the amplifier shown, this amounts to 36 watts per channel.

Instead of measuring r.m.s. voltage, we could also have measured or calculated the peak or maximum a.c. output voltage, and used this figure in our calculation (bottom cover waveform). The power so calculated is the instantaneous peak output power. In the case of a pure sine wave, the peak value is 1.414 times the r.m.s. value of the wave. As power is proportional to voltage squared, the instantaneous peak-power output is $(1.414)^2$ or exactly 2 times 36 watts, or 72 watts. Hence, the same amplifier that is capable of delivering 36 watts of steady-state average sine-wave power will deliver on peaks an instantaneous peak power of 72 watts.

The center waveform shows a music signal having an amplitude somewhat greater than the sine waves shown. This symbolizes the fact that this same amplifier will handle 44 watts of average music power at the same distortion level. In actually taking music-power measurements, music signals, as such, are not used because of their highly random nature. But it is possible to discover an amplifier's performance on music peaks by applying a sine-wave signal and maintaining the significant supply voltages in the amplifier at their no-load values. This technique, which has been standardized by the IHFM and EIA, is described in the accompanying article.

Fig. 1 below shows the relation that exists between voltage and power in a sine-wave signal. As mentioned above, a measurement of r.m.s. output voltage yields the continuous, steady-state average sine-wave output power; a measurement of peak-output voltage yields instantaneous peak output power. Fig. 2 indicates how the output power of an amplifier falls with time to its steady-state value. When the amplifier is called upon to handle short bursts or pulses, as in music, its performance is more nearly described by the music-power rating rather than the lower steady-state power.

Fig. 3 compares the performance of the same amplifier when handling a music signal and a sine-wave signal. The music signal was first adjusted to give maximum unclipped output. When a sine wave having the same peak-to-peak amplitude was applied, the amplifier clipped the peaks of this signal. It was necessary to reduce the amplitude of the sine-wave signal somewhat to get rid of the clipping. This indicates that the amplifier's performance on music signals is better, in terms of peak handling power, than with pure sine waves. This undistorted sine-wave yields an average power of 36 watts (instantaneous peak power 72 watts), while the music signal yields a power whose instantaneous peak value (88 watts) is equal to that produced by a sine-wave signal with an average power of 44 watts per channel. —Editors.

(Cover illustrations by George Kelvin)

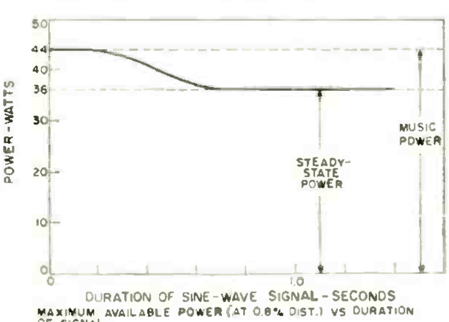
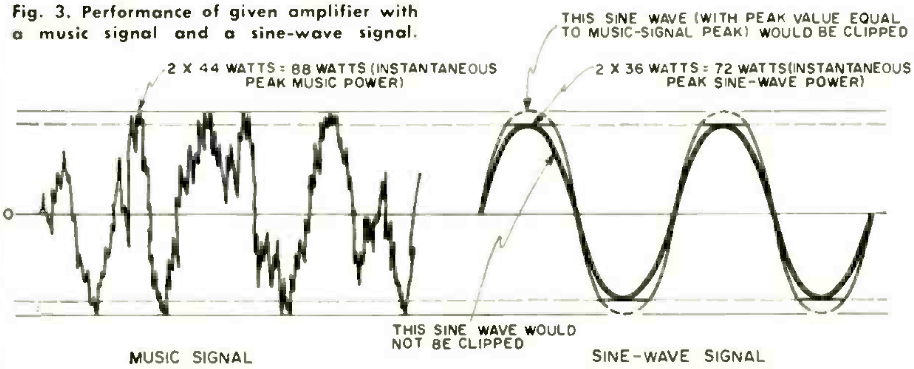


Fig. 2. Maximum available power vs duration of signal that is applied.

Fig. 3. Performance of given amplifier with a music signal and a sine-wave signal.



Detecting Microwave-Radiation Hazards

THE HEAVY concentration of electromagnetic radiation produced for the military and industry has triggered considerable concern for the safety of personnel. The matter has been exhaustively investigated by the military and industry alike and the investigators have agreed that 1 milliwatt per cm.^{2} can be considered a safe continuous dosage, leaving no detectable physiological damage in animal and human subjects. An average power level between 1 and 10 mw. per cm.^{2} is safe for incidental or occasional exposure, while a level above 10 mw. per cm.^{2} is potentially hazardous.

These figures, although authoritative since they are based on many actual experiments, include one underlying assumption; namely, that the damage caused by exposure to electromagnetic radiation is primarily of a thermal nature. The radiation has as a primary effect the heating of body tissues and fluids, since water is an excellent absorber of such energy.

But many other experiments indicate that thermal effects are not all that occur. Although we cannot say for certain that these "athermal" effects cause physiological damage, it may well be that such damage is of a type and degree that makes it practically impossible to detect, even with the penetrating research tools available for such diagnosis.

For example, suppose such low-level irradiations, which are considered "safe," cause minute changes in body chemistry, the effects of which might not show up for many years. Such consequences cannot be assessed within the time span of the experiment, hence all clues to the real cause of them will be lost. For example, one experimenter found that u.h.f. radiation affected the inhibiting activity of the cortex, the gray mantle of the brain, and animals which had heretofore been tractable became very aggressive.

In another experiment, the inhibiting action of certain drugs on the digestive processes was partly cancelled by a u.h.f. field. Again, another experiment showed that the threshold of dark-adapted eyes to minimal light stimulation was lowered in a weak u.h.f. field.

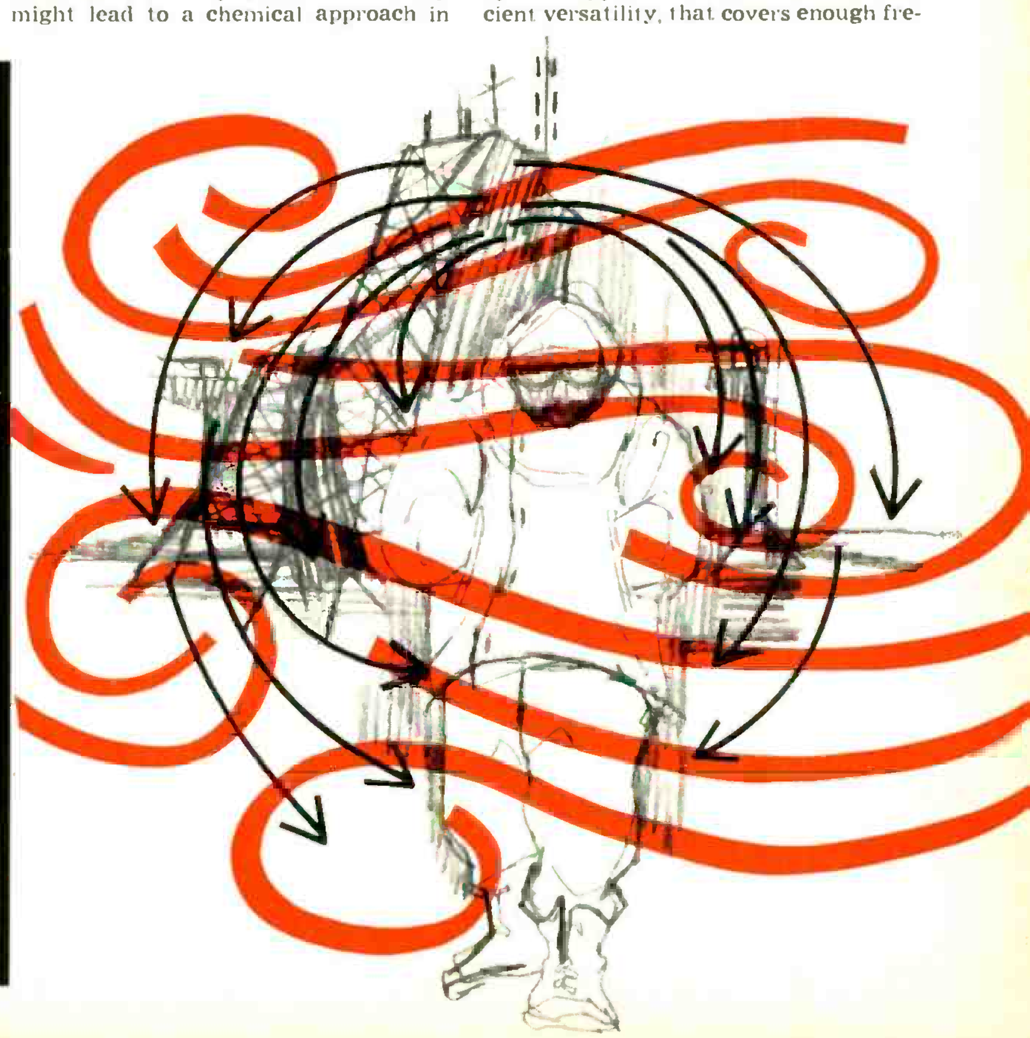
The alteration of certain substances by electromagnetic radiation has been demonstrated repeatedly. Human blood serum can be affected by radiation in a manner never achieved by heating. Glycogen, an important substance in human muscle activity, can be affected by microwaves and experiments in this area raise some hope that the discovery might lead to a chemical approach in curing cancer. The problem of possible athermal effects and their consequences to biological organisms, and eventually man, is now the subject of much renewed investigation in several of our universities as well as in our industrial laboratories.

The Problem of Dosimetry

The possibility that low-level athermal effects may be as important as the thermal action above 10 mw./cm.^{2} makes the problem of accurate dosimetry more acute. By "dosimetry" is meant the measurement of radiation actually received and active in the subject's body. This, at present, can only be arrived at by a wild estimate. The radiation received on the *surface* of the body can be measured, for certain frequency ranges, with reasonable accuracy. For this we must use laboratory-type instruments, hardly suited to being worn by a person who must work around radiation-producing equipment. The matter becomes even more acute at microwave frequencies, such as those to which radar technicians are exposed, where even the accurate measurement of energy arriving on the surface is quite a problem. No accurate portable (pocket-type) dosimeter which has sufficient versatility, that covers enough fre-

Accurate methods of measuring microwave radiation are becoming more important with the use of high-power radars and space communications systems. Here are the types of instruments and techniques that are being utilized.

By TOM JASKI



quencies, and is usable on all people—small or large, fat or thin—is presently available. Many attempts have been made to build such instruments, but in the final tests they always fall short of the requirements.

Instruments Available

Basically the instruments currently available for dosimetry can be divided into two types. One is the field-strength meter, familiar to every TV technician and radio amateur. This is principally a sensitive receiver, usually a superheterodyne, with a meter which indicates the strength of the signal received. Sometimes field-strength meters are very simple affairs, with a tuned circuit and diode rectifier before the meter. These can be considered "receiver" types.

The second basic type is the power-level meter. This is usually a sensitive bridge which uses some transducer that can convert electromagnetic energy into another form of energy or produce a change due to thermal effects. The thermal transducer used with these meters is called a *bolometer*. The bolometer is either a *thermistor*, which decreases in resistance with an increase in temperature, or a *barretter*, which is a resistance element which increases its resistance as the temperature rises.

A third type of radiation meter, the echo chamber, need not concern us since it is useful only at relatively high power levels. In addition, there are some chemical substances which will show thermal effects from radiation and will change color. However, these substances are very unstable and rather sensitive to humidity, hence impractical at the present time.

The Transducers

A thermistor is a bead of some metallic oxide (which has a negative resistance coefficient) with two wires inserted in it. The bead is subjected to high temperatures, sintered, and then assumes semiconductor properties. It has an advantage in that it is more sensitive than other bolometers.

A barretter is a very thin piece of platinum wire in a suitable mounting. The wire is far too thin to be seen with

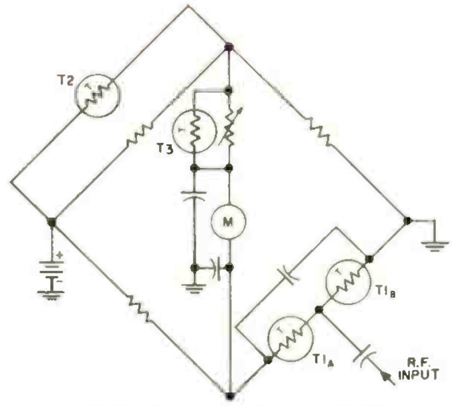


Fig. 2. A simplified r.f. power bridge.

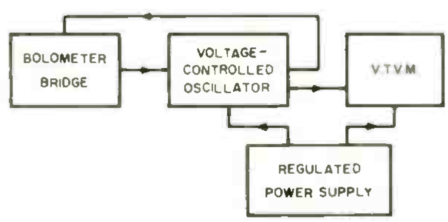


Fig. 3. Block diagram of the microwave power meter whose photo is shown in Fig. 5.

the naked eye. The barretter is constructed of a thin platinum wire surrounded by a sheath of silver. This combination is then rolled out to a very small diameter, often less than a thousandth of an inch. This thin combination wire is then mounted in a suitable holder after which the silver sheath is carefully etched away, leaving the microscopically thin platinum wire. The barretter has the advantage of low mass, that is, it responds much more rapidly than a thermistor. By this same token, it can be burned out rather easily by overloads.

Another type of transducer used is a crystal. Certain crystal diodes (1N21, 1N23, etc.) are available for such service. The crystal, when subjected to electromagnetic radiation, generates a small voltage analogous to the generation of voltage in a silicon solar battery by light.

A bolometer (of whatever type) will absorb energy from the r.f. field in which it is placed and convert this energy to heat, resulting in a change of character of one sort or another. With the thermistor it is a reduction in resistance, with the barretter an increase in resistance, and with the crystal a small voltage.

All of these devices are sensitive to temperature. In instruments used to measure the r.f. field any temperature variation in the environment or in the equipment involved in the test must be taken into consideration. Such compensation can be handled in several ways, as will be noted later.

Power-Level Meters

Fig. 1 shows a simple commercial power-level meter while Fig. 4 shows the accessories for the instrument. The accessories include a connecting cable with a group of antennas covering the frequency range from 200 to 10,000 mc. The dipole is adjustable and can be tuned from 200 to 800 mc. Each horn will respond to a broad range of frequencies with the most sensitive range of the instrument being 2 mw., one-fifth of the agreed hazardous dosage for human subjects.

Fig. 2 is a simplified schematic of the bridge circuit. It is, basically, a Wheatstone bridge with two thermistors (T_{1A}, T_{1B}) in one leg of the bridge. These thermistors are placed in series as far as the d.c. in the bridge is concerned, but they are in parallel to the r.f. energy entering through the cable. Thermistors T_2 and T_3 are included for purposes of temperature compensation. T_2 varies the resistance of the opposite leg of the bridge in accordance with the temperature of the instrument while T_3 varies the sensitivity of the galvanometer circuit with ambient temperature.

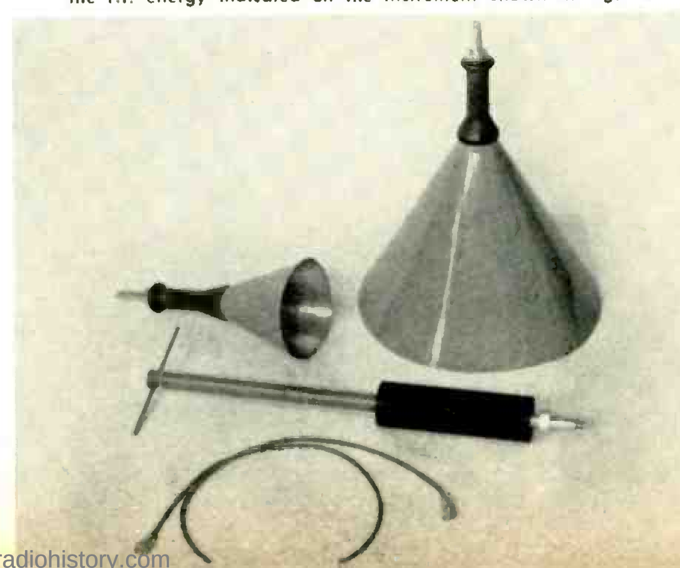
While this instrument is simple and reliable, it is somewhat limited as to sensitivity.

Fig. 5 shows a more elaborate power-level meter designed for microwave measurements where the field-strength meter is too limited in application (too narrow-band, for one thing).

Fig. 3 is a block diagram of the *Hewlett Packard* Model 430C microwave power meter shown in the photograph of Fig. 5. Basically, it consists of a bridge, an oscillator, a v.t.v.m., and a

Fig. 1. Typical power-density meter (Empire Devices Products Corp.) with a frequency range of from 200 to 10,000 megacycles.

Fig. 4. The dipole antenna and microwave horns used to pick up the r.f. energy indicated on the instrument shown in Fig. 1.



regulated power supply. The bridge is an a.c. type with power supplied by the variable-output oscillator. The amount of power supplied is inversely proportional to the unbalance in the bridge—the greater the unbalance, the lower the power. The reason for this arrangement is shown, in principle, in Fig. 7. The bolometer, being insensitive to frequency, will react to r.f. as to an equivalent amount of d.c.

This is demonstrated in Fig. 7A for use with a thermistor and in Fig. 7B for a barretter. Direct current flows from the bias battery through the bolometer, heating it slightly. The oscillator supplies a 10.8-kc. signal which flows through the remainder of the bridge (and the bolometer as well).

Fig. 5. Another typical microwave power meter, the Hewlett Packard Model 430C.

With the bridge in balance, Fig. 7A, V_1 has the same voltage on its grid as on its cathode. This allows a certain amount of conduction and an a.c. voltage can be measured at point "X" by the v.t.v.m. in the instrument. Notice that the leg opposite the bolometer is a resonant network, resonating at 10.8 kc.

Now the thermistor is placed in an r.f. field. This heats the thermistor, lowers its resistance, and thereby the voltage on the grid of V_1, making this tube less conductive. This reduces the output from the oscillator (which is controlled by V_1) and now the voltage across the resonant network is once again the same as across the thermistor. At point "X" the v.t.v.m. now measures less voltage, the difference being calibrated on the face of the meter as an *increase* in r.f. power.

Similarly, with the bridge connected for the barretter in Fig. 7B (the same bridge with V_1 reversed), the voltage at point "X" is lowered when the barretter increases in resistance due to the presence of an r.f. field.

Pocket-Type Dosimeter

In contrast to the laboratory-type instruments pictured and discussed thus far, Fig. 6 shows a pocket instrument

Fig. 6. Model of the Richardson dosimeter built by author. Three small wire loops, each terminated in 10-megohm resistors, act as pickup antennas for the instrument.

constructed by the author in accordance with data supplied by Dr. A. W. Richardson of St. Louis University. This instrument consists of a simple resistive-type antenna (R_X, R_Y, R_Z in Fig. 8), a diode detector, an a.c. amplifier, a second detector, and a meter. The amplifier can only amplify a.c., hence the instrument is limited to the measurement of *modulated* microwaves, whose modulation frequency lies within the response capabilities of the amplifier. Unmodulated r.f. will not be indicated on the meter.

This instrument has some obvious disadvantages, due to the simplicity of its circuitry. It will possibly show the same radiation level for what are actually different levels modulated by a different waveshape, because of the limited response of its amplifier. Continuous-wave energy will not be registered at all. In addition, the instrument is sensitive to hand capacity and will pick up "noise"—stray radiation from such sources as fluorescent lamps, etc.

Unsatisfactory as this instrument is, it is a step in the right direction. The military and industry are actively seeking a pocket dosimeter which will do the job of warning personnel of excessive radiation. Such an instrument must meet certain criteria: it must be compact, accurate, sensitive, frequency insensitive within a broad range, stable, and preferably inexpensive. Obviously this is a big order.

Even with a satisfactory dosimeter,

(*Continued on page* 79)

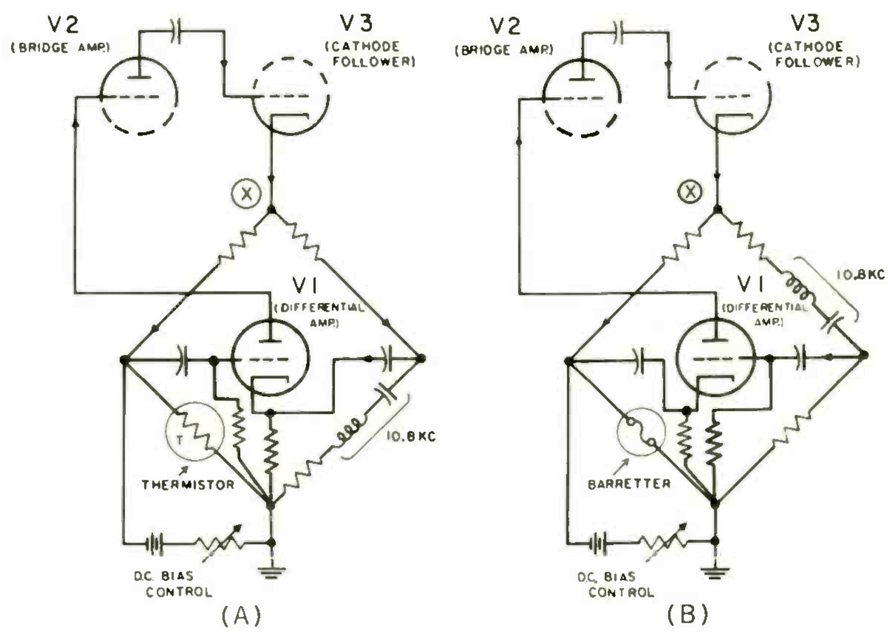
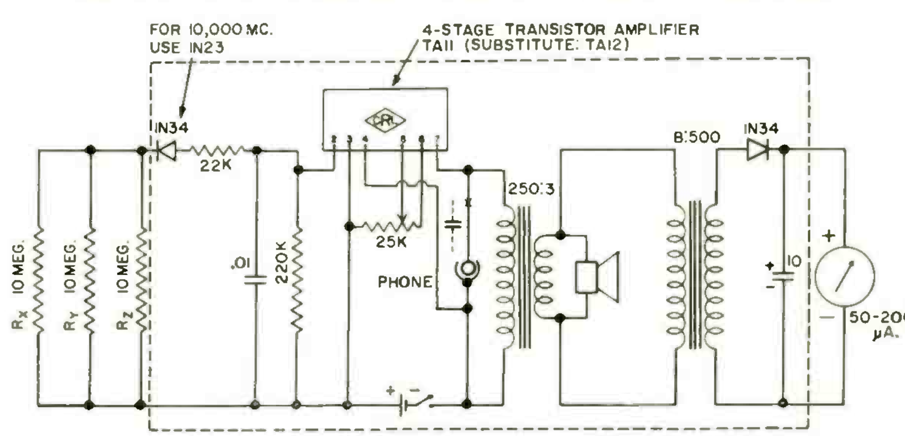


Fig. 7. Simplified schematics of the (A) thermistor bridge and (B) barretter bridge.

Fig. 8. Circuit diagram of the dosimeter that is shown in the photograph of Fig. 6.



DO YOU WANT WARRANTY WORK?

Whether it pays for you to take on "authorized" repair work under a manufacturer program must be weighed against your particular situation, but you must know what factors the decision involves.

ONE STATEMENT can be made concerning "warranty work" without fear of stirring up disagreement: it has become a matter of major importance to the independent electronic service industry. Beyond this, there is a variety of opinions, most strongly held, and few in accord with each other. Some service spokesmen hail it as an effective antidote to captive service; others indict it as an insidious evil—as bad as captive service, if not a form thereof.

Nothing is simplified by the fact that the broad term covers many plans that vary from each other, with different merits and drawbacks. Yet this variety cannot be made the scapegoat for the discord. Take any specific warranty plan and you will stir up as much disagreement over it as on the subject in general.

It also helps little to point out that, broadly speaking, "warranty work" has been a factor in electronic service for many years, or that even the hotly disputed "extended" warranty is not a late innovation. The cause for dissension lies elsewhere: although long-term guarantees and those that include labor are not new, they have become widespread with respect to TV service only lately. This removes them from the class of incidental matters and brings them into the bread-and-butter category. If they take hold, they are bound to make changes in the complexion of the industry, one way or another.

A universally applicable verdict on warranty plans cannot be handed down for several reasons. What may be said for or against one plan need not apply to another. For any version, moreover, it is difficult to reconcile the long-range interests of an entire industry with the immediate situation of a particular shop. Individuals and groups must reach their own decisions. However, they cannot do so unless some of the smoke surrounding the issue is cleared away. To this end, a brief history of what "warranty work" is, how it came into being, and why, is necessary.

What Is Warranty Work?

In broad terms, "warranty work" is service performed on equipment under the terms of an agreement made with the buyer prior to the necessity for such service, as distinct from service contracted and paid for as the need arises. The TV service contract of an earlier day, which was often a direct agreement between owner and service shop, thus also falls into this category.

An agreement of the kind noted may exist with respect to a TV set, a table radio, an auto radio, a Citizens Band unit, two-way communications equipment, or other gear. In fact, many readers will recognize that extended warranties have been used and accepted for many years relative to some of the types of equipment just mentioned, TV sets aside, for many years—in some cases, before there were such things as TV sets. With certain types of equipment, such as the auto radio, just the type of warranty that is causing such dispute now has been with us for a long time without raising much argument.

What has brought the extended warranty into TV service today? Until recent years, there was such a thing as a "standard" industry warranty for 90 days on all parts and tubes, labor excluded, with a year's warranty on the picture tube. The chief factor in encouraging extensions is the present system for merchandising TV receivers. Years ago electronic equipment, like other durable goods, was sold to the consumer by the same establishment that maintained its own service department. The purchaser turned to the immediate vendor for service and satisfaction. The dealer found it good business to stand behind the product he sold. In addition, the profit he was able to realize from the sale gave him some flexibility with respect to after-service.

However, merchandising has come a long way since that earlier day. The growth of the discount house and the separation of function that has made the seller one specialist and the service dealer another have been profound changes. The seller, working on a lower mark-up than was true once, seldom assumes much obligation for after-sale performance. A distressed buyer is either on his own, or he takes his complaint right to the manufacturer, for want of a handier agency.

Beyond the conventional parts guarantee, the set maker may elect to give the buyer little more than sympathy. If he chooses this path, his reputation suffers and he incurs a competitive handicap—especially if other TV manufacturers provide more than he does. So he looks for a way to reassure the buyer. He may go so far as to establish his own service facilities. Enter captive service. In addition to or instead of such facilities, manufacturers have "discovered" the extended warranty, which may involve the independent shop.

Terms and Conditions

His great new discovery is not an unmixed blessing even for the manufacturer. Despite its many advantages, administration of an extensive program brings its own headaches. However, his problems are not our present concern: first consideration must go to the people who buy TV sets and those who fix them. Since the effects of a warranty depend on its terms, the latter have to be taken into account.

For the customer, there is the conventional, 90-day parts warranty and something beyond it. In one form of extension, the period covered remains 90 days, but the degree of coverage is increased: he need pay no labor fees for work done. In other forms, all parts may be protected for a year, but the manufacturer will cover labor charges only for 90 days, or perhaps not at all. The broadest type of extension is probably that in which all parts and service fees are covered for a year. There are various combinations of these basic terms.

Almost all warranties, even the broadest, have some exclusions. Defects due to externally inflicted damage are not covered. Often the manufacturer does not consider transportation as chargeable service. This means that, although there is no fee levied for actual work performed, the customer must pay the service dealer his regular house-call fee for coming down to look at the set and also to bring it to the shop, if necessary, or the owner must bring the ailing receiver in himself.

For the service dealer, there are many more factors to consider. To begin with, he generally must become an "authorized" service dealer of the manufacturer. This seldom prohibits him from working on other makes, or even from acquiring other authorizations, but it usually carries important requirements. He is frequently expected to meet certain minimum conditions. His test equipment and shop facilities may have to come up to prescribed standards. He may have to provide some evidence of technical competence.

He may also be required to stock a minimum complement of parts, possibly including tubes, made by the authorizing manufacturer or used in his equipment. Parts under guarantee, of course, must generally be replaced by "exact" components obtained from this manufacturer. In addition, the latter may stipulate that *any* set made by him, even one that is out of warranty, be provided only with exact replacements procured from him or his distributor. This condition, not an easy one to police or enforce, is not usually made. In any case, the service shop receives a direct replacement or credit for any guaranteed part it must remove and discard, making no profit on that component.

As to the handling of labor charges, there is much variety. Some plans make the dealer a service contractor. The manufacturer gives him a flat fee for each warranted receiver for which he assumes responsibility and, win or lose, he must keep the customer happy for the length of the guarantee period without additional re-imbursement. In other cases, the dealer receives nothing initially. Instead he is individually paid for each job on a warranted set.

Even within the limits of a per-job arrangement, there are many alternatives. The dealer is seldom permitted to establish his own rates or even determine the fee for each job on an individual basis working from an agreed-on hourly rate. He is generally handed a flat-fee schedule. For example, this might allow him $1.75 for changing a tube or performing some other minor operation for a TV set on a walk-in repair. If house calls are included in the warranty, he may get a flat allowance of $5.00 for each one. He may be allowed $2.00 for the labor in repairing any radio using tubes, $3.00 for his work on a transistor radio, $1.00 for repair or replacement of a clock used in a radio, $2.50 for an auto-radio repair, $13.75 to replace a picture tube in the customer's home, $4.00 for an automatic, portable phonograph, and so on. The examples cited, which cover labor only, have been culled from the schedules of several manufacturers to give the dealer an idea of what he may expect.

Before attempting any evaluation, we must consider a final, important element. With whom does the service technician deal under this program? In obtaining authorization, he may have to go directly to the manufacturer. However, either all or some of the manufacturer's role may be delegated to a local distributor. For obtaining parts, the distributor is likely to be more directly involved. Labor claims may have to be turned over either to the distributor or directly to the manufacturer.

As to the relationship with the equipment owner, it may range anywhere from being very close to being nonexistent. The owner may be "assigned" to a particular dealer from the outset, be referred to him when trouble occurs, or choose him from a list of available, authorized dealers. In any of these cases, there is direct dealer-owner liaison. In other programs, the owner takes his complaint—and his set—to the distributor or the dealer who sold it to him. This middle man then goes to the service-shop operator. Under this arrangement, the latter may never even get to know who the set owner is, much less have contact with him.

Advantages & Disadvantages

The equipment manufacturer is quick to point out what he considers real advantages to the service dealer. His authorization, which may involve signs that can be placed in or about the shop and possible listing in Yellow-Pages advertising under the manufacturer's name, can enhance the dealer's reputation. There are frequently some phases of special technical training or provisions for a flow of service data and other technical information that are exclusively part of the packaged program, not available to non-participating dealers. The manufacturer also holds out the prospect for additional work, additional profit, and additional post-warranty customers.

The attractiveness of some of these enticements is by no means assured. In the long run, the dealer may notice no increase in the number of jobs he gets. If extended parts-and-labor warranties become widespread and solidly established, some argue, this will not increase the amount of available work because it has no effect on the frequency with which equipment breaks down. What the dealer gains in warranty work will simply be lost in jobs that are no longer coming in directly from the customer.

Assuming that new business is indeed brought in, which may well be the case, this does not automatically mean additional profit. Take the case of the $5.00 allowance for a house call on a TV set. Many authorities, including some manufacturer-affiliated service companies, insist that the average shop needs at least $7.00 on each outside call just to break even. In fact, most manufacturer-sponsored service companies charge $7.00 or more. If this equipment maker allows less to an independent for the same service, the warranty program may be a cheaper way of doing things! On the other hand, there are many independent shops that regularly charge $5.00 or less. Thus your own decision with respect to a particular flat-fee program may depend on how your regular, average rates for various types of work stack up against the manufacturer's allowance.

Even if your regular rates are higher, some argue, warranty work may pay off. If it brings in new work, the increased volume may enable greater efficiency, resulting in the ability to make profit at the lower rates. As part of this, it may pay you to keep your staff busy on a break-even basis that will do no more than help maintain shop size.

When you get a flat amount to cover each set for its entire warranty period, another factor must be considered. Some manufacturers who have tried this system have based their allowances on honest, extensive research into the frequency-of-repair rates on their sets over many years. The fee may be a sincere attempt to give the dealer fair payment for the probable work he will have to perform, on the average. Nevertheless, many dealers who have hopefully entered into such agreements, in recent years, have dropped out after the first year because they lost money.

What has happened here? Evidently the manufacturer's research has not taken the human element into account. His figures were based on repair records for sets not covered by warranty. When the owner knows he has some insurance, he becomes another sort of person. He wants his money's worth. Minor irritations that he would be willing to overlook if they involved additional cost suddenly loom large if service is "free." The complaint rate rises.

As to increased non-warranty business, it would seem that this is ruled out when the customer does not deal directly with the service establishment. This need not be true. Many set owners continue to call on accustomed sources for service even after their warranties have expired. Thus the manufacturer, distributor, or non-servicing dealer may be in a position to direct some worthwhile business your way. On the other hand, direct warranty dealing with the customer does not guarantee that he is yours forever. If he is unhappy with the set or upset over some annoying exclusion that was "overlooked" by the salesman who sold him on an "unlimited" warranty, his only scapegoat is the service dealer. He will not make a good customer.

Another point: if you want this sort of business, you must be prepared to deal with claim forms and other paperwork. In a well-organized shop, this requirement is not the formidable obstacle many people have made it out to be. Nevertheless, red tape is red tape. It does mean extra work.

Your financial status should also be

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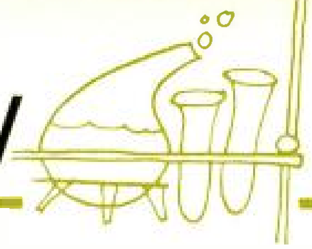
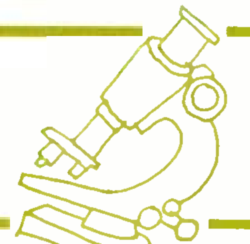
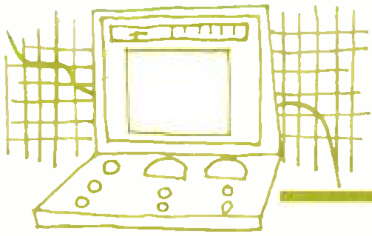
HOW  SOLUTIONS ARE ANALYZED  ELECTRICALLY



By JOHN R. COLLINS

The method, using a polarograph, is widespread. How it's done; maintenance and other data for technicians.

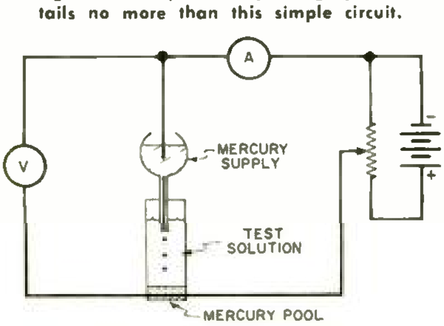
IF YOU ARE associated with some phase of medical electronics, or if you work in a laboratory where metallic alloys are developed or the properties of germanium are investigated, you probably have already encountered the polarograph. If not, this instrument, some day, may well play a part in your occupation; for polarography is a growing science, and more and more industries are finding ways to use it.

Polarography is a method of finding the chemical composition of solutions by passing an electric current through them and simultaneously recording the current and the voltage. Both qualitative and quantitative information is obtained in this way.

While nearly all of the chemical elements can be detected with the polarograph, it is especially valuable where traditional analytical methods are slow and difficult. Thus, it is used for determining the amount of titanium in steels and nickel-base alloys, for detecting minute traces of thorium, and (since almost anything can be dissolved) for the analysis of glass and refractory materials.

Biochemical and medical uses have become increasingly important in recent years. They involve organic substances with complex molecular structures and are, therefore, far more difficult to analyze. Streptomycin, penicillin, proteins, and vitamins can all be detected and analyzed with the polarograph. It is also useful for diagnosing certain diseases through the analysis of blood samples.

Fig. 1. A basic, manual polarograph entails no more than this simple circuit.



Compared with other analytical methods, polarography has many attractive features. It is fast, accurate, and operates with very dilute solutions containing only traces of the substances to be analyzed. Furthermore, the sample is not destroyed or materially altered by the test.

Basic Apparatus

A simple, manual polarograph is illustrated in Fig. 1. The container or cell for the test solution has a pool of mercury in its bottom. A bulb filled with mercury is suspended above the cell, and a small tube extends from the bulb into the test solution. Electrical contact is established with the test solution by means of a wire through the base of the cell to the mercury pool, and by the small mercury tip at the end of the tube. Droplets of mercury fall from the tube at the rate of one every few seconds, so that a fresh tip is always in contact with the solution.

Since the mercury tip is small and readily polarized, its voltage varies over a range as the setting of the potentiometer in Fig. 1 is changed. The mercury pool, on the other hand, tends to maintain a constant voltage, and thus serves as "ground."

With the battery polarity as shown, the mercury pool is the positive electrode and the mercury tip is the negative electrode. The ammeter and voltmeter are connected as shown to permit measurement of the current through the test solution and the voltage across it.

To perform an analysis, the test solution is placed in the cell and the potentiometer is swept slowly over its entire range, while careful record is made of current and voltage readings. At the beginning, a small current, called the *residual current*, will flow; it will increase slowly as the voltage is raised. Residual current is due to minute impurities, too small for analysis, that are nearly always present, and also to the capacitance existing between the electrodes. Since the mercury tip is constantly being replaced, the layer of electrons on the tip must also be renewed, and current flow, although small, is continuous.

As the potentiometer setting is changed, a point is reached where the current increases abruptly, in a sudden wave. This is called the *diffusion current*. Current flow continues at the new level and increases only slowly as the voltage is further increased.

Theory of Operation

To understand the reason for the sudden surge of current, it is necessary to visualize what is taking place in the solution. The test solution contains ions of the unknown substance, that is, positive or negative charged particles having either a deficiency or a surplus of electrons. When a positive ion is in contact with a negative electrode, electrons will be transferred from the electrode to the ion, and this will produce current flow. However, the transfer does not occur until a critical voltage level is reached, and that causes the sudden current surge.

The process by which a positive ion takes on an electron is called *reduction*, and the ion is said to have been *reduced*, since its positive charge has either become less or ceased to exist altogether. Similarly, a negative ion will give up an electron at a positive electrode, and that process (for an obscure reason) is called *oxidation*, a word for which the reader may have another meaning.

The important fact is that both oxidation and reduction occur only when critical voltage levels have been reached, and the critical voltage is different for each element and molecule. Therefore, by measuring the precise voltage at which this *current wave* occurs, it is possible to deduce the substance that caused it. In this way, a qualitative chemical analysis is performed.

The height or amplitude of the current wave depends on the number of reducible or oxidizable ions in contact with the electrode; and this number is in proportion to the concentration of the solution. If the solution is of uniform composition, current will continue at the same level, since a new tip is constantly presented to the solution and the number of ions in contact with it remains the same. By measuring the *height* of the current wave it is therefore possible to deduce the *amount* of the element in the solution. Thus, a quantitative analysis is obtained with this technique.

Automatic Equipment

A practical, automatic polarograph is shown in Fig. 2. It operates with either storage batteries or a regulated power supply. The polarizing voltage applied to the cell is obtained through a motor-driven slidewire, which moves at a constant rate. There are three voltage ranges: 0 to +2 volts, −1 to −3 volts, and +1 to −1 volt. The polarity of the mercury-dropping electrode can be reversed by throwing a switch, so a wide range of voltages is available for both oxidation and reduction analyses.

The current pattern is charted by a motor-driven pen recorder. A standard cell is incorporated in the equipment to permit accurate calibration of the polarizing voltage. The associated mercury-dropping electrode and cell, shown in detail in Fig. 3, is contained in a water jacket to permit temperature regulation, since conductivity increases with temperature and might lead to erroneous interpretations, if no correction is otherwise provided.

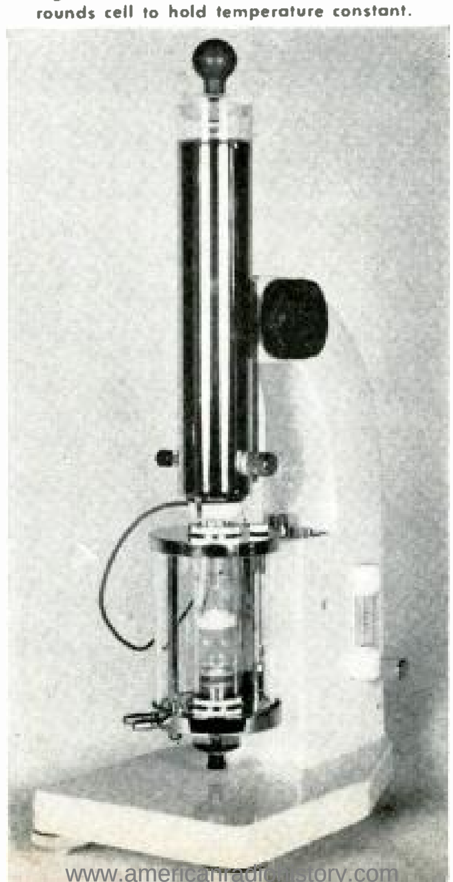
Part of a typical curve produced by a recording polarograph is shown in Fig. 4. As the mercury-dropping electrode is made more negative, the residual current increases only slightly, as previously described, until a point is reached where the current suddenly increases to a new level, producing an S-shaped wave. Since both the beginning and end of the wave are poorly defined, it is customary to identify the critical voltage in terms of the *half-wave potential*, that is, the voltage at the point on the curve midway between the top and the bottom of the wave.

The top of the wave has a characteristic saw-tooth appearance. This results from the fact that each drop begins as a tiny particle and increases in size until it falls from the tube. The current is proportional to the area in contact with the solution, and accordingly increases as the mercury drop becomes larger, then falls off as the drop is released and a new tip is begun. Thus, each peak represents the point at which a mercury drop was released. The usual dropping rate is one every 2 to 4 seconds. Faster rates would make smaller oscillations, but tend to stir the solution and cause erratic results.

The diffusion current is measured from the projected base line to the midpoint of the saw-tooth wave, as shown. Since the current depends not only on the concentration but also on the temperature, temperature must either be controlled or allowed for in estimating the quantity of the reduced or oxidized substance in the solution. Standard concentrations are often used to calibrate the instruments.

Fig. 2. This automatic polarograph connects to the cell in Fig. 3. The chart has recorded 2 current waves (see text).

Fig. 3. Mercury-dropping electrode (top) with associated cell (bottom) for holding the test solution. Water jacket surrounds cell to hold temperature constant.



The polarograph can be used to detect and identify a number of different substances in a single solution. If two substances are present, for example, a curve such as that recorded on the polarograph chart in Fig. 2 will be produced. In order to be distinguished, the substances should have oxidation or reduction potentials that differ by at least 0.15 volt. If the difference is less than that amount, the two waves tend to merge, forming one long, continuous wave.

Other Factors

An important consideration in polarography is the nature of the electrolyte in which the test sample is dissolved. The oxidation and reduction characteristics of substances are not the same in neutral or acid electrolytes as they are when dissolved in an alkali solution. Much present research is devoted to the investigation of supporting electrolytes, since they make it possible to oxidize or reduce substances that otherwise cannot be identified. Furthermore, two substances that have almost identical half-wave potentials in one electrolyte may have quite different half-wave potentials in another solution, and can thus be separately identified.

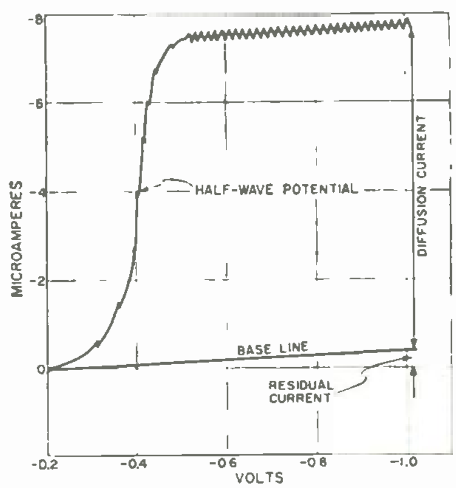


Fig. 4. Analytical curve traced for a particular solution, with details noted.

The influence of supporting electrolytes emphasizes the fact that, while the equipment itself is automatic and easy to operate, a trained chemist is needed to plan the tests and to interpret the results.

Oxygen is one of the most easily reducible elements: its presence in a solution produces a broad polarographic wave that tends to obscure the presence of other substances. For this reason, it is customary to bubble either hydrogen or nitrogen gas through a test solution for about ten minutes before a polarographic analysis is made to remove the dissolved oxygen. However, the fact that oxygen is readily detected by polarography is an asset when it is desired to test for its presence. As a result, the polarograph is often used to determine the amount of oxygen in blood plasma, orange juice, soils, fer-

(*Continued on page* 111)

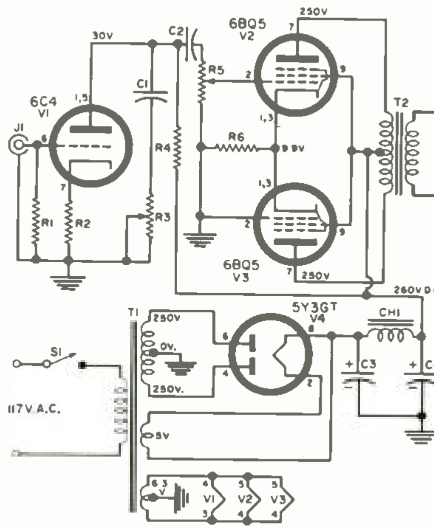
COMPACT HI-FI POWER AMPLIFIER

By **MELVIN LEIBOWITZ** / Delaware Electronics Supply Co.

Constructing a 6-watt amplifier in which the output tubes serve as their own phase inverter.

MODERN tubes and components have done much to destroy the old-fashioned idea that high-fidelity amplifiers must be cumbersome and expensive. The unit to be described is a case in point. Excellent performance is obtained although a mere handful of lightweight, inexpensive components are required in the construction. The very simplicity of this circuit is partly responsible for its performance as there is so little to go wrong with it.

The design of this amplifier, as is the case with any amplifier, centers around the output stage. EL84/6BQ5 tubes were selected for the output stage for several reasons. They will produce adequate power at low distortion with only 250 volts on the plates and screens. Plate current requirements are modest. The most important consideration in the use of 6BQ5's was their low drive requirements. Only 22.5 volts grid-to-grid are required to drive the tubes to full output. Compared with the better known 6V6, the 6BQ5 will produce more output with lower distortion, less plate-current consumption, at about one-third less grid drive. This means that if we use the 6BQ5, our power supply may be reduced in size and the voltage amplifier stages preceding the power amplifier stage may be simplified. We have achieved a large part of our goal simply by choosing the correct output tubes. A little unusual circuitry now comes into play to enable us to reach our goal of the "ultimate" in a simple, yet good, amplifier.



R_1—470,000 ohm, ½ w. res.
R_2—4700 ohm, 1 w. res.
R_3—100,000 ohm pot
R_4—560,000 ohm, ½ w. res.
R_5—500,000 ohm audio-taper pot
R_6—130 ohm, 2 w. res. ±5%
C_1—.02 µf., 600 v. capacitor
C_2—.1 µf., 600 v. capacitor
C_3,C_4—20/20 µf., 450 v. elec. capacitor
J_1—Phono jack
CH_1—5-15 hy., 75 ma. filter choke
S_1—S.p.s.t. switch
T_1—Power trans. 250-0-250 v. @ 75 ma.; 5 v. @ 2 amp; 6.3 v. @ 2.5 amp. c.t.
T_2—Output trans. 8000 ohms c.t., 15 watts, to 3-4 ohm sec. (Triad S-21-A, see text)
V_1—6C4 tube
V_2,V_3—EL84/6BQ5 tube *V_4—5Y3GT tube*

Circuit diagram of the amplifier. The signal for output tube V_3 is the voltage developed across unbypassed resistor R_6.

It will be noticed that there is no phase inverter in the amplifier and, at the same time, the hook-up of the output tubes is unconventional. The output tubes act as their own phase inverter. This type of circuit is not new and can be found in some of the audio handbooks. The circuit is not used much despite its advantages of good inherent balance, simplicity, and low drive requirements. There are those words "low drive" again!

Only one tube is driven in this circuit as opposed to two in the normal type of output stage. This means that the required driving voltage is halved which, in this case, now amounts to 11 volts. Almost any tube will supply the required 11 volts when driven from a ceramic phono cartridge, FM tuner, or tape deck so we eliminate the multi-tube input stages found in most amplifiers and end up with a single 6C4. Inasmuch as we do not have a great deal of voltage amplification we do not need a lot of filtering in the power supply, hence almost any filter choke and capacitors will do the job. Since we are not striving for maximum gain in the input stage, the cathode resistor has not been bypassed, thus giving us desirable inverse feedback and saving the cost of the bypass capacitor.

Some further information about the output stage is in order. The plate current of V_2 varies in accordance with the signal. The voltage across the cathode resistor, R_6, will also vary as a result.

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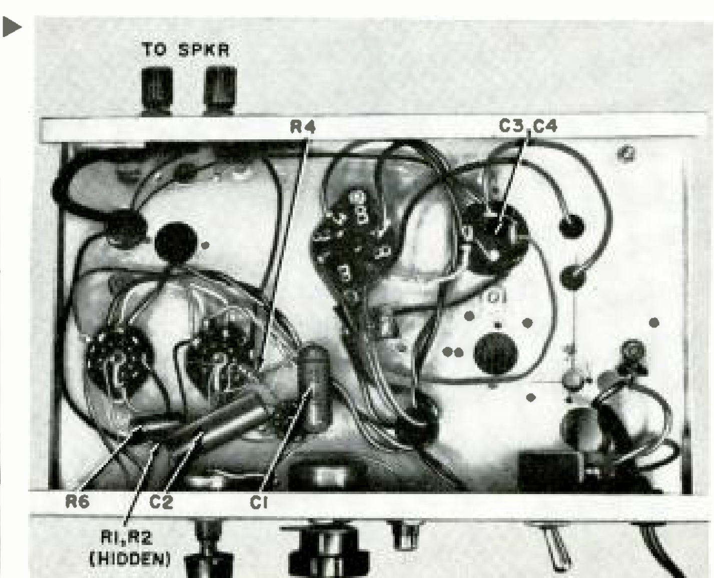
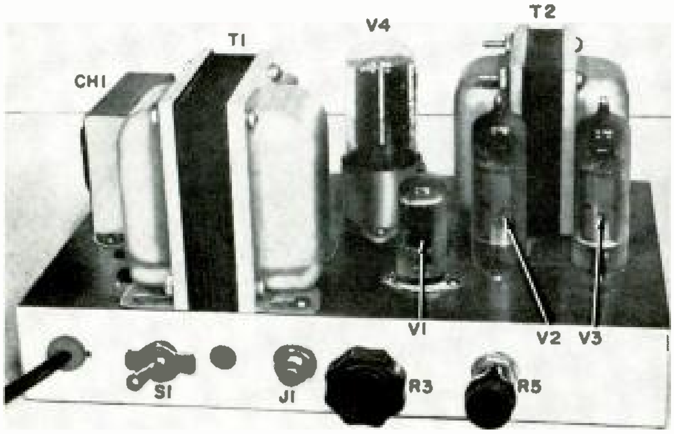
Bottom view of chassis shows the small number of parts. ▶



Unit is built on a 5½" x 9½" x 1½" hand-punched chassis.



Devices that take counts and control machinery depending on that count have resulted in improved product quality and reduced cost. Here is how these devices operate.

By **ED BUKSTEIN** / Northwestern TV and Electronics Institute

GENEROUS use of counting equipment has permitted industry to approach that long-sought goal: maximum quality of product at minimum cost per unit. Two general types of counters are used in industry—those that merely count and those that *control* as well as count. The first type is used for totalizing objects moving by on a conveyor belt, items coming off an assembly line, pieces stamped out by a punch press, etc. The second type, the controlling counter, is an active part of the machine or system to which it is connected. This type of counter is used, for example, to stop a machine after the required number of items has been produced, to separate the items into batches for automatic packaging, to supply input information to a computer that calculates production schedules and take-home pay for "piece" workers, and many other uses.

In its simplest form, the totalizing counter is a purely mechanical device. It consists of a set of numbered wheels like those that indicate automobile mileage. Each wheel is connected to the next wheel through a ten-to-one reducing gear so that ten revolutions of one wheel will produce one revolution of the next wheel. The numbered wheels therefore indicate units, tens, hundreds, thousands, etc. The units wheel is operated through a ratchet by a lever mounted on the outside of the counter case. The lever of this so-called *stroke* counter is mechanically linked to one of the moving parts of the machine to which it is connected. Each operation of the machine therefore depresses the lever and advances the units wheel one count.

The *revolutions* counter is similar to the stroke counter except that it is actuated by a rotating shaft instead of a lever. This type is useful in connection with rotating machinery in which each revolution of a shaft represents one unit of production. Both the stroke counter and the revolutions counter are useful for production totalizing, as an aid to scheduling preventive maintenance procedures, for validating machine guarantee, and for providing a comparison of day-shift and night-shift production. A disadvantage of both the stroke counter and the revolutions counter is that they must be mounted on or near the machine to be monitored. These counters are therefore not useful as *remote* indicating devices. Remote indication is often required so that the production rates of many machines may be monitored and coordinated from a centralized control office. Another disadvantage of stroke and revolutions counters is that they are not readily adaptable to counting operations in which the available mechanical force is small (counting objects on a conveyor belt, for example). These disadvantages are overcome by the electric counter. This is similar to the stroke counter except that the lever is actuated by a solenoid. The solenoid can be controlled by a relay or by a switch mounted on the machine, and the counter can be located at a distance. An electric counter, also known as a register, is shown in Fig. 1.

The number of wheels of a register provide visual readout, but switches may be built into the register to provide electrical readout as well. Electrical readout is useful for the operation of remote indicators and for providing input information to adding machines, tabulators, and digital computers. As shown in Fig. 2, a ten-position switch for each number wheel of the register provides the electrical equivalent of the number displayed on the register. Many registers, connected to different ma-

Industrial Counting Techniques

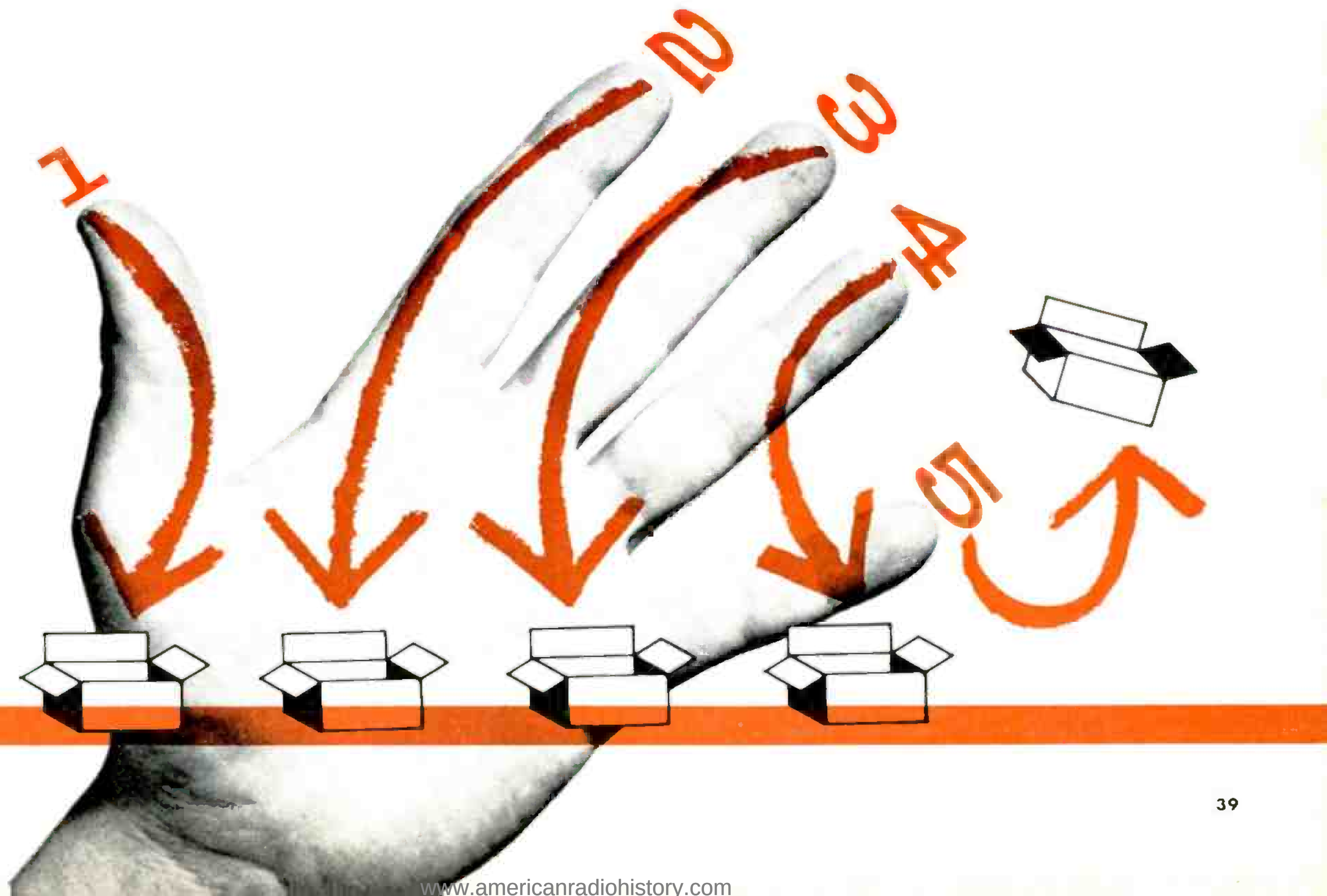


Fig. 1. The electrically operated counter, unlike purely mechanical counters, can be located at a distance from the machine or from the process that is being monitored.

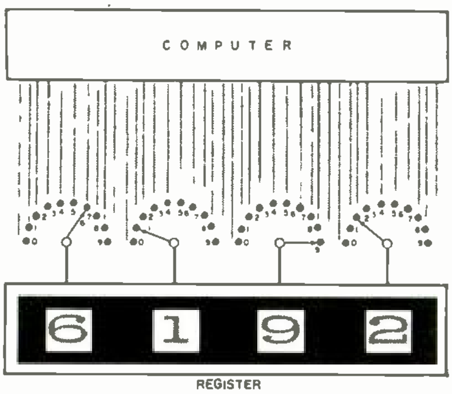


Fig. 2. Register with electrical readout can supply input information to computer. Computer calculates production schedules and controls the flow of raw materials.

chines, may communicate with a computer in this manner. The computer, responding to this input information, performs calculations, controls the flow of raw materials, and coordinates the actions of the machines.

Sensing Heads

When a counter is actuated by either reciprocating or rotary motion of the machine to which it is connected, some inaccuracy of count may result. Inaccurate count may result from (1) machine operations which occur when no raw stock is being fed into the machine and (2) counting of spoilage and substandard parts that will later be rejected. For these reasons, the counting equipment is often designed to count the objects themselves rather than the machine operations. As shown in Fig. 3A, this technique involves a sensing head which will produce one output pulse for each object to be counted. Since the output level of the sensing head is relatively low, an amplifier is required to raise the pulse level sufficiently to operate the counter. A photoelectric sensing head (Fig. 3B) is frequently used for counting objects passing by on a conveyor belt. Each object momentarily obstructs the light beam, and the phototube produces an output pulse. A variation of the photoelectric counting technique is used for counting stacked paper cups. As shown in Fig. 3C, the stack of cups moves with respect to the photoelectric scanning head. The lip of each cup momentarily reflects light to the phototube, producing an output pulse. Small objects such as bolts, washers, etc. may be counted by allowing them to fall on a metal plate attached to a microphone (Fig. 3D). The sound produced by each object is therefore converted to an electrical pulse. As illustrated in Fig. 3E, counting techniques may be used for performing lineal measurements. A friction wheel rides on the surface of a long strip of material (paper, cloth, plastic, etc.) and the wheel is coupled to a brass disc having a steel insert. Each revolution of the disc causes the steel insert to pass by an inductive pickup element. By proper choice of circumference of the friction wheel or by appropriate gear ratios in the wheel-to-disc coupling,

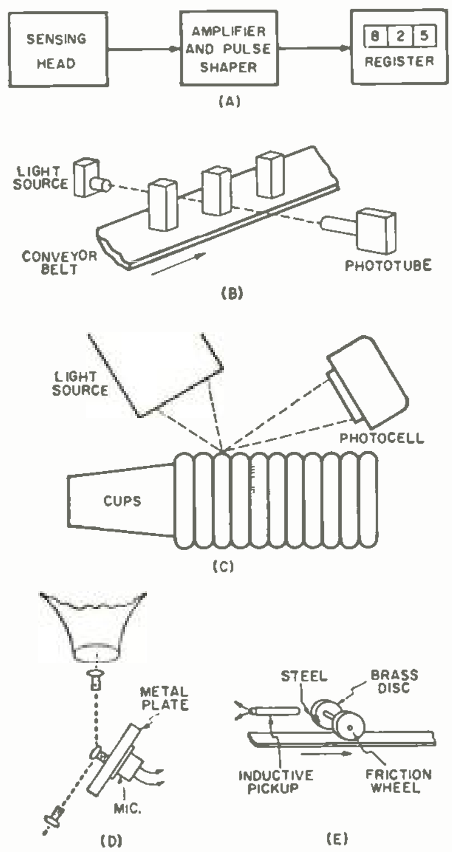


Fig. 3. Sensing head produces output pulse for each object to be counted. The amplified pulse actuates a register. See text.

each pulse induced in the pickup element may be made to represent one inch, one foot, one yard, or any other unit of linear measurement.

Electronic Scalers

Modern, high-speed production machinery often operates at a speed which the register cannot follow. The inertia of the number wheels and other mechanical components of the register keeps it from accurately counting the high rate of input pulses. In situations of this type one or more decade counters may be used ahead of the register as shown in Fig. 4. The decade counter (see "Basic Decade Counters," Electronics World, August 1958) is a frequency divider having a ten-to-one ratio of input to output pulses. Since the pulse frequency (representing the production rate) is divided by a factor of ten, the register operates at only one-tenth of the production rate. If two decades are used as shown in Fig. 4, the register will be pulsed once for every 100 units of production. The decades introduce a two-fold advantage: (1) the pulse rate is reduced to a value which the register can accurately follow and (2) the lifetime of the register is prolonged because of the lower counting rate.

With two decades preceding the register, as shown in Fig. 4, each count shown on the register represents 100 units of production. The register reading must therefore be multiplied by 100 to determine the true production rate. Since the register will not advance until 100 units have been produced, special indicators must be used to display numbers less than 100. For this purpose, neon indicators or *Burroughs* "Nixie" tubes are generally connected to the decades. The instrument shown in Fig. 5 contains two decades, each of which has four neon lamps numbered 1, 2, 4, and 8. Fig. 6 shows the indications for a total count of 57,639. The digits 576 are displayed on the register, and the digits 3 and 9 are indicated by the lighted neon lamps (1 plus 2 in the second decade and 1 plus 8 in the first decade).

Predetermined Counters

A switch may be built into the register in such a way that its contacts will close (or open) when the number wheels have advanced to a specific reading. Registers of this type are useful for predetermined counting, the switch being used to stop a machine after the preset number of items have been produced. This is one of the basic techniques of automation since it frees the operator from the responsibility of monitoring and stopping the machine manually. In a modification of this technique, the built-in switch energizes a solenoid that automatically resets the counter to zero, allowing the count to begin

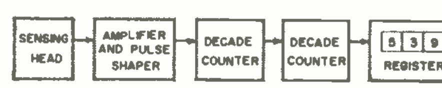


Fig. 4. Decade counters reduce the pulse rate to low value which register can follow.

Fig. 5. A totalizing counter containing two decades. Register and lamps show total count.

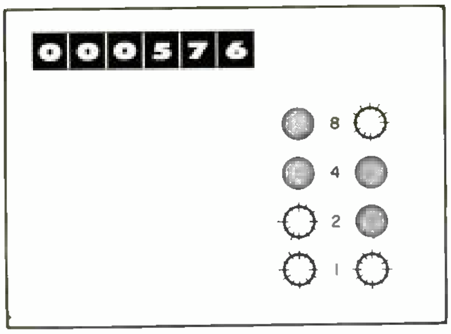


Fig. 6. Register and neon indications for total count of 57,639. Neon lamps indicate units and tens; register indicates hundreds, thousands, and so on.

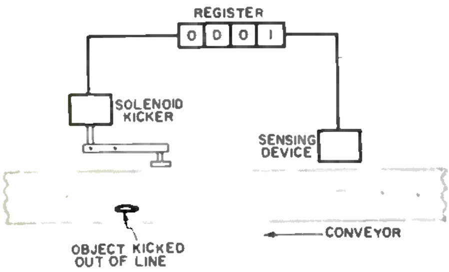


Fig. 7. Object pushed out of line by the kicker represents end of the batch.

anew. The switch contacts may also be used to energize a solenoid "kicker" as shown in Fig. 7. Every 144th (or some other selected number) object on a conveyor belt is "kicked" out of line. In this manner, the objects on the conveyor belt are *batched* or *grouped* for subsequent packaging. The "out of line" object may be detected visually by an operator or automatically by a phototube, causing another conveyor belt to bring the next empty container into the filling position. In this way, exactly 144 (or other selected number) objects are packaged in each container. For high-speed counting applications in which the number wheels of the register cannot move fast enough to maintain an accurate count electronic predetermined counters are used.

Fig. 8 illustrates the use of a predetermined counter for controlling the cutting of a long strip of material into predetermined lengths. A friction wheel, riding on the surface of the material, rotates a brass disc having a steel insert. Each time the steel slug passes the inductive pickup, it changes the reluctance of the magnetic path of the pickup coil. The resulting pulse in the pickup coil is fed into the predetermined counter. Each count therefore represents one unit of length, depending upon the circumference of the friction wheel. When the desired length of material has passed through, the predetermined counter produces an output pulse to actuate the cutting device. In this manner, the strip of material (sheet metal, paper, cloth, plastic, etc.) is cut into equal lengths. Increased definition of length can be achieved by the use of many steel slugs in the brass disc. If the friction wheel has a circumference of one foot, for example, and the brass disc has 100 equally spaced steel slugs, each pulse to the counter will represent a distance of one hundredth of a foot.

The cutting operation illustrated in Fig. 8 may be followed by an automatic *stacking* arrangement as shown in Fig. 9A. The cut sheets of material pass from one conveyor to another over a deflector plate which is normally in the down position. On the second conveyor, the sheets are counted photoelectrically and then drop into the prime piler. The photoelectric sensing head feeds pulses into a predetermined counter so that, when the desired number of sheets has been stacked, the counter produces an output pulse. This pulse is used to actuate the deflector mechanism, raising the deflector plate to the up position. The sheets are now deflected into the *waster* pile until the prime pile has been removed. A remote reset button is used to reset the counter to zero and to lower the deflector plate. The sheets then go to the prime piler until the required number has again been stacked.

To eliminate the unnecessary rejection of prime sheets into the waster pile (while the prime pile is being removed) two prime pilers may be used. An arrangement of this type is shown in Fig. 9B. Here, the predetermined counter is designed to automatically reset to zero after it has reached the required count, and the output pulses from the counter alternately lower and raise the deflector plate between the two prime pilers. When the deflector plate is in the up position, the sheets drop into prime piler No. 1. After the required number of sheets has been stacked, the counter produces an output pulse to lower the deflector plate. The sheets now pass over the deflector plate to prime piler No. 2 while pile No. 1 is being removed. When the required number of sheets has been stacked at the No. 2 position, the counter produces another output pulse to raise the deflector again. In this manner the sheets are fed to one prime piler while the other pile is being removed. The waster pile receives only those sheets which are rejected by an inspection device. A photoelectric scanning head, for example, may be used to check each sheet for the presence of pin-holes. The output of this scanning head raises the deflector plate which allows the rejected sheet to fall into the waster pile.

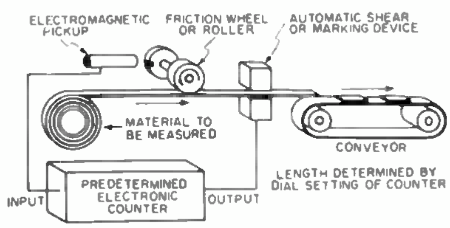


Fig. 8. Strip of material cut into equal lengths under predetermined-counter control.

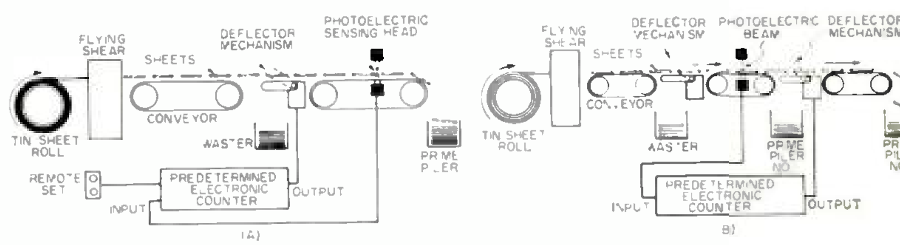


Fig. 9. Predetermined counter (A) controls number of sheets stacked in prime pile. Sheets are directed to waster pile while prime pile is being removed. (B) Predetermined counter directs sheets to one prime piler while other prime pile is removed.

Fig. 10 illustrates the use of the predetermined counter in a coil winding application. As each turn winds onto the coil form, a steel slug in the brass disc passes an inductive pickup element. The counter therefore receives one pulse for each turn applied to the coil. The dials on the front panel of the counter are set to indicate the required number of turns so that the counter will produce an output pulse when this number of turns has been wound. At this time the counter produces an output pulse to actuate a brake mechanism, stopping the rotation of the coil.

When the rotation of the coil is suddenly stopped, some problems of a mechanical nature arise—the coil may overwind, the windings may loosen, or the wire may kink. Such problems can be eliminated or minimized by winding the last few turns at reduced speed. This can be accomplished by the use of a *dual* predetermined counter. Such a counter is capable of counting to two different numbers in sequence, producing an output pulse after each of these numbers. If the coil is to have 500 turns, for example, the dual predetermined counter can be set to 490 and 10. The output produced by the counter after the 490th turn has been applied is used to slow the rotation of the coil form. The last 10 turns are wound at a reduced speed, and the counter produces an output pulse when the 10th "slow" turn has been applied. This output is used to completely stop the coil form and may also be used to activate a wire cutting device.

In the manufacture of slide fasteners (zippers) a dual predetermined counter is used to control the insertion of the metal elements. As shown in Fig. 11, one channel of the counter controls the

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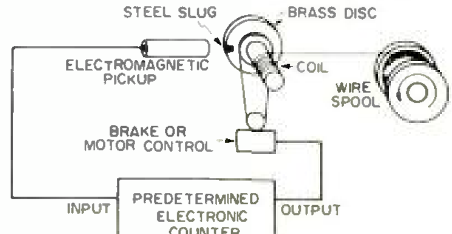
Fig. 10. Predetermined counter stops rotation of coil after right number of turns.



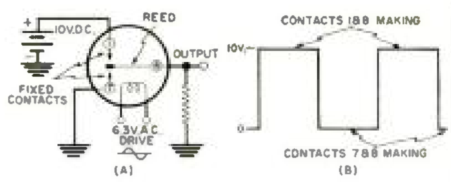


Fig. 1. Configuration (A) using a contact modulator with a d.c. input. Modulated output (B) is a square wave whose amplitude equals that of the d.c. input.

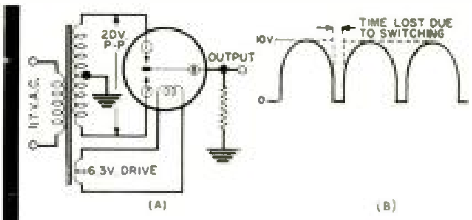


Fig. 2. When an a.c. input is applied to the chopper (A), detected output (B) resembles that of a full-wave rectifier.

MEASURE D.C. WITH YOUR SCOPE

By **LEE R. BISHOP**

A simple adapter, outboard or built in, can convert any oscilloscope into a precision d.c. voltmeter.

PERHAPS the most popular test instrument in electronics is the multimeter. It has earned its position because of its versatility in being applicable to many different types of measurements. Among the instruments that follow it in popularity, the oscilloscope has always ranked high. This device is also highly versatile. With variations in hook-up, it too can duplicate the functions of other instruments, some of them quite expensive. The scope can do many things the meter cannot, and other things the meter can. The scope can often perform with great precision. For example, with proper calibration, it can serve as an excellent a.c. voltmeter.

To date, d.c. voltage measurements are ordinarily considered best left to suitable meters, with the oscilloscope seldom considered. However, with the addition of a simple adapter, an ordinary scope, even though it may have only an a.c. input, can be made to match the performance of many precision d.c. voltmeters in use today.

The contact modulator, or "chopper" as it is more commonly called, forms the heart of this easily constructed device. A chopper is very similar to the ordinary vibrator used in one type of car-radio power supply, in that each of these devices has two fixed contacts and one vibrating contact. Unlike the automobile vibrator, however, the chopper's vibrating reed is driven by and synchronized with an a.c. voltage applied to its coil. Commercial choppers are housed in hermetically sealed cans varying in size from ½ inch to 4 inches in height, and are usually based so that they can be plugged into standard and miniature tube sockets.

How the Chopper Works

The schematic of a circuit using a chopper is shown in Fig. 1A. Near every peak of the 60-cycle sine-wave signal applied to the coil, the movable reed will be pulled to one of the fixed contacts. Near the peak of the next half cycle, the magnetic field of the chopper's drive coil will have reversed its direction so that the reed will be pushed to the other fixed contact. The reed thus makes connection with the fixed contacts 120 times per second, or 60 times per second with each individual contact.

This making and breaking or interruption can be said to modulate the d.c. voltage applied by the 10-volt source in Fig. 1A, enabling it to be passed through the vertical amplifier of an oscilloscope for display. The waveform produced by this action is shown in Fig 1B. Note the gaps due to switching time.

In addition to being able to modulate, the chopper can also serve as a phase-sensitive demodulator or detector. This type of action can be noted from the configuration of Fig. 2A. In this case, an a.c. rather than d.c. input is applied to the fixed contacts. On the first half cycle of the sine wave applied as the drive signal, the reed will make the upper, fixed contact. If this contact is positive-going during the half cycle, the reed will feel a positive voltage. On the next half cycle, the chopper reed will make with the other fixed contact, which is connected to the bottom of the transformer's secondary. Since polarity of signal in the transformer will have reversed at the same time, the reed will again sense a positive voltage.

Thus chopper output will be as shown in Fig. 2B, with two output pulses in the same polarity for every cycle of input and drive signals. Essentially this circuit is functioning as a full-wave rectifier. Reversing either the transformer's secondary leads or the chopper's drive-coil leads will cause the pulsating d.c. output to change its polarity, because the reed would touch the fixed contacts on negative rather than positive half cycles.

The Adapter; Reading D.C.

The properties of the contact modulator just described make it suitable for more than one function in conjunction with an oscilloscope. The circuit of Fig. 5 is for an outboard adapter using these properties. In the author's case, the scope was modified internally to incorporate the addition, with the chopper's drive coil connected to the filament winding on the main instrument's power transformer. This eliminated the cost of a separate chassis, filament transformer, and miscellaneous hardware. While such modification is not likely to present much of a problem with any

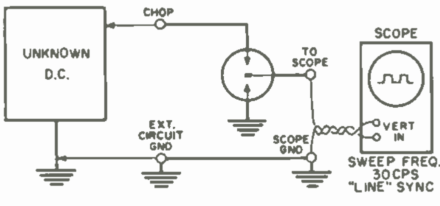


Fig. 3. Connections to the oscilloscope and the unknown voltage when the adapter is being used to make d.c. measurements.

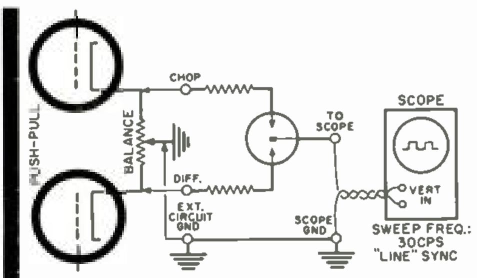


Fig. 4. The adapter may also be used for precise d.c. or a.c. balancing adjustments. This is how it would be connected for d.c. balancing of cathode currents in an amplifier push-pull output stage.

oscilloscope, the independent outboard version is shown for those who may prefer it.

The circuit has been arranged not only to provide indirect measurement of d.c. voltage, but also to permit instantaneous comparison of two voltages. This provision enables balancing adjustments of various types to be made with a convenience and precision unmatched by conventional meters while maintaining isolation between the circuits under comparison. A familiar example of this type of adjustment would be the balancing of the push-pull output stage in an audio power amplifier.

Fig. 3 shows the equivalent circuit and output waveform when the contact modulator is used in its d.c. measuring configuration (switch S_1 of Fig. 5 in the "Chop" position). Only one contact of the chopper will see the applied d.c. voltage and this will occur at the rate of 60 times a second. Since this rate is established by the frequency of the external line voltage through the drive coil, the scope is set up for "Line Sync." It should also be adjusted for a sweep frequency of 30 or 60 cps to obtain a convenient display. With output from the adapter applied to the vertical input of the scope, the latter will alternately be switched between ground and the applied d.c. voltage. This switching results in the square wave. The amplitude of this waveform reflects the magnitude of the potential difference between the applied d.c. and ground.

Because of the high impedance of the scope input circuit, the 20,000-ohm resistor in series with the chopper lead will not affect the amplitude accuracy of the square wave to any significant extent. The resistor has been included to protect the chopper contacts in the event of sticking or overload.

None of the available methods for calibrating the scope will be covered in extensive detail. A conventional calibrating circuit, built into the scope or external, may be used. The square-wave output from the contact modulator is then simply fed into the scope input and amplitude of this waveform is measured on the calibrated face or against the standard used.

For the greatest possible accuracy, a standard battery or cell, or one whose output voltage is accurately known, should be used. This battery is first applied to the d.c. ("Chop") input of the contact-modulator adapter, and the scope face is then calibrated against the square-wave output, whose amplitude is taken as the rated output of the battery. This method will cancel out whatever small error is introduced by the adapter due to the dropping resistor. Even if this is not done, however, note that the error thus introduced will be no more than a fraction of one per-cent.

Balancing Applications

Use of the device in the "Diff" position, as it would be applied in the static (d.c.) balancing of one type of push-pull output stage, is shown in Fig. 4. In this case, the chopper alternately samples the voltage on each cathode. Assuming that the two stages are not initially balanced, the scope's vertical input will alternately see the d.c. potential at one cathode and then the other. The waveform will again be a square wave, but its amplitude will not reflect the actual voltage at either cathode. It will rather reflect the potential difference between one cathode and the other, and its phase will reflect the direction of unbalance. As the potentiometer is adjusted toward correct balance, waveform amplitude will dwindle. Finally, when balance is reached, the chopper's reed will sense no difference in potential as it switches from one contact to the other, and the scope trace will become a straight line.

Although the technique outlined does not yield the absolute value of the voltages involved (which can be obtained in the "Chop" function), only the relative value is involved where balancing is concerned. The straight line achieved is a sensitive indication of precise balance.

In some cases, a balancing adjustment must be made dynamically. The phase-sensitive, demodulating capability of the chopper is well suited to this function. As an example, the same amplifier used in Fig. 4 will serve. In this case, however, the chopper's coil is excited from the same signal generator or other a.c. source that provides input for the amplifier or other device to be balanced.

The chopper will first look at the signal waveform at one of the push-pull tubes. As the synchronized drive signal goes through 180 degrees, the chopper samples the waveform at the same electrode of the other tube. Because of the synchronization, the alternately sampled signals will have the same phase and, under ideal phasing conditions, will be half a sine wave in each case. In this type of balancing, the control is adjusted to make the alternate half cycles identical to each other in amplitude and appearance, so that a uniform waveform appears.

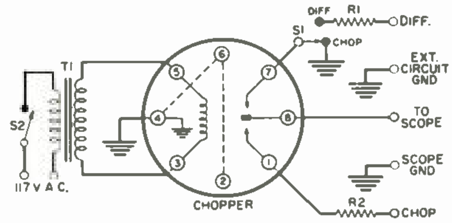
Auxiliary Information

The principal limitation on the use of a chopper for the applications described is its voltage rating. Ordinarily a contact modulator should not be used to measure more than 70 volts directly. However the construction of dividers suitable for measuring higher voltages is a simple matter.

With the exception of the contact modulator itself, the few parts required for the adapter are easy to obtain and inexpensive. While the chopper itself will cost several dollars, over-all expense is kept low by the small expenditure required for the remainder of the circuit. The chopper may also require a special order by your parts dealer or distributor. The type used by the author was Model IC-252, manufactured by *Collins Electronic Mfg. Corp.* It plugs into a conventional octal socket. Any 6.3-volt "break-before-make" unit with similar ratings will do as well. For anyone interested in conserving space, the smaller *Airpax* 175 contact modulator may be substituted for the *Collins* unit. The former, which is comparable in size to a 12AU7 tube, can be plugged into a 7-pin miniature tube socket.

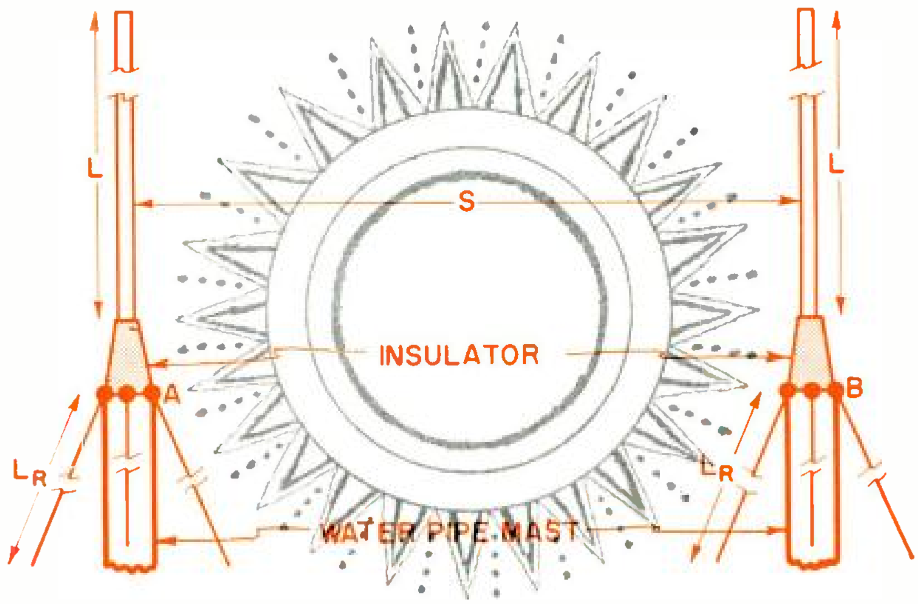
As to construction notes, there are no special precautions to be observed in this simple device. The leads to the chopper coil, which connect to pins 3 and 5 in Fig. 5, should be twisted, as is customary with filament wiring. Only pin 4 of the chopper itself need be grounded to the chassis of the device. All grounds shown are tied together. Pin numbers referred to, of course, are for the *Collins* IC-252. If another contact modulator is used, its pin numbering should be checked. –30–

Fig. 5. Few parts and simple construction are required for the adapter. The transformer may be eliminated (see text).



R_1, R_2—20,000 ohm, ½ w. res. ± 10%
S_1 S.p.d.t. switch
S_2 S.p.s.t. switch
T Fil. trans. 6.3 v. @ 1 amp.
Chopper Collins IC-252 contact modulator or equiv. (see text)
1 Octal tube socket
1—6" x 3" x 2" chassis
5—Test jacks

With dwindling sunspots the serious ham DX'er must look to 40 and 80 meters for sustained long-distance contacts. Here are practical antenna suggestions for these bands.



ANTENNAS for LOW-BAND DX

By BARRY A. BRISKMAN, K2IEG

SELECTING an antenna system for the higher frequency bands (20, 15, and 10 meters) is a comparatively simple matter these days. Directive rotary beams for these frequencies abound, both in single and tri-band versions. Likewise, towers and rotators to complete the systems are widely available and, although they represent a sizable investment, are rather common in today's ham shack.

With the sunspot maximum dwindling rapidly, it will soon become apparent that the serious DX-er must look to 40 and to 80 meters for sustained, long-distance communications, particularly during hours of darkness. As the maximum usable frequency falls, DX skip likewise falters and amateurs become locked in the inescapable prison of vanishing ionized layers. Conditions even now show a marked decay of long-distance skip on 10 and 15 meters and 20 meters is beginning to show a lack of DX conditions after about 9 p.m. local time.

The average amateur probably doesn't think of 40 and 80 meters as DX bands: more likely he associates these portions of the spectrum with traffic nets and short-skip "ragchews." Not so! Forty, for example, is capable of sustaining DX propagation with amazing strength and regularity, although the preponderance of commercial broadcast and jamming stations chases most foreign DX to the c.w. portion of the band. Most phone DX will be found on SSB either on the extreme low or high end of the phone band. Phone DX seems more common in the wee hours of the morning when commercial QRM abates a bit. Nevertheless, there is DX to be worked.

You can work it on a simple half-wave dipole, but more ambitious operators will want skywires which tend to make their signals stand out amidst the onslaught of average signals which are so predominant on the lower frequencies.

Some Suggestions

If you are limited in horizontal stretching space (and who isn't) even a half-wave may pose a problem. However, if it must be a dipole, you can greatly improve performance by getting it up in the air. The author installed two identical dipoles one wavelength apart; one 32 feet high and the other 65 feet up. They were both cut for 7.2 mc. and had their major lobes in the same direction. Switching from one to the other provided interesting, but understandable, results. During the day, *i.e.* on short skip, there was almost no difference in reports between the two. At distances exceeding 1000 miles, the higher antenna showed a marked improvement, and at distances over 3000 miles, the author was often unable to hear or be heard by stations when using the lower antenna. Nothing odd about this, but it really underlines the old axiom about "the higher the better" and can really shock you when you realize the vast difference just a little height can make.

An even better DX panorama is viewable by the lucky man using a quarter-wave vertical ground plane on 40. The antenna is much simpler to construct than one may think and possesses a good, low angle of radiation in all directions. It is not excessively difficult to fit on even the smallest lot and can be mounted on a simple water-pipe mast at any reasonable height, assuring clearance of r.f.-absorbing obstructions in proximity to it. Assuming the builder constructs the vertical section of fairly large tubing, the v.s.w.r. remains low over a fairly wide bandwidth and the feedpoint impedance approximates 50 ohms without requiring matching devices.

Next to a rotary beam, a rhombic, or other high-gain wire system, no antenna is as effective for DX as a ground plane on 40 and 80 meters. An 80-meter version can be constructed of light, aluminum TV tower about 65 feet long which, if properly mounted, will require no guys. The author is able to carry on regular schedules with New Zealand on 75-meter phone with this type of antenna when the ZL stations are not even audible with a dipole at 65 feet.

Two Verticals

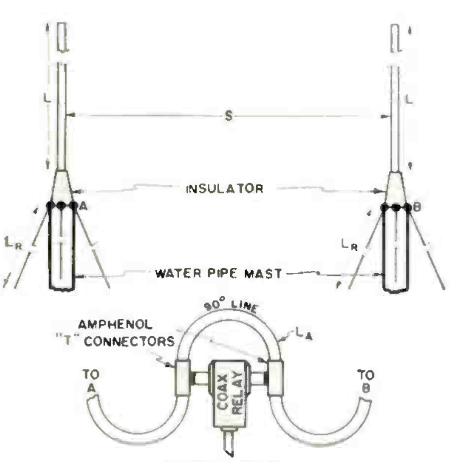
For the price of a bit more real estate, you can employ two identical ground planes as a switchable, vertical beam giving nearly 5 db gain. This is accomplished by mounting the antennas an electrical quarter wavelength apart and feeding either one directly and the other (reflector) through 90 electrical degrees of coaxial line.

Fig. 1 shows a typical switchable beam for 7.2 mc. which can be used in four directions for nearly universal coverage. It has a gain of nearly 5 db over a typical half-wave dipole and a low angle of radiation which is ideal for DX work. The antenna will also provide a fair match to 50-ohm coaxial cable and, although some standing waves are present, they are not excessive. Needless to say, the same scheme is feasible on 80 meters but the size of the system grows to unrealistic proportions for the average ham installation.

Wire with 3-db Gain

Assuming that you have a fairly large lot, say in the neighborhood of 150 feet by 150 feet, there are a number of ways to utilize wire to best advantage. An extended double zepp is a modest configuration which will give 3-db gain on the band for which it is cut, operate as a slightly long half-wave dipole at half its resonant frequency, and act as a current-fed long wire of 5½ waves on its second harmonic. Feeding it with a flat line and tuning results in a low v.s.w.r. and allows operation of the antenna on all bands if necessary. Fig. 2 lists the length of this type antenna.

Fig. 1. A pair of verticals connected together through a quarter-wave line makes a simple directive array. A coaxial relay permits the quarter-wave line to be inserted ahead of either antenna A or B, thus changing the directivity pattern. The array will fire toward the element which does not have the quarter-wave line in series with it. The coax lines from the "T" connectors to the two antennas can be any length but both lines must have exactly the same length. If the quarter-wave line is shorted out completely, the beam will fire at right angles to the plane that includes the two elements. Gain will now be in the order of 2.8 db.

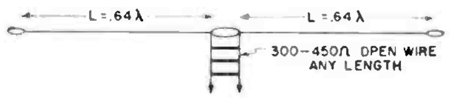


FREQ. (MC.)	L	L_R	L_A*	Z FEEDLINE	S	VSWR
3.8	64'	67'	42' 8"	50Ω	64' 8"	1.3:1
7.0	33' 5"	35' 9"	23'	"	35'	1.25:1
7.2	32' 6"	35' 3"	22' 5"	"	34'	1.2:1
14.2	16' 5"	17' 10"	11' 5"	"	17' 4"	1.4:1

L_R = RADIAL (4 EACH ANTENNA) * = VERY CRITICAL
L_A = LENGTH 1/4λ SECTION

If you have a couple of poles, say about 50 feet high or higher, separated sufficiently to allow this configuration, it is possible to stack a second extended double zepp from ⅜ to one wavelength above the first and drive them both for additional gain and low angle radiation.

This same scheme can be used to advantage by locating the second antenna in the same horizontal plane, either ahead of or behind the first. Fig. 3 illustrates this idea and lists spacing and feed data. In both cases, remember that the antennas (this means the lower in the case of vertical stacking) should be as high above the ground as possible. Once a height of one wavelength above



FREQ.	L	GAIN f	2f	3f	4f
1.75	342'	3DB	2.8DB	—	5.8DB
3.8	162'	"	"	—	"
7.0	85' 5"	"	"	3.9DB	"
7.2	83' 2"	"	"	3.9DB	"
14.2	41' 3"	"	"		"*

f = FUNDAMENTAL
2f = 2X FUND.
3f =, 4f = } ETC.
* = 6 METERS

Fig. 2. Length measurements to be used for the extended double zepp antenna.

ground is achieved, there seems to be little advantage in going any higher. Feeding antenna systems of this type with tuned, open-wire feeders allows you to operate with a tolerable v.s.w.r. over a large bandwidth.

Parasitic Elements

Dipole antennas may be up-graded to medium-gain unidirectional arrays by adding either a single parasitic reflector and/or one or more parasitic directors with appropriate spacings. Feedpoint impedances drop to a low figure that make matching to coaxial lines a little difficult, but a system of this type will still outperform a simple half-wave by a considerable margin. Fig. 4 shows two schemes based on this idea and gives suitable lengths for various bands. Again, feeding with 72- or 300-ohm parallel line and tuning is probably the best method of overcoming feedpoint impedance problems, although there will still be a moderate degree of mismatch. Even though systems of this type begin to be quite massive at 80 meters, they are still not impractical. On 40 meters they are entirely feasible and work with excellent results.

Lots of Room?

If you are fortunate enough to live on a farm or have extensive real estate at your disposal, you are in a fabulous position for constructing high-gain, low-frequency antenna systems. There is nothing like a good set of V-beams or rhombics.

These are straightforward arrangements and have been so thoroughly discussed in every antenna manual that they don't require extensive treatment here. There is, however, one center-fed long wire which the author has found to be excellent on all bands. After playing with wires for some years the author has never found another length that outperforms this one on 160 through 10 meters. The antenna is 534 feet each side, fed with any length of 450-ohm open-wire feeders and tuned. An antenna of this nature, which is about 60 to 80 feet high at the center with each end sloping to about 40 feet, will give amazing performance on all bands.

There are a few pointers to remember when building long wires. They are balanced and work best if center fed. While resonant lengths are important, the most important factor to remember is that even though the over-all length may be off slightly, both sides should be the same length to assure balanced currents in the wire. So don't use approximations for determining lengths. A few minutes more with the tape measure can mean a whale of a lot in the final result.

To summarize, there is a wide variety of antennas that will perform well on low-frequency DX. Try some of these. The author believes you will be as satisfied as he is. —30—

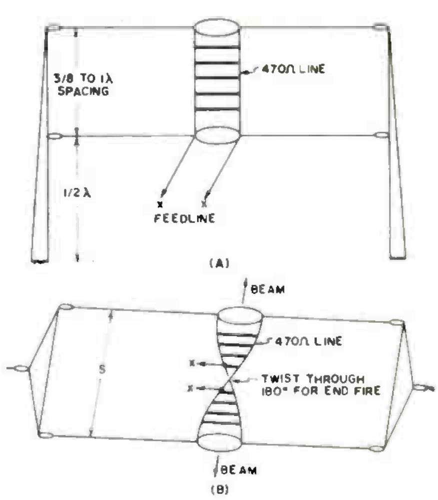
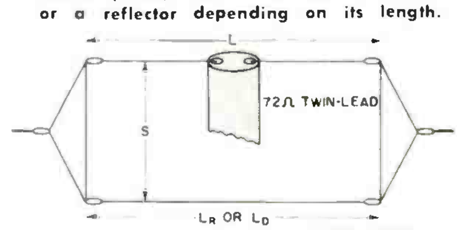


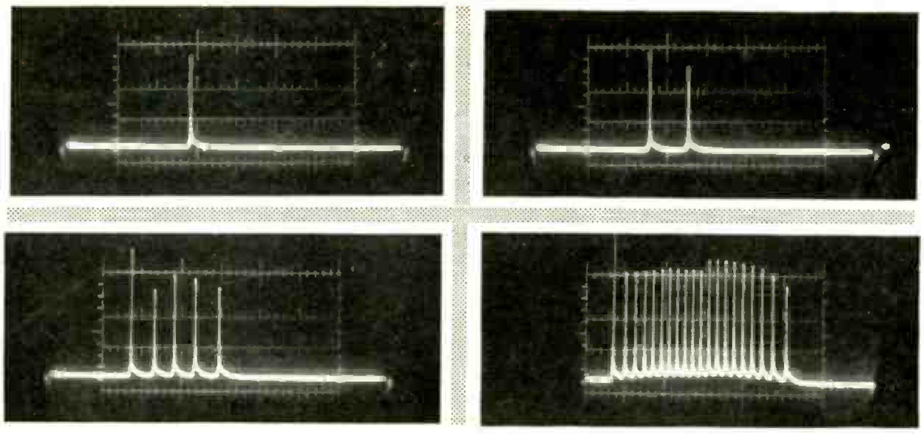
Fig. 3. A pair of extended double zepps, stacked vertically or arranged horizontally, provides some additional gain and produces a somewhat lower angle of signal radiation.

Fig. 4. A parasitic element, parallel to the driven element and on the same horizontal plane, acts either as a director or a reflector depending on its length.



FREQ.	L	L_R	L_D	S	GAIN (APPROX. USING REFLECTOR)	F-B
3.8	130'	134'	128'	50'	5DB	15DB
7.05	66'	68' 6"	64'	26'	"	"
7.2	64'	66' 8"	61' 8"	24'	"	"
14.15	33'	35' 6"	31' 6"	13'	"	"
14.2	32'	33' 9"	30' 4"	12' 4"	"	"
14.3	31'	32' 10"	29' 11"	11' 8"	"	"

L_R = REFLECTOR–BEAM FIRES THROUGH DIPOLE
L_D = DIRECTOR " " " " DIRECTOR



Waveforms generated by the experimental circuit shown in Fig. 1B as the T_2 secondary voltage is raised from a value of 58 volts. As many as twenty or more output pulses are produced for every half-cycle of the applied line voltage.

Novel Glow-Lamp Pulse Generator

By **MICHAEL S. ROBBINS** / Project Engineer, Antronic Corp.

An unusual neon-lamp circuit that produces multiple pulses that are synchronized to the line frequency.

MANY WRITERS have described d.c.-powered glow-lamp relaxation oscillators but, unlike these, the circuit described herein is powered by a 60-cycle a.c. source and for that reason exhibits novel characteristics. The author has used the unusual generator to be described as a special audio test generator and as a stable line generator for TV service.

Basic Circuit

The basic circuit is shown in Fig. 1A. R_1, C_1, and PL_1 form the familiar *RC* relaxation oscillator. T_1 is a "Variac" or other similar source of variable 60-cycle a.c. Normally a relaxation oscillator operates at a d.c. potential equal to or exceeding the firing voltage of the glow lamp. Initially the lamp will not conduct below this voltage. When, as in this circuit, the oscillator is powered by an a.c. source with a *peak* voltage equal to or exceeding the firing voltage, the lamp will conduct at least once during each half-cycle. This condition is illustrated in the waveform of Fig. 2.

NO. OF PULSES	T_2 SEC. VOLT. (r.m.s.)
1	58
2	64
3	72
4	81
5	85
6	90
7	97
8	102
9	107
10	114
11	120
12	122
13	130
14	134
15	140

Table 1. Output pulses versus voltage.

If the peak voltage remains above the firing voltage for approximately one oscillator period, capacitor C_1 will charge sufficiently to extinguish the lamp and then be discharged by resistor R_1. Thus the lamp will conduct twice for each half-cycle, *i.e.*, each 1/120th second at 60 cps. If the peak voltage is again raised so that this process will occur twice for each half-cycle, the lamp will conduct three times. By increasing the voltage still more, the lamp can be caused to conduct three, four, five, and up to twenty or more times per half-cycle.

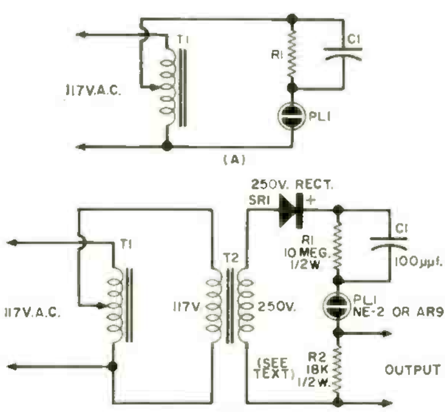
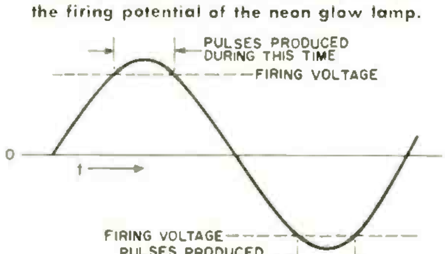


Fig. 1. (A) Basic circuit and (B) experimental circuit for unidirectional pulses.

Fig. 2. Pulses are produced at the peaks of the sine wave when its value exceeds the firing potential of the neon glow lamp.



Two important characteristics of this circuit may be deduced from the foregoing. First, the number of times that the lamp conducts during each half-cycle is an incremental function of the *peak* voltage and the periods of conduction occur at twice the line frequency, in this case at 120 times per second.

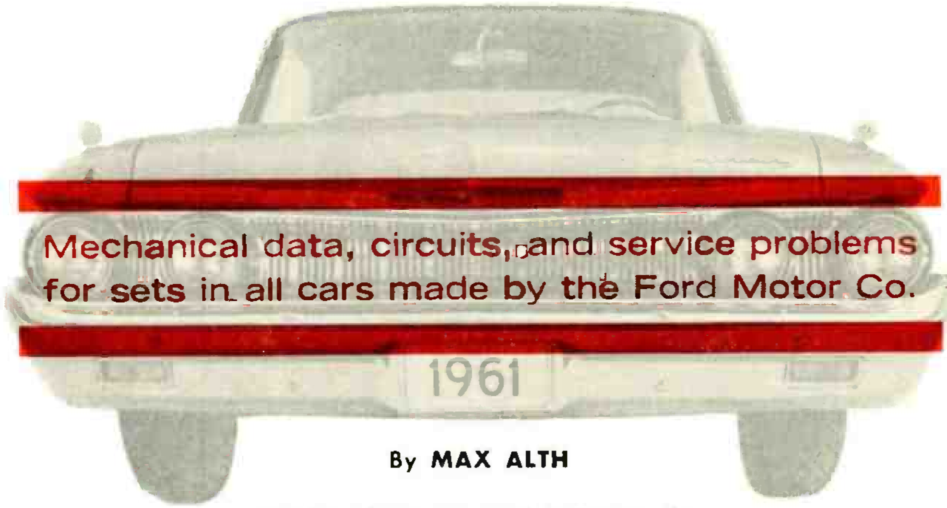
Applications

A practical application (Fig. 1B) is a line-synchronized pulse generator. Three new components have been added to the circuit of Fig. 1A. SR_1 is the silicon rectifier used to clip the sine wave, thereby causing the production of pulses of one polarity only. R_2 is the output *load* resistor, the value of which is dependent upon the output voltage requirement and the stray capacity of the load. For tests, an 18,000-ohm resistor was used. T_2 is a small power transformer used for isolation and step up.

The output waveforms of this pulse generator are shown in the photographs. Table 1 gives the experimental values of the power-supply voltages for different numbers of pulses.

The arrangement shown may be added to one's basic "repertoire" of circuits. It should lend itself nicely to many counting, timing, and service applications. The unit has also been used as a known-frequency audio test generator by replacing R_2 with a small interstage audio transformer. Since the output is synchronized with the a.c. line and since many television stations are line-synchronized, the unit makes a stable line generator for TV service. In this application the output is applied to the grid or cathode of the CRT. The resulting pattern is a group of white or black horizontal lines, depending on the polarity of the rectifier and whether grid or cathode feed is used. —30—

AUTO RADIOS FOR 1961



Mechanical data, circuits, and service problems for sets in all cars made by the Ford Motor Co.

By **MAX ALTH**

THE FORD MOTOR COMPANY, unlike *General Motors*, has no affiliate that manufactures automobile radios. Receivers installed as original equipment in its 1961 vehicles, including the *Comet, Falcon, Ford, Lincoln, Mercury,* and *Thunderbird* lines, are therefore obtained from other manufacturers—and *Ford* uses two such sources. An original-installation radio will have been produced for the car maker by *Motorola* or *Bendix*.

This situation sounds far more troublesome than it actually is. After all, the principal problems relate to removal (and re-installation) of the receiver or in-car difficulties. For most practical purposes, it will make little difference, with such problems, which radio is used.

Auto radios have always been fairly easy to take out and put back in the vehicles made by this manufacturer. Fortunately, this year's models are no exceptions. The routing of the "A" lead and the dial-light lead in the *Fords*, a bit unusual, is indicated in the cut-away view of the dashboard where the radio mounts, in Fig. 2.

The practice of mounting speakers in the face-up position, carried over from other years, has its drawbacks: it may result in the destruction of the cone in a year or so. Dust and dirt funnel down into the speaker very readily, and the sun's rays don't help when they strike the cone. Some shrewd technicians have taken to installing a second grille cloth over these speakers. Flock-covered wire screening seems most effective in extending the useful life of the speaker.

Ignition Problems

Years ago, service technicians who worked on radios in *Ford Co.* cars were plagued by an assortment of ignition-noise problems. For the most part, these seem to have been solved, with the *Thunderbirds* alone warranting special mention in this connection. These sets generally run quiet when new but may develop ignition noise after a few months of use. In most instances, the cure is achieved with "blockbuster" treatment: the use of a 1000-μf. capacitor connected to the battery side of the ignition coil. If that doesn't do the trick, *Motorola* has a noise filter (Choke 1K590489) that may be connected simply by plugging it in series with the antenna lead. A touch-up adjustment of the antenna trimmer will have to follow. Also available is an "A" line r.f. filter (Choke 24A472535) that can be connected in series with the specific electrical accessory in the car that may be causing the interference—or in series with the radio's "A" lead.

The Circuits

We have already stated that *Ford* uses both *Motorola* and *Bendix* radios. Considering the two sources and the variety of models, a comprehensive treatment of the circuits is something of a problem. The situation is further confounded by another fact. Consider the case of *Motorola*, for example. This company actually manufactures two lines of auto-radio sets. Those supplied to car makers as original equipment, to be installed at the factory or by the auto dealer, are called "contract" sets. This group is further subdivided, because *Motorola* supplies such radios to *American Motors, Chrysler Corp., International Harvester,* and others, in addition to *Ford*. However, *Motorola* also makes a line under its own name for the "after market," that is, for purchase by the car owner for installation after he has bought his vehicle without a radio. These are called "branded" receivers.

Although auto-radio circuits have tended to become more or less standardized within a few basic types, there are model-to-model differences. However the 10AX receiver, whose circuit is shown in Fig. 1, is a useful starting point. A 12-volt set designed for universal after-sale installation, it is typical of the popular hybrid circuit design in the branded group and also helpful in describing contract sets. In addition, it has some circuitry of special interest.

One transistor is used as an audio driver and another, single-ended, provides 2.8 watts of audio output power. Although push-pull transistor output stages still appear, a single power transistor is becoming more frequent in this function. In *Ford* radios, this arrangement provides between 2 and 2.8 watts of output.

Notice that both a thermistor (R_{18})

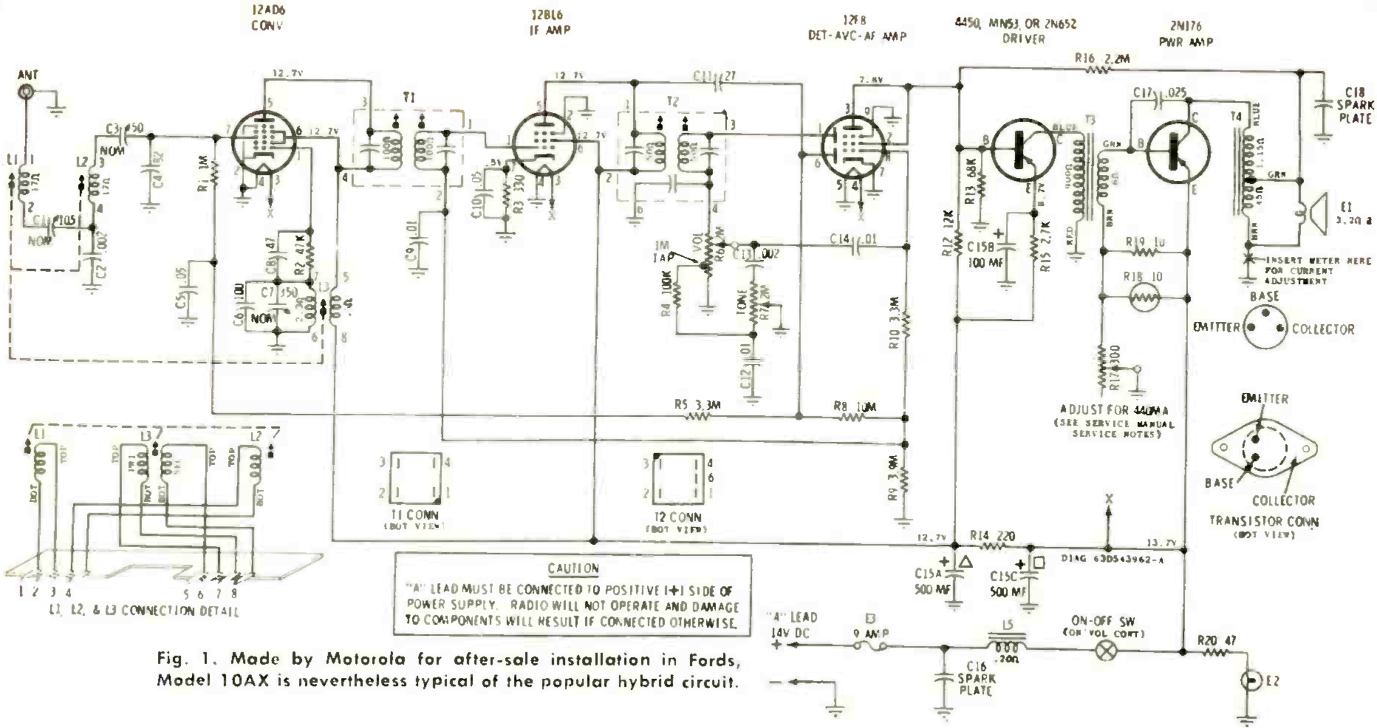


Fig. 1. Made by Motorola for after-sale installation in Fords, Model 10AX is nevertheless typical of the popular hybrid circuit.

and a rheostat (R_{17}) are used in the base of the output stage to control bias. Also of interest is the continued use of *Motorola's* "Volumatic" circuit, which appears to have won considerable acceptance. In this configuration the a.g.c. voltage, normally applied to the r.f. and i.f. tubes, is also fed to the grid of the 1st audio amplifier (12F8 in Fig. 1) through resistor R_{10}. This d.c. voltage thus changes bias on the audio stage to compensate for changes in signal strength. Since the audio stage is not included within the normal a.g.c. loop, there is no interaction between these two. Control action is therefore quite effective. This is especially noticeable in the form of little or no apparent change in volume when the vehicle passes under a bridge or through some other low-signal area. The effectiveness of this circuit results in a mild problem during peak alignment procedures. However, it should not be necessary to break any connections: simply keep the test signal to a minimal, recognizable level.

Comparison of the circuit for this branded model with contract receivers is interesting. Contract model 14MFM (as used in *Ford* cars) or 04MD (the same circuit used in *Falcon* automobiles) is typical of other hybrids in this group. A noteworthy circuit variation is the absence of the "Volumatic" circuit, which means the a.g.c. output is not tied to the grid of the 1st audio amplifier. In addition, the combination of thermistor and rheostat to control bias of the output transistor is missing. Instead the configuration shown in Fig. 3 is used.

The junction of R_{14} and R_{15}, the bias-network resistors for the output transistor, is returned to ground through the heater (pins 3 and 4) of the detector and 1st a.f. amplifier, the 12AE6A. Changes in the supply voltage, which is applied across this heater, or in the ambient temperature, also change the heater's resistance. This action, being much like that of a thermistor, provides automatic bias correction. Other contract models, in fact, use a thermistor for this purpose instead of a tube heater, but without the addition of the variable resistor found in the branded sets.

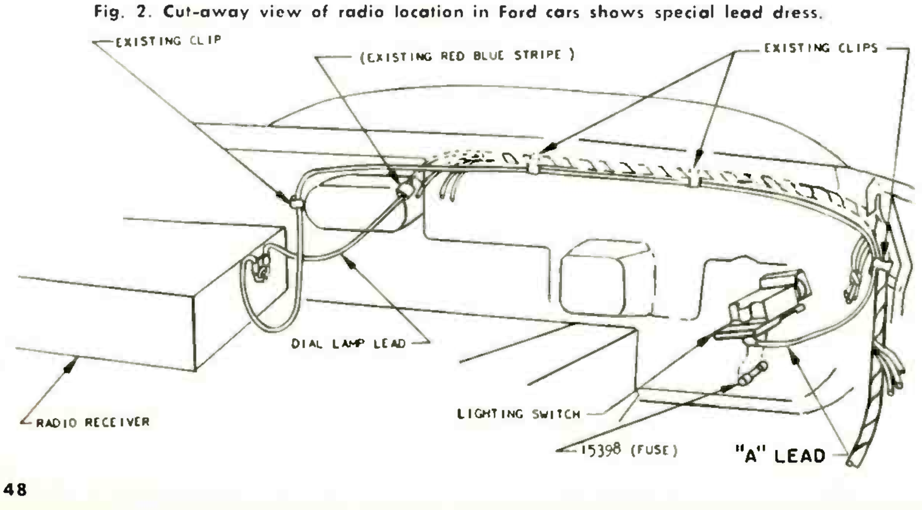
The use of a manually adjustable bias control along with an automatic control is due to the possibility of transistor-to-transistor variation, for which the former adjustment compensates. *Motorola* feels that transistor uniformity has improved to the point that interchangeability without fixed correction is practical. However, there is always the chance that this will not work out in practice. Therefore, if a good transistor in a circuit that has no defects distorts or otherwise fails to give satisfactory performance, it may save time to try another good transistor before doing anything else.

For the rest, the 14MFM and 04MD generally resemble the branded set in the schematic of Fig. 1. An important exception is the addition of another stage, an r.f. amplifier, built around an added tube, a 12BL6. Although other stages are functionally similar to those of the 10AX receiver in Fig. 1, minor differences include changes in tube types. The converter and i.f. amplifier tubes are the same as those shown, but a 12AE6A is used as the detector and 1st audio in the contract set, rather than the 12F8 shown in Fig. 1. The audio driver is a 2N573 transistor, and the output transistor is an MN29 (which, however, may be replaced with a 2N176).

Also available for some models are all-transistor radios, not unconventional in circuitry for such types. These include the 1TMS for *Thunderbird* and the almost identical 1TMC for *Lincoln Continental*. Of special interest in these is the fact that they use not one printed-circuit board, but eight little ones. Actually the chassis board is manufactured in one piece—then separated into other pieces. Accordingly, when a replacement is needed for one section, a complete board must be ordered and the desired section is broken off.

These all-transistor versions use an r.f. transistor and two i.f. stages, tuned to 262.5 kc. This means that there are more than the ordinary number of align-

Fig. 2. Cut-away view of radio location in Ford cars shows special lead dress.



ment adjustments. The procedure involved is not unusual, but getting to the adjustments is a bit tricky. Fig. 4B shows the front of the receiver after the dial and dial background have been removed, as they must be to gain access to antenna, r.f., and oscillator adjustments. Fig. 4A is a rear view after two clutch-head screws have been taken out from the top front of the set, the cover has been removed, and the two grounding straps for the r.f. chassis board have been unsoldered. Fig. 4C depicts the suggested dummy antenna load for front-end alignment. If an i.f. alignment signal is to be injected through the front end, a .1-μf. capacitor in series with the generator lead is recommended. Fortunately, a re-alignment should not be necessary unless the set has been tampered with or a component in one of the resonant circuits has been replaced.

Some Service Problems

Virtually any piece of electronic equipment will show a tendency to some special problems, after it has been in use a while, that could not be antici-

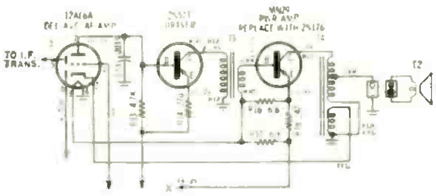


Fig. 3. Output-transistor bias for Model 14MFM is regulated by 12AE6A heater.

pated. Such difficulties that have been found in field experience on the radios used in the autos of the *Ford Motor Co.* are included here.

Distortion after re-installation. Satisfactory operation is established on the test bench prior to re-installation. About ten or twenty minutes after the latter, however, distortion begins to set in. Sometimes the symptom does not develop until the car's engine is running. This may be due to the increase in supply voltage when the generator is working or in operating temperature within the car's environment (particularly with the engine running). The probable cause is that the bias control has been set "on the edge," so that it is satisfactory during bench operation although not for conditions in the auto. A slight re-adjustment should eliminate trouble.

Gradual Fading. The customer may report this symptom is not always evident. Changes in the audible output are slow rather than rapid or fluttering. *Before* pulling the set, make sure the antenna trimmer is set properly. Often this trimmer was originally adjusted by the auto mechanic who installed the set, and he may not have been qualified to do it properly. Peak the trimmer with the volume control set high and while tuned to a weak station at the high end of the broadcast band. All sets are subject to some fading with weak signals. With the antenna trimmer improperly adjusted, the consequent loss in sensitivity causes the symptom to appear on signals that are not so weak.

Weak Signal. In addition to the primary symptom, tuning may be broader than usual and background noise lower than usual, as though volume were turned down. Defective front-end tubes should be suspected in the hybrid receivers. Input resistance of the tubes sometimes becomes lower after some use. While resulting changes in operating characteristics would not be too noticeable in ordinary tubes using high plate voltages, gain can be cut severely in the low-voltage types. Since most tube testers cannot check these tubes and may damage them, test by substitution.

Set noisy. Signal will seem weak and there may be a tendency to oscillation. Tuning may be so broad that several stations can be received simultaneously. Try peaking each r.f. and oscillator coil in the front end. If a coil cannot be peaked sharply, it may be open. Look for a broken lead near the coil-mounting bracket where the leads come out from under the coil cover. These fine wires are often pinched here during installation. There is generally enough lead left to permit re-soldering the connection.

Flutter. As distinguished from rapid fading, this symptom is regular, rhythmic, and very fast, evident only when the engine is running, and probably most noticeable with the volume control turned partly down. It may be considered a type of low-level motorboating.

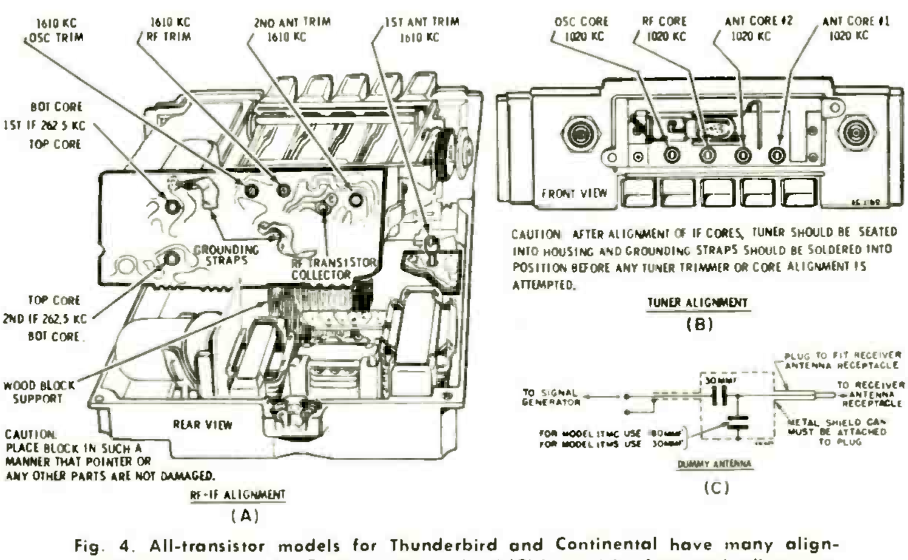


Fig. 4. All-transistor models for Thunderbird and Continental have many alignment adjustments (A, B). Dummy antenna load (C) is used for front-end adjustment.

The cause: the pulsating d.c. produced by the car's generator is getting through the radio's power supply. Sometimes the symptom is noted on the test bench if the set is powered by a battery eliminator with poor filtering. A defective filter capacitor probably needs replacement.

Low background whistling, which may appear only at certain dial settings. Alignment may be needed. If it is no help, suspect parasitic oscillation in the plate circuit of the converter. Try connecting a 470,000-ohm damping resistor across the primary of the first i.f. transformer. Some later sets have such a resistor in place. A lower value may be necessary in some of the stubborn cases.

Distortion. Improper emitter current may be suspected. When an ammeter check is made, the symptom disappears; or else the symptom disappears after adjustment but re-appears when the ammeter is removed. The high internal resistance of the instrument may alter current during adjustment. Use an ammeter with the lowest possible internal resistance on the appropriate current scale or try to compensate for this possibility another way.

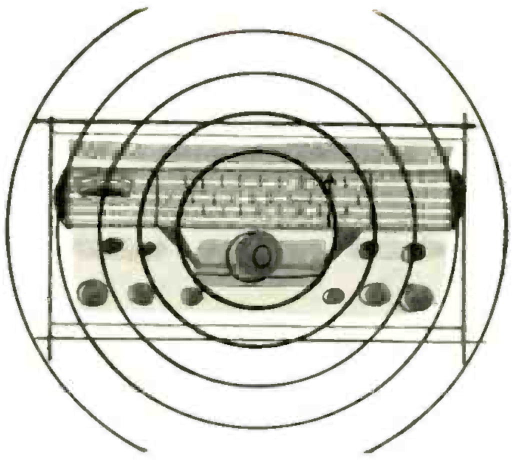
Dead Set. The characteristic thump is heard when the set is turned on, but little else. Checking indicates a possible short in the r.f. section. Suspect trimmer capacitors for the r.f. coils. Try opening these capacitors by turning their screws counterclockwise. Sometimes splattered solder or flaked-away mica causes shorting between the plates of one of these components.

Short output-transistor life. Possible causes for early destruction of transistors were noted in the article on 1961 auto radios that appeared in the May issue. In addition, excessive voltage due to some defect outside the radio may be responsible, such as a faulty generator, defective regulator, or loose battery cable. Many drivers know that such troubles can cause lights in the auto to burn out in a minute or two. Transistors are subject to a similar hazard.

Manual control fails to move the dial pointer or its associated tuning mechanism. This may happen because the clutch mechanism is stuck in the disengaged position or because oil or grease has contaminated the clutch surfaces. If the clutch appears to be stuck open, look for nicks, burrs, and bent shafts in the assembly. If slippage is evident, wash the clutch faces with a solvent that will not damage the drive disc. *Do not* add or remove grease from other parts. The quantity and type of lubrication applied at the factory is intended to last for the life of the receiver.

For the rest, the technician is on his own with conventional troubleshooting procedures. —30—

IMPROVING RECEIVER SENSITIVITY



Description of a "noise alignment" technique that boosts the sensitivity of communications receivers. / By **JIM KYLE, K5JKX**

MANY owners of communications receivers add countless accessories to their equipment in the never-ending search for ultimate performance. On the other hand, relatively few attempt to modify the set in any way. Many even hesitate to attempt re-alignment.

Why this seeming paradox? Is it because receivers today are so complex that the average owner is afraid to tackle the job of modification? Or is it because so little information on general adjustment and modification of communications receivers is available?

One of the three major classifications of receiver performance standards is that of sensitivity. Many existing receivers fall short in this category, being unable to pull in weak signals with the reliability of newer models.

The purpose of this article is to describe a method of obtaining the ultimate in sensitivity and to describe a test which will enable the receiver owner to determine if his equipment reaches this goal.

No special equipment is required for the adjustment or the test. However, one internal modification to receiver circuitry, to facilitate proper adjustment, is described.

Before proceeding, it might be well to define our terms.

Sensitivity & Noise

What is sensitivity? For the purpose of this article, it is defined as a receiver's ability to receive a weak signal and to produce usable intelligence from that signal.

Sensitivity is not to be confused with gain. Gain, in this article, will mean the amplification of a small voltage into a larger voltage. This voltage may be either a signal, which is desired, or noise, which is not wanted.

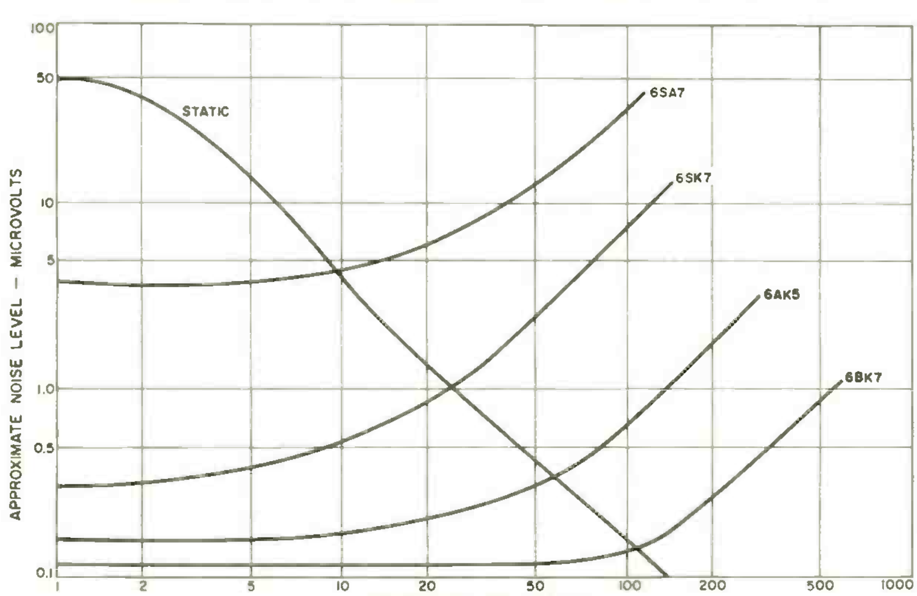
Noise is defined as any voltage in the output signal which was not present in the input signal. It may consist of auto-ignition pulses, static, or the "white noise" characteristic of vacuum-tube operation at high gain.

Reviewing these definitions, it becomes obvious that high gain in any circuit is not necessarily synonymous with high sensitivity—since if appreciable noise is introduced into the circuit at an early stage, it can easily mask the desired signal at the output. In effect, the noise in the circuit establishes a "floor," below which a signal cannot be received.

The noise can be either internal or external to the circuit. Internal sources include the components of early stages, and the "equivalent noise resistance" of the early-stage tubes. External sources include auto interference, atmospherics, and "antenna noise," which may be lumped together under the term "static."[1]

Internal noise is primarily a design problem. Most receivers manufactured in the last 10 years have such low internal noise that external sources establish the floor. Those which have

Fig. 1. This graph compares external noise or "static" to internal set noise. Internal noise varies according to the tube type in the receiver's first stage—the graph shows approximate average noise levels for the 6SA7, 6SK7, 6AK5, and 6BK7 duo-triode. Note that static is the limiting factor at lower frequencies. At higher frequencies, tube noise limits the receiver's performance. Proper adjustment of the set, as described here, can reduce tube noise level effects.



higher noise, and older models, can easily be altered to take advantage of later design techniques.[2]

External noise, or static, falls into three major categories: auto and similar impulse-type interference, atmospheric noise, and "antenna noise" which is made up of the received cosmic noise level and of the equivalent noise resistance of the antenna.

So far, two principles have been established: gain is not necessarily equal to sensitivity, and noise establishes a floor below which no signals can be heard. Ultimate sensitivity, now, can be defined as sensitivity great enough to receive a signal which is equal to the static noise level.

Noise vs Frequency

At this point, another factor rears its head. This is the relative distribution of noise throughout the frequency spectrum. This factor determines the best approach to the attainment of ultimate sensitivity.

Internal noise, no matter what the amount, remains at approximately the same level throughout the spectrum up to the u.h.f. range.[3]

On the other hand, atmospheric noise and static decreases in almost linear fashion as the frequency rises. It ceases to be an important factor in the neighborhood of 30 mc. but occasionally is found as high as 150 mc.

The relationship of noise from various sources is illustrated in Fig. 1. Note that even with the noisiest receiver, static remains the limiting factor up to about 10 mc. With less noisy front-end tubes, static can be the only factor establishing the noise floor up into the TV bands.

But at the 10-mc. point with a noisy receiver, and at higher frequencies with better-designed sets, the equipment's sensitivity is limited by internal noise—a factor over which the user has at least some control.

Most internal noise originates in either the first r.f. amplifier or the first mixer of the receiver. While the r.f. stage controls the noise level in a well-designed set, the mixer contributes an appreciable amount of noise in many receivers now in use.

And virtually all receivers develop an appreciable noise output with no signal tuned in.

Noise Alignment

This noise output can be eliminated by "noise alignment," the process described in the following paragraphs. Performing a noise alignment will also show whether the set is capable of ultimate sensitivity. If the set is capable, the noise alignment will bring it to this state.

To simplify the noise alignment process, four components must be added to the receiver as shown in Figs. 2 and 3. Total cost of the components is less than $2.50, and since all are mounted on the chassis rather than the front panel, resale value of the set is not affected.

Purpose of the added components is to permit individual adjustment of gain in the r.f. and i.f. amplifier stages. Most sets utilize a variable resistance in the common cathode return of these stages for a manual gain control, as shown in Fig. 2. Changing this wiring to the circuit of Fig. 3 permits individual-stage maximum gain to be independently adjusted while retaining over-all control on the set's front panel.

Wiring of the added variable resistors is not critical, except that leads of the bypass capacitors should be less than ¼-inch long. Mount the variable resistors in a location where they will be easily accessible during the noise alignment procedure.

When the parts have been installed, the set is ready for noise alignment. Set the bandswitch to its highest range, turn both audio gain and r.f. gain full on, and let the set warm up. If it has not been re-aligned recently, touch up the i.f. transformers according to the manufacturer's directions to ensure that the set has its maximum possible gain.

Now, disable the stage immediately preceding the mixer tube. The simplest method of doing this is to remove the r.f. amplifier tube from its socket, if this will permit the rest of the set to function normally. Otherwise, short out the mixer-signal-grid-circuit tuning capacitor.

The hissing sound of circuit noise will at this point still be emanating from the loudspeaker. Adjust the new control marked "I.F. Adjust" until the hiss just disappears.

At this stage, replace the r.f. tube removed earlier or remove the short across the tuning capacitor. When the tube has warmed up, noise should again be evident in the output. Attach a small carbon resistor (51 to 82 ohms) across the set's antenna terminals and remove all other external connections.

Now, adjust the other new control, marked "R.F. Adjust," until noise once again disappears. Substituting the actual antenna for the resistor dummy should bring back the noise. Back off slightly on the "R.F. Adjust" control until the noise is just barely audible.

Noise alignment is now complete. Secure both controls in position with a drop of glue on each shaft.

If noise disappears and reappears as described, the receiver is capable of ultimate sensitivity and is, in fact, adjusted to this point. If noise fails to reappear at any point, the receiver can be improved.

If noise fails to reappear when the r.f. stage is reconnected, the fault lies in the mixer circuit. Substitution of a low-noise mixer[2] followed by complete re-alignment will improve performance.

If noise reappears when the r.f. stage is reconnected but fails to do so when the antenna is substituted for the resistor dummy, the fault lies in the first r.f. amplifier circuit. A number of low-noise front-end stages are described in the literature[4].

To test a receiver before deciding whether to perform noise alignment on it, simply connect the resistor dummy in place of the antenna and adjust the front-panel r.f. gain control until noise disappears. If noise reappears when the antenna is reconnected, the set is capable of ultimate sensitivity without modification.

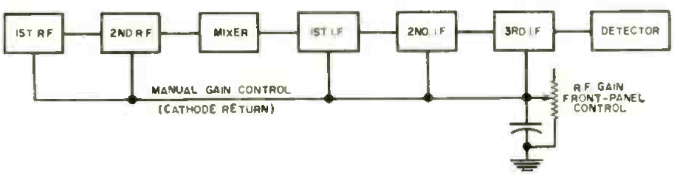


Fig. 2. Most communications receivers follow this circuit arrangement in order to accomplish manual control of gain.

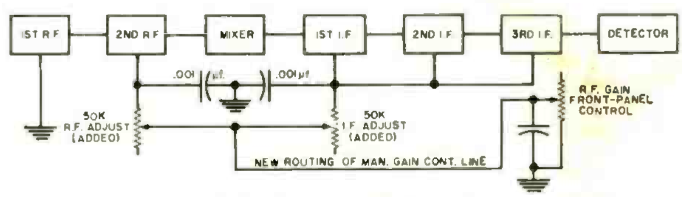


Fig. 3. Improved circuit recommended requires two variable resistors and two additional bypass capacitors as shown.

Once noise alignment has been performed, the adjustments need not be changed unless tubes are replaced. In that case, repeat the procedures.

Noise alignment is also applicable to converters used for v.h.f. and u.h.f. reception. First, noise-align the receiver to be used with the converter. Then connect the converter ahead of the receiver and repeat the procedure, using the receiver's "R.F. Adjust" control when the procedure specifies the "I.F. Adjust" control and using the converter's gain control when procedure calls for use of the "R.F. Adjust" control.

When this procedure has been completed on a receiver, the set's over-all gain is reduced to the point necessary to prevent internal noise from being amplified to audibility. Gain in excess of this amount is not only wasted, it is harmful since it introduces nerve-racking noise into all signals. Front-panel controls still provide a reduction in gain. In most cases, noise alignment also improves a receiver's overload characteristics, due to the reduction in unnecessary gain.

REFERENCES

1. *Terman, F. E.: "Electronics and Radio Engineering," McGraw-Hill Book Co., 1955. Section 22-17, pp. 855-858.*
2. *"Improving the HQ-129X," CQ, May 1959; "Updating the NC-240D," CQ, November 1957.*
3. *Terman, F. E.: op cit. Section 12-13, pp. 434-439.*
4. *"The S-9er Mark II," CQ, May, 1959; "More on the S-9er Mark II," CQ, May, 1959; ARRL Handbook.*

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COMPUTER ARITHMETIC CIRCUITS

In binary systems, the actual calculating is the job of circuits like the ones described here.

By **ED BUKSTEIN**, Author, "Digital Counters and Computers"

THE ARITHMETIC section is the calculating portion of the computer. It is in this section that the actual computations are performed. In a sense, all other circuits and components of the computer are merely supporting equipment to provide the input and extract the output of the arithmetic section. The arithmetic section consists of combinations of logic circuits designed to satisfy the rules of binary arithmetic. (See "Computer Logic Elements," December 1960, and "Computer Logic Circuits," January 1961.)

Since the binary number system uses only two symbols, 0 and 1, there are only four basic additions: 0 plus 0, 0 plus 1, 1 plus 0, and 1 plus 1. These combinations are listed in Table 1. As in any other number system, 0 plus 0 equals 0. The sum of 0 and 1 is 1, and likewise 1 plus 0 yields a sum of 1. The addition of 1 and 1 yields a sum of 0 and a carry of 1 into the next column (in the same sense that, in the decimal system, 9 plus 6 yields a sum of 5 and a carry of 1 into the next column). The binary addition of 1 plus 1 is presented in a more familiar form, as follows: $1 + 1 = 10$.

This, of course, does not imply that 1 plus 1 equals *ten*. The answer does *not* represent the decimal number ten, but rather the binary number "one-oh" which is equivalent to decimal number "two" (see "Numbers Systems and Codes," ELECTRONICS WORLD, November 1959).

One of the basic circuits for performing binary addition is the *half-adder*. As shown in Fig. 1, this circuit has two input terminals (for receiving the pair of binary bits to be added) and two output terminals (for *sum* and *carry* outputs). The half-adder can perform any of the additions shown in Table 1, producing the correct answer in terms of sum and carry. As an example, assume that the circuit is to perform the addition of 1 plus 0, as shown in Fig. 1C. To represent the binary 1, an input (pulse or d.c. voltage) is applied to one of the input terminals. To represent the binary 0, input is *not* applied to the other terminal. Under these conditions, an output will appear at the sum terminal but not at the carry terminal.

This, of course, is the correct answer for the addition of 1 plus 0. As another

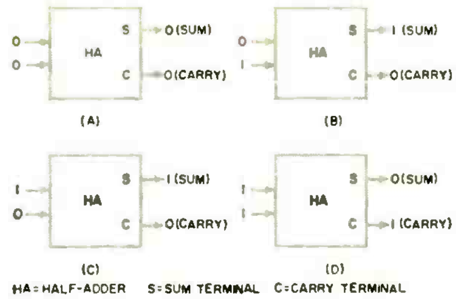


Fig. 1. Symbol (A) for the half-adder. Possible input combinations (B, C, D), and the various outputs they produce.

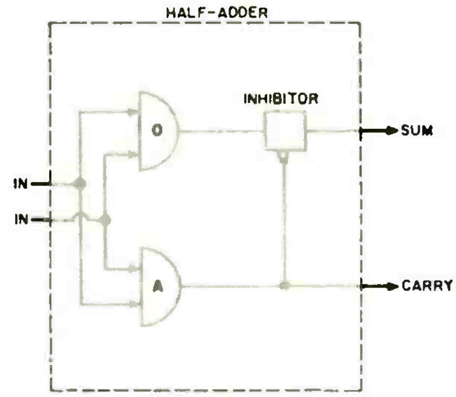


Fig. 2. A half-adder is this combination of "or," "and," and "inhibitor."

example, consider the addition of 1 plus 1, as shown in Fig. 1D. To represent the two ones to be added, input is applied to both input terminals. Output will now appear at the carry but not at the sum terminal.

To obey the rules of binary addition listed in Table 1, the half-adder must (1) produce an output at the *carry* terminal when input is applied to *both* input terminals (representing the addition of 1 plus 1), and (2) produce an output at the *sum* terminal when input is applied to *either one but not both* of the input terminals (representing either 1 plus 0 or 0 plus 1).

A configuration of logic circuits that satisfies these requirements is shown in Fig. 2. An input applied to either one (but not both) of the input terminals will pass through the *or* and *inhibitor* circuits and will appear at the sum terminal. If inputs are applied to both input terminals, the *and* circuit will produce an output. This output, which appears at the *carry* terminal, activates the inhibitor to prevent output from appearing at the sum terminal.

The usefulness of the half-adder is limited because it has only two input terminals. A more useful adding circuit would have three input terminals: two for receiving the pair of bits to be added and a third terminal to receive a carry signal that may be coming from a preceding circuit. Consider, for example, the addition of a pair of five-bit binary numbers: $10011 + 01010$.

This addition can be performed using five adding circuits, one for each column of bits. The adding circuit for the extreme right-hand column can be a half-adder because obviously there can be no carry into this column. The adding circuits for the four remaining columns, however, must each have three input terminals: two for the pair of bits to be added and the third to receive the carry signal which may come from the adder for the preceding column. An adding circuit having three input terminals is known as a *full-adder* and, as shown in Fig. 3A, consists of two half-adders and an *or* circuit.

The first half-adder receives the pair of bits in the column to be added, and the sum of this pair is then added (by the second half-adder) to the carry signal from the preceding column. Fig. 3A illustrates the addition of 1 plus 0 and assumes that there is a carry signal coming in from the circuit for the preceding column. Inputs, represented by the 1's in Fig. 3A, therefore appear at two of the three input terminals. Since the first half-adder receives only one input, it produces an output at its sum terminal but not at its carry terminal. This sum output is applied, along with the carry input signal, to the second half-adder. Since this latter half-adder receives two inputs, it produces an output at its carry terminal but not at its sum terminal. The end result is that an output appears at the carry output terminal but not at the sum output terminal. This result (sum=0, carry=1) is correct for the addition of 1 plus 0 plus 1.

The eight possible combinations of three-bit additions (the third bit represents the carry input) are listed in Table

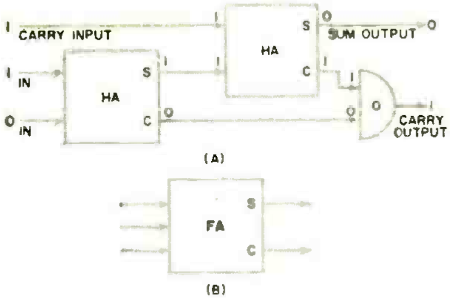


Fig. 3. Two-half-adders plus an "or" circuit (A) make up a full-adder (B).

2. The full-adder can perform any of the additions listed in this table, producing the correct answer in terms of sum and carry. The characteristics of the full-adder can therefore be summarized as follows:

(1) An input to any one (but only one) of the three input terminals will produce an output at the sum terminal only. (2) Inputs to any two (but only two) of the input terminals will produce an output at the carry terminal only. (3) Inputs to all three input terminals will produce outputs at both the sum terminal and the carry terminal.

The *or* circuit shown in Fig. 3A is required because a carry signal may come from either one of the two half-adders. In either case, the carry output of the circuit is applied to the carry input terminal of the adder for the next column. A single block may be used to represent the full-adder diagramatically, as shown in Fig. 3B.

The Parallel Adder

In the *parallel adder*, a separate adding circuit is used for each column of bits so that all columns are added concurrently (rather than one at a time as in a *serial adder*). Fig. 4 shows a parallel adder capable of handling a pair of five-bit numbers. In computers designed to operate on pure binary numbers, the numbers are often 30 to 40 bits in length—the circuit shown in Fig. 4 could therefore be extended to 30 to 40 stages in parallel.

The ten input terminals of Fig. 4 are arranged in two groups of five each, one group for each of the five-bit numbers to be added. As in the previous drawings, those input terminals labeled 1 receive inputs and those labeled 0 do not. For identification, the five stages in Fig. 4 are labeled *1*, *2*, *4*, *8*, and *16* (corresponding to the positional values of a binary number). The *1* stage receives the right-most bit of each of the two numbers to be added. This stage therefore adds the "right-hand column." The *2* stage receives the bits of the second column from the right: the *4* stage adds the next column; etc. The sum and carry outputs produced by the five stages are as follows:

1. The *1* stage receives input at only one of its two input terminals. This stage therefore produces an output at its sum terminal but not at its carry terminal.
2. The *2* stage receives inputs at two of its three input terminals. This stage therefore produces output at its carry but not its sum terminal.
3. The *4* stage receives only one input —the carry from the *2* stage. An output therefore appears at the sum but not the carry terminal.
4. The *8* stage receives only one input and produces output only at its sum terminal.
5. The *16* stage receives only one input and produces output at its sum terminal only.

By contrast, the *serial* adder is slower in operation but simpler in circuitry.

In the serial adder, the binary numbers to be added are represented by pulse trains in which each binary 1 is represented by a pulse and each 0 is represented by a "missing" pulse. Several examples are shown in Fig. 5. The pulse trains are shown here with respect to a *clock* or reference waveform, which indicates the "possible" pulse positions.

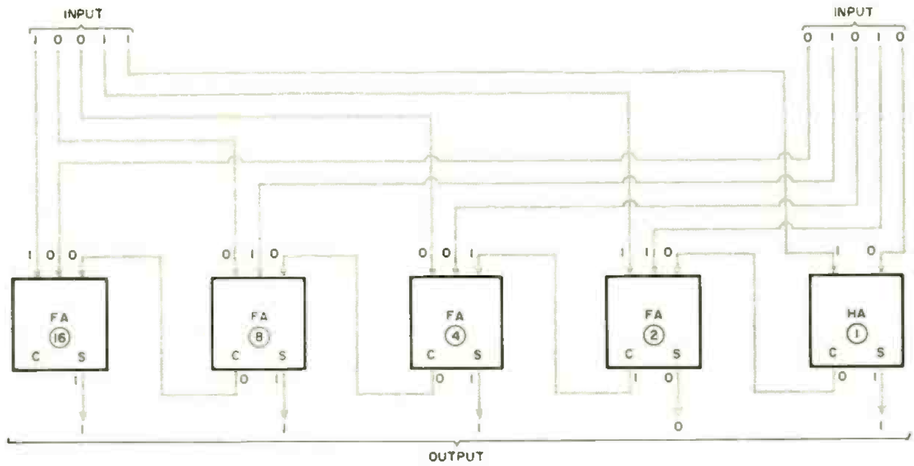


Fig. 4. This 5-stage parallel adder gives binary sum (output) of 5-bit numbers.

As indicated above and as shown in Fig. 4, outputs appear at four of the five *sum* terminals. These outputs represent binary number 11101. This binary number is equivalent to decimal number 29 and is the sum of the two input numbers applied to the circuit: 10011 and 01010 (19 and 10).

The Serial Adder

An advantage of the parallel adder is its high operating speed. When the two input numbers are applied to the circuit, the outputs (representing the answer) appear almost instantly. A disadvantage of the parallel adder, however, is the large amount of circuitry required: one stage per column to be added. By con-

	sum	carry
0 + 0	0	0
0 + 1	1	0
1 + 0	1	0
1 + 1	0	1

Table 1. Additions (left) possible with half-adder, with sum and carry outputs.

Table. 2. Additions (left) possible with full-adder of Fig. 3, with output results.

	sum	carry
0 + 0 + 0	0	0
0 + 0 + 1	1	0
0 + 1 + 0	1	0
1 + 0 + 0	1	0
0 + 1 + 1	0	1
1 + 0 + 1	0	1
1 + 1 + 0	0	1
1 + 1 + 1	1	1

Fig. 5. Pulse trains representing binary numbers. "Missing" pulses represent "0."

The pulse trains representing the two binary numbers to be added are applied to the first half-adder (HA_1) as shown in Fig. 6. The right-most pulse (or missing pulse) of each waveform is applied to HA_1 to represent the right-hand column of bits. A short time later, HA_1 receives the pulses (or missing pulses) representing the second column from the right. Still later, the bits of the third column reach HA_1, etc.

The delay shown in Fig. 6 has a duration of one pulse time (the time between one clock pulse and the next). If the clock frequency is one megacycle, for example, a one-microsecond delay would be used. An output from the carry terminal of either half-adder will therefore be delayed one microsecond and then applied to HA_2. This delay is necessary so that a carry signal from one column of bits will emerge from the delay *just in time* to be added to the next column of input bits.

The addition of 1001 and 0101 is illustrated in Fig. 6. These two input numbers are represented by the waveforms shown at *B*. Since a half-adder produces an output at its carry terminal whenever it receives simultaneous pulses at both of its input terminals, HA_1 pro-

(*Continued on page* 107)

OUTBOARD VU METER

By **HAROLD REED**

Here are complete construction details on a high impedance, low impedance meter circuit with input sensitivity that is down to about 50 millivolts.

IN THE AUTHOR'S article "Outboard Signal Level Indicator" (November 1960 issue) which used a miniature electron-ray tube, two disadvantages in using a vu meter circuit were pointed out. One is the higher resulting cost while the other is the adverse loading condition that would occur if placed across certain circuitry. This could be overcome only by using a high-impedance bridging circuit, causing losses and necessitating signal amplification.

Since it is realized that some readers may not be concerned about the additional cost and would prefer to use a vu meter, it was decided to design a vu meter system suitable for use in the conventional manner as well as being applicable for bridging across high impedance circuits and usable, too, on low signal level circuits.

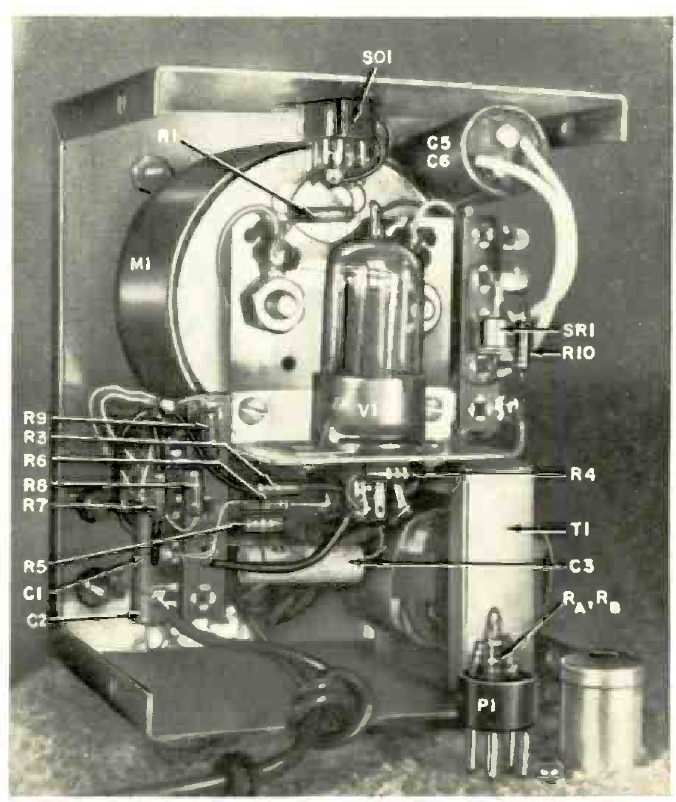
Standard VU Meter Circuit

The standard vu meter circuit is shown in Fig. 1. It consists of the meter which, itself, has an internal impedance of 3900 ohms. It is connected to a 3900/3900-ohm T-pad composed of Arms *A* and Arm *B* for adjusting meter sensitivity. A 3600-ohm series resistor is placed on the opposite side of the pad. This terminates the input of the T attenuator in 3900 ohms when bridged across the terminated 600-ohm source, that is, the parallel impedance of the source and load resistor in series with the 3600-ohm resistor, gives an effective total impedance of 3900 ohms. The series resistor also raises the input impedance to 7500 ohms which places negligible loading across a 600-ohm source. But this is still too low to use across high-impedance circuits. Also, with no attenuator loss, it requires a signal of 1.228 volts for 0-vu reading. Thus, low-level signals cannot be monitored.

Outboard Meter Circuit

The "outboard" vu meter circuit is shown in Fig. 2. There are two inputs. The low-impedance input is for use across 500/600-ohm sources, or lines. The high-impedance input is suitable for bridging across high-impedance circuits

Completed vu meter. The plug-in attenuator pad is at the top of the cabinet. The "Hi-Lo" switch determines which input to utilize.



Inside view of the vu meter. The tube and the small parts are attached to a bracket that is mounted directly on meter terminals.

as well as any low-level signal source.

The circuitry involved when using the low-Z input consists of the standard vu meter circuit which has already been discussed. The only difference here is the addition of the meter switching component S_1. Provision is made for a plug-in arrangement of the attenuator pad. A listing of resistor values for the T attenuator for various signal levels above 1 milliwatt is given in Table 1.

The high-Z input works into the grid circuit of the 12AX7 voltage amplifier stage V_{1A}. Input signal level is adjusted by potentiometer R_2. The other half of the 12AX7, V_{1B}, serves as a cathode-follower. A cathode-follower works best into an impedance of not less than 10,000 ohms which is provided for by R_8. The output impedance of the follower is approximately 800 ohms. This and R_8 in series across resistor R_9, presents an effective impedance of about 3900 ohms to the meter, which is necessary for proper dynamic operation of the meter.

A half-wave supply using a silicon diode rectifier powers the high-impedance circuit. Filtering is provided by resistor R_{10} and capacitors C_5 and C_6. Since the current drain is only about 1 ma., most any crystal diode can be used if it has a peak inverse voltage rating of at least 175 volts.

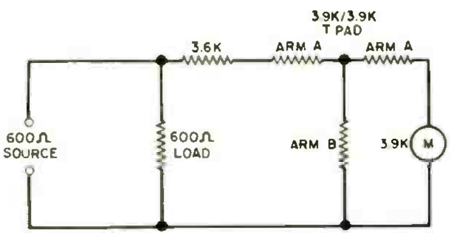
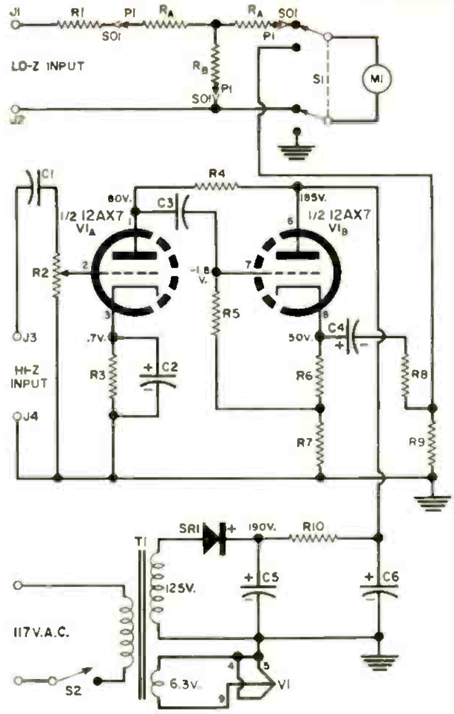


Fig. 1. The standard vu meter circuit. It is designed to bridge across terminated 600-ohm lines. With only the 3600-ohm series resistor in the circuit, that is, with Arms "A" shorted and Arm "B" open, it requires 1.228 volts input for zero vu meter reading.

Construction Data

The outboard vu meter is assembled in a 3" x 4" x 5" aluminum box. The meter, controls, and binding posts are all mounted on the front of the box. Power switch S_2 is in tandem with the input control R_2. Switch S_1 is a slide-type unit. The attenuator pad for the low-input section is at the top. Any small connectors will serve for this purpose. The three pad resistors are soldered to the plug half of the connector and then plugged into the mating socket. In this way, different attenuator pads can be made up and plugged in as required. If the builder wishes to change the circuit sensitivity frequently, a switch can be used in place of the plug-in arrangement and various attenuator pads switched in as desired.

The 12AX7 tube socket is placed on a small aluminum bracket which is attached to a small piece of Bakelite. The Bakelite is mounted on the terminals of the vu meter as shown in the photo. Small component parts are attached to this sub-assembly. The power transformer is fastened to the bottom of the enclosure.



R_A, R_B—See text
R_1—3600 ohm, ½ w. res.
R_2—500,000 ohm pot (with switch S_2)
R_3—1500 ohm, ½ w. res.
R_4—270,000 ohm, ½ w. res.
R_5—470,000 ohm, ½ w. res.
R_6—4700 ohm, ½ w. res.
R_7—120,000 ohm, ½ w. res.
R_8—10,000 ohm, ½ w. res.
R_9—6200 ohm, ½ w. res.
R_{10}—3300 ohm, ½ w. res.
C_1,C_3—.01 µf., 600 v. capacitor
C_2—25 µf., 25 v. elec. capacitor
C_4—4 µf., 150 v. elec. capacitor
C_5,C_6—20/20 µf., 250 v. elec. capacitor
M_1—3-inch vu meter
S_1—D.p.d.t. slide switch
S_2—S.p.s.t. switch (on R_2)
T_1—Power trans. 125 v. half-wave @ 15 ma.; 6.3 v. @ .6 amp. (Stancor PS8415)
SR_1—300 ma., 140 v., 200 v. p.i.v. silicon diode (International Rectifier SD-92.)
J_1,J_2,J_3,J_4—Binding post
P_1,SO_1—3- or 4-pin matching plug and socket (Amphenol 91-MPM4L and 91-MPF4L miniature cable connector or equiv.)
V_1—12AX7 tube
1—3"x4"x5" aluminum box

Fig. 2. Complete schematic of the meter circuit. An external power supply can be utilized if portability is not necessary. Pin-7 voltage is referred to pin 8 here.

The low-impedance input is to be used for bridging across low-impedance circuits such as 600-ohm lines and other sources of lower impedance. A suitable attenuator pad is selected, according to the signal level of the circuit being monitored, from Table 1. This pad, when plugged into the attenuator socket should then provide a zero vu reading on the meter for the peak signal level being monitored. Switch S_1 should be thrown to the "down" position to use the low-Z circuit.

For example, the common 600-ohm line level is +8 vu above 1 milliwatt. This represents a signal level of 1.95 volts across a terminated 600-ohm source. From the table it is seen that the R_A legs of the attenuator must each be 882.4 ohms and the R_B leg 8177 ohms to obtain a zero vu reading on the meter for this line voltage level. Other attenuator pads may likewise be made in accordance with the signal levels to be monitored.

Table 1 is a standard table of resistance values for vu meter circuit attenuators. In most applications the nearest EIA resistor values will suffice. If greater accuracy is required, parallel or series arrangement of resistors may be employed to more closely match the values given in the table.

The high-impedance input of 0.5 megohm is suitable for bridging across high-impedance circuits and for monitoring low signal level circuits. Switch S_1 is now thrown to the "up" position. In this case, the input potentiometer R_2 is adjusted to obtain a zero vu reading on the meter according to the signal level of the circuit being monitored. This input will provide a zero vu meter deflection with an input signal level as low as 50 millivolts. If a higher input impedance is desired, the builder may increase the input potentiometer to one megohm. As with any high-impedance, low-level circuit, good shielding and grounding practices should be observed in the external leads to the input terminals.

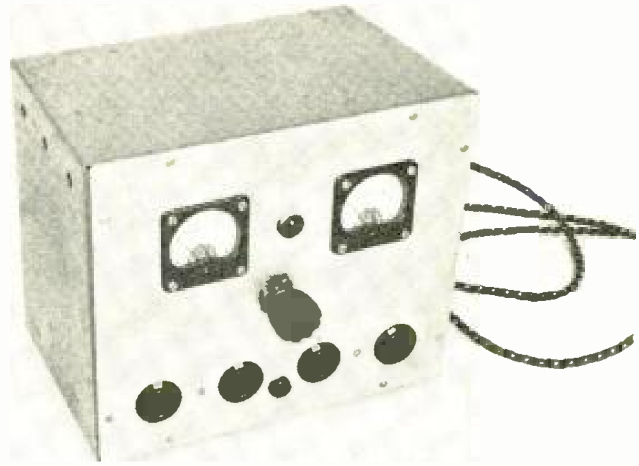
If, in some applications, it is desired to use the high-impedance input across a balanced circuit, a small 1 to 1 isolation transformer can be connected between the balanced circuit and the meter circuit input.

The economy-minded constructor might consider the inexpensive vu meters advertised by some of the electronics parts dealers. —30—

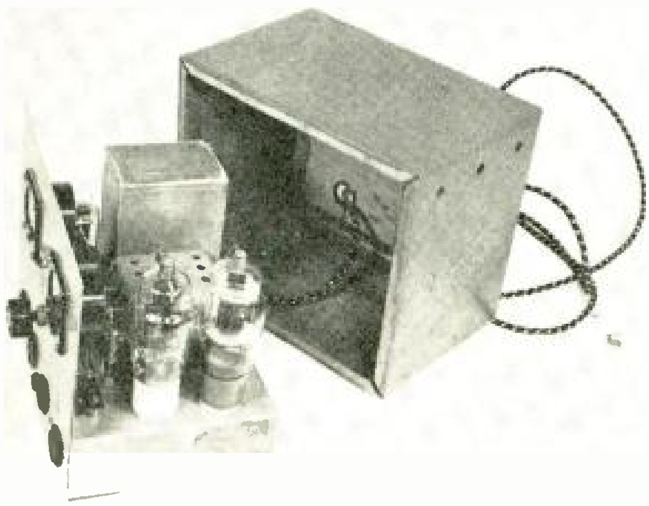
Table 1. Attenuator data based on a reference level of 1 milliwatt in 600 ohms.

Level VU	Volts	Attenuator Loss in DB	R_A Ohms	R_B Ohms
+4	1.228	0	0	Open
5	1.378	1	224.3	33800
6	1.546	2	447.1	16790
7	1.734	3	666.8	11070
8	1.946	4	882.4	8177
9	2.183	5	1093	6415
10	2.450	6	1296	5221
11	2.748	7	1492	4353
12	3.084	8	1679	3690
13	3.460	9	1857	3166
14	3.882	10	2026	2741
15	4.356	11	2185	2388
16	4.887	12	2334	2091
17	5.484	13	2473	1838
18	6.153	14	2603	1621
19	6.904	15	2722	1432
20	7.746	16	2833	1268
21	8.692	17	2935	1124
22	9.751	18	3028	997.8
23	10.94	19	3113	886.4
24	12.28	20	3191	787.9
25	13.78	21	3262	700.5
26	15.46	22	3326	623.3
27	17.34	23	3384	555.0
28	19.46	24	3437	494.2
29	21.83	25	3485	440.0
30	24.50	26	3528	391.9
31	27.48	27	3566	349.1
32	30.84	28	3601	311.0
33	34.60	29	3633	277.2
34	38.82	30	3661	246.9
35	43.56	31	3686	220.0
36	48.87	32	3709	196.0
37	54.84	33	3729	174.7
38	61.53	34	3747	155.7
39	69.04	35	3764	138.8
40	77.46	36	3778	123.7

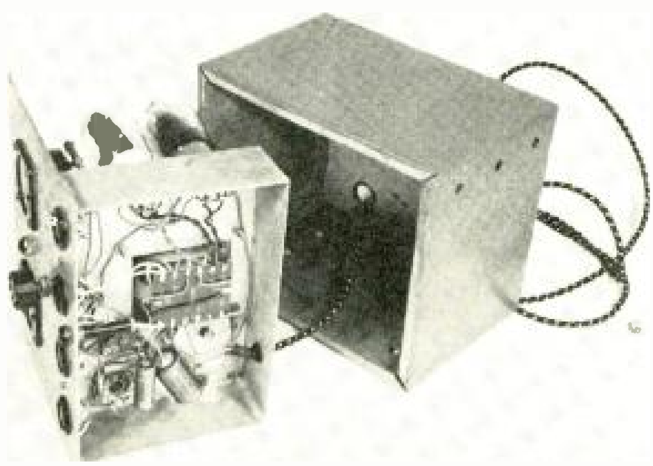
ADJUSTABLE D.C. POWER SUPPLY



Home-built supply uses monitoring voltmeter and milliammeter. The mid-panel control allows output voltage to be varied.



This top-chassis view shows the pair of 807's that are used.



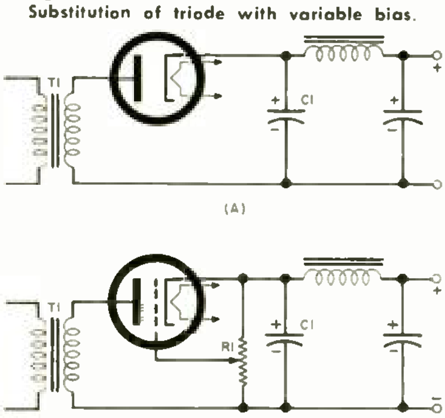
Bottom-chassis view showing the transformer terminal board.

By ROY HARTKOPF

A variable "B+" supply for the technician and experimenter. Delivers over 300 volts at low current and 100 ma. at 100 volts.

MOST experimenters, particularly those who are always trying out new and unusual circuits, feel the need for some kind of separate power supply. To build a power supply for each rig is time-wasting and expensive and it is often this prospect which prevents a new and interesting circuit being tried. Even when a conventional power supply is available, the voltage is usually too high or too low for the requirements of the circuit.

Fig. 1. (A) Basic half-wave rectifier. (B) Substitution of triode with variable bias.



This article describes a simple and inexpensive controllable power supply which can be made from junk-box oddments and which can be made to give a voltage anywhere between the maximum (over 300 volts with light loads) and zero simply by turning a knob on the front panel.

It should be emphasized that this is *not* a regulated power supply. A regulated supply is one in which the voltage is kept constant irrespective of variation in load and power-line voltage. Often the output of such power supplies is controllable over fairly narrow limits but, essentially, it provides a fixed and precise voltage. The experimenter trying out a new circuit, however, does not worry overmuch about precision and stability. He wants to know if it will work and to get some idea of the most suitable high voltage required, especially if the circuit and components vary from a standard tested specification.

Power-supply circuits are among the most familiar of all electronic circuitry and there is little need to describe the simple, high-voltage supply shown in Fig. 1A, except to point out that current will flow through the diode whenever the voltage in the secondary of the transformer is higher than the voltage across the filter or storage capacitor, C_1. If no current is being drawn from the power supply, there is no drain on C_1 and its voltage rises until it becomes equal to the peak voltage across the secondary of T_1, that is, about 1.4 times the r.m.s. voltage of the secondary of the transformer.

Now let us examine the circuit of Fig. 1B. The diode of Fig. 1A has been replaced by a triode with its grid connected to the moving arm of a potentiometer, R_1, the ends of which are connected across the high-voltage supply. If the moving arm is at the positive end of R_1 the triode behaves much like the diode in Fig. 1A and under no-load conditions the same peak voltage is built up. Suppose now that we rotate the potentiometer until the moving arm is at the negative end. The grid is now at zero potential—several hundred volts negative with respect to the cathode; and current through the tube is entirely cut off. The small current flowing through R_1 gradually reduces the high voltage until it becomes about equal to the cut-off voltage of the triode. As soon as the voltage falls below this value the triode allows current to flow until this voltage is built up again. So we see that the simple circuit of Fig. 1B will give an output voltage varying from the maximum which the transformer will give down to a minimum, depending on the cut-off bias voltage for the tube.

Practical Circuit

The circuit of Fig. 1B has practical disadvantages. It is only a half-wave rectifier circuit which makes filtering difficult, and gives very poor regulation of the output voltage. The addition of a second triode and the use of a line transformer with the normal center-tapped secondary provides a practical circuit which will be satisfactory for most jobs. This is shown in Fig. 2A.

If it is desired to supply low-voltage equipment, such as transistors, it is necessary that the voltage should be controllable down to zero. This can be arranged by connecting the bottom end of the potentiometer to a negative supply, as shown in Fig. 2B. Any rectifier will do provided it can take the reverse voltage and deliver a few milliamps. One thing is essential, however. The negative supply must be turned on before the main control tubes heat up, otherwise the power-line supply voltage will initially rise to some 20-70 volts—quite enough to ruin valuable transistors!

Construction Details

Fig. 3 is the schematic of the circuit built by the author, while the unit itself is shown in the photographs. There is nothing critical about the components or the wiring. In order that the power supply can be made either positive or negative with respect to ground, the whole circuit is left floating and ground connections are arranged on the equipment to be measured.

The main rectifier tubes are a pair of 807's. These are readily available and will carry a reasonable current, but almost any other power tubes will work as well. The 5Y3 was used to provide the bias voltage. It, too, is readily available and is directly heated and an unused 5-volt winding was utilized on the power transformer. The 807's require a 6.3-volt winding of their own which is tied to the cathodes to avoid the possibility of a heater-cathode breakdown. The built-in voltmeter gives some indication of the voltage setting. The milliammeter gives a quick and continuous indication of the current consumption of the test circuit.

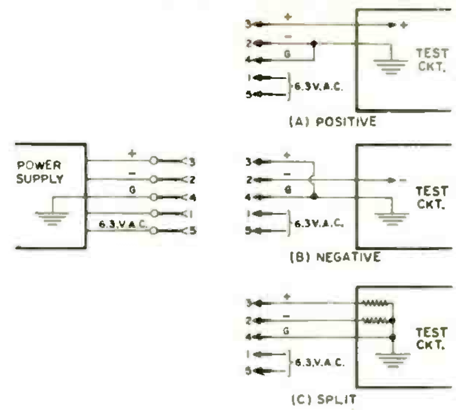


Fig. 4. Methods of making output connections.

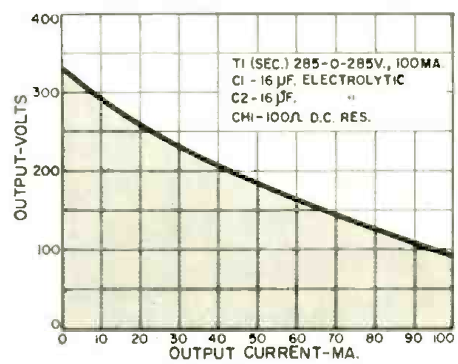


Fig. 5. Shaded area shows range of outputs.

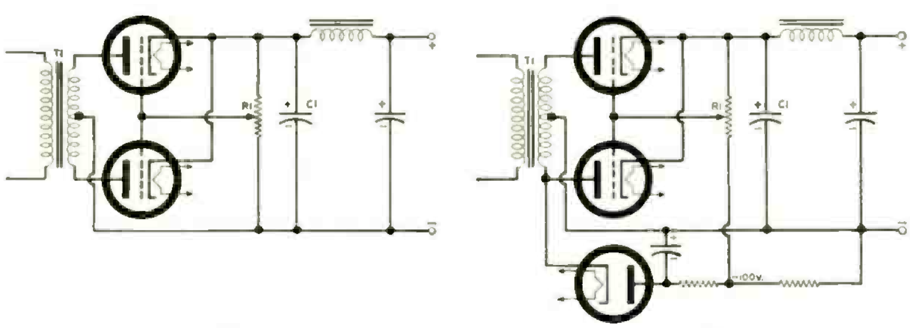

(A) (B)

Fig. 2. (A) Full-wave rectification with adjustable output. (B) To make the output controllable down to zero volts, another rectifier must be added as shown here.

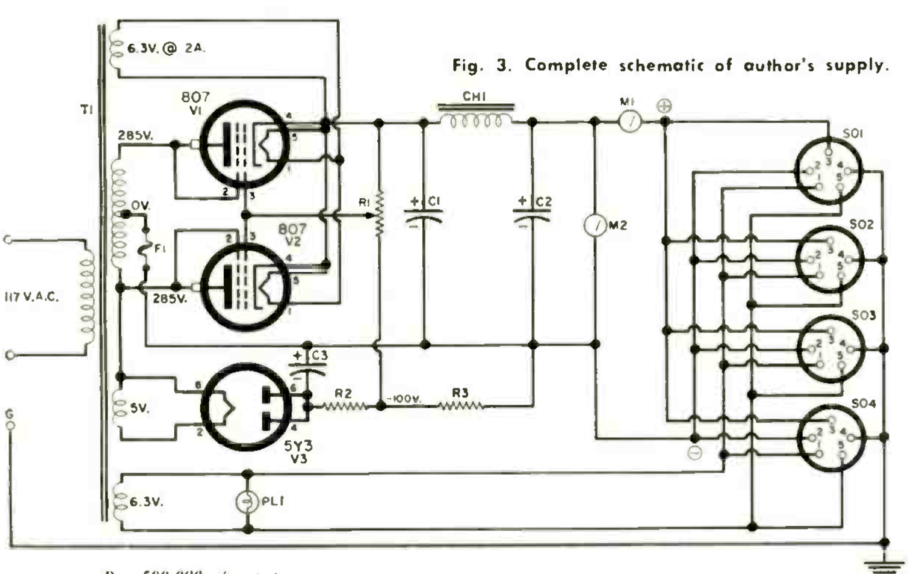


Fig. 3. Complete schematic of author's supply.

R_1—500,000 ohm pot
R_2—250,000 ohm, 1 w. res.
R_3—100,000 ohm, 1 w. res.
C_1, C_2, C_3—16 µf., 450 v. elec. capacitor
CH_1—2-20 hy., 100 ma. choke
F_1—150 ma. fuse
PL_1—6.3-volt pilot lamp
SO_1, SO_2, SO_3, SO_4—5-pin socket
M_1—0-100 ma. meter
M_2—0-500 volt meter
T_1—Power trans. 285-0-285 v. @ 100 ma.; 6.3 v. @ 1 amp.; 5 v. @ 2 amp.; 6.3 v. @ 2 or more amps. (see text)
V_1, V_2—807 tube (see text)
V_3—5Y3 tube (see text)

As mentioned previously, the whole power supply is floating and it must be remembered that all components, including both sides of the electrolytics, can be several hundred volts positive (or negative) with respect to ground. Fig. 4 shows how the output can be connected to give a positive, negative, or split supply. The split supply is very useful for trying out some types of d.c.-amplifier and transistorized circuits. Four identical outlets are provided on the power supply. These can be useful but it must be remembered that if units wired for different supplies are plugged in at the same time the supply will be short-circuited, causing the fuse to blow.

The difference between a controllable power supply and a regulated one has already been mentioned and, in fact, the regulation of the supply described is poor. The triodes have a high impedance compared to the normal rectifiers and thus the output voltage drops markedly as soon as current is drawn. The shaded area of the graph in Fig. 5 shows the range of voltages and currents available with the circuit described. A transformer with a 385-volt secondary instead of 285 volts will lift the whole curve by better than 100 volts. A larger filter electrolytic would improve the regulation (provided the dissipation ratings of the triodes are not exceeded).

The average experimenter will find that a power supply along the lines described can be built from components taken from the "junk box" and will solve the problem of quickly getting the right voltage for an experimental hook-up. —30—

MAC'S service shop

Second Guessing

IT SEEMED too early to start the air-conditioner, but actually it was the first downright hot day of the year. Barney's temper was keeping step with the rising temperature inside the service shop, for he muttered and grumbled continuously as he sweated over a portable TV receiver.

"OK! OK! I read you loud and clear" Mac, his employer, finally said; "but I wish you'd learn to suffer in silence. What's bugging you, Daddy-O?"

Barney winced as he always did when Mac burlesqued beatnik jargon, but he quickly took advantage of the opening.

"This dog has a very common complaint: it hums," he explained. "Any raw graduate of a radio school should be able to find the cause of a hum in nothing flat, but I've been on this nasty little monster for an hour and still can't make head nor tail of the symptoms."

"Such as—" Mac invited.

"Such as the fact the volume control has no effect on the hum. Neither does pulling the audio amplifier tube. Usually that points toward an open filter capacitor, but I've bridged 'em all with a good unit with no improvement. Next I tried shunting the signal on the plate of the audio amplifier tube to ground with a large capacitor. That made the hum go 'way down. Moving the capacitor over to the grid of the output got rid of the hum entirely. That convinced me the hum voltage must be getting on the grid somehow. I thought maybe the socket was leaky between a filament pin and the grid pin, but nothing shows up on the highest range of the v.t.v.m. ohmmeter. Neither is it a case of the grid resistor opening up and leaving the grid floating.

"Then there's another kookie symptom: when I touch the glass of the 12CU5 output tube envelope, the hum disappears! Yet putting a grounded metal shield around the tube has no effect. I've been turning these things over and over in my mind until I'm about ready to flip."

Mac walked over to the tube rack, took out a new 12CU5, put it in place of the one in the receiver, and turned on the set. There was not the slightest trace of hum.

"Oh no!" Barney moaned. "It simply *can't* be a bad tube! I ran all the tubes through the tester the very first thing, and I found nothing wrong with any of them. Anyway, that hum has to be connected with some external signal getting onto the grid: otherwise, why does touching the glass envelope with the finger affect it?"

"It's the old story of allowing a fixed idea to block out what your senses and reason are trying to tell you," Mac consoled him. "It happens to all of us over and over. You dismissed the possibility of a faulty tube after you had checked them all, but a small amount of filament-to-grid leakage often will not show up in these tubes during a routine check. Usually, if the tester is a good one, the leakage can be made to reveal itself by leaving the tube in the 'check' position until all the elements are thoroughly heated before the leakage test is made. In other cases, the standard good practice of tapping the tubes gently during leakage checks will reveal a clinker that otherwise may slide by."

"OK," a chastened Barney agreed; "but that still doesn't explain why touching the glass killed the hum."

"True; so let's think about it a minute. The a.c. voltage from the filament was being transferred to the grid through a very high resistance. Now you know the body picks up a considerable amount of the 60-cycle a.c. field with which we are surrounded. Touching the vertical post of an oscilloscope with your finger while the horizontal sweep is set to display a 60-cycle signal will testify to that. The distorted waveform shown also reveals that the signal picked up by the body contains a high percentage of harmonic content and phase shift when it is transferred to the vertical input post with a touch of a finger.

"When you brought your finger close to the grid by touching the glass envelope of the tube, you induced some of this signal your body was picking up onto that grid that was already carrying the a.c. signal transferred to it by the tube leakage. It so happened that the frequency, phase, and amplitude of the induced signal was just right to buck the leakage signal; so the hum was cancelled out. Shielding the tube reduced the induced signal and very likely aggravated the hum a bit, although you didn't notice it."

"Makes sense," Barney nodded. "It seems I either give up a line of thinking too soon or hang on to it long after I should be turning loose. Sure is tricky knowing when it's best to try a new tack."

"You're so right," Mac agreed. "I was reminded of this just last week. Tom, our friendly competitor, asked me to help him with a noise problem he had with a receiver in a drive-in eating place over on the other side of town. This outfit has an arrangement whereby they feed radio programs out to the post speakers when they are not being used for intercom purposes. Most of the music comes from an FM tuner with an antenna mounted atop a wooden pole about a hundred feet back from the highway to reduce ignition interference. There is no problem there, but the owner also wants to use his AM tuner to pick up news programs, sports events, and certain kinds of music he can't get on the FM set.

"Now the AM tuner is mounted in the same rack as the FM tuner, and it has a loop antenna mounted on the back of the chassis. The noise produced by the fluorescent lights, the neon lighting, the flashing lights in a big sign, from food and drink blenders, and from thermostatically controlled switches in various kitchen devices is so great that only the local broadcast station can be received decently. The drive-in owner wanted to be able to receive at least three other popular out-of-town stations. All three of these stations were close together in frequency about the middle of the band. Our local station, of course, is at the high end of the band."

"What's that got to do with it?"

"Keep listening, and you'll see. My first suggestion was that he put noise-silencing filters on the gadgets producing the noise, but after he made a survey with a transistor receiver and explained how many different things were causing the noise and how they produced a noise-field extending some fifty feet out from the kitchen, I gave that up. My next brainstorm was to try to increase the amount of signal fed to the antenna so that the signal-to-noise ratio would be boosted enough for quiet reception. He ran a long wire out to the wooden pole and fastened the end of the wire to the single-turn antenna coil inside the loop. This helped, but the loop in the kitchen still picked up too much noise to be drowned out by the pepped-up signal.

"I was beginning to think in terms of putting the tuner in a doghouse away from the kitchen and running the output into a cathode-follower that would feed a low-impedance line running to

(*Continued on page* 126)

AN ACCURATE TRANSISTORIZED TACHOMETER

By **NEIL T. LARSEN**

A high-accuracy tach with good temperature stability which can be home-constructed at a cost of about $17.

THE unit described here was designed and built for a friend who required a stable, accurate, and cheap instrument for measuring engine speeds. It is essentially a pulse-rate meter and may easily be adapted for use as an audio-frequency meter or a rate meter in a radiation detector. It may also be used with various transducers such as a photo-electric pickup ("Transistorized Tachometer Pickup," ELECTRONICS WORLD, August, 1960). The principle of operation is very simple and enough information is presented to permit the builder to modify the basic unit to suit his particular needs.

The cost of the original unit, which used a surplus 0-2 ma. meter, was about $17. If a portable instrument is desired, it may be made to operate from a 6.75-volt mercury battery. This would eliminate the zener diode regulator necessary when the unit is installed in an automobile and would reduce the total cost by about four dollars.

Theory of Operation

Several tachometers of various sorts have been described in the technical magazines and a general discussion of applications will not be undertaken here. Instead the reader is referred to the article "A Transistorized Tachometer" in the January, 1959 issue of this magazine.

Tachometers usually fall into two general categories: those using either permanent-magnet generators or drag-cup indicators like an ordinary speedometer which require mechanical connection to a rotating shaft, or units utilizing electrical pulses from the ignition system together with some sort of power amplifier to drive a meter movement.

In this second group, which is the only type practicable for home construction, several variations are possible. One such unit, available as a kit costing about as much as the tachometer described here, uses only one transistor and is more or less representative of the second type. The input signal is obtained from the "hot" distributor point, filtered through a low-pass filter, and rectified. An averaging filter following the rectifier furnishes a current proportional to the pulse rate (or rpm) to a transistor operating as a (more or less) linear d.c. amplifier with the indicating meter in either its collector or emitter circuit.

This type of circuit has two very serious drawbacks. First, fluctuations in the input pulse shape from one car to another affect the meter calibration in spite of the filters. This effectively prevents using the instrument for accurate measurements unless it is calibrated point by point against a tachometer of known accuracy in the particular automobile in which it is to be installed.

Still worse, this type of circuit is very temperature-sensitive, which is quite a drawback in something that is to be used in an automobile. Users have found temperature sensitivities of almost 1% of full scale per degree Fahrenheit. This is not surprising, in view of the fact that the d.c. current gain (h_{FE}) of most germanium and silicon transistors will be approximately 1.4 times as great at 90°F as at 40°F. This means that a given input frequency will cause a 40% higher reading at 90°F than at 40°F if no feedback or compensation is used, and it isn't, in the available units. This makes the instrument good only for very rough indications of engine speed.

The situation is usually further aggravated by operating at the low collector currents necessitated by the small amount of power available from the filter. This may make the amplified collector cut-off current (I_{co}) of the transistor a sizable fraction of the meter current at higher temperatures. This current may change by a factor of 10 for a temperature change of 40°F, causing the meter to read up-scale from zero even when no signal is applied. This deflection adds to the regular deflection and introduces an additional variable error.

Some refinements have been published which tend to reduce the effect of pulse shape variation by using an overdriven preamplifier and a zener clipping diode to obtain constant amplitude pulses. However, the temperature effects will be as serious as before if this combination is followed by a linear power stage. An additional modification that has been tried is to use a balanced two-transistor differential amplifier to drive the meter and reduce, to some extent, the zero drift. However, unless the transistors are closely matched and a considerable amount of degenerative d.c. feedback is used, results are not satisfactory. Some zero and calibration drift will still be noted.

Problems of temperature instability of calibration and zero calibration error due to the calibrating waveform having been different from that being measured, and the requirement for a sensitive (expensive) microammeter are all eliminated or made negligible by the simple circuit shown in Fig. 1. It will be recognized at once as a monostable multivibrator. In this m
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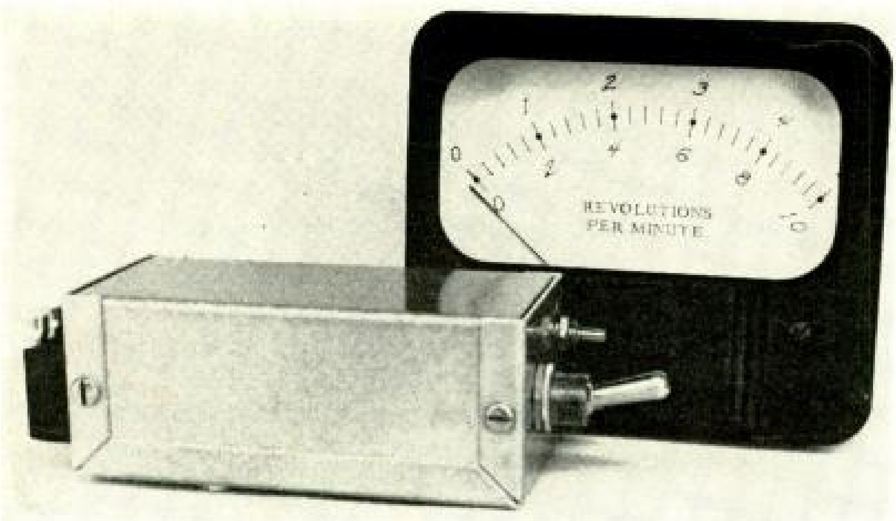
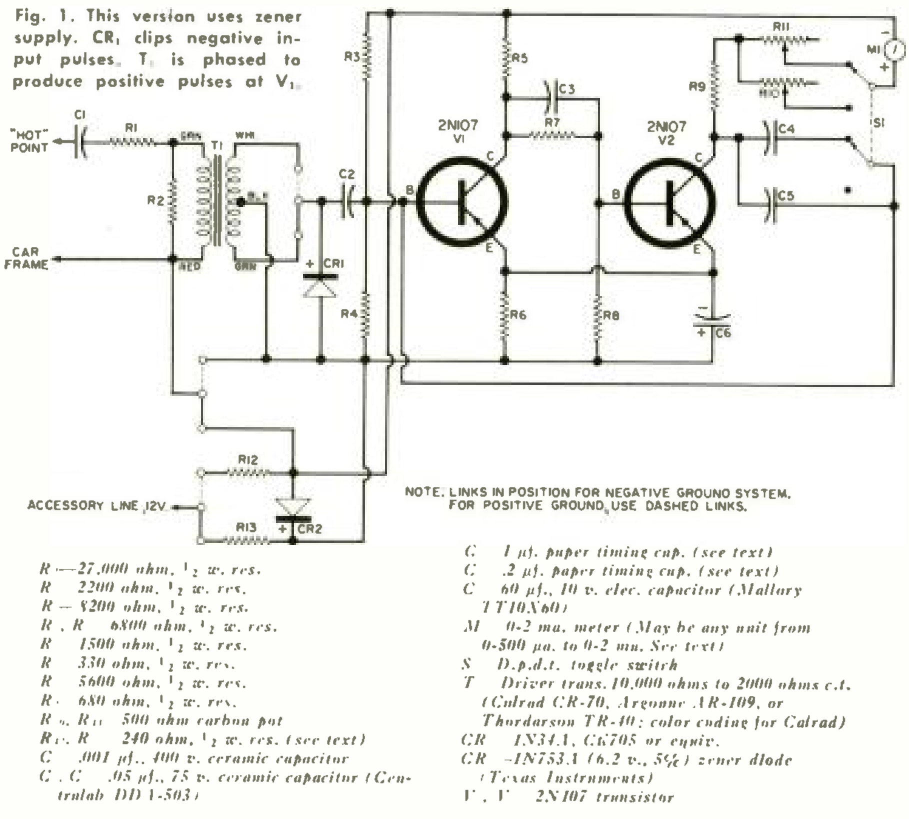


Tach control unit and indicator. Top surface of control unit mounts to the underside of dash. Toggle switch is used to select 0-5000 or 0-1000 range.

Fig. 1. This version uses zener supply. CR_1 clips negative input pulses. T_1 is phased to produce positive pulses at V_1.



R—27,000 ohm, ½ w. res.
R 2200 ohm, ½ w. res.
R — 8200 ohm, ½ w. res.
R , R 6800 ohm, ½ w. res.
R 1500 ohm, ½ w. res.
R 330 ohm, ½ w. res.
R 5600 ohm, ½ w. res.
R 680 ohm, ½ w. res.
R, R 500 ohm carbon pot
R , R 240 ohm, ½ w. res. (see text)
C .001 µf., 400 v. ceramic capacitor
C , C .05 µf., 75 v. ceramic capacitor (Centralab DD 1-503)
C 1 µf. paper timing cap. (see text)
C .2 µf. paper timing cap. (see text)
C 60 µf., 10 v. elec. capacitor (Mallory TT10X60)
M 0-2 ma. meter (May be any unit from 0-500 µa. to 0-2 ma. See text)
S D.p.d.t. toggle switch
T Driver trans. 10,000 ohms to 2000 ohms c.t. (Calrad CR-70, Argonne AR-109, or Thordarson TR-40; color coding for Calrad)
CR 1N34A, CK705 or equiv.
CR —1N753A (6.2 v., 5%) zener diode (Texas Instruments)
V , V 2N107 transistor

transistor are either zero or else some value determined solely by the collector and emitter resistors, and the supply voltage. The transistor characteristics (and any temperature-induced variations in them) have almost no effect. The independence of the meter reading on the transistor characteristics was shown by replacing the type 2N107 transistors for which the circuit was designed with type 2N241A's, which have about three and one-half times the gain. This resulted in a change in the full-scale reading of less than 2%.

When either of the transistors is off, the current through it is actually less than the normal amplified I_{co}, because it is slightly reverse-biased by the other transistor. This means that no zero drift occurs; in fact, since the "off" current is less than 0.1% of the "on" current, it is not even necessary to provide an initial zero adjustment. When either of the transistors is on, it is saturated, and the collector-emitter drop is only about −0.2 volt. This is roughly 3% of the 6-volt supply voltage, and therefore can change by as much as 10% without affecting the "on" current by more than about 0.3%. This ensures that the initial calibration will hold at all temperatures in the operating range of the instrument.

In this regard, since the insensitivity to temperature is dependent on the two transistors operating as true switches, the tachometer will be stable only within a certain range of temperatures. This range can be maximized by proper design, and, for this unit, it is calculated that reliable operation can be expected from 40 F to 120 F. Outside of this range, triggering will become erratic and then shortly stop altogether.

Beyond the low end of the temperature range, the meter will swing to its right stop and stay there; this is due to V_1 turning off without being triggered and forcing V_2 into saturation. Only about 4.2 ma. will flow through V_2, so there is no danger of meter damage. Beyond the high end, the opposite will happen. The triggering pulses will no longer be able to turn V_1 off, and the needle will rest at zero. The original unit was placed in a 40 F refrigerator after being carefully calibrated at full-scale. After it had had sufficient time to cool completely, it was removed and quickly tested again. The calibration had not changed by as much as a needle width. After the unit had been installed and in operation for some months, a thermometer was laid across the control portion (mounted under the dash), and the car left closed on a very hot day. After several hours, operation was checked and the temperature noted. Operation was quite satisfactory, and the temperature was over 120 F, the highest mark on the thermometer.

The power dissipated in the transistors is approximately equal to the product of the average collector currents and the saturation voltages, if switching is rapid, as it is here. Thus, if the average collector current of V_2 is 2.0 ma. (for a 0-2 ma. meter movement), the collector dissipation in the transistor will be 0.4 milliwatt, with 4 mw. delivered to the load. This is an efficiency of 91%; still higher efficiencies might be obtained by raising the collector supply voltage, but this is not an important consideration here. The point is that cheap transistors may be used to deliver more power more reliably to a cheaper, more rugged meter than would be possible using heavier transistors operating as linear amplifiers.

An additional advantage accrues from this type of approach: the linearity of the transistors has no effect on the linearity of the scale calibration. The linearity will be determined primarily by the linearity of the meter used, and if this is reasonably good, the scale need be calibrated at only one point, preferably at the top of the range. Using a *Triplett* Model 630 as an indicator and a precisely calibrated audio oscillator as the signal source, the original unit did not show as much as 1% deviation from true linearity, assuming that the meter introduced no compensating errors.

Circuit Details

As stated earlier, the tachometer is basically a monostable multivibrator. While previous devices have used low-pass filters at their inputs to provide pulses of sufficient area (power) to drive the metering circuit, a high-pass filter is used here. This is done because very little power is required to trigger the multivibrator, and the steep leading edge of the pulse generated when the breaker points open gives much more

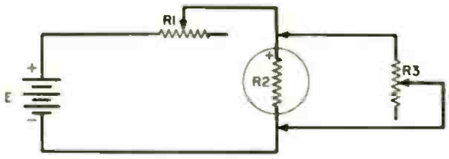


Fig. 2. Circuit for measuring meter resistance, R_2, in terms of resistors R_1 and R_3.

precise triggering than a slowly rising pulse. In the input circuit, the primary function of T_1 is to facilitate connection to either positive- or negative-ground ignition systems. C_1 is a d.c. blocking capacitor. Resistor R_1, together with the low primary inductance of T_1, form part of the high-pass filter. R_1 and R_2 form a voltage divider to reduce the amplitude of the incoming pulse, which is much too large. R_2 may require adjustment in some cases: it should be as small as possible while still permitting reliable triggering at the highest temperatures to be encountered. Its value is not critical, and it has no effect on the calibration. Diode CR_1 serves to short out negative-going voltage spikes.

Capacitor C_2 blocks the bias on V_1 from the secondary of T_1 and also acts as another high-pass filter section in conjunction with the input resistance of the multivibrator. R_3 and R_4 furnish the bias to V_1. When no pulses are being received, V_1 is conducting heavily. Resistors R_3 through R_8 are chosen so that when V_2 is off, V_1 is saturated; and R_5 through R_{11} are chosen so that when V_1 is off, V_2 is saturated. When V_1 is saturated, the emitters of both transistors are at about -1.08 volts with respect to the positive power ground. The collector of V_1 is at about -1.28 volts. The base of V_2 is at about -0.5 volt, which means that it is biased in the reverse direction by approximately 0.9 volt, if it is assumed that the I_{co} is zero. As the I_{co} increases with temperature, this bias decreases, and this is one of the effects that sets the upper temperature limit. With this reverse bias, the collector current of V_2 is essentially zero, and no meter reading results.

Now, if a positive-going pulse of sufficient amplitude arrives at the base of V_1, it is driven out of saturation and its collector voltage increases, that is, it tends toward the negative supply voltage. This negative-going signal is coupled to the base of V_2 through C_4, bringing V_2 out of cut-off. As V_2 begins to conduct, the timing capacitor (or capacitors) C_3 couples the positive-going swing at the collector of V_2 to the base of V_1, reducing its conduction still further. This regenerative action causes a rapid switching, and very soon after the initiating pulse arrives, V_1 is cut off and V_2 is saturated.

The timing capacitor is charged by the switching action in such a direction as to hold V_1 cut off for a period of time determined principally by R_3, R_4, C_3, and the collector voltage swing of V_2. As V_1 comes back into conduction, the regenerative switching occurs again, V_1 saturates, V_2 is cut off, and the circuit is ready for the next pulse.

It is seen that the current through V_2 consists of a train of rectangular pulses. These pulses have a repetition frequency exactly the same as the triggering source, an amplitude determined by the supply voltage and load resistances, and a length determined primarily by the timing capacitor. The pulses have an average d.c. value which is proportional to the product of the frequency of the pulses and the area under an individual pulse. Therefore, the meter in the collector circuit will be deflected in proportion to the frequency if it measures the average current through it, rather than the peak. Most meters are damped sufficiently to do this, and only for frequencies below about 20 cps does the pointer vibration become visible. This would correspond to an engine speed of 400 rpm in a 6-cylinder engine.

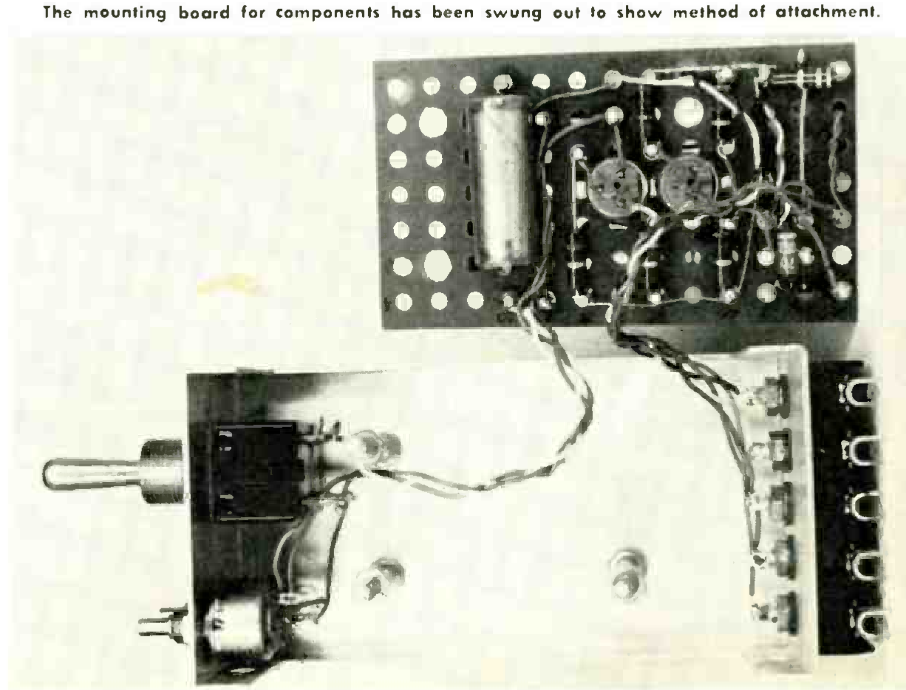
The remaining components that have not been mentioned are C_5 and the resistors in the collector of V_2. C_5 aids the switching action by lowering the charging source impedance for C_3 during the switching interval. R_8 through R_{11}, plus the d.c. resistance of the meter, form the load for V_2. It is desirable that, after the unit has been calibrated, the d.c. resistance in the collector of V_2 be close to 1000 ohms, within 10% if possible.

Meters vary widely in quality and a good surplus meter with a resistance of 500 ohms or less is much more desirable in this application than a new cheap meter with high resistance and poor damping. The better Japanese imports are generally suitable. If the resistance of the meter is not known, it may easily be measured by the simple arrangement shown in Fig. 2. Here, E is a battery or single cell, R_1 and R_3 are variable resistors, and R_2 is the resistance of the meter to be measured. With R_3 removed, R_1 is set to give full-scale deflection on the meter. With a 1.55-volt dry cell for E, R_1 will typically be between 1000 and 2000 ohms. R_3 is then added and adjusted to bring the meter reading down to some fraction, k, of its initial reading. With the value of E noted, R_3 will typically be between 10 and 500 ohms. The meter and battery are then disconnected and R_1 and R_3 measured on an ohmmeter. The exact equation for R_2, the meter resistance, is: $R_2 = R_3/[k/(1-k)-(R_3/R_1)]$ if it is assumed that the internal resistance of E is very small in comparison with R_1. This is true if the dry cell is reasonably fresh. If R_3 is adjusted to give exactly one-half-scale deflection, so that $k = 1/2$, then the equation reduces to: $R_2 = R_3/(1-R_3/R_1)$.

In most cases, R_1 will be much greater than R_3, and the fraction R_3/R_1 will be negligible compared to unity. However, if the meter resistance measured in this example were 500 ohms, and the value of R_1 were not taken into consideration, the value that would be arrived at by the approximation that $R_3/R_1 = 0$ would be 339 ohms, which is grossly in error. The article "Measurement of Meter Resistance," in the July, 1960 issue of this magazine discusses the measurement in more detail, but the author presents the approximate equation without stating that he is doing so, and the reader must be sure to realize the limitations on the measurement that are imposed by this. In the author's example, the error in his measurement of the resistance of a 30-ohm meter movement will be about -1.5% from this source alone if only 1.55 volts is used for E. An error in the measurement of 10% is tolerable for our purposes here, but if one is interested in a meter's resistance for the construction of shunts and multipliers, it is necessary to use the exact equation.

The model shown here was built for installation in a passenger automobile, and has ranges of 0-1000 and 0-5000 rpm. The low speed range was included in order to obtain better accuracy in setting the idling speed of the engine. In a four-cycle engine, each plug fires once every two revolutions, so that

The mounting board for components has been swung out to show method of attachment.



there are three pulses per revolution from the breaker points in a six-cylinder engine and four in an eight. This makes the tachometer input frequency for a six-cylinder engine: $f_6 = rpm/20$. and for an eight it is $f_8 = rpm/15$, where f_n is pulses per second. Five-thousand rpm produce a frequency of $333\frac{1}{3}$ and one-thousand rpm a frequency of $66\frac{2}{3}$ for an eight. For a six, the frequencies are 250 and 50, respectively.

Sports-car and hot-rod fans may wish the range extended to 6000 rpm full-scale. Others may wish special ranges for checking the operation of vacuum and centrifugal spark advances. or for non-automotive use. There may be some who have meters on hand with sensitivities different from 0-2 ma. they wish to use. For this purpose. the relation $I = 0.0285fC$. where I is the meter current in ma., f is in cycles per second, and C is the timing capacitor (C_5 in Fig. 1). in microfarads. This equation may be used for a rough calculation of I, f, or C when the other two quantities are specified. For example, if a full-scale deflection is desired on a meter with a sensitivity of 1.2 ma., at a frequency of 250 cps, the value of C required will be 0.167 μf. This will be within ±10% of the correct value if the resistors used in the rest of the circuit are within 5% of the specified values and the collector supply voltage is exactly 6 volts. If the final calibration is then made with the calibration potentiometer, the component values will be close enough to optimum to ensure reliable operation. In this way, various meters and ranges can be accommodated; some may wish to build a battery-operated unit to make some of the scales of the shop multimeter direct reading in frequency or rpm, for example.

It must be kept in mind that the range of possible combinations of meters, speeds, etc., is not unlimited. On the low end, a full-scale deflection of 60 cps with a 2.0 ma. meter is about the limit; below this, a more sensitive meter must be used to avoid overlapping of the pulses and the resulting erratic triggering and nonlinearity. On the high end, the maximum frequency that can be measured on a linear scale is about 1.2 kc. Above this point, the meter inductance must be bypassed and better quality switching transistors used to preserve the rectangular waveform.

Construction Notes

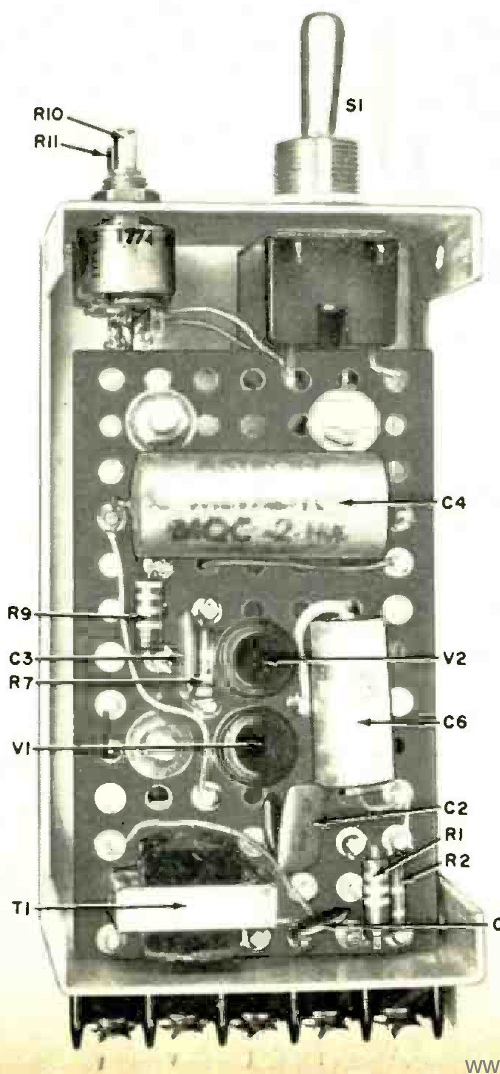
Construction is very simple and details will not be given here. Lead dress and parts placement are not critical, and some of the components used in the author's unit (the calibration pots, for example) were surplus units whose new cost would not be justified for the average builder. Replacing these with standard units, or using a self-contained battery supply, will require a new layout. In general, however, the type of construction illustrated lends itself well to this sort of device, so photographs are included. The perforated board used is available from several distributors; the terminals to which all connections are made are *USECO* No. 1290, with shank length to fit the particular board used. The staking tools for these cost about $3 and are well worth the money if much work of this nature is planned.

For a more compact unit, *Ohmite* 1/10-watt TR series resistors are recommended and may be used for all resistors except R_{12} and R_{13}. Metallized paper capacitors may be used for the timing capacitance, but not electrolytics. Any stable carbon or wirewound potentiometers may be used for the calibrating pots, preferably those having a screwdriver adjustment or a shaft lock.

The connections shown as dashed lines in Fig. 1 are alternates for use in automobiles with a positive ground. A triple-pole, double-throw switch may be used here, or, if the tachometer is to be used on only one car, the switch and the unused resistor (R_{12} or R_{13}) may be omitted entirely.

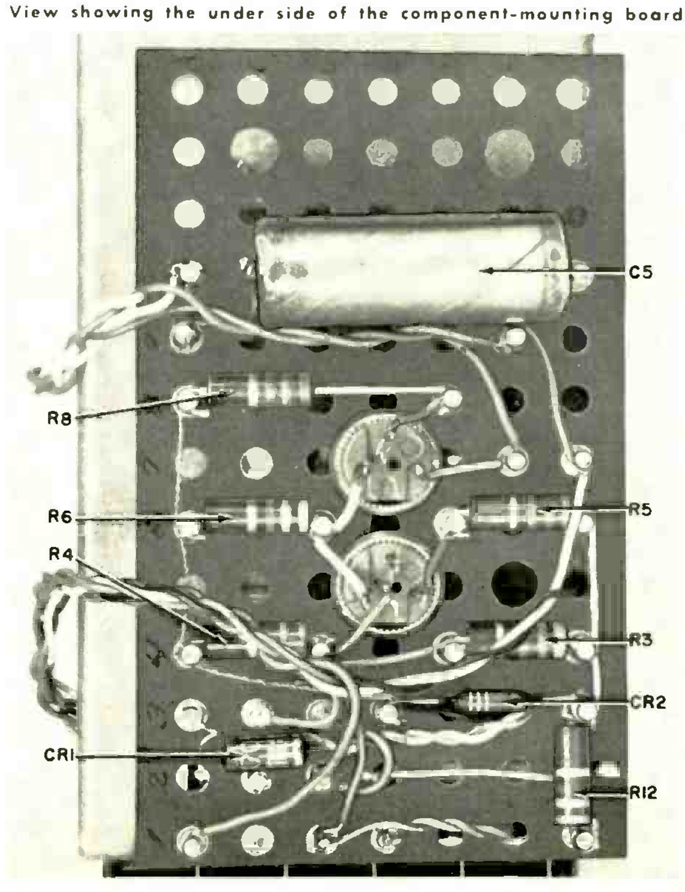
The power for the unit may come from self-contained mercury batteries if it is to be portable, or from the car's electrical system. In this case, zener diode regulation (using CR_2) is necessary, and it is recommended that the zener obtained have a 5% tolerance if the greatest possible temperature range is desired. The average current drain (exclusive of the zener) is about 4 ma. With six-volt ignition systems, it is not possible to design simultaneously

(*Continued on page* 98)



◀ View with top removed. Pots are used to calibrate each range.

View showing the under side of the component-mounting board.



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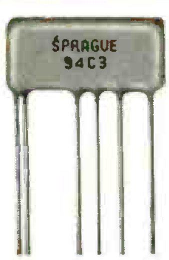

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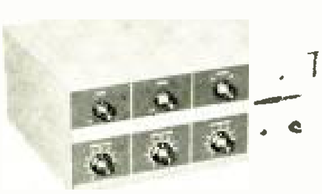

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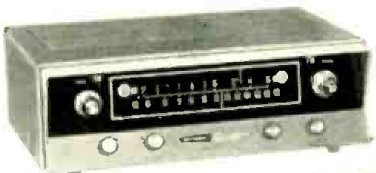

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CALENDAR of EVENTS

MAY 22-24
1961 Electronic Parts Distributor Show. Conrad Hilton Hotel, Chicago. Closed Show. Hours 9 a.m.-6 p.m. Details from Electronic Industry Show Corporation, Suite 1501, 11 S. LaSalle St., Chicago 3, Illinois.

National Symposium on Global Communications. Sponsored by the AIEE and IRE. Sherman Hotel, Chicago. Details from Donald G. Campbell, ITT Kellogg, 5959 S. Harlem Ave., Chicago, Ill.

National Telemetering Conference. Sponsored by PGSET, AIEE, IAS, ARS, ISA. Sheraton Towers Hotel, Chicago. Jack Becker, AC Spark Plug Div., General Motors, Milwaukee, Wisc. for program information.

MAY 22-26
1961 Conference of Society of Photographic Scientists & Engineers. Sponsored by SPSE. Arlington Hotel, Binghamton, N.Y. Details from SPSE, Box 1609, Main Post Office, Washington, D.C.

MAY 30-JUNE 2
Radio and Electronic Component Show. Sponsored by Radio and Electronic Components Manufacturers' Federation. Olympia, London, England. Information and tickets from the Federation, 21 Tothill St., London S.W. 1.

JUNE 5-8
Summer Instrument-Automation Conference and Exhibit. Sponsored by Instrument Society of America. Queen Elizabeth Hall, Toronto. Information from ISA Headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

JUNE 12-13
Third National Symposium on Radio Frequency Interference. Sponsored by PGRFI, Sheraton-Park Hotel, Washington, D.C. W. Gerald James, American Machine & Foundry, 1025 N. Royal St., Alexandria, Va. for program information.

JUNE 12-17
Conference on Components and Materials. Sponsored by the Electronics and Communications Section of The Institution of Electrical Engineers. The Central Hall, Westminster, London, England. Details from I.E.E., Savoy Place, London W.C. 2.

JUNE 14-15
Fifth National Conference on Product Engineering and Production. Sponsored by PGPEP of IRE. Hotel Sheraton, Philadelphia. John A. Knoll, RCA Surface Communications Engineering, Location 1-4, Camden, New Jersey for complete program information.

JUNE 19-20
Second National Conference on Broadcast & Television Receivers. PGBTR and Chicago Section of IRE. O'Hare Inn, Des Plaines, Illinois. Contact Neil Frihardt, Motorola Inc., 4545 W. Augusta Blvd., Chicago, Ill. for program details.

JUNE 26-28
Fifth National Convention on Military Electronics. Sponsored by PGME of IRE. Shoreham Hotel, Washington, D.C. Harry Davis, SAFRD, Pentagon, Washington 25, D.C. for program details.

JUNE 28-30
Joint Automatic Control Conference. Sponsored by PGAC, ISA, AIEE, AICHE, and ASME. University of Colorado, Boulder, Colo. Dr. Robert Kramer, Electrical Systems Lab., MIT, Cambridge 39, Mass. for program details.

JULY 10-14
Fourth Annual Institute in Technical and Industrial Communications. Sponsored by and held at Colorado State University, Fort Collins, Colo. Information available from Dr. Herman M. Weisman of the University.

JULY 16-20
1961 Music Industry Trade Show. Sponsored by National Association of Music Merchants. Palmer House, Chicago. Details from NAMM, c/o Cooper, Burns & Golin, 203 N. Wabash Ave., Chicago 1, Illinois.

JULY 16-21
Fourth International Conference on Medical Electronics & 14th Conference on Electronic Techniques in Medicine & Biology. Sponsored by IFME, JECMB, IRE-PGBME. Waldorf-Astoria Hotel, New York, N.Y. Program information from Dr. Herman P. Schwan, University of Pennsylvania, School of Electrical Engineering, Philadelphia, Pa.

AUGUST 1-3
Fourth Western Regional Meeting of the American Astronautical Society. Sponsored by AAS. Sheraton-Palace Hotel, San Francisco. Saunders B. Kramer, Lockheed Missiles and Space Div., Sunnyvale, Calif. is general chairman.

AUGUST 16-18
Second International Electronic Circuit Packaging Symposium. Sponsored by the Department of Electrical Engineering and Bureau of Continuation Education, University of Colorado, Boulder, Colo. Information on program available from the Bureau.

AUGUST 22-25
1961 Western Electronic Show and Convention. Sponsored by 7th Region of IRE and WEMA. Cow Palace, San Francisco, Calif. Information available from WESCON, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

AUGUST 30-SEPTEMBER 1
Third Annual AIME Semiconductor Conference. Sponsored by the Metallurgical Society of AIME and the Southern California Section of AIME. Ambassador Hotel, Los Angeles. Pre-registration with J. O. McCaldin, 11601 Montana Ave., Los Angeles 49, Calif.

SEPTEMBER 5-8
16th National Conference of the Association for Computing Machinery & First International Data Processing Exhibit. Statler Hilton, Los Angeles, Calif. B. J. Handy, Jr., Litton Systems, 5500 Canoga Ave., Woodland Hills, Calif., chairman.

SEPTEMBER 6-8
1961 Joint Nuclear Instrumentation Symposium. N.C. State College, Raleigh, N.C. Contact H. S. McCreary, Westinghouse Special Atomic Project, 107 Terrace Court, Pittsburgh 27 on program.

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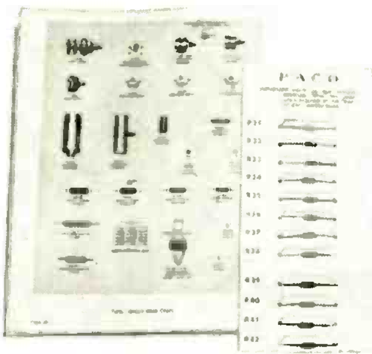
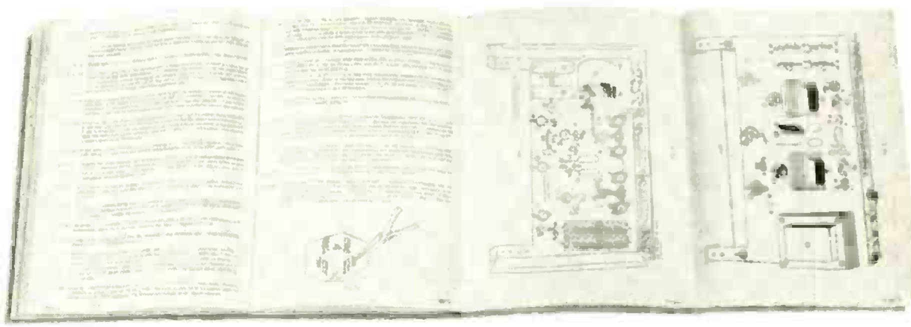


No mistaken identity or endless searching. Parts are clearly pictured and labeled; resistors are neatly mounted and identified!



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Reveals dried out, shorted, or open electrolytics—in the circuit—with Paco's exclusive Capacity Dial. Instantly finds open or direct shorted capacitors without removing from circuit. Great time saver!

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SIMPLE SEQUENTIAL TEST: reveals open or shorted capacitors, including electrolytic types.

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Protect your boat against shoals and underwater hazards with this compact, easy-to-read depth finder. Transistors prolong battery life, provide utmost accuracy and portability. A boon to fishermen—locates hard-to-find schools of fish. A low cost safety device for every boat owner.

Specifications:

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FAST, EASY READINGS: made possible by means of over-sized scale calibrated at one-foot intervals from 0 to 120 feet.

Model DF-90: Kit, complete with PACO-detailed assembly-operating manual. **Kit Net Price: $84.50**

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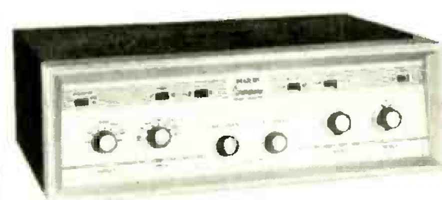

PACO Model SA-40 STEREO PREAMP-AMPLIFIER KIT

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PACO KITS BY PACOTRONICS

How to Check Speaker Characteristics With a Scope

By JIM KYLE

Lissajous figures on scope may be employed to check impedance and reactance.

A STANDARD test procedure for audio amplifiers is to bridge the vertical input of an oscilloscope across the amplifier input and to connect the horizontal input of the scope across the amplifier output. In this manner the scope display is unaffected by signal irregularities, but indicates instantly whenever the amplifier contributes any change.

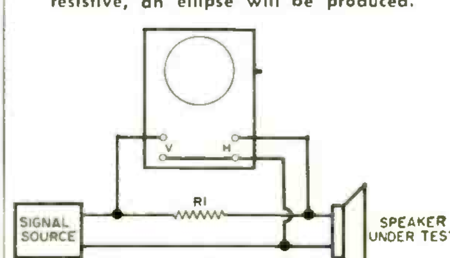
Not so widely known is the fact that a similar test setup can be used to check loudspeaker response. While loudspeakers have no "output" terminals, it *is* possible to measure effective speaker impedance as a variable of frequency, and this characteristic is closely related to the performance of the loudspeaker.

The setup is shown in the diagram. Resistor R_1 should have the same value as the rated speaker impedance; 15 ohms will suffice for most cases. This resistor serves a dual purpose: it serves to isolate the speaker from the driving amplifier, thus removing any effects due to amplifier damping, and it also stabilizes the voltage fed to the scope vertical input.

At all frequencies for which the speaker impedance is essentially resistive and approximately equal to the value of R_1, the scope display (when V and H gains are properly set) will be a single line inclined at a 45-degree angle. When speaker impedance rises, the scope trace will shift toward the horizontal axis. If speaker impedance drops below the value of R_1, the trace will shift toward the vertical axis. In either case, the line will remain straight as long as speaker impedance remains essentially resistive, becoming an ellipse as the speaker exhibits some reactance.

—30—

The value of resistor R_1 is the same as the value of the loudspeaker impedance. As the impedance of the speaker rises and falls, there will be a tilt in the Lissajous figure produced on the scope screen. If the speaker impedance becomes reactive rather than resistive, an ellipse will be produced.



Compact Hi-Fi Amplifier

(*Continued from page* 38)

Thus there is a component of signal voltage on the cathode of V_2. Since the cathode of V_3 is in parallel with that of V_2, it will also have signal impressed on it and since the grid of V_3 is grounded, the cathode will swing around the grid, which is equivalent to having the grid swing around the cathode as we are accustomed to having it. The cathode resistor *must not be bypassed.*

None of the parts in the amplifier is critical, however, you should make every effort to get the output transformer specified in the parts list. This is an excellent unit, modestly priced, that employs interleaved windings to reduce leakage. Note however that the secondary impedance is 3-4 ohms. For those requiring 4-, 8-, or 16-ohm impedances, the *Triad* S-31-A may be used instead. All other specifications remain the same.

This amplifier has plenty of high-frequency response so tone controls have been kept to a minimum and only a simple treble attenuator is employed. The output power is just over 6 watts before the scope shows any noticeable distortion.

The amplifier is built on a 5½"x 9½"x 1½" chassis. Construction is straightforward and, due to the small number of components involved, should present no problems.

The small size and light weight of the amplifier makes it ideal for use as an all-around hi-fi unit and also for use as a monitoring amplifier in broadcast stations, as a power amplifier for professional tape recorders, and as a second-channel stereo amplifier for the many non-professional stereo tape recorders now on the market. The amplifier may be incorporated in the speaker cabinet in this latter instance. Components have been designed out of the amplifier, not the quality or performance. —30—

Sound on Tape

By **BERT WHYTE**

THERE is very little activity in the tape world at present, but I suspect that this is just the lull before the storm —meaning that all sorts of rumors are rife about new tape developments and that we will probably have them sprung on us at the forthcoming shows. All I can comment on this is that new developments are always interesting, but that the tape industry can ill-afford to make changes just for the sake of changes. If the item is something significantly new and better and easily recognizable and acceptable to the public as such, well and good. Otherwise, it would be best to leave things as they are and concentrate on a higher degree of stability and improvements in tape processing.

I was a little amused to see that in the tape machine world things come full cycle, as in other industries. If you recall, in the early days of the two-channel stereo tape, there were a number of units whose sole function was stereo tape playback. The *Ampex* 600 was one of that type and I remember what howls went up from a lot of people when they decided to replace that unit with the first of the "A" series, which would record monophonically as well as play back stereo.

In subsequent models stereo recording was added and now we are back at the beginning, as *Ampex* announces a stereo *playback only* unit to be used through the tape-head inputs of modern preamps. Other manufacturers are following suit and now it is cheaper than ever to own stereo tape playback equipment.

In seeking an answer to this new trend, one can run into all sorts of arguments. What seems most valid to me is this ... unless the person buying the recorder has some very compelling reason for wanting to record either mono or stereo, he is many dollars ahead on the strictly playback versions.

Many people think they are going to find dozens of reasons for using the record function. Truth of the matter is that the average guy records his kids a few times and uses it at a party just for kicks, maybe he transfers a few discs to tape and finds out this isn't cheap, and perhaps he ventures into some off-the-air FM recording. In any case, in all of these activities, he is served, at least as far as the present is concerned, with mono recording, and the occasions on which he can use stereo are strictly limited.

The main argument always put forth to defend stereo recording facilities is that we will be able to tape great stereo music from FM-multiplex. This, of course, is very intriguing but as you are aware the battle over what multiplex system shall ultimately be utilized is still raging. You can call it political boondoggling or what you will ... there is and has been one system eminently acceptable for some time, but as of this writing, multiplex is still not a fact.

More than this ... I was flabbergasted by the poor quality of mono FM transmission I recently encountered. A friend asked me to tape one of the Saturday afternoon broadcasts of the Metropolitan Opera. Now I own one of the best and most expensive FM tuners money can buy, I have a high-gain directional antenna, and *Ampex* tape equipment. No reason in the world for poor results on my end. Well gosh-amighty! Overlooking the fact that whoever was engineering the pickup and the mixing had a very poor balance, I picked up the most miserable collection of crackling noises, squeals, grunts, groans, low-frequency oscillation, etc. I tried some other stations and, in greater or lesser degree, all these stations had spurious noises.

All of my equipment was checked and in perfect working order. One of the most annoying things I encountered was the very frequent over-modulation coming from the station which caused overload distortion, even if the master gain was turned down on my own recorder. It would seem that the FM stations are in need of some self-discipline, and they would do well to clean up their transmissions before multiplex finally comes along and they give it an unwarranted black eye which could upset the apple cart all over again.

BRAHMS
HUNGARIAN DANCES
DVORAK
SLAVONIC DANCES
Vienna Philharmonic Orchestra conducted by Fritz Reiner. London 4-track stereo LCL80069. Price $7.95.

Reiner is the conductor here, batoning the Vienna Philharmonic instead of his more familiar Chicago Symphony Orchestra. This is but another of the continuing interchange of artists and orchestras made possible through the *London/Victor* "lend-lease" program. Such a program, intelligently administered, can bring us much rewarding music from artists and orchestras heretofore denied the facility of working together due to contractual difficulties.

Thus far, this program has scored some notable successes . . . for example *Victor* was able to "borrow" the great Renata Tebaldi and the sensational new prima donna, Birgit Nilsson, for its recent production of "Turandot."

Now this combination of Reiner and the Vienna Philharmonic is a "natural" and should have resulted in an outstanding performance. However for reasons best known to themselves, *London* assigned Reiner these pleasant but innocuous "Dances." Surely, this great conductor and orchestra could have been given repertoire that would have showcased their talents more properly.

As it is, Reiner gives a good serviceable reading of eight of the more familiar Brahms "Dances" and five of the Dvorak "Dances," but he is clearly outgunned by such specialist conductors of these works as Talich, Dorati, and Kubelik.

It would be nice to report that the sound qualities had saved the day. Alas, although a great deal of it is quite clean, there is also an unfortunate tendency for the bass to get "muddy" and the percussion is rather flabby and lacks definition. Directional effects were not overly pronounced and a good deal of the time the right channel needed a few db boost in order to "pull" the sound into balance. The derived phantom middle was not of sufficient weight nor stability to form a really good illusion of three-channel sound.

On the plus side must be mentioned that the dynamics were nice and wide and handled without strain. Crosstalk was pleasingly minimal and background hiss was quite low even when the tape was played at full room volume.

As a matter of interest, it shoud be noted that the stereo disc of this program received some plaudits for the good sound quality. I compared both and, in general, the disc was cleaner and in better balance. Because of this and other similar experiences, I'm convinced that somewhere, somehow, somebody is "goofing" when the tape is processed for dubbing, or perhaps in the dubbing process itself.

TCHAIKOVSKY
PIANO CONCERTO #1
Van Cliburn, pianist with anonymous orchestra conducted by Kiril Kondrashin. Victor FTC2013. Price $7.95.

This was recorded on the occasion of Van Cliburn's triumphant return from Moscow, utilizing the services of Kondrashin to conduct for him. Thus, except for the orchestra, we can hear the team that made musical history in 1958 in Russia.

The question always arises . . . is Van Cliburn really *that* good? I don't believe such a question is as easily answered as the utterances of most critics would have you believe. Yes, with few reservations, this young man has clearly shown himself to be worthy of his publicity. He has abundant technical facility, a great singing tone, tremendous dynamic control, great expressiveness in his phrasing. But, I must add, that this exists in the repertoire at his command and I don't feel that he should be compared to such masters as Rubenstein and Hofmann until he broadens his musical base.

The performance recorded on this tape is for the most part all one could ask, but I felt that certain sections of the first movement were taken at a slower pace than I can ever remember hearing on other occasions. All in all, though, a thrilling reading.

Soundwise, this is only fair. The piano has a rather hard, clangorous sound and many times is projected so forcefully in the phantom middle channel that other instruments are washed out. The strings seem rather thin and they have a tendency towards shrillness. Directionality was good, depth effects accented with the moderately spacious acoustics. Dynamic range and frequency response quite wide. Little crosstalk was evident, but background hiss was high enough to intrude in the *pianissimo* sections. For sound qualities, the older Gilels recording with the Chicago Symphony is to be preferred, even though it was a two-channel master.

In passing, let me offer my sympathy to Van Cliburn and other newly hatched virtuosos. In this day when everyone seems to prefer that which is the "newest" or "biggest," their lot is not an easy one— as witness the adulation the critics are now affording the latest sensation, Sviatoslav Richter.

MUSIC FROM "EXODUS" AND OTHER GREAT THEMES
Mantovani and his Orchestra. London LPM70042. Price $7.95.

The music from "Exodus," is, in this case, two three-minute snippets from the score, serving only to show that as far as movie music is concerned, this is better than most. The rest of the tape is given over to other movie themes and excerpts from Broadway shows. Thus we have such as the theme from "A Summer Place," ditto from "The Sundowners," and various others.

From Broadway we are given the ubiquitous "Seventy-Six Trombones," the "Carousel Waltz," and others of similar genre. All of them are played to the hilt in the familiar Mantovani manner . . . swooping strings, lush woodwinds, rich counterpoint of french horn.

Say what you will about Mantovani, there is no denying that he is the most successful practitioner of this type of music and his highly disciplined orchestra would do credit to some more elevated musical organizations.

As for sound, this is exemplary. Stereo effects are carried out well without excesses, all is quite clean, crosstalk was virtually absent, and background hiss unobtrusive at a good level of reproduction.

LIKE BONGOS!
Time ST/2025. Price $6.95.

It was inevitable that the current rage for hyped-up "super-stereo" discs would also find expression on tape. Here is a typical example of more or less standard "pop" tunes, being elaborately orchestrated with a great variety of percussion, but with bongos being most prominently featured and a passle of winds, baritone saxes, guitar, piano and organ, and bass filling out the orchestra.

Typical of what is on the reel are such as "Taboo," "Glow Worm," "Caravan," "Babalu," etc.

The sound is very bright and clean, recorded in the usual ultra-close fashion, with much frequency boosting in the middle ranges. Directionality is as you would expect, taken to "ping-pong" extremes with, however, the saving grace that three-channel originals are used and there is a fair phantom middle that helps to fill in the hole.

Reverb is used with lavish hand and is variable . . . thus one can get a moderately echoed bass pluck, at the same time as a bongo sounding as far out as Mammoth Cave. Channel switching is also used, so that what appears as a string bass on the right side in one number, will appear on the left in the next, or even change sides *during* a number.

This is very high-level recording and it was therefore not too surprising to notice some print-through and pre-echo. Oddly enough in spite of the signal intensities, crosstalk was very low. Background tape hiss was just apparent at a good room level.

You'll never hear this sound from a live group, but if nothing else it serves as a good test for transient response.

-30-

Answers to the WAVEFORM QUIZ

(*Continued from page* 8)

1. A cut-off frequency of 300 cps would be best. To obtain a sine wave by filtering a square wave, we must filter out the harmonics of the repetition frequency. Since a square wave has no even-harmonic content, we can avoid the cost of selecting a filter that cuts off at the second harmonic (200 cps).

2. A sine wave of the same frequency, slightly attenuated in amplitude. Sine waves are able to pass through frequency-selective circuits without change of waveform, no matter in which order they are encountered.

3. Mix two sine waves which are separated by a frequency equal to the lower original frequency. For example, mix a 1-kc. and a 2-kc. sine wave. The output consists of only three frequencies: 1 kc. (original), 2 kc. (original), and 3 kc. (sum frequency). The difference frequency is the same as one of the originals.

4. The trigger output will be a 100-cps square wave. The Schmitt trigger circuit converts periodic waves to square waves with very steep sides.

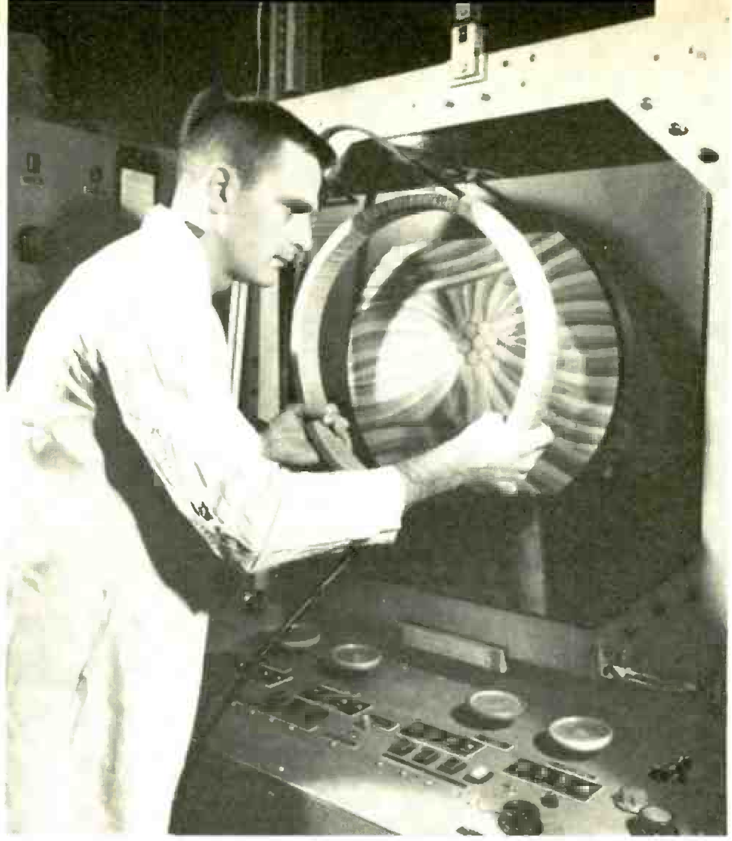
5. Transformers and one-stage amplifiers.

6. A differentiator. The actual circuit values of the differentiator will determine exactly how steep or sharp the spikes will be.

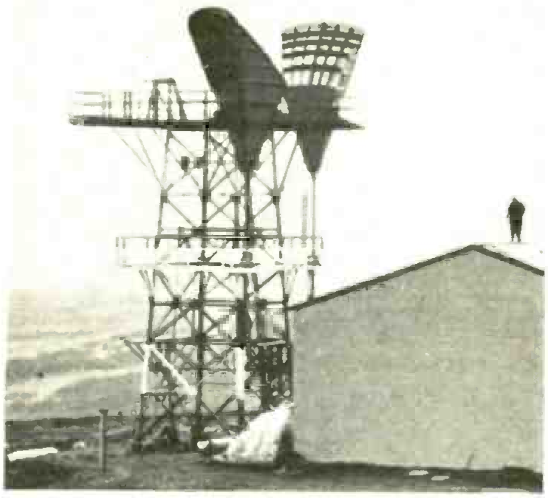
7. The base voltage will be minus one-half volt and the top voltage will be plus one-half volt. After passing through a capacitor, a square wave loses its d.c. reference and spaces itself equally about a zero voltage line within a few cycles of operation. -30-

Brighter Color-TV Picture Tube ▶

A rainbow of color is produced on *RCA's* new color-TV picture tube during testing at the company's plant. The 21-inch tube (21FBP22) has improved phosphors that provide up to 50 per-cent brighter pictures with greater sharpness and contrast. Currently being used in *RCA Victor* color-TV sets, the improved tube also greatly enhances black-and-white images. These tubes are available to all other manufacturers for use in color sets they are now marketing or plan to market under their own brand names.



Recent Developments in Electronics



◀ **First BMEWS Telephone Circuits**

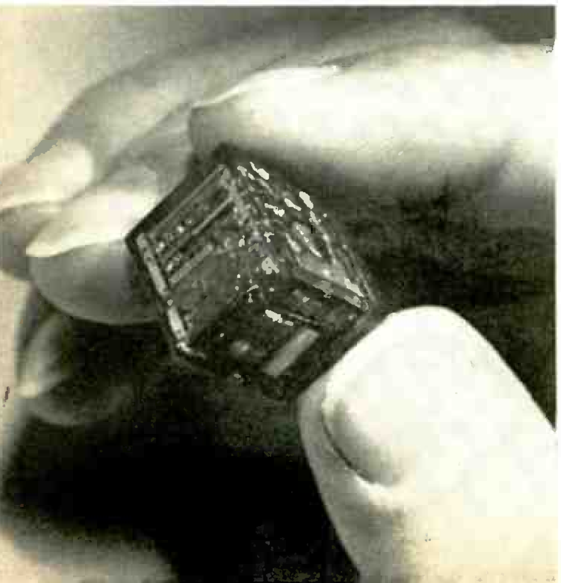
The first telephone circuits of the Ballistic Missile Early Warning System communications network have been made available for Air Force use between the missile-detection station at Clear, Alaska and Fairbanks. Messages are received and transmitted in both directions by the horn-shaped antennas on the tower shown, at one of the relay stations in the system being built by the *Western Electric Co.*

Heart Sentinel for Space

Tiny transmitter on chimp's lap is part of *International Rectifier Corp.'s* ground-monitoring equipment for checking heart conditions of future space travelers. Electrodes taped to chimp's chest can pick up signals that may be transmitted instantly from out in space to earth-based receiver. Signals are being displayed on scope in this photograph. ▼

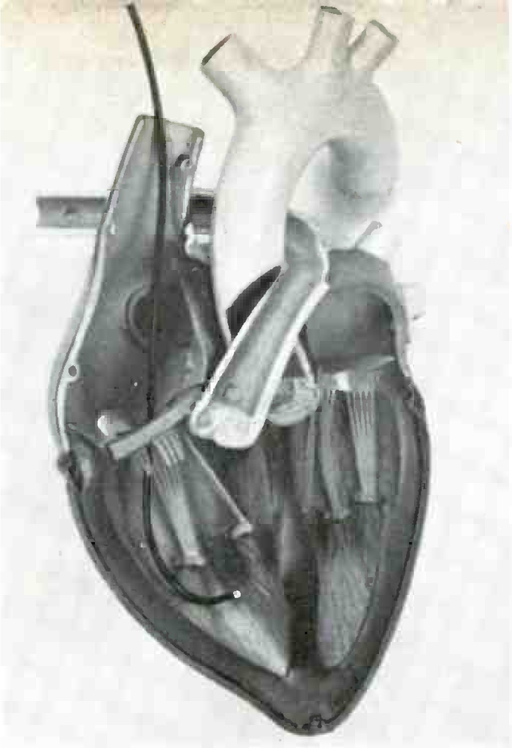
Solid-Block Amplifier

This complete amplifier circuit is an example of a new technique developed by *Convair* to reduce weight and volume of missile components while increasing reliability. The solid block contains transistors, diodes, resistors, and capacitors used in missile's servo system. ▼



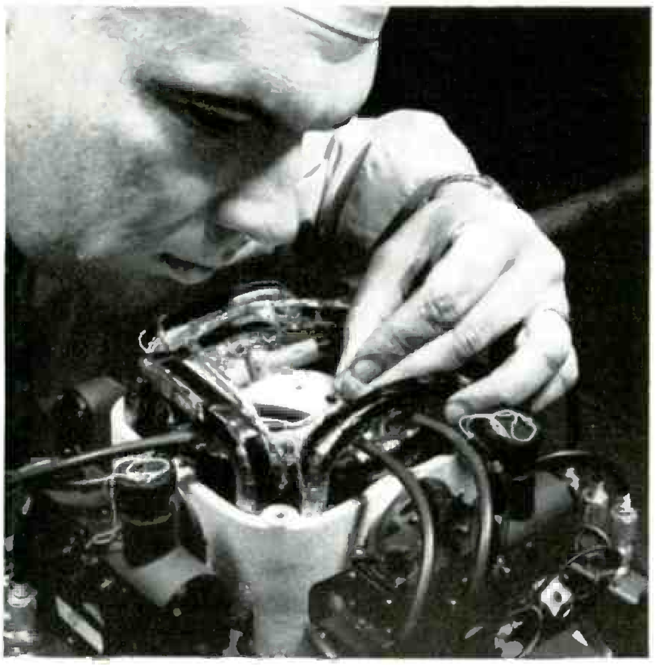
Braid Carries Heart Pulses ▶

Human hearts that have stopped beating can be started by sending timed electrical pulses to the heart through a thin stainless steel wire braid covered with plastic. The braided wire is attached to an electronic device—the "Pacemaker"—that is worn around the patient's neck. The "Pacemaker" is transistorized and powered with mercury cells; it operates up to 40 days between battery changes and its pulse rate is adjustable between 60 and 180 beats per minute. The braid, developed by *National-Standard Co.*, consists of 16 stainless wires, each the thickness of a human hair. The steel braid (actually a catheter) is inserted through a vein at the neck, and thence into the heart. Sometimes the patient's heart regains enough strength to continue by itself after a week or two. One patient, however, has carried the equipment for two years.



Outer-Space Radar ▶

Radar that uses a coherent light beam to detect distant targets has been developed by *Hughes Aircraft Co.* for use in orbiting satellites. The device marks the first practical application of the optical maser (or "laser"). Light from the laser transmitter (top) pulses out to a target, and is then reflected back and collected by the mirror in a telescope (below). Associated electronic equipment then amplifies and processes the signal to provide range and distance data.

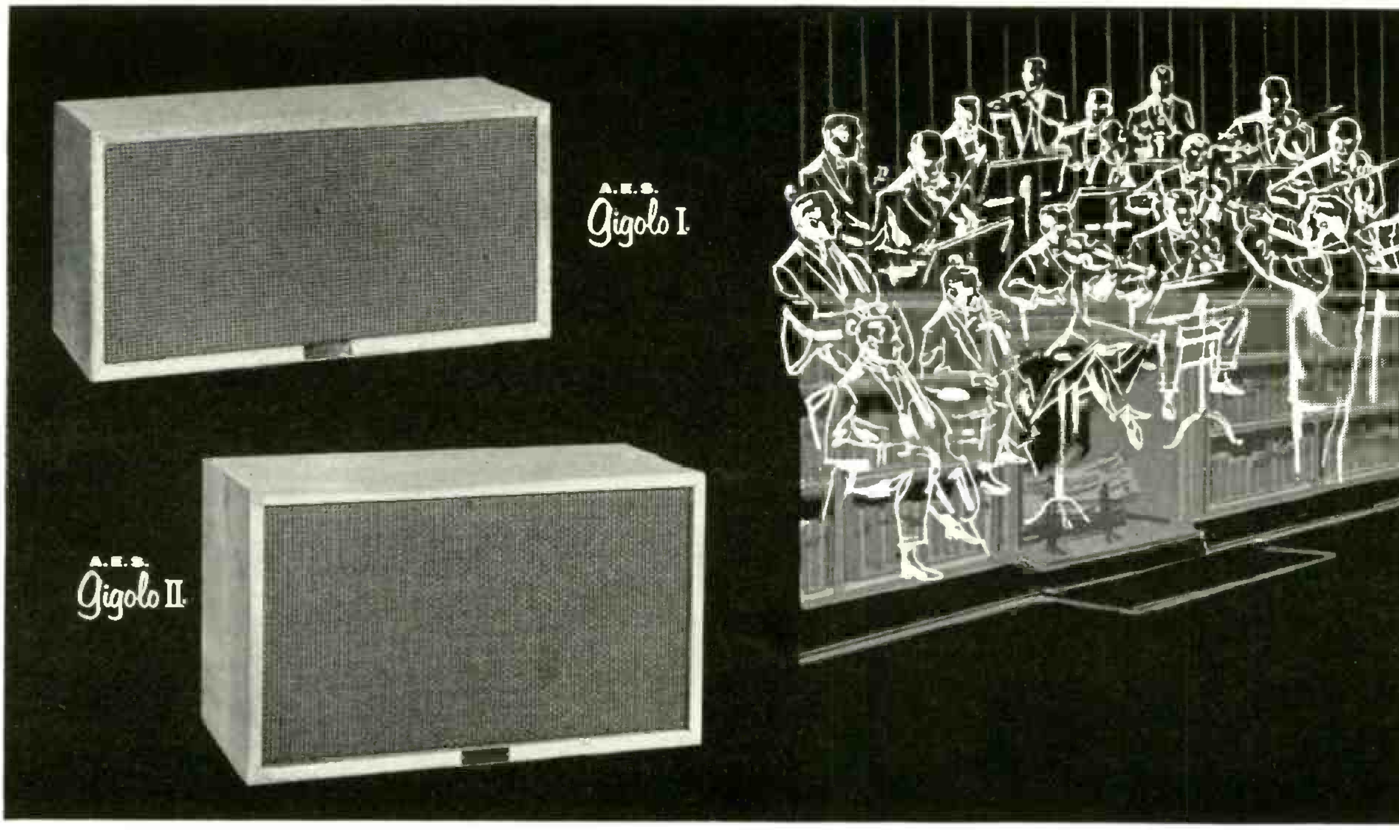


◀ Electrically Suspended Gyro

First prototype of an electrically suspended gyroscope, developed by *Minneapolis-Honeywell* for use in the "Polaris" submarine navigation system, is being checked here. The gyro's rotor is suspended in a magnetic field that is produced by external coils to which high voltages are applied.

New "Dark-Heater" Tube ▶

The electronics technician in the photo is examining two small heater wires in a laboratory demonstration of a new *RCA* chemical coating that greatly extends the life of radio and TV receiving tubes and also improves their performance. The "dark-heater" wire at the left, using the new coating, has a 20 per-cent lower operating temperature than the bright-glowing conventional tube heater at the right. The company intends to use the new heaters in a wide variety of popular tubes intended for home radios, auto radios, TV sets, and phonographs. The new tubes are expected to last longer since there is less possibility of heater damage and shorts. In addition, the tubes are expected to have more stable characteristics, less a.c. leakage and hum, and a greater margin of safety in heater-cathode voltage ratings.

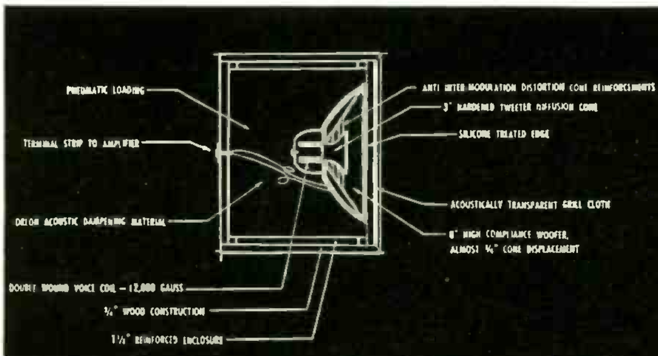


It is the belief of A. E. S. Inc., that we have developed the high fidelity industry's first performance duplicator, by this we mean, not just a unit to reproduce sound close to that of the real thing, but to give such a live performance that it would be considered not only reproduction but duplication, to the point of temporary deliverance to the live performance.

This may seem to be quite an elaborate statement, but along with our own opinion we have in the past two years had many customers who have purchased our Gigolo speaker write in and tell us of comparison tests conducted in their homes with originally purchased speaker systems costing in many cases well over $100.00, these units considered to be the industry's finest. Although their original system was a fine piece of reproducing equipment it was still only reproduced sound, where in the case of their newly purchased Gigolo the sound seemed to be alive.

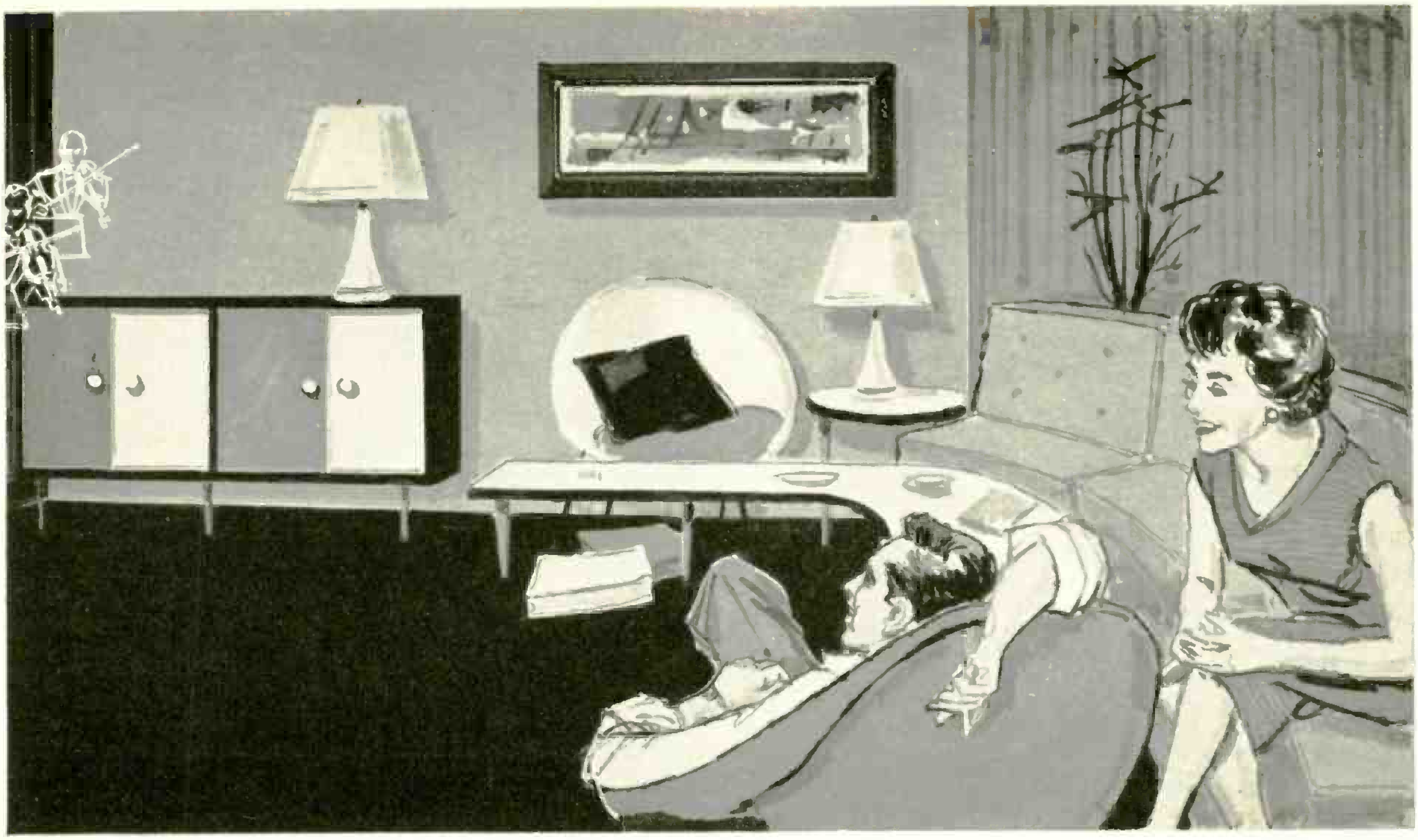
This remarkable performance plus the fact that we have sold in the past two years thousands of Gigolos, on a 100% GUARANTEE, cash return basis and have received only .5% (one half of one percent) returns, should prove that this is not just another advertising claim but a reality.

In the past, we have guaranteed the Gigolo to sound better than any bookshelf speaker manufactured for home use on the market today regardless of price or your money back. We still make this offer and at the original price of $15.00 each. Please place your order now to insure reasonably prompt delivery.



The GIGOLO I is constructed with a resonant resistant wood product of at least ¾" thickness throughout. Its outside dimensions are: 24" long, 12" high, 9½" deep. The heavy construction and the fine workmanship suggest a value far exceeding its low, low price. All units sold on 100% money back Guarantee. Price $15.00. Unfinished Only, F.O.B. Factory.

The GIGOLO II is made of the finest select natural birch. All the wood used for the enclosure is at least ¾" thick. Outside dimensions are 24" long, 13½" high, 12" deep. Our grill cloth is supplied by one of the country's largest manufacturers of acoustic grill material. Your GIGOLO II comes to you completely assembled and sanded ready for finishing in either blond, walnut, cherry, mahogany or ebony. All units sold on 100% money back guarantee. Price—$49.50. Unfinished Only, F.O.B. Factory.

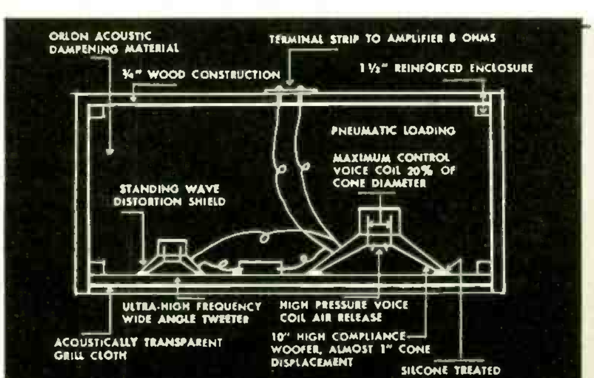


AND NOW IN ANSWER TO THE QUESTION OF SO MANY THRILLED GIGOLO OWNERS "IF THIS IS WHAT YOU CAN OFFER FOR $15.00 WHAT CAN BE DONE FOR A REASONABLE AMOUNT MORE?" IN ANSWER TO THIS WE PRESENT THE GIGOLO II.

HERE IS A SYSTEM WITH THE ABILITY TO REPRODUCE SUCH REALISTIC SOUND, HANDLE LARGE AMOUNTS OF POWER AND REPRODUCE SUCH EXTENDED FREQUENCIES BOTH HIGH AND LOW THAT WE DO NOT RECOMMEND IT FOR HOME USE. A SYSTEM OF THIS TYPE WOULD MORE SUITABLY BE USED IN PROFESSIONAL APPLICATIONS, SUCH AS THEATRES, AUDITORIUMS, OR LABORATORIES, BUT FOR THOSE WHO FEEL THEY MUST HAVE SOUND REPRODUCING EQUIPMENT BEYOND THE LIMITS OF HUMAN PERCEPTION WE OFFER THE GIGOLO II FOR PUBLIC SALE.

SPECIAL NOTICE

All units purchased from A. E. S. Inc., either the recommended Gigolo I for home use, or the Professional Model Gigolo II, are completely covered by our 100% MONEY BACK GUARANTEE. Upon receipt of your Gigolo, if you find any of the statements made in this advertisement were misleading or untrue, or if your Gigolo is not completely satisfactory either in workmanship or performance, including reproducing frequencies and handling power beyond your requirements you may return this unit to the factory for full purchase price refund.



A. E. S. Inc.
3338 Payne Ave., Cleveland 14, Ohio

Gentlemen please ship.................. Gigolo I —$15.00 Each
.... Gigolo II—$49.50 Each

I understand these units are guaranteed and if I am not satisfied I may return for a full purchase price refund.

Name ....

Address ....

City and State..

Enclosed find check.............. money order..............

Industrial Counting Techniques

(Continued from page 41)

number of elements in each section, and the other channel controls the spacing between one section and the next. The long strip thus produced is later cut into individual sections. Each time the steel slug passes the pickup coil, corresponding to the insertion of one metal element, a pulse feeds into the predetermined counter. When the required number of elements has been inserted, channel A of the counter produces an output pulse. A solenoid now retracts the pawl from the ratchet, stopping the feed of metal. When the steel slug has passed the pickup coil a number of times corresponding to the desired spacing between sections, channel B produces an output pulse. The pawl now engages the ratchet, and metal elements for the next section are inserted.

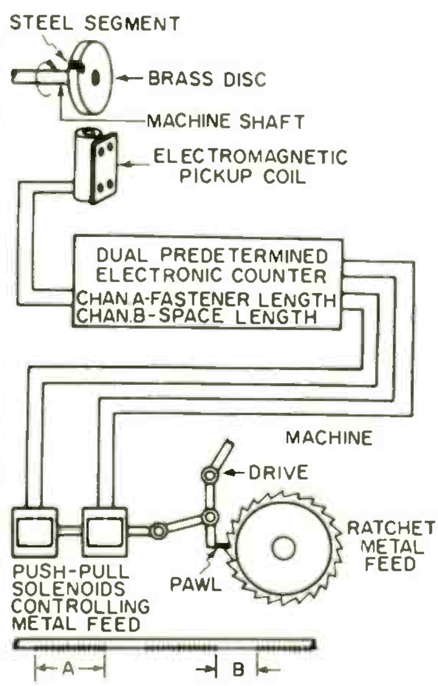


Fig. 11. Use of a dual predetermined control to insert proper length of metal elements utilized in a slide fastener.

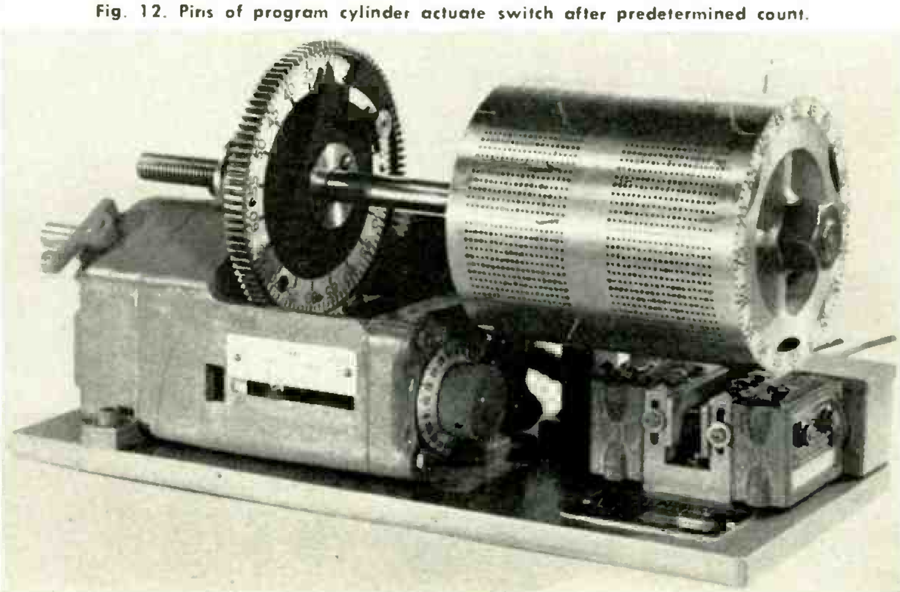
The "Programonitor"

The "Cyclo-Monitor," manufactured by *Counter and Control Corporation*, is a unique and versatile form of controlling counter. This unit consists of a rotating gear which moves axially on a threaded shaft. Segment cams attached to the front and back of the gear operate switches near each end of the gear travel. A mechanical clutch reverses the gear rotation so that one counting cycle is completed during clockwise rotation and the next cycle during counterclockwise rotation. The count cycle can be preset to the desired number by means of calibrated dials, and units are available for stroke, revolutions, and electric (solenoid) counting. An expansion of this basic unit, the "Programonitor," is shown in Fig. 12. The *program cylinder* of this unit is a drum containing many holes arranged in a helical pattern. Pins inserted in selected holes operate Microswitches at predetermined counts during the complete counting cycle. Pins may be inserted, for example, to produce switching actions after 50, 125, 237, etc. pulses. Simply by changing the locations of the pins, a different switching program can be achieved. Units of this type are used industrially for controlling the pattern of holes punched in sound-dispersing tubes for automotive mufflers and for controlling the winding of stator coils for motors and alternators.

Conclusion

Industrial counting is no longer simply a method of totalizing, but a form of automatic control. Such control has contributed significantly toward improved quality of product and reduced production costs. More important, perhaps, it has freed many workers from the tedium of routine tasks, allowing their talents to be utilized in more challenging and productive areas. —30—

Fig. 12. Pins of program cylinder actuate switch after predetermined count.



Microwave-Radiation Hazards

(*Continued from page 33*)

however, problems of r.f. radiation measurement will not be entirely solved.

Problem of Effective Dosage

Even after we measure the radiation to which a subject has been exposed, the problem is only half solved. In the first place, not every subject is affected by radiation to the same extent. Frequency of the radiation is also an important factor. At some frequencies, people with thick layers of subcutaneous fat absorb radiation readily while at other frequencies the fat acts as a virtual insulator. Ultra-high frequencies pass through the body and can heat internal body tissues but layers of fat will obstruct the radiation.

With microwaves the problem becomes more difficult. Some of the microwave energy is reflected at the body surface—the amount of reflection depending on the body surfaces, the polarization of the energy, and the intervening medium between the generator and the subject. Microwave energy can be readily absorbed by the skin and fatty tissue directly beneath the skin and will not heat the body tissues underneath directly but as a result of stepped up circulation of the blood.

Thus, although the dielectric properties of body tissues are well known and have been measured with some degree of accuracy, we cannot predict the effects of radiation on an individual without knowing a great deal about his physical makeup. Moreover, when we must deal with the minute radiation involved in athermal effects, the problem becomes even more complex. One Dutch physician, W.A.G. van Everdingen, sought to eliminate this problem by inserting, subcutaneously, small capsules of glycogen of precise concentration and viscosity.

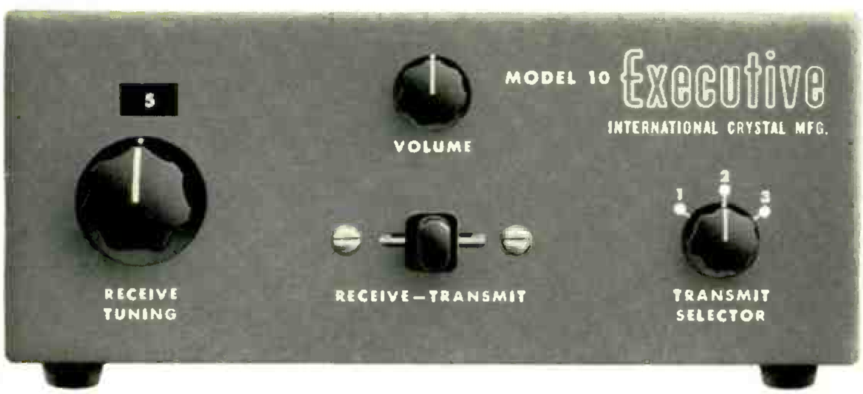
The glycogen shows a rotation of its optical plane of polarization which can be measured with a polarimeter. This procedure is obviously unsuited to use with human subjects, although it did provide accurate dosage measurement for test animals.

Conclusion

Although we have reached a high level of sophistication in the radio and electronics fields, here is one problem which will plague scientists for some time to come—accurate radiation dosimetry for electromagnetic radiation in the u.h.f. and microwave regions. With space travel, enormous power levels will be required for communication and this will aggravate an already serious problem, creating additional hazards for personnel. Accurate personal dosimeters are expected to provide the answer.

In addition, new tools and approaches are needed to solve the major riddle of athermal effects which, although not considered dangerous to human life, will have to be re-evaluated in the light of future developments. —30—

MODEL 100
Available after June 15



MODEL 10
Available after June 15

MODEL 50
Available after April 15

Technical BOOKS

"SEMICONDUCTORS AND TRANSISTORS" edited by Alexander Schure. Published by *John F. Rider Publisher, Inc.*, New York. 135 pages. Price $2.90. Soft cover.

A discussion and evaluation of theory and characteristics of semiconductors and transistors with specific attention being given to atomic structure, quantum theory, conductors, insulators, and semiconductors. Conduction by holes, semiconductors with impurities, and the semiconductor rectifier are analyzed along with characteristics of *p-n* and *n-p* types.

Review questions are included at the end of each chapter.

* * *

"101 KEY TROUBLESHOOTING WAVEFORMS FOR VERTICAL-SWEEP CIRCUITS" by Robert G. Middleton. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 121 pages. Price $2.00. Soft cover.

This is the third in this author's current series dealing with scope waveforms as an aid to TV troubleshooting. This volume covers the four types of vertical-oscillator and vertical-output stages. Along with photos of 101 abnormal waveforms, the author provides descriptions of circuit symptoms, evaluation tests, and notes. A comparison between the set on the test bench and the scope patterns included in the text can reduce service time and eliminate costly guesswork.

* * *

"CITIZENS BAND RADIO HANDBOOK" by David E. Hicks. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 187 pages. Price $2.95. Soft cover.

This practical guide covers choosing equipment, getting a license, and discusses CB equipment circuits, antenna systems, fixed and mobile station installations, maintenance and repairs, servicing adjustments and measurements, as well as operating procedures.

A glossary of CB terminology and an appendix containing the latest FCC CB Rules and Regulations are also included.

* * *

"ALTERNATING CURRENT ELECTRICITY" by Alexander Efron. Published by *John F. Rider Publisher, Inc.*, New York. 93 pages. Price $2.25. Soft cover.

A basic text on alternating current which would be entirely suitable for the beginning student or the student tackling the subject on his own. The text is clear, well-written, and progressive with every chapter including problems of graded difficulty as well as questions and problems for self-testing.

* * *

"TV TROUBLE ANALYSIS" by Harry Mileaf. Published by *Gernsback Library, Inc.*, New York. 220 pages. Price $3.20. Soft cover.

This volume demonstrates in a practical fashion how and why components and circuits fail and how these failures affect the audio and video sections of a TV receiver. By familiarizing himself with the theory and operation of a receiver in trouble, the technician can improve his practical performance by cutting down on servicing time and increasing his ability to pinpoint troubles on unfamiliar sets.

* * *

"ABC'S OF RADAR" by Alan Andrews. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 112 pages. Price $1.95. Soft cover.

To judge by our correspondence there is considerable interest in the subject of radar but unfortunately not too many texts at a basic level are currently available. This volume should close this gap for technicians, students, and users. The text covers how radar works, types of systems, microwave principles, antenna systems, receivers and indicators, tuners and modulators, in addition to material needed in studying for the FCC Radar Endorsement Examination.

* * *

"SERVICING AGC SYSTEMS" by Henry Carter & Thomas Lesh. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 121 pages. Price $2.00. Revised edition. Soft cover.

This is a completely revised edition of an earlier work and now embraces a.g.c. circuit theory for every type of system in use—including the modern BU8 variations. Nine chapters cover the a.g.c. systems in various forms from their correct functioning to a.g.c. in trouble. The text includes line drawings, partial schematics, and CRT screen photos.

* * *

"RADIO AND TV TROUBLE CLUES" by Sams Staff. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 96 pages. Price $1.50. Soft cover.

This practical handbook for the service technician is based on actual experiences of running down and curing "tough dogs." The first two chapters cover locating troubles while the third section includes a series of unusual troubles and their solutions. The text is lavishly illustrated with photos, schematics, and line drawings.

* * *

"1960-1961 TV CIRCUIT HANDBOOK" by Samuel L. Marshall. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 135 pages. Price $3.95. Soft cover.

This volume is intended to serve as

a one-source reference to all new circuits used in 1961 TV receivers. Thirteen chapters cover circuits used by all the major manufacturers—from remote-tuner controls to picture tubes and including the latest in color TV.

The receivers of twenty-one manufacturers have been included along with troubleshooting data, schematics, and block diagrams of the units being discussed.

* * *

"BASIC MATHEMATICS" by Norman H. Crowhurst. Published by *John F. Rider Publisher, Inc.*, New York. 141 pages. Price $3.90. Soft cover. Vol. 1.

This is the first of a projected four-volume series which is designed to cover the field of mathematics progressively. This first book deals with arithmetic as an outgrowth of learning to count with counting, addition, subtraction, multiplication, division, fractions, decimals, percentages, and graphs covered.

If your basic grasp of some of the fundamental operations of mathematics is shaky, here is the place to start—with arithmetic. Heavy use is made of illustrative material.

* * *

"BASIC TRANSISTORS" by Alexander Schure. Published by *John F. Rider Publisher, Inc.*, New York. 142 pages. Price $3.95. Soft cover.

This is a comprehensive, but basic, approach to the subject of transistors. The lavish use of schematics, photodiagrams, line drawings, and cartoon illustrations help to convey the content. Review questions are included at the end of each section to aid the reader in determining his grasp of the material.

* * *

"AN INTRODUCTION TO ELECTROTECHNOLOGY" by S. J. Kowalski. Published by *John F. Rider Publisher, Inc.*, New York. 294 pages. Price $7.00.

This text covers a.c. and d.c. electricity at a college level with considerable emphasis on the mathematical aspects. Those seeking a rigorous treatment of the subject and with sufficient mathematical background should find this

Single-Turn Coil Adjustment

By HOWARD S. PYLE, W7OE

HERE'S one that has apparently "gone by the board." Both radio hams and commercial builders have used the stunt to be described for many years as an easy method of obtaining single-turn adjustment of an inductance by means of switching. It is *still* a good trick and well worth using.

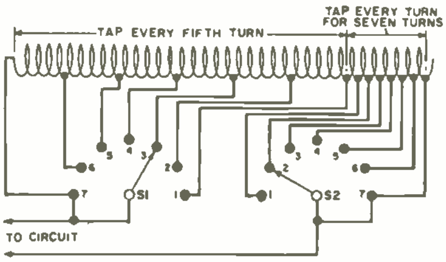
Suppose, for example, that you have a 37-turn airwound inductor which you want to adjust, a turn at a time, for use in an antenna tuner—maybe a base-loading coil for a vertical antenna or some similar application. You have trouble getting an alligator clip or equivalent on the turn you want, without shorting out adjacent turns. Furthermore, if the coil is mounted in a metal housing, as is customary with antenna tuners and such devices, you find that despite all your care, including a "seat of the pants" compensation calculation, the adjustment doesn't hold when you put the cover plate back on the cabinet.

Wouldn't it be nice to simply turn a knob on a rotary switch and pick your turn? You can: you don't need a 37-point switch for a 37-turn coil, nor a 50-point switch for 50 turns. For the 37-turn coil shown in Fig. 1, two 7-point rotary switches will do the trick. For 50 turns, two 10-point switches; for a 30-turn coil, use two 5-point switches. From the example shown in Fig. 1, you can figure out the correct switch for about any size coil which the ham would ordinarily use.

And, to make it easier to solder your taps to the coil turns, particularly on fairly closewound coils, use the stunt illustrated in Fig. 2. Merely push down the adjacent turn each side of the one you want to tap, using a small screwdriver or similar tool. For the single-turn taps which connect to S_2 in Fig. 1, stagger these "push-downs" around the coil, as shown in Fig. 2.

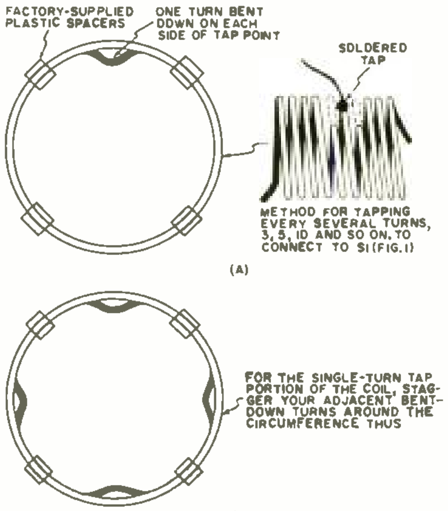
This single-turn coil adjustment method is ideal for the conventional coil stock made by many manufacturers. It will also work well on your home-built coils whether spacewound of bare wire or closewound of insulated wire. —30—

Fig. 1



NOTE: WITH SWITCHES IN POSITION SHOWN, 12 TURNS ARE IN THE CIRCUIT AND ALL UNUSED TURNS ARE SHORTED OUT

Fig. 2



book useful. Practical examples and worked-out numerical presentations make this volume suitable for home-study providing the abovementioned prerequisites are met.

* * *

"MOST-OFTEN-NEEDED 1961 RADIO DIAGRAMS AND SERVICING INFORMATION" compiled by M. N. Beitman. Published by *Supreme Publications*, Highland Park, Ill. 190 pages. Price $2.50. Soft cover.

This is Volume 21 in this publisher's radio series and like its predecessors provides schematic diagrams, printed circuit views, all alignment and other service details needed to handle 1961 model radios, including auto sets, transistor portables, AM-FM combinations, stereo, etc.

Twenty-nine set makers are represented in this volume.

* * *

"ELECTRICAL PRINCIPLES OF ELECTRONICS" by Angelo C. Gillie. Published by *McGraw-Hill Book Company, Inc.*, 517 pages. Price $10.00.

This is a basic text for the radio-TV service technician, the electrician, the layman, and the student. It provides clear, precise explanations of the fundamental laws and principles of electricity and describes the new techniques and devices currently used by the electrical and electronics industry.

Since mathematics is used extensively throughout the text, including test problems at the end of each chapter, the reader is warned to sharpen his mathematical skills before tackling this book.

* * *

"PRACTICAL AUTO RADIO SERVICE & INSTALLATION" by Jack Greenfield. Published by *Gernsback Library, Inc.*, New York. 156 pages. Price $2.95. Soft cover.

Not only does this volume tell how to get the radio into or out of the car but it describes in detail the different types of sets, the equipment and components needed to set up an auto radio servicing shop, how to remove and install rear-seat speakers, how to troubleshoot and repair all types of auto radios in addition to tuners, power, interference suppression, FM, and auto phonographs. The text is copiously illustrated.

* * *

"R/C PRIMER" by Howard G. McEntee. Published by *Kalmbach Publishing Co.*, Milwaukee. 66 pages. Price $2.00. Soft cover.

This book tells how to install and operate radio-control equipment in planes, boats, and other models. Nine chapters cover frequency and licensing information, control with various types of equipment, components, transmitters, installation, model boats, field and installation tests, maintenance, and troubleshooting. The text is detailed and well illustrated but is based on commercial equipment rather than "build-it-yourself" gear.

* * *

"JONES NORTH AMERICAN AM-FM RADIO —TV STATION LISTINGS" compiled and published by *Vane A. Jones Co.*, 3749 N. Keystone Ave., Indianapolis 18. 90 pages. Price $1.00. Soft cover. Vol. 3.

This is an updated listing of over 7000 stations operating in the U.S. and Possessions, Canada, Cuba, Mexico, and the West Indies. The booklet lists stations by location, frequency, and call letters.

* * *

"TUBE SUBSTITUTION HANDBOOK" by Sams Staff. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 96 pages. Price $1.50. Soft cover. Vol. 2.

This is a revised and up-to-date listing of tube substitutions and covers over 4450 recommended substitutes.

The directory of receiving tubes has been expanded to 1644 types while three additional sections list 186 industrial and 494 European substitutes for American receiving types and 453 American receiving-tube substitutions for European types.

* * *

"SECOND-CLASS RADIOTELEPHONE LICENSE HANDBOOK" by Edward M. Noll. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 240 pages. Price $3.95. Soft cover.

This is a basic text covering all the information needed to pass the FCC's second-class radiotelephone license exam (which is required of anyone who services and some who operate two-way mobile radio equipment).

There are six chapters of questions and answers covering Elements I, II, and III. The 650 questions are arranged progressively. —30—

A new arrival in a community usually keeps dealing with the first service shop he uses. Make sure it is yours.

By **ERNEST W. FAIR**

Get the New Customer First

WHEN A new resident establishes himself in a neighborhood, he seldom has had any previous contacts with local merchants, including service dealers. When he needs their services, he may ask a neighbor's advice or try one at random. In any case, as long as he gets reasonable satisfaction, he is likely to stay with the first contact he has made in each area for an indefinite period. This rule applies to his choice of an electronic service dealer as much as to any other type.

It follows that an extra effort to land such a customer is well worth making, even though it may not be easy. A few such newcomers will wander into your shop on a strictly random basis—if no competitor is doing anything to get them himself. However, if you belong to the majority of dealers who are looking for more business, why settle for this handful?

How do you get these new clients? Your regular advertising and promotion techniques for stirring up new business are probably not good enough, because they may not have the right approach for the special situation and because they seldom will be timed right. Remember, for example, that most people who have just moved have good reason to be in the market for service soon. Their TV sets may have acquired malfunctions in the process of moving. An antenna installation may be an immediate requirement. Perhaps there is a need to re-install and adjust a hi-fi system. You've won at least half the battle if you have reached them before they have had a chance to look for anyone. Your special methods must be built around two important points: getting their names and addresses quickly and then making fast contact.

There are some excellent sources for getting the names. High up in this category are the offices of local public-utility companies. To make certain they have gas, electricity, and a phone available by the time they move into their new homes, people generally make arrangements in advance. You can be waiting at the newcomer's door before he gets there! Although the utility companies have no reason for going out of their way for you (*i.e.*, you can't expect them to mail you all new names automatically), they may let you check directly at their offices. To get names early, check as often as possible. Once a week is a good idea, if you can manage it. In some cities, such lists are published in business and legal newspapers.

Another good source is made up of local real-estate people, including builders. These are worth trying because the names may be had well in advance of most moves and because the proportion of home buyers is high. The latter types are more likely to be in the market for new sets and other equipment or new installations.

Newspaper-delivery boys should also be considered. Although they cannot provide the most complete or earliest lists, their cooperation should be easier and cheaper to get if you run into trouble with other sources. An offer of, say, twenty-five cents for each new name should settle the matter.

Chambers of Commerce often make up such lists for their members. The only drawback is that your competitors may be members of the same group. If they are also making use of this source, you are better off with one of the agencies that can give you the names more quickly.

Some shop owners work together with local owners of other small businesses in exchanging newcomer names. The usual procedure is to cooperate with a few carefully selected firms, none of which is in competition with any other. Grocers, druggists, and service stations are among the better candidates. You will need other sources so that you can have names to exchange, but these fellow dealers may give you names that have not turned up in other ways.

Your old customers can often be helpful in tipping you off on new people coming into the community. Getting active, continued cooperation is difficult without organizing a special program that would probably include some reward, but it doesn't cost a thing to drop a conversational question about anything new in the neighborhood—like new faces—every time you deal with a regular customer. You may catch a prospect or two that has slipped by other dragnets.

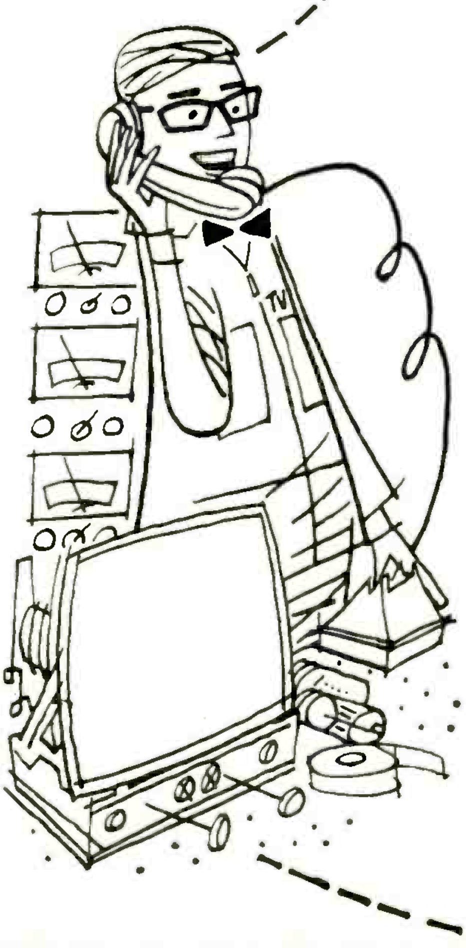
Finally, check the social or "society" section of local newspapers. Churches and other organized groups often give welcoming parties to recent arrivals, and these affairs will be listed. You will note that the strongest potential sources have been listed first. Nevertheless, local conditions may make a preferred source difficult to use or change the order of value. In any case, all of the suggestions have some merit.

Now let's assume that you reliably have the names of new people coming in. You still have to decide what to do with them. Even if your competitors have not been shrewd enough to acquire such lists as actively and successfully as you have done, it pays to do a good job of making contact. If your competitors are managing to keep up in the matter of getting names, the way in which you handle prospects is even more important.

A personal call is always the best type of contact. Try to make one early and try to make it yourself. However, if you are too busy, you may be able to delegate the chore to someone else, preferably a member of your shop staff who is likely to make a good impression. Mailed appeals are certainly useful and should

not be overlooked. However, in an active community, a recent arrival may get so many of these that he doesn't pay much attention to any. The personal call is successful because it is flattering. Any printed matter you might ordinarily mail can be taken along and handed over to the prospect directly.

Where conditions rule out the practicality of direct visits, the telephone may be your next best weapon. It retains the advantage of permitting a contact that is personal and flattering. It also involves little time, effort, or expense. Perhaps you can arouse the prospect's curiosity enough so that he will act on your invitation to drop into your shop for a look around when he is nearby, even if he has no particular work in mind.



The "Welcome Wagon," a relatively new development, is also a good substitute for your personal visit. Such enterprises usually exist in the more active communities—the very ones where it may be difficult for you to make personal calls yourself. These projects generally use well trained hostesses to call on the newcomers, present them with gifts, and apprise them of the services available from those local firms which the enterprise represents. Since these "wagon" enterprises, whatever titles they may use in various parts of the country, accept only one subscriber from each type of business, they have a special value. They are worth the fee they charge partly on the ground that they will not accept your competitors if you join up with them first.

For all the importance given here to some form of personal contact, the need for other supporting techniques, mostly involving the printed word, cannot be eliminated. Some printed matter can and should be brought along, as already noted, even on the personal call.

The most productive type of promotion item is one that, in addition to carrying your message, has some other value to the customer so that he will keep it and use it. Many business firms offer maps of their city or area. Especially useful to the new arrival until he can find his way about the strange community, these maps are most practical to obtain in quantity in a growing area that sees a reasonable rate of newcomers. To defray costs, they can be worked out cooperatively to carry the messages of a few other, non-competitive merchants.

A window sign or similar poster specifically directed to this type of customer is also helpful. One approach used begins, "Newcomer to the community? Come in and get acquainted." You can work out your own message. If you are offering a map or other introductory gift as an inducement, this sign is the place to mention it. As to good locations for such signs, this is something you will have to work out yourself, because there are so many local variables. It is hard to anticipate in general what locations are most likely to catch newcomers or where you will have least difficulty in getting permission to place the posters. Don't overlook your own shop window, especially if you are well located. It costs nothing.

Advertising in such places as hotels and motels also should not be overlooked. People who are going to settle in a new community often make their first contacts there at just such establishments: they frequently stop at one of these while seeking new homes or making arrangements for their moves.

Finally don't neglect an old standby—the Yellow Pages of the phone directory. When a specific item or service is needed in a hurry, a person without prior contacts is more likely to use this source than a regular resident. However your ad here should be prepared to carry a word or two of welcome to new neighbors. This may guide such people to choose your listing from a handful of similar advertisers.

Although some of the suggestions made here have been shown, on the average, to be more effective than others, there are no fixed rules. Local conditions can make averages meaningless. The resourceful shop owner will be ready to experiment, as he must in all things. If he makes the effort, he is almost certain to come up with a profitable program that outweighs its cost. —30—

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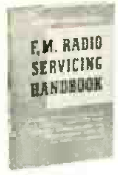


2404. FM RADIO SERVICING HANDBOOK, King
This is a practical guide to frequency-modulated V.H.F. radio receivers, their design, construction, alignment and repair. Includes chapters on adaptors, aerials, and high-fidelity audio equipment. A good introduction to FM theory, kept as non-mathematical as possible. $5.00

2410. TELEVISION AND RADIO REPAIRING, Markus
This book shows how to test, repair and replace each component of TV and radio receivers, power supplies, resistors and condensers, coils, tuning devices, and speakers. Shows what servicing involves, how to get information and tools necessary. The book includes the T.V. Detect-O-Scope. $7.95

2422. HANDBOOK OF TV REPAIR, Hertzberg
The simple mechanical and electrical maladies which are the great majority of television set troubles – what you can do about them and what not to try. Covers tubes and testing, antennas, UGH converters, fringe-area reception, the set and the chassis. $2.50

2506. FUNDAMENTALS OF RADIO AND ELECTRONICS, Everitt, et al
All you need to know on electronics and radios is found in this book—including transistors and vacuum tube principles and circuits. A product of close collaboration among five radio authorities, it is perfect for self-study. 832 pp. $11.35

2402. PRACTICAL RADIO SERVICING, Marcus and Levy
Dealing with the common types of radios in use, a-c/d-c receivers, phonograph players, and battery and three way portables. This book not only describes circuit fundamentals and servicing instruments and methods, but also gives graded job sheets giving valuable practical experience. Includes the indispensable Radio Detect-O-Scope. Illustrated. $8.95

2403. ELEMENTS OF RADIO SERVICING, Marcus and Levy
Gives practical, step-by-step procedures for finding troubles in radio receivers and making repairs. Readers with a background of simple radio theory can easily understand the book. Emphasizes over-all servicing procedures. $7.25

2406. ESSENTIALS OF TELEVISION, Slurzberg, Osterheld and Voegtlin
Comprehensive study of basic TV circuits. The operation of a color set and three monochrome receivers is described in detail from the antenna to the picture tube and loudspeaker. Features the sound section, waveforms, the picture tube, etc. Complete with illustrations, examples, questions, problems. $8.95

2409. TELEVISION FOR RADIOMEN, Noll
Here are the principles and essential mathematics of television. Detailed studies of cascade tuners, new video amplifier techniques, large screen picture tubes, modern deflection systems, latest antenna detail. Covers U.H.F., color TV, transistors, some topics not dealt with before. Construction, operation and servicing of television. $10.00

2411. TELEVISION SERVICING, Levy and Frankel
Explains how to find the section in which the trouble occurs and then to find the defective component. From the circuits discussed, which are employed in over 95% of TV receivers now in use, the reader gains an understanding of the principles involved. A knowledge of basic electronics is essential. $7.75

2423. BE YOUR OWN TELEVISION REPAIRMAN, Guth
Seventy-five percent of the time the only trouble with your TV set is a faulty tube. With this complete book, covering all manufacturers' models, you can easily replace the tube yourself. One dollar saves big repair charges. $1.00

2804. RADIO AND TELEVISION MATHEMATICS, Fischer
Whenever you need to look up the use of a formula or the correct substitution of numbers, you can find it here—rapidly. More than 700 step-by-step solutions of the usual problems encountered in radio, television and industrial electronics, including all those needed for FCC exams. $6.95

2419. BASIC TELEVISION, Grob
The basic book for training television servicemen and technicians. No mathematics other than simple arithmetic and algebra is needed. 660 pages with illustrations. $9.25

2420. TELEVISION FUNDAMENTALS, Fowler and Lippert
A simple nonmathematical presentation of the basic principles the radiotechnician must know in order to install and service television receivers. Sound treatment of each element of the system—from the antenna to the picture tube. $8.50

2424. TELEVISION SERVICING, 3rd Edition, Buchsbaum
Complete, most recent information on the design, construction, and servicing of both black-and-white and color sets. Shows how to locate and repair every conceivable trouble. $7.15

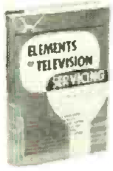
2427. COLOR TELEVISION FUNDAMENTALS, Kiver
This book can teach anyone familiar with monochrome television how to install and service color TV sets. All circuit discussions employ highly successful step-by-step approach. $7.25

2006. THE ELECTRONIC EXPERIMENTER'S MANUAL, David A. Findlay

With a few dollars worth of basic tools and this book to guide you, you can explore the wonderworld of electronics experimentation more completely than ever before. 10 big sections, including exciting projects you'll build and use. $4.95

2412. TELEVISION AND FM ANTENNA GUIDE, Noll and Mandl

Two antenna experts tell you their secrets of antenna choice for best reception everywhere, including fringe and difficult areas. Discusses general characteristics, lengths spacings, and principles including impedance matching and loss factors. Several new types of antennae based on author's own experimentation included. $5.95



2425. ELEMENTS OF TELEVISION SERVICING FOR BENCH AND FIELD, Marcus and Gendler

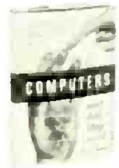
An up to date discussion of installation, servicing, and repair of TV receivers. An ample, practical guide designed for the serviceman familiar with radio reception. $8.15

2017. ELECTRONIC EXPERIMENTER'S HANDBOOK, 1961

A do-it-yourself goldmine! Includes 40 all-new projects — 20 data charts and tables on circuits, resistors, transformers, capacitors, ham and citizens band radio, sound levels—and more. Projects for your shop, for your hi-fi and audio systems, for the ham and SWL and for fun. $1.00

2413. CLOSED-CIRCUIT AND INDUSTRIAL TELEVISION, Noll

This text exhaustively studies theory and practice of closed-circuit and industrial television, present and potential. The technical section of the book covers TV transmission and its application to specific commercial equipment. $4.95



2007. COMPUTERS AND HOW THEY WORK, James Fahnestock

A fact-filled guidebook to electronic computers. Covers the history of computers and explains the workings of every major computer system ever used. Must reading for career-minded students and electronics pros who want a more complete knowledge of this important field. $4.95

2358. MECHANICS VEST POCKET REFERENCE BOOK

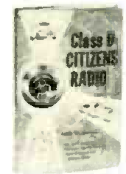
Over 200 fact-filled pages including tables, charts, formulas, for every aspect of mechanical work. Also includes logarithm table, conversion factors on gears, U. S. versus foreign measurements, etc. $2.50

2012. JOBS & CAREERS IN ELECTRONICS, 1961

Your key to a top-paying position in electronics! Describes interesting jobs for engineers, technicians, technical writers. Includes five big sections on opportunities in electronics, planning a career, testing your aptitude, case histories of careers and spare time electronics. $1.00

2408. ESSENTIALS OF ELECTRICITY FOR RADIO AND TELEVISION, 2nd Edition. Slurzberg and Osterheld

This book provides the necessary background of electronics principles for an understanding of television, frequency modulation, and radio circuits. Electrical principles are explained in terms of electron flow. $8.25



2008. CLASS D CITIZENS RADIO, Leo G. Sands

Now, with more than a million vehicles equipped for its use, Citizens Radio is a major phase of the electronics field. Here's the story on the whole field—its history, rules, and everything about how it works. Learn exactly what Citizens Radio is, its applications, what you need, FCC rulings, etc. $4.95

2415. MANDL'S TELEVISION SERVICING, Mandl

This standard textbook of television servicing includes recent information on transistor circuits, color TV, UGH and VGH receivers, cascade tuners, automatically focused tubes. A master table lists over 100 trouble symptoms, with possible causes and page number for full servicing instructions for that fault. $7.50

2502. ELEMENTS OF RADIO, 4th Edition, Marcus & Marcus

This excellent one-volume course on the essentials of radio has sold over a million copies! It employs the unique "spiral" method of instruction and is profusely illustrated. $7.00

2011. STEREO & HI-FI DIRECTORY, 1961. Ziff-Davis

New! Over 1200 component listings, 800 photos; latest models, prices! Entire sections on every phase of stereo and monaural high fidelity. $1.00

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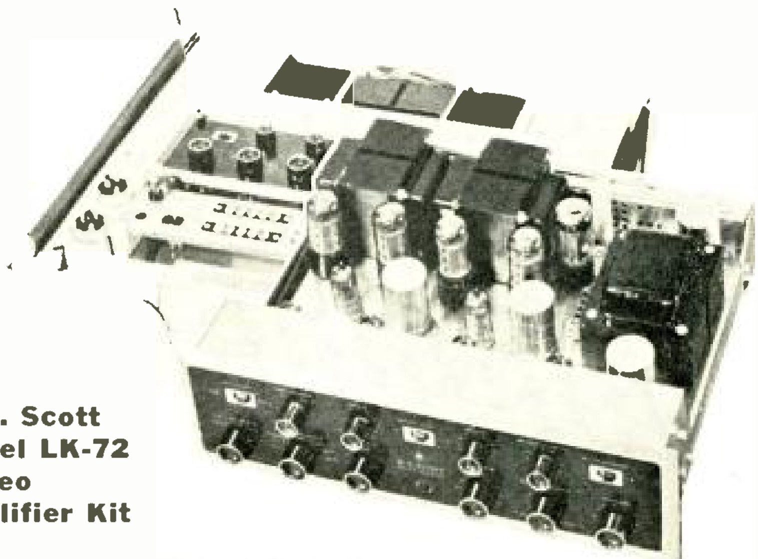
New Audio Test Report

LAB TESTED ELECTRONICS WORLD

H. H. Scott Model LK-72 Stereo Amplifier Kit
Lafayette 100-Watt Stereo Power Amplifier
Fisher 202-R AM-FM Tuner



H. H. Scott Model LK-72 Stereo Amplifier Kit

THE MODEL LK-72 is *H. H. Scott, Inc.'s* second kit entry in the hi-fi field. Like its predecessor—an FM tuner—no effort has been spared to make the building job simple, a lot of fun, and yet have the builder end up with a unit that looks and works like factory-built equipment. We are still very much impressed with the clever "Kit-Pak" where the container doubles as a carrying case and a work area. All the leads are pre-cut and pre-stripped, and this even includes the preparation of the shielded leads, thus eliminating this normally time-consuming task. Sockets and terminal strips are already riveted to the chassis.

This reviewer, having built a good many kits in the past, whizzed through the complete construction in only about 11½ hours. But, even the novice should be able to do a good job and a fast job, thanks to all the help given by the manufacturer, in just a little more time than this. Incidentally, the kit does not use any printed wiring. Although some may consider this a bit old-fashioned, hand-wiring is easier to trace and service.

The Model LK-72 is an integrated stereo amplifier rated by its manufacturer as a dual 36-watt (music-power) or a dual 30-watt (steady-state sine-wave power) unit. Two type 7591 pentodes, with fixed bias, are used in push-pull for each output stage. These are driven by 7199 triode-pentodes, operating as driver and phase-splitter. Ahead of the 7199 are two 12AX7's in each channel, operating as equalized preamps and tone-control amplifiers. These tubes use d.c. on their heaters to minimize hum.

In addition to the customary operating controls and input and output facilities, there are some unusual features included. A front-panel center-channel level control is provided to control the amplitude of a signal derived from the two stereo output channels. This signal may be fed to a separate power amplifier and speaker located midway between the left and right speakers to provide center "fill," if desired. It can also be used as a mono speaker in other parts of the home. A tape-monitor switch is also provided that permits the user to listen to the output of the tape recorder while it is actually making a tape.

Although there is a scratch-filter switch on the unit, there is no rumble-filter control. This is because this amplifier, like all the company's hi-fi amplifiers, has built into it a permanently connected sharp cut-off filter operating below 20 cps to eliminate subsonic frequencies.

A unique stereo balancing arrangement is used to make sure that the balance control is properly set. To use it, simply switch the mode switch back and forth between two positions marked "Bal A" and "Bal B," while adjusting the balance control to get equal loudness from both loudspeakers. In the "Bal A" position, both stereo channels are combined and applied only to the left speaker; in the "Bal B" position, both channels are applied to the right speaker. Since exactly the same signals are applied to each speaker in turn, these will produce equal output in a properly balanced system.

After completing the construction of the amplifier, we ran our usual tests with the following results:

Frequency response: At an output level of 2 watts, frequency response through the tuner input measured within +1 and - 0 db from 30 cps to 15 kc., the limits of our test. The range of the bass control at 30 cps was ±18 db to −18 db, and the range of the treble control at 15 kc. was +15 db to −19 db.

Power response: Using our usual standard of 2 per-cent maximum total harmonic distortion, we measured an output power (steady-state sine wave) of 32.5 watts at 1000 cps, 29.3 at 30 cps, and 32.8 watts at 15 kc. This performance is quite good when compared to other amplifiers we have checked which readily produce rated power output at the mid-frequencies but whose output power drops off considerably (at the same distortion rating) at the frequency extremes. The power-response curve is seen to be very flat, ranging from less than + .1 to −.5 db at the 2 per-cent distortion levels. At the manufacturer's rated power output of 30 watts, we measured only .42 per-cent distortion at 1000 cps.

Intermodulation distortion: Using frequencies of 60 and 6000 cps at an equivalent sine-wave output power of 30 watts, we measured .93 per-cent intermodulation distortion.

Sensitivity: For full-power output of 30 watts per channel, the following input voltages were required: for low-level magnetic phono input, 3.5 mv.; for high-level magnetic phono input, 11.7 mv.; for tuner or auxiliary input, .54 volt, all taken at 1000 cps.

Hum and noise: These measurements were taken with a 6-mv. signal applied to the low-level magnetic phono input and with the volume control adjusted for a 2-watt output. Under these conditions, hum and noise measured −65 db on the phono inputs and −67 db on the tuner input, with reference to 2 watts.

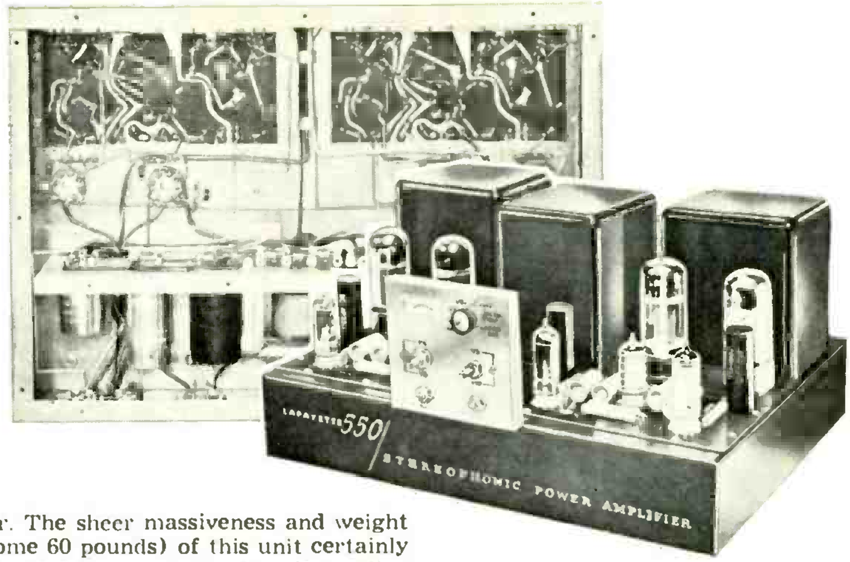
Equalization: We then checked the accuracy of the RIAA phono equalization provided by the amplifier, and we found it to be within +1.8 and −.1 db of the standard curve. This is well within the 2-db tolerance specified for this standard. We also checked the accuracy of the NAB tape equalization, and this was found to be within +0 and −2 db of the standard curve.

Channel separation: This averaged 57 db from one channel to the other, as measured at 1000 cps. This figure is far better separation than exists in any phono cartridge that would be connected to the amplifier.

In summary, the Model LK-72 is a conservatively designed, versatile integrated stereo amplifier that should be a pleasure to build and a pleasure to use. The kit is available for $149.95 without case. —30—

Lafayette 100-Watt Stereo Power Amplifier

ONE OF *Lafayette's* latest hi-fi components is the Model KT-550, a 50-watt-per-channel stereo power ampli-



fier. The sheer massiveness and weight (some 60 pounds) of this unit certainly gives the impression that you're getting a lot of amplifier for your dollar. The conservative design, with its more-than-ample reserve of power, and the use of no less than six feedback loops permitting up to 50 db of feedback, combine to make this one of the best hi-fi amplifiers on the market.

The circuit uses ten tubes and five silicon diodes in all. New 7027A's are used as output tubes. The silicon diodes are employed with a heavy-duty choke and high-C, high-voltage electrolytics in a very well regulated voltage-doubler supply. Functionally, the amplifier is quite similar to others that are available, but it does have an added important feature. A switched meter, along with controls, is incorporated so that the bias for each of the output tubes can be accurately adjusted. Also, the meter permits an a.c. balance adjustment for the output tubes to be made.

After we put together the kit, we ran it through our usual tests with these results:

The sensitivity of the amplifier is such that full 50 watts output occurs in each channel with .98 volt input.

The frequency response was ±1 db from 4 to 75,000 cps at 2 watts output. At maximum power output, the frequency response was +0, −1 db from 13 to 55,000 cps—well beyond the audible range.

Our over-all hum figure was −60 db with open-circuited input, and −67 db with the input shorted. These figures are both related to an output of 2 watts. We found that, as with other amplifiers, proper polarization of the a.c. line and grounding helps to reduce hum.

The IM distortion (60 and 6000 cps at a 4 to 1 ratio) varied from a mere .1% to only .44% from 2 watts to 50 watts. These are well below the 1% figure that this reviewer considers representative of top performance.

The harmonic distortion at 1000 cps varied from .12% to only .35% from 2 watts to 50 watts. At 30 cps and maximum power output, the harmonic distortion was .68%, and at 15,000 cps, it measured .57%. This distortion is extremely low at 50 watts output, but it does rise sharply beyond this power level, as do most good amplifiers, to the point where we get 2% harmonic distortion at 52.5 watts output. This reviewer has always considered that even 2% harmonic distortion is undetectable by most individuals. Another interesting point is that the harmonic distortion stayed well below the 2% figure even with both channels delivering their full power output. Some amplifiers cannot deliver full power in both channels and maintain good performance, but because of the extremely well-regulated power supply of the Model KT-550, this unit passes this test with flying colors. Here is a case where the manufacturer does not gain much by quoting a music-power rating figure. With a well-regulated supply and a well-designed amplifier with fixed bias, music-power rating would only be very slightly higher than a continuous sine-wave power rating.

We found that both the IM and harmonic distortion were about twice the above values when we followed the manufacturer's adjustment procedure. We actually adjusted the bias and balance controls for minimum distortion, and the figures so obtained are those quoted above. If one has access to a distortion meter, we would suggest that the controls be adjusted for minimum distortion at 20 watts output. But even if test equipment is not readily available for these adjustments, the IM and harmonic distortion would be below 1% and 2% respectively using the method outlined by the manufacturer. We doubt that even the most critical ear would be able to detect this slight difference in performance.

The construction of the unit is extremely simple if one follows the manual and, like nearly all power amplifiers, it does not take very long to build. Our estimate is around 6 to 8 hours depending on the constructor's experience. Two printed circuit sub-assemblies help to simplify and speed construction.

In summary, then, from the test results obtained, we would rate this amplifier along with the very best in the field. It will provide excellent hi-fi performance whose quality would be limited only by that obtained from the other components in the system. The unit is available as a kit for $134.50 and factory-assembled for $184.50. -30-

Fisher 202-R AM-FM Tuner

TRUE TO its advertised claims, the *Fisher* Model 202-R AM-FM tuner combines unusual features, fine craftsmanship, and truly deluxe design. Most unusual and novel is the "Microtune" feature which permits automatic a.f.c. suppression whenever the set is manually tuned. As soon as the hand is removed from the tuning knob, a hum-sensing circuit actuates a relay which applies the a.f.c. again. This feature is particularly valuable for the less technically minded and assures perfect tuning. The a.f.c. is *not* required in this design to minimize drift.

Using a total of 16 tubes, many of them multipurpose types, and 9 semiconductor diodes, this tuner has exceptionally fine performance characteristics on both AM and FM. The following data was obtained during our laboratory tests on the FM section of a factory-aligned unit:

Usable sensitivity (IHFM standard, 30-db quieting and distortion): at 90 mc., 1.0 μv.; at 98 mc., 0.8 μv.; at 106 mc., 1.2 μv.

Volume sensitivity (IHFM standard, 20-db quieting): at 90 mc., 0.8 μv.; at 98 mc., 0.8 μv.; at 106 mc., 1.0 μv.

I.F. bandwidth: 230 kc. at -3 db points.

Drift: No discernible drift when a.f.c. is on.

Hum: 60-cps and 120-cps hum was less than -66 db. (Our equipment limitations prevent measurement of a better figure.)

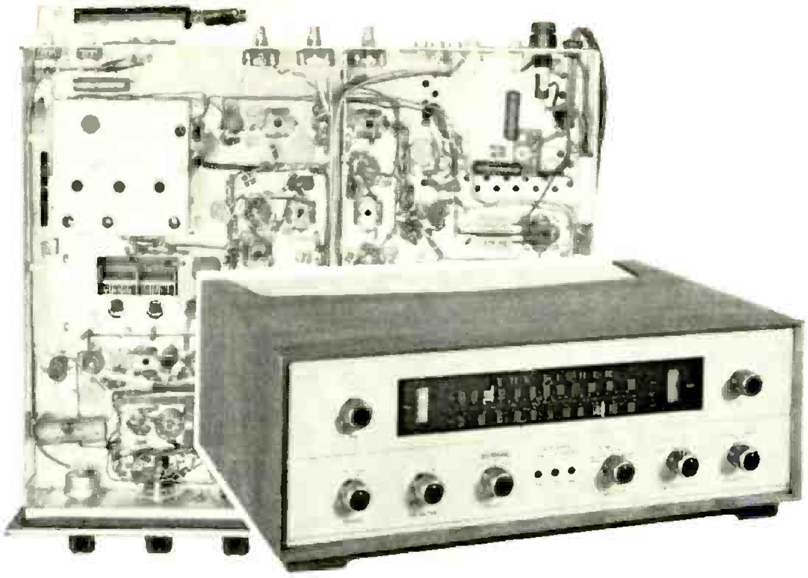
Maximum audio output: 4 volts r.m.s.

Audio response: Within ± 1 db from 40 to 15,000 cps (the frequency limits of our test equipment).

Although we did not measure it, the manufacturer claims a capture ratio of only 1.5 db. This means that unwanted signals and noise on the same frequency as the desired stations are rejected even when they are 84 per-cent as strong as the desired station.

The great sensitivity, excellent selectivity, and over-all fine performance are no miracle since a cascode r.f. amplifier is used and this is followed by no less than six i.f. stages. Five of these operate as limiters with a gated-beam tube included in this group. These are followed by a wide-band ratio detector using a pair of matched crystal diodes. Special features include a muting circuit to suppress between-station noise, a semiconductor capacitor as a.f.c. element, and a "Local-Distance" switch to prevent overloading of the r.f. stages on strong local stations. Two balun input transformers are used for balanced 300-ohm or coaxial 72-ohm antenna input. A tuning meter is employed for proper tuning adjustment.

The AM section also includes a separate tuning meter and a number of unusual features. It is possible to select different audio and i.f. bandwidths for listening under different noise condi-



tions. A front-panel switch selects either the built-in ferrite-core antenna or an external aerial. Delayed a.v.c. and a 10-kc. whistle filter are provided. The circuit utilizes an r.f. amplifier stage and two stages of i.f. and gives excellent performance. Technical specifications of the AM portion of the tuner were measured as follows:

Usable sensitivity (for 1-volt output): at 600 kc., 2 μv.; at 100 kc., 1.5 μv.; at 1500 kc., 2.5 μv.

Selectivity ("Sharp" response): −6 db at ±3.6 kc.

Audio response ("Wide" response): within ±1 db from 40 to 8700 cps. (Note: An even wider response position is available whose high-frequency limit is set by the 10-kc. whistle filter.)

Cathode-follower outputs are provided for both AM and FM sections and there are separate output-level controls. A special switch position is provided to correct the phase of stereo signals when an AM-FM stereo broadcast is being received.

In addition to the excellent performance of the AM and FM sections separately, they were also tried out in a simple stereo arrangement. The results were the best that this reviewer has yet heard with this type of stereo set up. From the viewpoint of price ($329.50) and performance, the *Fisher* Model 202-R certainly is a deluxe instrument in every respect. —30—

Within the Industry

(*Continued from page* 20)

The NEC annually presents a Fellowship, valued at $2500, to an outstanding graduate in electrical engineering to further his study in electronics. The Fellowship covers a year of graduate study at any of the ten colleges and universities participating in the NEC.

* * *

ADOLPH WOLF has joined *Electro-Voice, Inc.* as vice-president of manufacturing.

He was formerly assistant chief production engineer for *Zenith Radio Corporation.*

Mr. Wolf will fill a vacancy created by the retirement of Fred Lester, who is remaining as a member of the board of directors. Among his responsibilities will be the direction of all production facilities for the electro-acoustic firm's plants in Buchanan, Michigan; Washington, Illinois; and Eureka, Illinois.

* * *

FRANK PYLE, JR. has been elected vice-president and **ROBERT L. WEBSTER** treasurer at *Utah Radio Products Corporation* . . . **JOHN J. PACCONI, JR.** is the new national field sales manager for *Audio Empire* . . . *Allied Radio Corp.* has promoted **RONALD KRAMER** to the post of product merchandiser of semiconductors, resistors, capacitors, and special-purpose tubes. He was formerly senior control buyer for the firm . . . **TUDOR R. FINCH** has been named assistant general manager of the semiconductor products division of *Motorola Inc.* in Phoenix. He was formerly with *Bell Labs* . . . **ROBERT STROME** is the new sales manager of *Marantz Company, Inc.* He was formerly with *Ampex* . . . **ZEKE R. SMITH** has been appointed executive vice-president and general manager of *Potter & Brumfield* . . . *International Resistance Co.* has named **JOHN S. KANE** manager of its plastic products division . . . The appointment of **THOMAS A. PERROTT, SR.** as vice-president and director of sales has been announced by *Federated Electronics, Inc.* . . . **HORACE R. POTTER** has been elected president of the *Reeves-Hoffman* division of *Dynamics Corporation of America.* He has been with the division since 1951 . . . **JOHN CIHOCKI** has been appointed director of educational services at *Channel Master Corp.* He is active in the firm's transistor radio service clinic program . . . **WILLIAM J. HENDERSON** has been upped to the post of general sales manager of *FXR, Inc.*, Woodside, N. Y. maker of microwave test instruments and associated equipment. —30—

Throw Away Your Antenna Pulley Block

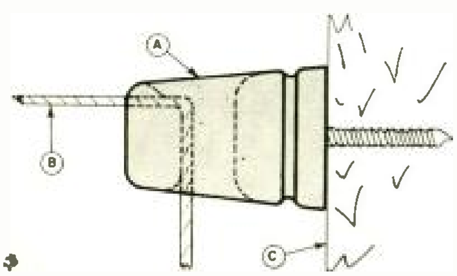
By HOWARD S. PYLE, W7OE

DOES the pulley block on the house, tree, or mast that supports your antenna stick, rust, squeak, and bind? Often, when you attempt to raise or lower it, does the down-haul rope or cable "jump the track" and get really stuck between the sheave and the housing? Why don't you end it all by throwing the pulley block away and using the stunt described below?

For just a few cents—much less than the cost of a good pulley block— you can get from your power company, electrical or hardware dealer, what is known as a "service entrance insulator" of the screw-in type. Replace the screw-eye or eye-bolt and pulley block which you are now using with one of these insulators. They come in many sizes and the choice is yours. Any of them will hold any strain that the average ham antenna of the horizontal-wire type will impose on them. Remember, they hold long spans of heavy insulated copper wire for many years.

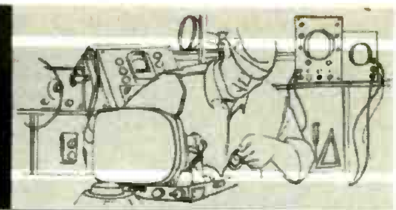
Reave your down-haul rope or cable through the eye in the insulator, which has a smooth glazed finish. You'll find that the down-haul will slip easily through it without friction and with no sheave to squeak, stick, or rust and that it will do so indefinitely. You can make it an even smoother slide if you rub a cake of wax or a candle along the length of the down-haul.

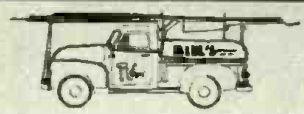
As long as we mentioned down-hauls, why use a rope for this? Why not the smoother, longer-lasting plastic-covered stranded steel wire clothes line? It will outlast any rope, and has no stretch nor shrinkage. It works ideally in the insulator "pulley" described above. You can get it in 50- or 100-foot lengths from any hardware or variety store, or from the general mail-order houses. Two cautions however; be sure that you do not nick or cut the plastic overlay during installation as this would permit moisture to enter and rust the steel inner core; second, if you have a metal mast which you sometimes use as a vertical radiator, don't use the plastic line. The metal core could be at a resonant frequency and, with its parallel proximity to the mast, impair your radiation. If the mast is used solely for the support of a horizontal-wire antenna, this poses no problem. —30—



A-GLAZED PORCELAIN SERVICE ENTRANCE INSULATOR
B-DOWN-HAUL ROPE OR CABLE
C-TREE, MAST, HOUSE GABLE OR OTHER SUPPORT

SERVICE INDUSTRY NEWS





A GENUINE UPSWING in color TV is in the making, if we are correctly interpreting reports reaching us since the publication of "Color TV Service Today" in our April issue. The trend comprises at least two key developments on the manufacturing end of the industry, an advance in transmitting equipment, and a widespread upsurge of editorial and technical support from service associations.

RCA's announcement of an improved version of the three-gun CRT, type 21FBP22, holds the promise of brighter, sharper pictures in reproducing both color and monochrome pictures. Operationally similar to its predecessors, the new picture tube uses higher-efficiency phosphors of the sulfide type.

The actual gain in performance should be considerable, despite the modest sound of the change. Color phosphors have been a bottleneck for some time. Earlier phosphors have been relatively low in efficiency. This has meant that, when excited by the electron beam, the materials used have not been able to produce light output comparable to what is achieved in a monochrome CRT. The problem is further aggravated by the fact that, with three primary phosphors of differing efficiencies used, output of all three must be balanced to the least efficient one.

The result has been that brightness and contrast ratios available in color reception have not always been satisfactory under normal room lighting. In addition, size of the undeflected spots that can be produced on the face of a CRT has not been fine enough to produce optimum resolution, reducing sharpness of the picture. Furthermore, the persistence time of the phosphors has been kept somewhat long. While this has boosted apparent brightness, it has also resulted in smearing of the image in rapid-action scenes.

The new sulfide phosphors have higher efficiency and are closely balanced with respect to this characteristic. They also have shorter persistence. As a result, there is a marked improvement in picture brightness and the reproduced image is crisper, even during rapid action. One important factor is that color sets on public display, from which most prospective purchasers form their notions of the quality of color TV, will be less subject to a serious handicap. The ambient lighting in most dealers' showrooms or other points of public display is generally so great that color sets could not be adjusted for optimum performance. In fact, the average set in home use generally gave a better account of itself.

The new tube is available in two versions: a conventional one for use with a separate safety glass and another with an integral, laminated safety plate.

Zenith Is in Color

When color TV sets first hit the market many years ago, one of the leading set manufacturers, *Zenith Radio Corp.*, forthrightly announced that it had no plans to market sets, then or in the immediate future. This company stated its intention to continue active research but also said it would not offer a set for sale until it was assured that it could make a receiver that would provide the levels of performance, reliability, and serviceability that the public had come to expect from monochrome TV.

After eight years of research and development, *Zenith* now feels ready to make its bid. It promises the dependability and performance toward which it has been working in its newly announced sets, as well as simplified operation. Much of the quality is attributed to a new system of color demodulation employing a new tube type. Both the system and the tube are *Zenith* developments. The new CRT with improved brightness is also being used. Complete circuit details will not be revealed until the receivers are in quantity distribution. A happy note for independent service dealers: *Zenith* feels that well-trained independents will be able to render adequate service on the color sets and is making no plans to establish manufacturer service.

Other Color Gains

An important obstacle to color set sales has been the relatively small number of broadcast facilities capable of originating and transmitting color programs. Equipment costs have been high. Thus the added cost to advertisers in the color medium must also be high. Neither broadcaster nor advertiser is willing to make the investment as long as there are few color receivers in use—and many new-set buyers are staying away from color because there aren't enough programs available.

A break-through in this paradox may have been heralded by the work of Prof. William L. Hughes, of Iowa State University's Department of Electrical Engineering. It is reported to have made major simplifications practical in the additional equipment and reduction in additional costs for color-program origination and transmission. According to the developers, it will now be possible even for small stations to pick up, originate, and record color shows on a regular basis without unrealistic investment requirements.

Another straw in the wind is an editorial entitled "Color Television is Your Future," originally run in "TSA News." It has been picked up and featured by about a dozen other association publications throughout the nation. One of these periodicals, "ETG News" of Boston, Mass., is currently running a technical series on color by A.C.W. Saunders. Other associations are beginning to schedule technical lectures in this subject area again.

Bregenzer Honored

This winter Bert Bregenzer, president of the Electronic Service Dealers Association of Western Pennsylvania, passed away. This writer, who has had opportunity to observe this active, intelligent industry leader in some of the many duties he has performed for ESDA and also for NATESA, joins his many associates in regretting his loss. As a memorial to Bert, an entire issue of the "ESDA Scanner" has been given over to a tribute to this leader, including highlights, in pictures and words, from his long career. The list of offices he held and accomplishments to his credit are too numerous to describe fully here. However, they underscore the magnitude of the industry's loss.

Broadcast-Service Liaison

"NATESA Scope" reports a roster of half a dozen local affiliates who are reaping the benefits of promotion by broadcasters. These, along with the cooperating broadcasters, include: TESA-Quint Cities, Ill., working with WHBF-TV; ITTA-Indianapolis, Ind., working with WFBM-TV; LEA-Lafayette, La., working with KLFY; TESA-Iowa, North Chapter, working with KROC; TESA-St. Louis, Mo., working with KPLR-TV; and TESA-New Orleans, La., working with WWL. From reports we have received and run in the past, we know that the actual number of such cases of broadcaster-service cooperation, involving groups in or out of NATESA, is greater than six. In any event, the cooperative trend is growing steadily, and NATESA's special efforts in this direction will surely help it.

Kansas City Licensing

Litigation to kill the Service License Law in Kansas City, Mo., has resulted in confusion on many counts, but one point seems to be clearing up. The injunction enjoining the city from enforcing the law pending further court action was handed down after many service dealers had already applied for and obtained licenses. Where do they stand? It appears that, although no new licenses are being issued, those already in force have not been suspended. Accordingly firms and individuals holding licenses may display their certificates and may otherwise publicize the fact, as in their advertising, that they are license holders. —30—

Transistorized Tachometer

(*Continued from page* 62)

for good power supply regulation (which is necessary for stable calibration) and a wide temperature range without dissipating excessive power in the regulator. Therefore, those who wish to build this unit for use with 6-volt automobiles must use an independent battery supply.

Calibration

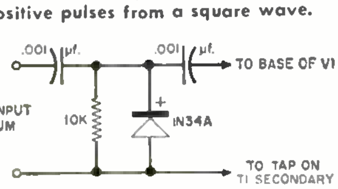
Calibrating the completed unit is quite simple. The most desirable signal source for this purpose is an accurately calibrated pulse generator or audio square-wave generator. If only a sine-wave generator is available, its output may be converted to a square wave by means of a Schmitt trigger. The transistor unit described in the article "Transistorized Square-Wave Shaper" (June, 1960), is suitable. A vacuum-tube unit may be used also, but it is important to remember to keep the peak input pulse amplitude below three volts. If it is not possible to obtain an audio generator, a test signal of high accuracy may be derived from the 60-cps line to give calibration points at 1200 rpm for a six-cylinder engine and 900 rpm for an eight. These test frequencies are not the best for calibrating a range of 5000 rpm, but the linearity of the unit is good enough that, with care, the resulting full-scale error will not be disproportionately large.

If a square wave is available, it is necessary to differentiate it and clip off the negative pulses. The train of positive spikes is used to trigger the tachometer, being applied to the base of V_1 through a 0.001-μf. capacitor. A suitable circuit is shown in Fig. 3.

To make the calibration, the pots are set near the middle of their ranges and the timing capacitor trimmed, if necessary, to give an rpm indication near that corresponding to the setting of the pulse source. The final adjustment is then made with the calibrating pots and the shafts locked. If meters with usable scales are not available, the scales may be hand-drawn on a special heavily coated white paper with a pressure-sensitive adhesive back that is carried by most art supply houses. It will be noted that the lower scale in the unit illustrated has five subdivisions between each numbered point; there should have been four on the lower and five on the upper.

The original unit was built and installed in January, 1960, and has operated without attention since that time, over a wide range of temperatures. —30—

Fig. 3. Differentiator-clipper for producing narrow positive pulses from a square wave.



HOW THE FCC MONITORS THE CITIZENS BAND

By R. L. CONHAIM, 19W7577
President, Dayton Citizens Radio Assn.

You won't get a violation notice unless you deserve it. But here is what to do if you get one, along with some suggestions for avoiding citations in the first place.

NEXT TIME you pick up your CB mike to make a transmission, stop for a second, and think who may be listening. You hope there'll be the station you're calling. But, in addition, there may be many other receptive ears. There are other stations in your own locality who monitor that particular channel. There are stations more than a thousand miles away who may pick you up on skip propagation. And, quite possibly, there may be one of Uncle Sam's FCC Monitoring Stations listening to you *via* ground wave or skip and routinely examining your signal and message content for compliance with applicable regulations.

This is not snooping on the part of the Federal Communications Commission. It is merely routine examination of the air waves to protect all users of all radio bands against communication-wrecking interference caused by a few wrongdoers. It is protection for the innocent person whose transmitter, unknown to him, is not functioning correctly.

To fulfill its monitoring functions, the FCC has set up under the Field Operating Division of the Field Engineering and Monitoring Bureau a number of monitoring stations, whose function is surveillance of the entire radio spectrum. At present there are 10 primary plus 8 secondary monitoring stations and 80 mobile units. All are interconnected by teletypewriter or radio networks to function as an efficient, alert guardian of the airwaves.

CB Requires Special Monitoring

The activation of the class D Citizens Band presented special monitoring problems. You can easily see why. In a short space of time, this relatively new band blossomed forth with hundreds of thousands of transmitters. The fact that this band was found to have a much higher percentage of violations than other bands could easily be traced to the very nature of the class D service. No operator ability or technical know-how is required. The equipment is low-priced and because of highly competitive conditions is no better than it has to be. Much home-built equipment, constructed by persons with limited knowledge and experience, is used. CB'ers are often "do-it-yourself" repairmen, and lack precision equipment necessary for determining compliance with technical standards. And, unfortunately, many CB enthusiasts have an almost total unfamiliarity with Part 19 of the Commission's Rules and Regulations—they prefer to accept rumors and scuttlebutt regarding operating standards.

With so much monitoring attention devoted to CB, with so many knotty problems yet to be solved, and with so many violation notices being issued, we thought it would be of interest to visit a monitoring station and talk face to face with FCC personnel about the problems created by CB.

Monitoring Station

For our purpose, we chose the Chillicothe, Ohio Secondary Monitoring Station. A letter to the FCC in Washington cleared the way and we arranged with the Engineer-in-Charge of the station for a visit at a time when personnel experienced with CB problems would be on duty. The fact that we would be dealing with able monitoring personnel had been dramatically demonstrated only a few days before our visit—the Chillicothe station had played an important part in helping to locate the errant Portuguese cruise ship, "Santa Maria," by the use of direction-finding techniques.

The Chillicothe Monitoring Station is located on a 325-acre, high, flat tract about 5 miles from Chillicothe, in Southern Ohio. Like all monitoring stations, this one is located away from big city noises and interference and on high, unobstructed flat ground where large antennas and direction-finding equipment can be erected and operated satisfactorily.

The Chillicothe Station is located off a back road on a large government reservation. The imposing array of rhombic antennas leaves no doubt that you have arrived at the right location, although other landmarks are noticeably absent. A compact, low building several hundred yards from the road is the headquarters for the operation. As you drive up the lane to the building, you can see in the background the direction-finding antenna, remotely controlled from inside the Monitoring Station.

We entered the compact office and met the Engineer-in-Charge, David Birnbaum, who ushered us through the remainder of the building. You get the impression that this operation is designed for efficiency. All the required facilities and comforts are there, but there is no gingerbread. Everything is strictly business. Because of its remote location and its 24-hour-per-day function, the building is equipped with a small kitchen for the convenience of its employees. An exceptionally neat repair room provides the necessary facilities for maintaining monitoring equipment. But, the heart of the building is an imposing and immaculate Monitoring room which occupies the central portion of the building. The operating heart of this room is an efficiently planned console, consisting of a large number of rack-mounted receivers, plus test and measuring equipment necessary to carry out the functions of the monitoring station. Nearby are a number of teletypewriters, interconnecting this station with other stations and offices of the FCC. Reference materials are incorporated in compact bookshelves. A rack-mounted tape recorder permits the recording of any signals which the engineer-on-watch may wish to have for convenience in preparing citations.

Receivers covering the spectrum from 10 kilocycles to 4000 megacycles are mounted in relation to their importance. Receivers for those bands requiring the most attention are grouped near the central portion of the console, while those for less used bands are mounted near the outer edges of the console. A crystal frequency standard, oscilloscope, and easily read clock are all part of the central portion of the main console. A desk top stretches from one side of the central console to the other for convenience in writing down information or using reference materials. The teletypewriter which connects the Chillicothe station to other stations in the monitoring net is centrally located. All equipment is so arranged that the engineer-on-watch, with his rolling swivel chair, can get swiftly from one part of the console to another. A central coaxial patch-panel allows him to interconnect any equipment he may wish to use.

Basically, all secondary monitoring stations have similar equipment. For special purposes, however, there may not be commercial equipment which will do the job. In such cases, monitoring station personnel make their own equipment. Primary monitoring stations have somewhat more elaborate equipment, can cover the entire radio spectrum, and usually have two engineers on each watch. The frequency standard used in secondary stations is usually a precise crystal standard, with crystals in ovens kept at very close temperature tolerances. Such standards are accurate to 2 cycles in 10 megacycles. By frequently checking the standard against WWV, very accurate frequency measurement is assured. Some of the larger primary monitoring stations use the more modern frequency counters.

How Monitoring Is Done

Some CB'ers look upon monitoring and investigative actions of the FCC as the same general function. In reality, however, they are entirely separate. Monitoring is routine checking of the radio spectrum. Investigation is the examination of specific complaints. Monitoring may turn up situations which need investigation. Monitoring stations may also take part in specific investigations, furnishing technical assistance. Investigations are handled primarily by the offices of the 24 Field Districts of the FCC. Investigations arise because of specific complaints from users of radio equipment, from ordinary citizens, or from the results of monitoring. Field offices are equipped with their own mobile investigative equipment.

Monitoring is normally done on the basis of so-called cruising assignments. On certain pre-scheduled days a given monitoring station, in cooperation with other stations in the monitoring net, will confine its attention to a particular portion of the frequency spectrum. When personnel is available, monitoring continues 24 hours per day, seven days a week. Even with shortage of monitoring personnel several 24-hour days of concentrated monitoring may be accomplished, with time off before or after the high-concentration period. So it's never safe to assume that come 5 p.m. or weekends, the FCC has "gone home" and the 11-meter band is open for any and all kinds of conversations.

Let's assume our typical monitoring assignment for the day is the class D Citizens Band. The operator on watch will use the receiver which covers the 27-mc. portion of the spectrum. He will tune back and forth listening for Citizens Band signals. When his receiver picks up a signal, he will check the time then make a frequency measurement. He may then listen to the signal to determine if it is the type of message authorized for use on class D Citizens Band. He watches the clock to be sure the 5-minute rule is adhered to. He also checks, as far as he is able, for compliance with other technical requirements of Part 19 of the Rules and Regulations.

During daytime hours, much of the CB activity of a monitoring station is based upon skip signals. If you get a violation notice, chances are it will come from some distant point—1200 miles or more away—unless, of course, you are within ground-wave distance of an FCC monitoring station.

If the Monitoring Station determines that the station being monitored is in violation of the rules, the operator will tape-record a portion of the conversation. This is for the purpose of identifying the signal, both for the monitoring station and for the benefit of the licensee. By including a portion of the conversation in the Official Notice of Violation, the licensee will be able to recall the particular conversation involved.

Based upon the call-sign given, the operator will then look up the name and address of the licensee from published files. If no information is available locally, a teletypewriter message to the FCC headquarters in Washington will bring the correct name and address.

Before any citation is issued, a list of proposed citations is sent to Washington headquarters by teletypewriter. Here the list is checked for validation and to avoid duplication. It is possible that two monitoring stations might propose to cite the same licensee for the same violation. By pre-screening each monitoring station's proposed list of citations, such duplication is avoided. When the list has been validated by FCC headquarters, the Official Notices of Violation are completed by the monitoring station and mailed to the licensees involved. The entire procedure from monitoring to mailing is accomplished in 1 or 2 days.

Violations on Class D Citizens Band

The two largest categories of violation being detected by FCC Monitoring Stations on class D Citizens Band are off-frequency operation and the use of class D stations for communications which are not permissible under the rules. The greatest number of citations are issued for these two reasons.

If you get the word from an FCC Monitoring Station, it may take one of two forms. You might get an Official Notice of Violation, FCC Form 793, such as shown in Fig. 2. However, if the violation is minor or represents some unsatisfactory condition in which no specific rule is involved, you are more apt to get an Advisory Notice, FCC Form 790. The Official Notice of Violation requires an answer. The Advisory Notice does not, since it is merely a warning. If the monitoring station detects a Citizen Band Station DX-ing, but does not hear the other end of the conversation, it may send a Violation Notice to the offender it hears, and an Advisory Notice to the unheard station which it can identify by the call sign heard being called by the offending DX-er.

"Notice of Violation" Procedure

You won't get a citation unless you deserve it. Monitoring Stations don't issue them for questionable cases. Only out-and-out violations are cause for citations. The FCC Monitors will give you the benefit of the doubt. They don't get paid according to the number of violations they issue. Many of these men are hams themselves. They are merely trying to uphold the regulations of the FCC. But, if you do get one, be sure to

Fig. 1. Monitoring console of the Chillicothe, Ohio FCC monitoring station. Technician is contacting other stations by teletypewriter.

FCC Form 793
March 1960

UNITED STATES OF AMERICA
FEDERAL COMMUNICATIONS COMMISSION

Form Approved
Budget Bureau No. 52-R162

P. O. BOX 251
CHILLICOTHE, O.

OFFICIAL NOTICE OF VIOLATION

The facts set forth below indicate that you have violated the requirements of law and treaty. This Notice is issued in accordance with Section XXX 1.76 of the Commission's Rules.

Within 10 DAYS from receipt of this Notice, a written answer in DUPLICATE shall be addressed to "Federal Communications Commission" and SENT TO THE ADDRESS ABOVE. DO NOT address your reply to an individual.

MAKE CERTAIN THAT YOUR ANSWER:
(a) IS COMPLETE IN ITSELF.
(b) IS NOT ABBREVIATED BY REFERENCE TO OTHER NOTICES.
(c) CONTAINS FULL EXPLANATION OF INCIDENT INVOLVED.
(d) EXPLAINS ACTION TAKEN TO PREVENT CONTINUATION OR RECURRENCE.

☐ An (X) denotes that item one of attached copy of this Notice must be completed by operator and submitted with your answer.

1. I, the undersigned, was the operator on duty at time of irregularity noted hereon, and hereby acknowledge this NOTICE:

(SIGNATURE OF OPERATOR) (OPERATOR LICENSE OR PERMIT NO. AND ISSUANCE DATE)

2. NAME AND ADDRESS OF LICENSEE:
R.L. Conhaim
2500 Woodway Ave.
Dayton 6, Ohio (Sample)

3. LOCATION OF STATION: Dayton, Ohio

4. CALL SIGN: 19W7577

5. CLASS OF STATION: Citizens

6. DATE OF IRREGULARITY: Feb. 5, 1961

7. HOUR OF IRREGULARITY (EST - GMT): 5:20 to 5:33 P.M. EST.

8. FREQUENCY DEVIATION

ASSIGNED	MEASURED	HIGH/LOW CYCLES
27225 Kc.	Note below	

9. PARTICULARS: Type A-3 emission. Excessive frequency deviation; non-compliance with Section 19.33 and communications exceeding 5 consecutive minutes; non-compliance with Section 19.61(f) of the Rules and Regulations governing stations in the Citizens Band Service.
5:20 P.M. "---YES, THAT MAKES IT BAD, I KNOW A LOT OF THE STORES UP TOWN ARE HAVING LOTS OF TROUBLE WITH THE WATER DRAINING DOWN, AND THEY CAN'T KEEP THE WALKS CLEAN--"
5:33 P.M. "19W7577"

	Measured	Deviation
5:20 P.M.	27222.04 Kc.	2960 cycles
5:29 P.M.	27221.76 Kc.	3240 cycles

Tolerance 1362 cycles.

Eugene M. Smalley — ISSUING OFFICER
David Birnbaum CH — ENGINEER IN CHARGE - LOCATION
2-10-61 — DATE MAILED/[redacted]
F.C.C. - Washington, D. C.

Fig. 2. Here's a sample citation with name and call sign of the author inserted.

read it carefully—as well as any other memo which is enclosed. It is the practice to enclose with CB citations a memorandum which fully explains the purposes for which CB is to be used and gives hints for avoiding future violations.

Fig. 2 is a specimen Official Notice of Violation. This is based upon a real notice, but the name and call letters of the licensee involved have been changed to those of the author.

Note that a square designated by an arrow is not checked in our typical sample. This square is rarely checked in the case of a CB violation. If it is, however, the operator who was on duty at the time of the violation must sign his name to item 1 of the notice.

Items 2, 3, 4, and 5 merely identify the licensee and class of station. Item 6 shows the date and hour when the irregularity was noted. Note that the time is given in Eastern Standard Time, which you will have to convert to your own local time. The assigned frequency is the CB channel closest to the measured frequency. That doesn't mean your transmitter was switched to that channel. For example, you might have been measured at, say, 26.971 mc. In this case you might have been off 6 kc. from channel 1 or 4 kc. from channel 2. The monitoring station would use the assigned frequency value of 26.975 (channel 2) since this is the closest standard frequency to your measured frequency. Some stations fill in the High/Low Channel block and some do not. Even if it is not filled in you can determine it by noting the difference between your measured frequency and the center frequency of the channel on which you were operating.

Item 9 gives the particulars of the irregularity. Many non-technically minded CB'ers may not understand the meaning of "type A-3 emission" shown on the sample. This merely means you were employing voice modulation with an amplitude modulated signal. This, of course, is the normal, authorized signal characteristic for class D Citizens Band. The violation notice then goes on to mention specifically the infractions of the rules which were noted. In each case, the particular paragraph of the FCC Rules and Regulations is mentioned. Note that a portion of the message is then included for identification purposes. In this particular citation, the frequency was measured twice, nine minutes apart. Note that the frequency deviation became worse during this period. This is quite common and just one more reason why you should not indulge in lengthy conversations. Many CB transmitters will wander farther and farther off frequency if the unit is left in transmit position over any appreciable period of time.

Be sure you answer your citation within ten days. If you are unable to answer during this period of time because of illness or other reason, have someone else send a brief answer indicating the reason for your inability to answer in full, immediately. Then send your complete answer as soon as you are able. Be sure your answer is complete in itself, without referring to other notices. Don't make up excuses. Give straightforward explanations and be sure to explain how you will avoid recurrences of the irregularities for which you were cited. If off-frequency operation is involved, have your unit checked by authorized repair personnel who are equipped to measure frequency accurately. If you need a new crystal, indicate in your reply whether or not you have installed or ordered a new crystal.

By all means stay off the air until you have had any technical irregularities corrected. You need not be concerned, however, that another Violation for the same irregularity will be issued within a few days of the first one. The Monitoring Station allows time for the first notice to be received, and your reply to be sent. During this interval they won't issue another citation for the same offense.

How Your Reply Is Handled

If the reply you send to the Monitoring Station is satisfactory, a copy of the citation is marked "Cleared" and sent to FCC headquarters in Washington where it is kept on file. However, if your reply is incomplete or otherwise unsatisfactory, the Monitoring Station will first

P.O. BOX	CITY
PRIMARY	
89	Allegan, Michigan
788	Grand Island, Nebraska
632	Kingsville, Texas
31	Laurel, Maryland
989	Livermore, California
36	Millis, Massachusetts
5165	Portland 30, Oregon
98	Powder Springs, Georgia
2215	Santa Ana, California
1035	Waipahu, Hawaii
SECONDARY	
810	Fairbanks, Alaska
5098	Fort Lauderdale, Florida
251	Chillicothe, Ohio
6310	Denison, Texas (Ambrose)
44	Belfast, Maine
191	Spokane 10, Washington
1101	Douglas, Arizona
719	Anchorage, Alaska

Table 1. A complete listing of all the primary and secondary FCC monitoring stations.

attempt to clear up the matter by correspondence with you. If you fail to clear it in this way, the matter is referred to Washington for investigation.

If you fail to reply to the first Official Notice of Violation, another notice is sent out by the Monitoring Station. If you still do not reply, a License Revocation Warning is sent to you. This usually jars loose even the most truculent die-hard. But, should you fail to answer that warning, you've had it. The Monitoring Station, in such a case, will send your file to Washington for license revocation proceedings.

How To Avoid Citations

The best procedure, of course, is to avoid citations in the first place. Don't just decide to take your chances. With 18 stations engaged in 24-hour monitoring, sooner or later your bad practices are going to be intercepted and the inevitable citation will result. Instead, adopt your own "Operation Clean-Up" by observing these points:

1. *Know The Rules and Regulations:* Theoretically, you should have read Part 19 of the Rules and Regulations before you applied for a license. But, it is obvious that many CB'ers are unfamiliar with the rules. The best idea is to buy Volume VI of the Federal Communications Commission Rules and Regulations. This volume is available from the Superintendent of Documents, Washington 25, D.C., for $1.25. When you purchase this volume you will automatically receive for an indefinite period substitute pages representing changes, deletions, or corrections. This will keep you up to date on all changes. Volume VI also contains Part 12—Amateur Radio Service and Part 20—Disaster Communications Service. You must buy the entire volume. You can't buy Part 19 alone. If you want more information about how the FCC is organized, buy Volume I for $2.50.

2. *Be Sure You're On-Frequency on All Channels Used:* Have each transmitter checked by qualified personnel with adequate equipment. Some transmitters need checking almost daily. Others can go for six months without checking. Only experience with your own equipment will indicate how long the checking intervals should be. Don't accept the word of people using CB receivers, wavemeters, grid-dip meters, or home-brew meters. Good frequency meters are precision devices and only a precision device can measure CB frequencies with the required degree of accuracy.

3. *Don't DX or CQ:* Even if a distant station calls you don't answer. Ground wave is rarely good for more than ten miles, even in mountainous terrain, and it may be less in average country. Don't repeatedly call "test." The FCC will interpret this as a CQ call. Call other stations only by number. Don't leave off the district prefix of your call sign. This is a common subterfuge used by DX-ers, but doesn't fool anyone. Monitoring Stations can easily fill in the missing district prefix with the aid of direction-finding techniques employed

by two or more monitoring stations.

4. *Watch Those Lengthy Conversations:* Stick to the 5-minute rule. How many times have you heard yackers say, "Well, I guess we've used up our five" when they've been talking for an hour. Keep a clock in your operating position and make sure.

5. *Watch the Rag Chewing and Hamming:* Conversations which are not necessary to your business or personal affairs are illegal. Discussions about equipment belong on the ham bands. Subjects you wouldn't bother phoning someone about are hardly worthy material for CB. Remember, base-to-base conversations rarely come under the heading of necessary communications required in your personal affairs or your business.

Finally, remember that Citizens Radio Service was provided for you and every other citizen to help you carry on your business or personal affairs, when no other form of communication is available. Don't abuse the privilege. If you and a good many others continue to do so, it can only result in a general over-all tightening of the regulations that apply to the Citizens Band operator.

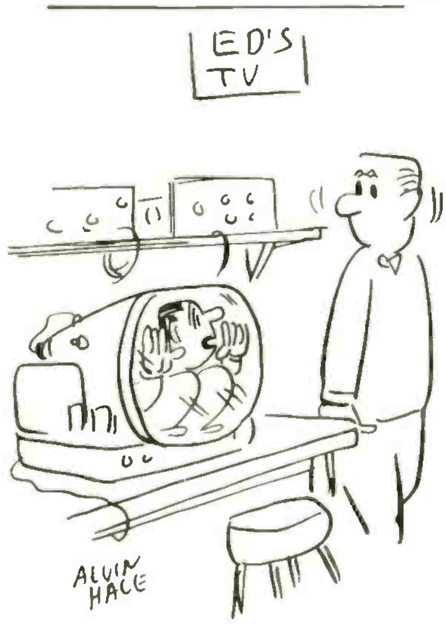
Let's hope the only official Notice of Violation you ever see, is the one in Fig. 2! —30—

REPUNCHING SOCKET HOLES

By ELWOOD C. THOMPSON

It is often found necessary, after a hole has been punched out in a chassis, to make this hole larger so as to accommodate an electrolytic capacitor or tube socket of larger dimensions.

An easy, quick, and accurate way of accomplishing this is to keep on hand a knockout from each of your previous punches. Then, say you punch a three-quarter-inch hole and find a larger hole necessary. All you need to do is refit the three-quarter-inch knockout, place the larger punch in the starting hole and punch away. Try it on a piece of scrap and see for yourself how simple it really is! —30—



"HELP"

IMPROVING the WILLIAMSON AMPLIFIER

By **TALBOT M. WRIGHT**

Changing a few resistors in the driver section results in reduced distortion in this hi-fi amplifier design.

THE Williamson amplifier, whether it be of the classic triode type or the "Ultra-Linear" version, has to some extent fallen into disfavor with audiophiles since it is now possible to build an amplifier at lower cost and still equal or better the Williamson's performance.

Many Williamson owners have discarded their trusty old amplifiers in favor of 50 or 60 watts in the never-ending chase after unmeasurable distortion. Many Williamsons have been converted to higher powers by the use of newer tubes and heftier output transformers. In some cases the proud owner has realized an audible increase in definition and an accompanying drop in distortion.

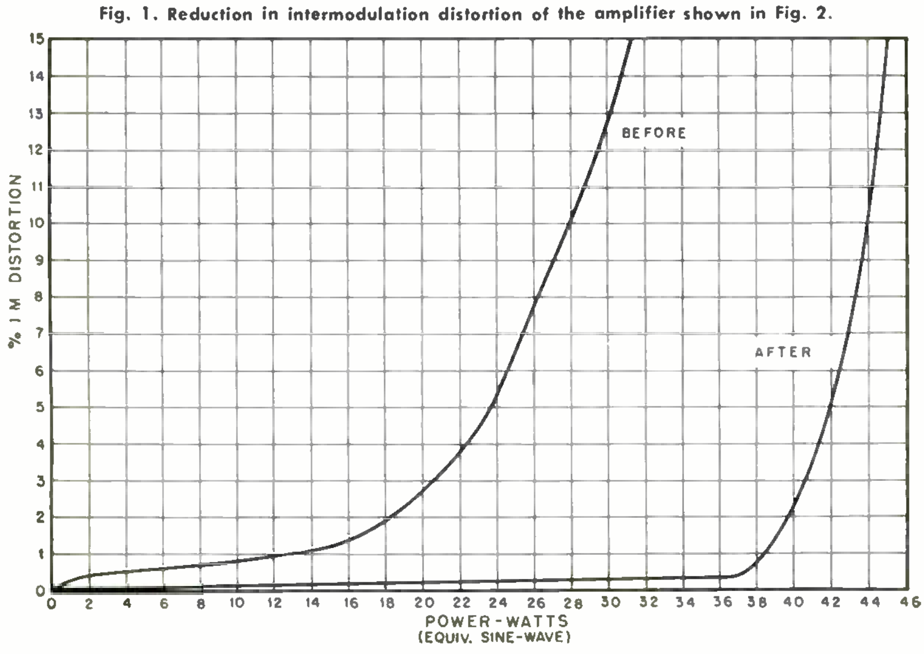
Frequently such an experimenter will add a high-power output stage to his Williamson drive system—in most cases paying for 50 watts in order to get a clean 20 watts. Even then he doesn't always get the improvement he expects. The fault lies not in the power stage but in the drive system. The two main faults of the Williamson are distortion at medium to high levels and instability. We'll discuss instability later—but first to the distortion.

IM Distortion

If you run an intermodulation distortion test on an average Williamson amplifier using the classic drive system you will find that the IM exceeds 2% at only slightly over half the rated power. By the time you reach rated power you find the distortion is well past the tolerable level. The result of this testing usually leads to a substitution of all the tubes in a wistful search for lower distortion. Sometimes this helps a little.

Basically the voltage amplifiers are producing much greater amounts of distortion than they should. "But," you say to yourself, "I followed the design scrupulously; even the voltages are what they should be." The point overlooked, however, is that the American 6SN7, 6CG7, or 12AU7 will not work well with the circuit values specified by Mr. Williamson in his original paper on the subject.

Fig. 1. Reduction in intermodulation distortion of the amplifier shown in Fig. 2.



A careful inspection of any U.S. tube manual will disclose the fact that the 6SN7 or 6CG7, as used in the Williamson amplifier circuit, is badly underbiased.

Take the push-pull driver stage for instance. Usually the plate loads are 47,000 ohms and the cathode resistor is around 560 ohms. This produces a bias of around 5½ volts with about 175 volts on the plates, assuming a supply of around 440 volts. The tube manuals indicate that the 6SN7 should be operated with 250 volts on the plate and an 8½-volt bias.

All you have to do is change that cathode bias resistor from its present value to 1000 ohms. A resistor of 1200 ohms works well, too. With a 1000-ohm bias resistor, there will be about 250 volts at the driver plates and the bias will rise to approximately 9 volts. Not only does this cut distortion but it means you can produce more drive voltage. Naturally, too, you can now put more signal voltage into the 6SN7 driver before it starts to draw grid current. The driver will stay class A, in fact long after the output stage has finally given up.

This change alone, of course, will not eliminate the distortion fed into the output stage. The first two stages are still underbiased and they hang together because of the d.c. coupling between them.

Let's start with the first stage. The bias resistor usually found there is 470 ohms. This should be increased to twice its value—simply add another 470-ohm resistor in series with the first. This raises the bias to around 3 volts, but increasing this bias causes the plate voltage of this stage to go up, thereby decreasing the grid-cathode bias across the phase-inverter—the next stage.

There are now two things to be done: lower the supply voltage to the first stage and increase the supply voltage to the phase-inverter. If each of these is changed in the right proportion, both stages will be biased correctly.

The average Williamson circuit uses a 33,000-ohm resistor from the 450-volt supply point to decouple the first stage; this must be increased to about 47,000 ohms. This will cut the current through the stage somewhat, producing a cathode bias of around 2½ volts, and it will also lower the plate voltage. The decoupling resistor to the phase-inverter is usually 22,000 ohms from the 450-volt point. This resistor should be reduced to 3900 ohms, pulling more current through the phase-inverter and raising the cathode bias.

When these last two changes have been made there should be about a 5½- to 7-volt bias from grid to cathode of the phase-inverter. Of course, if the initial supply voltage is much below 450 you will not get exactly the right bias, but it will be close enough to allow the first two stages to bias each other correctly. Typical voltages for this circuit are found in Fig. 2.

The net result of all these changes is to almost double the drive voltage available to the grids of the output tubes. With a 450-volt supply you can get well over 100 volts to each grid. With a 400-volt supply that drops to something near 350 volts due to lack of regulation in the power supply, you should still be able to get 80 volts of drive per grid.

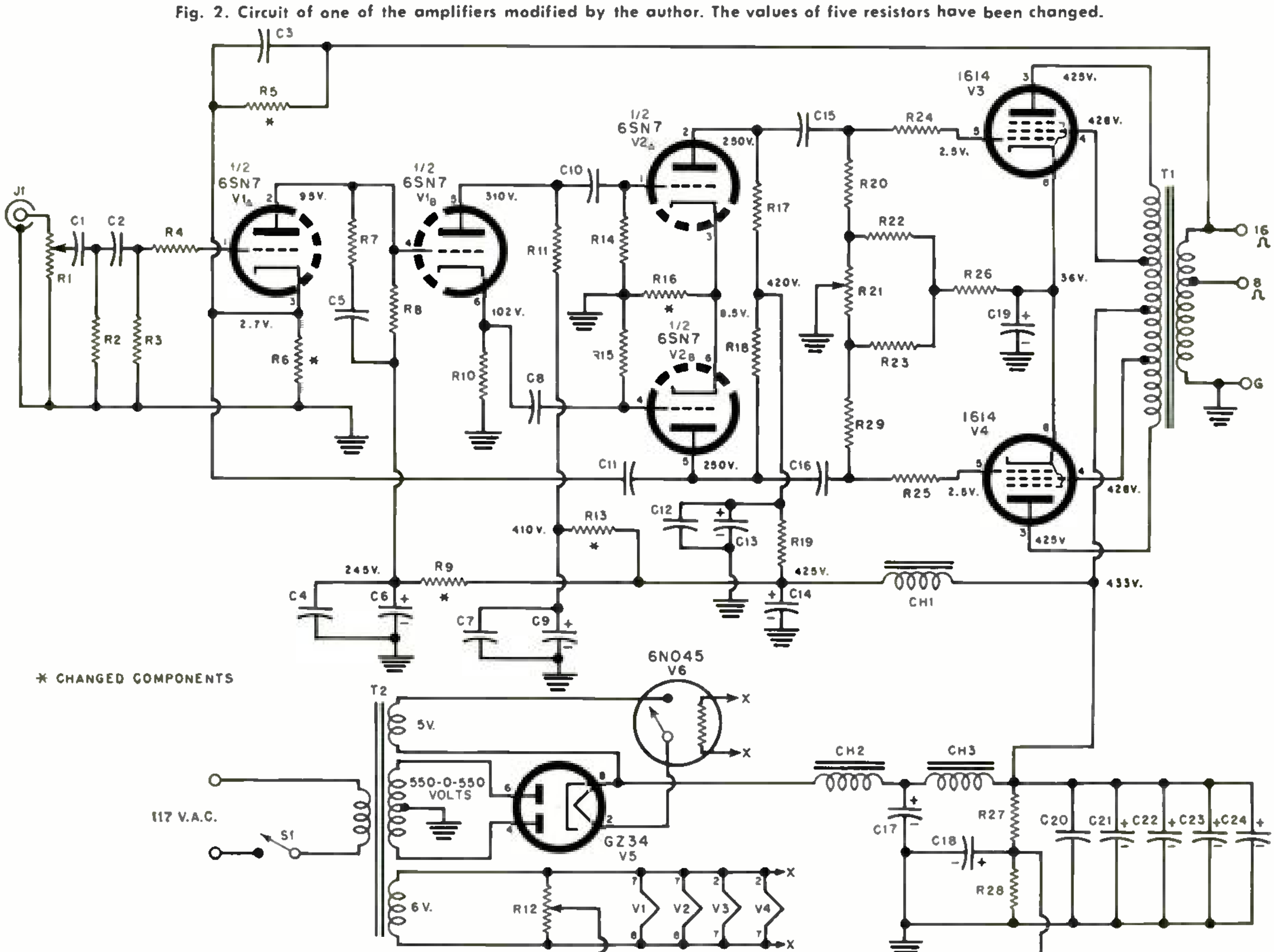
There is one thing more which must be done before you have the amplifier operating correctly. The output transformers used in Williamson amplifiers will not usually handle more than about 20 db of feedback, but increasing the resistor to the cathode of the first stage has already increased the feedback. Since the value of the cathode resistor has been doubled, it is necessary to double the value of the feedback resistor to put the feedback at its previous value.

With the changes outlined, any "Ultra-Linear"-type Williamson should not produce 1% distortion until it reaches overload. If the drive voltages to the grids of the output tubes are balanced, the distortion should be well below 0.5%.

Performance of the amplifier of Fig. 2 is illustrated in the curve of Fig. 1. For all IM tests, the generator supplied frequencies of 60 and 6000 cps at a ratio of 4 to 1. Readers should not be too concerned about the absolute values of power indicated nor a comparison of the power in one amplifier we have worked on with another. The important thing being shown here is the definite improvement in performance that occurred with the changes incorporated.

Amplifier No. 2 (see Fig. 3) uses four 5881's in a push-pull parallel triode output stage. In this one only the biasing modifications have been made. The tubes were chosen at random and no attempt was made to balance the drives beyond the tolerances provided by the 5-year-old 5% resistors already in the circuit. A 450-volt capacitor-input power supply was used in this circuit.

Fig. 2. Circuit of one of the amplifiers modified by the author. The values of five resistors have been changed.



R—1 megohm audio taper pot
R,R—1.5 megohm, ½ w. res.
R,R—10,000 ohm, ½ w. res.
R—18,000 ohm, ½ w. res.
R—910 ohm, 2 w. res.
R,R,R,R—47,000 ohm, 2 w. res.
R,R—22,000 ohm, 2 w. res.
R—200 ohm, 4 w. wirewound res.
R—3900 ohm, 2 w. res.
R,R—470,000 ohm, ½ w. res.
R—1000 ohm, 2 w. res.
R—150 ohm, 2 w. res.
R,R—100,000 ohm, ½ w. res.
R—100 ohm pot
R,R—100 ohm, 2 w. res.
R,R—1000 ohm, ½ w. res.
R—250 ohm, 10 w. wirewound res.
R—220,000 ohm, 1 w. res.
R—18,000 ohm, 1 w. res.
C,C—.1 µf., 400 v. capacitor
C—75 µµf., 400 v. capacitor
C,C,C,C—.01 µf., 400 v. capacitor
C—560 µµf., 400 v. capacitor
C—40 µf., 350 v. elec. capacitor
C,C,C,C—.25 µf., 400 v. capacitor
C—100 µf., 450 v. elec. capacitor
C—100 µµf., 400 v. capacitor
C—60 µf., 450 v. elec. capacitor
C—40 µf., 450 v. elec. capacitor
C—20 µf., 600 v. elec. capacitor
C—50 µf., 50 v. elec. capacitor
C—600 µf., 150 v. elec. capacitor
C,C,C,C—90 µf., 500 v. elec. capacitor
J—Phono jack
CH—7 hy., 50 ma., 500 ohm choke
CH,CH—8 hy., 80-100 ohm, 200 ma. choke
S—S.p.s.t. switch
T—Audio output trans. 6600 ohms to 8/16 ohms, 30 watts (Dyna A-420 or equiv.)
T—Power trans. 550-0-550 v. @ 200 ma.; 5 v. @ 2 amps; 6.3 v. @ 3 amps.
V,V—6SN7 tube
V,V—1614 tube
V—GZ34
V—S.p.s.t., 6.3 v. normally open, 45 second delay relay (Amperite 6N045)

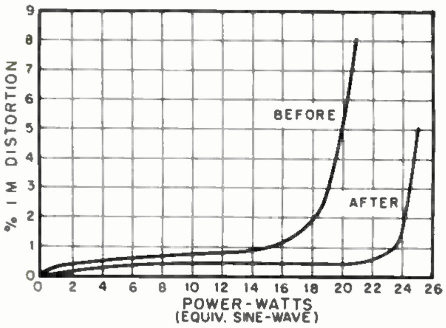


Fig. 3. Improvement in performance of amplifier using four 5881's in triode connection.

Amplifier No. 3 (see Fig. 4) uses two EL34/6CA7's connected as pentodes with a 250-ohm self-bias resistor and 5000-ohm plate-to-plate load. Again, no special effort was made to balance the drives. A 450-volt choke-input filter was used here.

Transient Response

All of the foregoing will cut distortion dramatically, but we have yet another problem to face: transient response. Improvement in an amplifier's transient response is usually more striking than improvement in distortion. Now, the high-frequency response of many Williamson amplifiers is ragged at best and it is nearly impossible to give a set of values to smooth the high end of all these units. However, the values given in Fig. 2 will be about right for an "Ultra-Linear"-type Williamson using either *Stancor* or *Dynaco* transformers. The *RC* values bypassing the plate load of the first stage aren't too critical. The small capacitive feedback loop from the plate of the lower driver to the cathode of the first stage is also non-critical. However, the value of the capacitor should not exceed 100 μμf. The only value that must be juggled with extreme care is the capacitor across the feedback resistor. About 50 μμf. to 150 μμf. is usual in this position. The only way to optimize the high-frequency response of the amplifier is to use an oscilloscope when making adjustments. In practically all cases, however, there will be no audible difference between results derived from using the given values and those derived from individual trimming.

The low-frequency transient response of the Williamson is less critical and easier to straighten out. Many amplifiers tend to get "bloopy" when hit by high-intensity, low-frequency sounds, due mainly to inadequate decoupling of the "B+." It is recommended that all of the stages be decoupled by at least 40 μf., although in these amplifiers one of the (surprisingly) critical points is the phase inverter which should be more heavily decoupled. The now 3900-ohm resistor decoupling the phase splitter should be bypassed with an electrolytic whose value is in the neighborhood of 80 to 100 μf. These changes will produce a stable amplifier if you have used a good output transformer.

Now that the amplifier has been stabilized, let's try to further improve the low-frequency transient response. The capacitor bypassing the cathode resistor of the output stage is usually somewhere between 20 μf. and 250 μf. Use of the 250-μf. capacitor bypasses the stage to around 6 cycles, that is, the stage is flat to about 10 cycles. Low-pitched musical waveshapes contain near-d.c. components and in order to handle these adequately you must have the output stage bypassed to approximately 1/10th of the lowest frequency you wish to reproduce. If you want to have good transient response below 60 cycles, you have to bypass the output stage more heavily than 250 μf. Capacity of 500-600 μf. (made up of a couple of 300-μf. electrolytics in parallel) will bypass the output stage to about 3 cycles and will give good transient response to around 30 cycles. It is a rare speaker system that can produce 30 cycles and it is a rare room that will sustain that low a note even if the speaker is capable of producing that note in the first place.

One word of caution: the use of very large bypassing values, 1000 μf. for example, may again lead to instability.

Other Improvements

A Williamson amplifier incorporating the modifications already outlined will sound good indeed but there is one additional thing you may do if you want to be "elegant." Any "Ultra-Linear"-type Williamson—even one with a choke-input power supply—will display a drop in "B+" during extremely loud passages. This has a limiting effect on the power output and the amplifier may not recover from overloads as quickly as you'd like. The remedy is to decouple the output stage more heavily. It has been found that four 90-μf. electrolytics connected across the center-tap of the output transformer will provide superb transient response. These capacitors hold enough of a charge to supply the output tubes with plenty of current during short-duration, high-intensity sounds and prevent a drop in "B+." The amplifier shown in Fig. 2 does not display the slightest change in "B+" until it is operating almost continuously in overload. The effect of this is most noticeable on low-frequency transients. Also, it will give the amplifier practically instantaneous overload recovery.

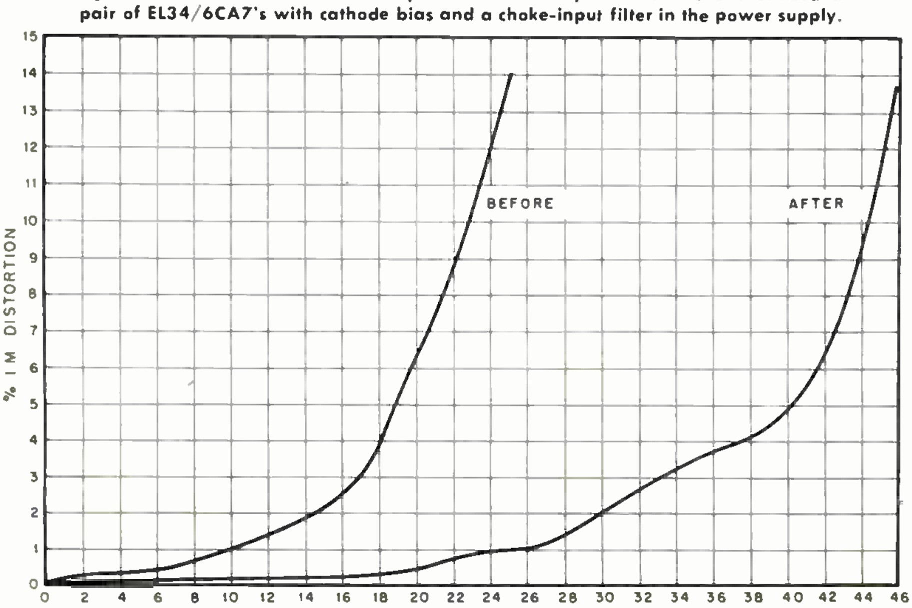
Changing the bypassing of the output-stage cathode and increasing the output-stage decoupling will likely produce no audible changes unless you have a really fine speaker system. With such a system, the improvement is readily apparent.

Of course, neither of the last two modifications is of much value if the phono preamp does not equalize correctly at the very low frequencies. Unfortunately, many preamps don't. The boost applied below 100 cycles in the RIAA curve is a help, but many record companies do not always apply the presumed low-frequency pre-emphasis. A discussion of equalization and tone-control is beyond the scope of this article, so we will assume that you can get the lows into your amplifier.

The modifications outlined can be made for around $10 and, in view of the improvement in performance, are well worth the money. It is not the author's intention to disparage the original Williamson amplifier design—it has much to recommend it. It is easy to build and by re-biasing the voltage-amplifiers it becomes non-critical of tube selection. Furthermore, the "Ultra-Linear" version is capable of delivering all the clean power needed to drive any speaker system except for some of the less efficient—although excellent—bookshelf types.

The use of a choke-input power supply combined with the additional bypassing and decoupling will permit the "Ultra-Linear"-type Williamson to deliver several watts more than ordinary circuitry permits. The distortion won't exceed 1% until you reach overload and will sound as though you have doubled the power output when what you have done is improve the overload performance. —30—

Fig. 4. Performance of another amplifier modified by author. This one utilized a pair of EL34/6CA7's with cathode bias and a choke-input filter in the power supply.



Arithmetic Circuits

(Continued from page 53)

duces a carry pulse during the time represented by clock pulse 1 (see waveform *C*). When a half-adder receives an input at either one but not both of its input terminals, it produces an output at its sum terminal. In the example illustrated in Fig. 6, this situation occurs twice: during clock pulse 3 and clock pulse 4 (see waveform *D*).

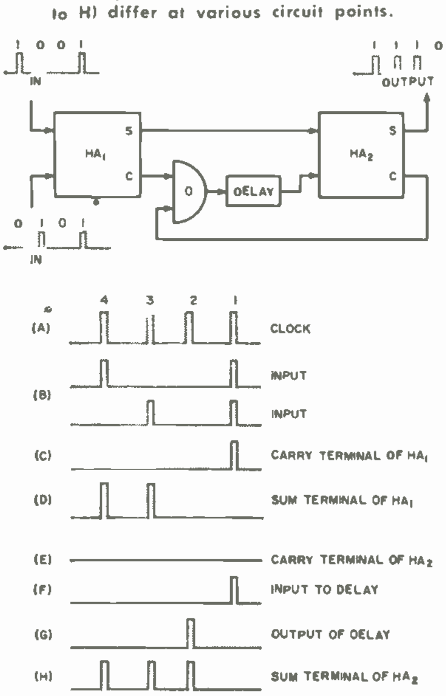
The carry output pulse from HA_1 produced during clock pulse 1 is applied through an *or* circuit to the delay. This pulse emerges from the delay one microsecond later, during clock pulse 2 (see waveform *G*). The second half-adder (HA_2) receives its inputs from the sum terminal of HA_1 and from the output of the delay. Whenever HA_2 receives simultaneous pulses from both of these sources it produces an output at its carry terminal. This situation does not arise in the example illustrated in Fig. 6 (see waveform *E*).

Whenever HA_2 receives a pulse at either one but not both of its input terminals, it produces an output at its sum terminal. This situation occurs three times in the example illustrated in Fig. 6 (during clock pulses 2, 3, and 4).

The output from the sum terminal of HA_2 (waveform *H*) represents binary number 1110. This is the binary representation for decimal 14, and is the sum of the two input numbers 1001 and 0101 (9 and 5). The output waveform of the serial adder therefore represents the binary sum of the two input numbers.

For illustration, the two input waveforms of Fig. 6 are shown with four bits each. The same circuit however, can be used to add larger numbers simply by extending the input waveforms to a greater number of bits. —30—

Fig. 6. Input and output of serial adder (top) are pulse trains. Trains (A to H) differ at various circuit points.



Do You Want Warranty Work?

(Continued from page 35)

sufficiently sound to tide you over for short periods. You will not get immediate payment for warranty jobs. You turn your paper in to the manufacturer or distributor at regular intervals, perhaps every thirty days, and there may be additional delay before re-imbursement.

There are some risks involved that may not be readily obvious. To put most extended warranties into effect, the set owner must register his set properly and have some proof of warranty to submit to the service dealer, where there is direct contact between the two. If the dealer is not careful, he may find himself submitting invalid claims on sets not properly covered, or for parts or labor outside the limits of the warranty. When this happens, the chances of getting satisfaction from the customer are not good. To avoid losses, be sure you are thoroughly familiar with the provisions of each manufacturer from whom you have authorization. Conditions vary so much that it is useless to state general rules in a "survey" article of this type.

Another risk may be involved if you are going to part company with the program some time after having tried it out. (This may not be a matter of your own choice. The agreement usually provides that either party may terminate it on short notice without reason.) If this occurs, do you have a stock of "dead" merchandise with which you are stuck? Some manufacturers will take back everything for full credit. Others will penalize you somewhat, say to the extent of 10 per-cent. Still others may make no adjustment.

The most serious, long-term charges against extended warranties in general are made on two counts. First, electronic service has traditionally relied on the mark-up on replaced components for part of its profits, in addition to labor fees. As broader guarantees become more popular, if they do, they will eat into this substantial source of income. The second charge is that the schedule of fees prescribed by the manufacturer tends to dictate the independent dealer's service charges and is not likely to help him bring them to the level at which he feels they should be. These are possibilities every dealer and dealer group must weigh for themselves, along with a number of other factors.

A final, interesting angle: the dealer who finds against participation in a warranty program for radio and TV sets may not be so adamant when it comes to other equipment, such as auto radios. In the case of radio and TV, he may feel that the new programs tend to bring about undesired changes in an already established way of doing business, without any benefits. With other types of equipment, he may feel that he is indeed branching out into business he would not otherwise have without incurring any reductions in business he already has. —30—

GABFEST SCHEDULED

THE Twelfth Annual Gabfest of the Uniontown Amateur Radio Club has been set for Saturday, June 17th at the Club Grounds on Old Pittsburgh Road, 2 miles north of Uniontown, Pa., just off Route 51.

There will be a "Swap and Shop" booth, refreshments will be available, and an impressive list of prizes will be awarded. The main drawing on registration will be a Drake 2A receiver while some lucky ham will take home a Hallicrafters HT-37 transmitter.

The affair is strictly stag. Registration is $2.00 at the door, $1.50 in advance. Contact Uniontown Amateur Radio Club, P.O. Box 819, Uniontown, Pa. for full details and registration. —30—

MATCHING LOW-Z VERTICAL ANTENNAS

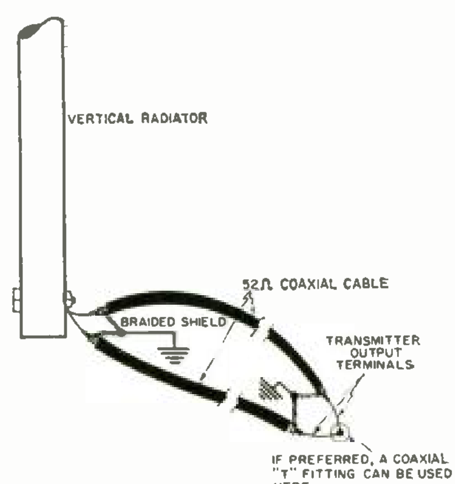
By HOWARD S. PYLE, W7OE

MANY authorities tell us that approximate impedance at the base of many of the conventional vertical radiators is in the neighborhood of 21-22 ohms; others argue the point, but so what? Results are what we are after and here is a trick that has worked well for the author.

The author was unable to find a coaxial cable with an impedance of less than 52 ohms (RG-8/U or RG-58/U closely approach this value). Many hams attempt to use 52-ohm or 72-ohm coax and have difficulty in matching to the load unless an effective matching unit is employed.

Try this: use two lengths of 52-ohm coaxial cable in parallel as a single feedline, as shown in the diagram. Theoretically, as with parallel resistors, the impedance of the line is cut approximately in half. Thus we come to a fairly close match with a nominal 26-ohm line matching a 21-22-ohm load.

The standing-wave ratio, using this trick, dropped from 3.5/1 to 1.5/1 with a commensurate increase in signal reports from other stations—to the tune of about two "S" units. —30—



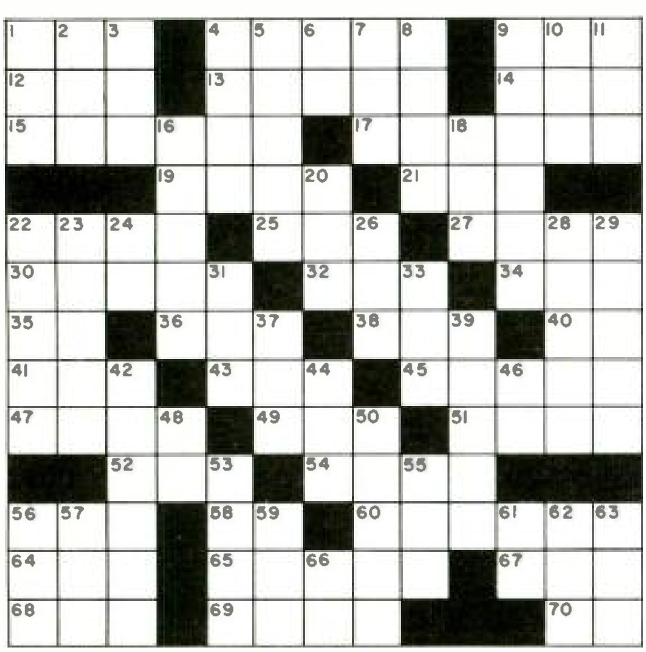
ELECTRONIC CROSSWORDS

By **BRUCE BALK**

(*Answer on page* 123)

ACROSS
1. British radio and TV network (abbr.).
4. One of the coordinates of a crystal.
9. Choke coil (abbr.).
12. Consumed.
13. Raise an antenna.
14. Highest note of the gamut.
15. Station selector portion of radio receivers.
17. Multi-band transmitting antenna
19. Screwdriver, for example.
21. Transmitter or receiver (slang).
22. ——— -pull output stage.
25. Fastener.
27. Vacuum-tube shell.
30. Modulation factor in FM.
32. Electrical or magnetic separation.
34. Born (Fr.).
35. Network of three impedances.
36. FCC agency which detects unlicensed radio stations. (abbr.).
38. Small, visible mark on radar screen.
40. True power plus reactive power (abbr.).
41. Greek letter.
43. Type of transmission (abbr.).
45. Electro-acoustic power ratio.
47. Of the same frequency and in-phase (abbr.).
49. Abbreviation used in reference to the power rating of transformers.
51. Carpenters' tools.
52. Unit of electrical resistance.
54. A spree or fling.
56. Attenuator.
58. Collector voltage (abbr.).
60. Speaker frame.
64. Before (poetic).
65. Pertaining to sound waves.
67. NBS' station call letters.
68. Engineers' organization (abbr.).
69. Energy-transferring device.
70. Voltage-current (abbr.).

DOWN
1. Element on an FM-TV transmitting antenna.
2. Unit of heat energy (abbr.).
3. American educator (initials).
4. Numerical value of black in the color code.
5. Act of malicious burning.
6. Rare gas used in hot-cathode, gas-discharge tubes (abbr.).
7. Interrupted continuous waves (abbr.).
8. Mix.
9. Electron emitter in a color TV picture tube (two words).
10. Girl's nickname.
11. Device to convert rotary to longitudinal motion.
16. Hypothetical medium serving as a propagator of radio waves.
18. Pen point.
20. Metal strip used on terminal-screw to facilitate soldered wire connection.
22. Coaxial lines or cables.
23. Perfect magnetic coupling between two coils.
24. One of the fifty (abbr.).
26. Connection point made in body of resistor or coil.
28. Mean amplitude of a variable quantity.
29. Bruins.
31. Greek letter (pl.).
33. Tube connection.
37. Wire covering (abbr.).
39. Momentary high-amplitude levels.
42. Radio tube electrodes, designated by letter "P."
44. Devotee of radio programs. (abbr.)
46. Captured enemy (abbr.).
48. Schematic designation for a filtering element.
50. Unit of acoustic absorption.
53. Single closed-circuit loop in a network.
55. American architect 1863-1942 (initials).
56. Low-voltage incandescent lamp.
57. Part of "to be."
59. Cry of a dove.
61. 1000 watts (abbr.).
62. Female sheep.
63. A "clean" ham station will not cause this (abbr.).
66. Near (abbr.).



Voice Procedure For CB Operators

By BROTHER ART

A plea to cut out excess wordage that makes operation inefficient as well as creates unneeded interference.

CITIZENS RADIO is now over two years old and with licensees numbering in the tens of thousands, some thought must be given to correct and concise voice procedures on the air. By adhering to the adage that "brevity is the soul of wit," up to 50 per-cent of the interference now encountered on the Citizens Radio bands can be eliminated and operations made more pleasurable for all licensees.

How often have you taken time to listen—just listen—to a typical one-minute contact? If the entire conversation were to be recorded the amount of excess verbiage would be staggering! If everyone now using the CB service will cooperate it will only be a matter of months before the bands will clear up and messages can be handled by more stations with less interference.

The greatest single time waster is the repeated use of call signs. All CB stations are licensed as mobile units. Thus it is completely unnecessary and in fact unlawful to state that "this is 2W2333 *mobile* calling." To state that you are mobile is broadcasting, in a sense, because your call sign as a CB station implies that you are mobile. And, if you are using the frequencies for business, who cares anyway? The person you are calling, if in your own license authorization, knows you are mobile. In turn, you know he is fixed or that he is your base station, so why call him "2W2333 *base, this is 2W2333 unit one mobile*, come in—over." Everything in italics is excess and need not be stated for good, effective communications.

The requirement for stations to sign their call signs and the sign of the station to whom they are talking holds only if you are working stations outside your own license authorization. Generally, not more than one, two, or three stations are on the road and talking among themselves under this application. When this happens, all parties concerned know what the voice at his other station sounds like and the shortest possible contact necessary to establish communication is all that is required. Also, when the conversation is underway, neither station need sign unless the conversation goes over 10 minutes or until the end of the conversation. (Stations of the same call authorization need not observe the five-minute rule.) Thus, 2W2333 would call the other station in his license authorization by simply stating "2W2333, come in, over." The other station would come back by stating "Go ahead," or in cases where interference is present on the channel, "2W2333, go ahead." When you hear such a conversation taking place, you automatically know that the two stations are licensed under the same call authorization and that they are conducting business as usual. They aren't interested in telling the world where they are or that one is fixed and the other mobile. They aren't interested in taking up the channel for unnecessary calling or talking just to hear themselves talk.

This brief, to-the-point type of communication and calling procedure is not only legal but is being encouraged by the FCC. It is encouraged because it cuts interference and tends to discourage the "broadcasters" who often wind up with tickets for infractions.

Why do many operators become "broadcasters"? Well, basically, because most of us have the urge to talk and be heard. When we get a microphone in front of us we like to talk—we really don't care too much about listening to what the other person is saying, but we really love to talk. It doesn't matter what the words are . . . we are *broadcasting* and the *entire world* is listening! So, we talk this up by dragging out the call signs and by repetition. In other words, we are hamming.

This is why you often hear the following: "*What is your* 10-20 *location there now*, over," (and/or the call sign routine). Everything in italics in this message is excess verbiage and constitutes "broadcasting." It marks you as a beginner who just got his mike and a person who has the urge to "broadcast"—the type the FCC looks for. "10-20, over" is all that needs to be said. This is the reason the codes were established—to keep on-the-air down to a minimum—and the rules require it.

So, when you catch yourself talking, using double words, or signing calls twice, or not thinking how you can make that last call one word shorter—you're telling the world that you are not a professional Citizens Bander—but a frustrated ham.

Incidentally, there is one very important provision which is too often ignored or overlooked and that is in regards to "secrecy of communications." This applies to the CB service as well as other radio services. In business, this means that if your competitor happens to overhear your office telling you that a service call is waiting and you reply that you can't get there right away, if he should just "happen" to stop by and take over the call himself, he is in direct violation of the act and can be fined up to $10,000 or get 10 years in the Federal lockup.

Or, if you hear Joe talking one night and you, in turn, tell Bill what you have heard Joe say . . . same deal! You can be fined $10,000 and get up to 10 years for even repeating a portion of what you heard on the air! So keep it clean, keep it brief, and CB operation will be better for all concerned! —30—

How Solutions Are Analyzed
(*Continued from page 37*)

mentation media, and other substances.

Maintenance

The polarograph is sensitive to vibration and must be mounted on a stable platform, using shock mountings. Only the mercury-dropping electrode assembly has to be protected in this manner—the recording unit can be mounted anywhere.

Weak batteries will affect the results, if they are unable to maintain a constant output throughout the period required to make a test. They usually produce a curve that starts to rise steeply, but falls off and becomes extended along the voltage axis. When this occurs, the batteries should be checked under load and replaced if weak.

Dirty contacts or a defective potentiometer can introduce additional resistance into the circuit. The result is a curve that falls off rapidly where the contact is imperfect and rises sharply when good contact is again established. In many polarographs, the potentiometer is a slidewire of resistance wire, such as constantan, and the contact is under pressure. To reduce wear and obtain best results, the assembly should be cleaned and lubricated from time to time.

For accurate results, it is essential that the mercury drops falling from the electrode be of uniform size and that they be formed and dropped at a constant rate. To accomplish this, the electrode should be clean, firmly mounted, and suspended in a vertical position. If air bubbles are permitted to form in the tube, they will also affect the dropping rate and give erratic results. —30—

PROTECTION FOR TAPES
By ROBERT HERTZBERG

TAPES being exchanged between "audio correspondents" in New York and London displayed poor volume and much noise, although they always sounded normal on their first playback on the initial recorder.

The trouble disappeared when they were mailed in flat tin cigarette boxes instead of the usual cardboard containers, the thin sheet iron apparently providing enough magnetic shielding to keep out stray fields. These boxes are light in weight, add only slightly to the cost of postage, and can be used many times. —30—

New Products and Literature for Electronics Technicians

Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, simply fill in the coupon appearing on page 128.

NEW SERVICE AIDS

1 Sencore is now releasing two new equipment items of interest to service technicians, the

Model SM112 deluxe v.t.v.m.-v.o.m., and a dual TV bias supply which is known as the BE113.

The Model SM112 can be used on the bench as a v.t.v.m. and also serve as a portable v.o.m. on service calls. Each scale on the v.t.v.m. has an indicating arrow. The function switch can be set to any position and one of the arrows will glow, indicating the exact scale to be read. The v.t.v.m. has six a.c. and d.c. voltage ranges, six resistance ranges, and zero-center scale. The v.o.m. features six a.c. and d.c. voltage ranges, two resistance ranges, and one d.c. current range. A six-inch meter is incorporated.

The bias supply can be used as a single 0-20 volt d.c. supply or as a dual 0-20 volt d.c. unit depending on receiver design. The supply is well filtered, providing virtually pure d.c. with less than 1/10th of 1% ripple. Calibration accuracy is better than equivalent battery tolerances, according to the company.

TUBE-CHECKER KITS

2 Paco Electronics Co., Inc. has added a self-service tube-checker kit to its line of test equipment. The new instrument is being offered in two versions, the floor model as T-61F and the compact counter model as T-61C.

Both models incorporate large, easy-to-follow instruction data cards and illuminated display headers. The floor model includes space for all popular radio and TV tubes. Both kits come with complete instructions for assembling. Factory-wired, ready-to-operate versions of both testers are also available if desired.

H.V. CARTRIDGE RECTIFIERS

3 Electronic Devices, Inc. has developed a new technique in the preparation of selenium cells for high-voltage cartridges which permits selenium rectifiers to be reduced in size up to 25% over units that had been previously available.

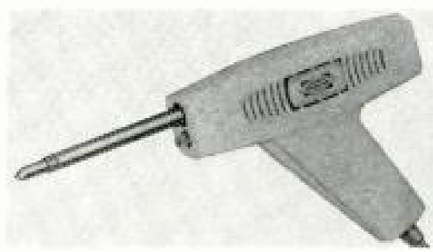
The new "Minisel" units are said to provide better electrical characteristics, i.e. lower forward voltage drop and lower leakage, as well as reduced volume. The line is being offered in p.i.v. values ranging from 50 to 25,000 volts and for current output requirements as high as 37.5 ma. d.c.

FAST-HEATING SOLDERING GUN

4 Portable Electric Tools, Inc. has available a new instant-heating, transformer-type soldering gun which is being marketed as "Shopmate" SG-125B.

The gun plugs into any a.c. outlet for immediate heat. Featuring a rigid single-pole with extensions up to 12 inches, the gun can solder in normally inaccessible areas. A prefocused "sight light" throws a beam of light on the exact working area to insure accuracy. Screw-in tips, which require no tools, are available in a wide assortment of sizes.

The gun features a white, streamlined thermo-



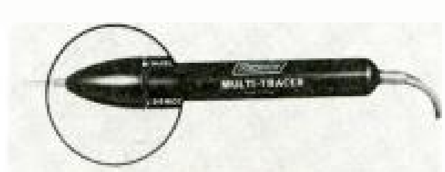
plastic housing which is flame-resistant and shatterproof. A hand-grip trigger lessens fatigue in operating the unit for long periods.

MULTIPLE TRACER UNIT

5 Mercury Electronics Corporation has just introduced a new service aid which does the work of four different instruments: signal injector, signal demodulator, signal tracer, and voltage tracer.

The Model MT-1 "Multi-Tracer" features an exclusive rotating head with detent action which selects one of the four instrument positions required. The signal injector features a transistorized signal generator with 10-volt peak output with strong harmonics in the r.f. range. The demodulator has an r.f. crystal detector circuit while the tracer has a low-loss signal circuit. The voltage section includes a neon indicator which glows when a.c. or d.c. voltage is present. Sensitivity is 55 volts to 600 volts.

The components of the Model MT-1 are mounted on a rugged phenolic board. A complete manual for troubleshooting is included with the instrument along with instructions for use.



V.T.V.M. IN KIT FORM

6 General Techniques, Inc. has introduced a new, professional-type vacuum-tube voltmeter in kit form as its Model VTV15. According to the company, when assembled, the resulting instrument compares favorably with laboratory instruments in sensitivity, accuracy, and versatility.

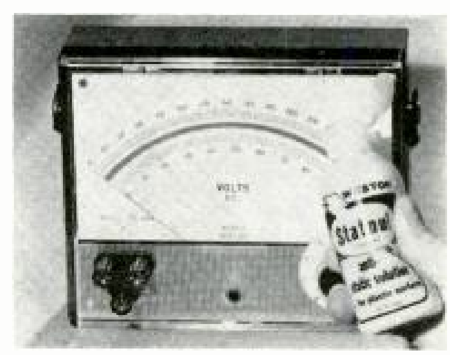
There are both zero and ohms adjust pots as well as a single combined function selector and on/off switch. The instrument has 1.5-1500 v. a. c. ranges; plus and minus d.c. from 1.5 to 1500 volts, 7 resistance ranges from direct reading to 1 megohm, peak-to-peak and db scales as well as a handy clip for holding the probe when not in use.

ANTI-STATIC FLUID

7 Weston Instruments Division has introduced a new chemical fluid which has been designed to prevent build-up of static charges on plastic-faced instruments.

Static electricity on meter and instrument windows deflects pointers, causes faulty readings, and attracts and holds airborne dust and dirt. The new anti-static fluid provides a thin, transparent coating which drains off static electricity.

Tradenamed "Statnul," the active factor in



the new fluid has a long chain molecule, highly attractive to plastic materials on one end. The other end consists of an ion (+) link which provides an excellent conductor independent of moisture. The product is being marketed in plastic squeeze bottles and impregnated cloths.

SOCKET PRESERVERS

8 Forway Industries Inc. has developed a line of "Thinline" tube socket preservers designed to prevent permanently wired sockets on electron tube testers from wearing out.

According to the company, the low height of the sockets makes them especially suitable for portable equipment where there is minimum clearance between the top panel and the cover of the tube tester.

The 7- and 9-pin sockets measure just 0.336" high above the equipment panel and the octal socket 0.7" high. The body is mica-filled phenolic while the contact pins are of beryllium copper, silver plated.

SIMPLE OSCILLOSCOPE

9 **Waterman Products Co., Inc.** is marketing a basic, low-cost scope which is suitable for student-experimenters, low-frequency industrial applications, and service work.

Designated the "Primer-Scope Mark I," the unit is portable and easy to operate. The instrument has a 3" cathode-ray tube which features an integral magnetic shield to prevent stray or spurious pickup.

The scope can be used for peak voltage measurement, a.c. signal waveform observation, equipment troubleshooting, signal tracing, frequency and phase comparison of two signals, etc.

The "Mark I" operates from 105-125 volt, 60-cycle sources, draws 40 watts at 117 volts, and has a .5 amp fuse. The unit measures 7¼" high, 3½" wide, and is 11¼" long. The instrument comes completely wired and tested.

"SIDE ARM" SCREWDRIVER

10 **Vaco Products Company** has developed a "side arm," T-handled screwdriver which converts into a high-torque driver to extend its usefulness as a service tool.

The set consists of a 4" plastic handle equipped with regular clutch at the end and an extra clutch in the center; a ¼"x 5" standard blade that may be inserted either in the regular socket or the side socket, and a No. 2 Phillips blade which can likewise be used in both positions.

MIDGET SOLDERING IRON

11 **General Electric** has announced the availability of a new series of midget soldering irons which feature improved performance, a new handle design, and redesigned tip and heater assembly.

According to the company, performance level has been raised by moving the heating element in the tip closer to soldering surfaces. The new handle has been streamlined and shaped to fit the operator's hand. With a new clip arrangement, the tip and heater assemblies can be changed faster and easier than with previous models.

The irons are available in ⅛" to ¼" tip sizes with 6-volt, 18- to 35-watt ratings.

THERMOELECTRIC ARRAYS

12 **Ohio Semiconductors** is currently introducing the TA-20 "Thermo-Array," a thermoelectric device which was formerly available only on special order. The "Array" is made up of several smaller TA-12 junctions and is also available as a finished "Thermo-Module" (Model TA-20M) with 1/16" thick aluminum plates on top and

bottom, ready for installation as a complete thermoelectric unit.

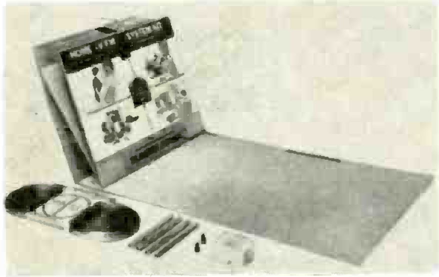
The single module measures 1½"x 1½"x ½" and is of rigid construction. It can pump more than 20 watts or typically attain a temperature differential between hot and cold plates in excess of 80 degrees C. Where individual modules are connected in series or parallel, capacities are correspondingly greater.

The basic thermoelectric configuration of the TA-20M can be used as a spot cooler for power transistors and similar heat-generating electronic components.

TV/FM SYSTEM KIT

13 Blonder-Tongue Laboratories, Inc. is now offering a TV/FM system kit which provides quality reception on up to four TV or FM sets from a single indoor antenna.

The Model HK-1 kit includes a new type of indoor antenna, a four-set coupler, 300-ohm



twin-lead, and installation hardware. According to the company, assembly and installation can be accomplished with just a screwdriver and a pair of snippers.

The antenna is assembled on a 72" x 18" cardboard which can be concealed in any convenient indoor location.

NEW TV KIT LINE

14 Transvision is marketing a new line of high-fidelity TV kits to meet the needs of those seeking improved audio performance from their television receivers. Special circuits have been incorporated to upgrade the audio.

The new circuits include d.c. restoration, ultra linear sweep circuits, push-pull audio amplifier, wide-band i.f. and video amplifiers with a flat 4-mc. response curve, a woofer-tweeter hi-fi speaker, extended-range tone control, and pre-assembled and aligned critical circuits.

Several models are being offered in this new line, details of which are available from the manufacturer.

CAPACITOR KITS

15 Pyramid Electric Co. is offering two new "Sportsmen's Delight" capacitor kits. One is the "Gold Standard" 111 Tackle Box which contains 75 assorted Mylar-paper molded capacitors and three (free) colorful trout flies packed in a plastic box.

The other kit, Model 515 "Lytik Kit," contains 15 assorted subminiature electrolytics, Type MLV, and three trout flies.

SOLID-STATE POWER SUPPLIES

16 Smith-Florence, Inc. has introduced a complete line of miniature solid-state power supplies. Two series are available. One provides from a 12- or 28-volt d.c. input, outputs from 400 volts d.c. to 2000 volts d.c. at 20 microamperes. The second series furnishes a 28 or 12-volt d.c. output at 100 ma. from a 117-volt a.c. source.

All power supplies are equipped with a standard octal plug for simplified mounting. Regulation is stated as 1 per-cent no load to full load.

5-BAND RECEIVER KIT

17 Allied Radio Corp. has added a five-band receiver to its "Knight-Kit" line of build-it-yourself electronic equipment. The R-55 employs a sensitive, selective superheterodyne circuit to receive international short-wave stations, ships at sea, aircraft, time signals, and amateur transmissions in addition to standard AM broadcasts. Coverage extends from 530 kc. to 36 mc. in four

bands plus a special range from 47 to 54 mc. for tuning the 6-meter amateur band.

The kit comes complete with metal cabinet, tubes, all parts, wire and solder, wall-size picture diagrams, and step-by-step instructions for assembly.

STABLE TV TUNER

18 Standard Kollsman Industries, Inc. has announced the development of an extremely stable v.h.f. television tuner adaptable to u.h.f. channels by insertion of adapter strips. The main feature of this tuner is the use of crystals to provide oscillator stability to a tolerance of ±50 kc.

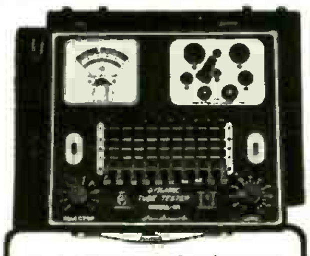
TRANSISTOR HEAT DISSIPATOR

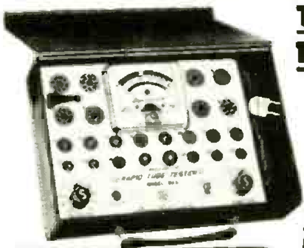
19 Methode Manufacturing Corp. is now in production on a heat dissipation device for use with semiconductor units of diameters varying from .325 to .335 and JEDEC outlines TO-5, TO-9, TO-11, and TO-39.

The unit has tested out showing a heat resistance of 200 degrees C over 48 hours.

MINIATURE PUSH-BUTTON SWITCH

20 Carter Parts Co. announces completion of high production tooling for its S6 series molded push-button switch.





Designed primarily for applications not exceeding 50 watts, the switch is said to be ideal for controlling relays, initiating meter and scope readings, pulsing counters, and panel lights.

It is available with choice of button colors, and in open, closed, and double-throw configurations.

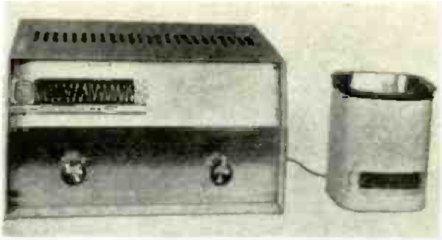
TWEEZER SOLDERING UNIT

21 **Oryx Company** has introduced a new tweezer soldering instrument for the production soldering of microminiature semiconductors. The instrument has separate heating elements in each arm, which develop 572 degrees F at the 1/32" tips. Designed for use with low-temperature solders to protect diodes, transistors, and bimetals, the tweezers can be used to position and hold the work rigidly while soldering and allow the operator an unobstructed view at all times.

Weighing one ounce, the instrument is six inches long and operates on six volts d.c. Six-volt transformers for use with the tweezers are available.

LOW-PRICED ULTRASONIC CLEANER

22 **Ultrasonic Industries** has developed a low-priced ultrasonic cleaning unit designed especially for a wide variety of consumer applications. Known as the "System Thirty," the new unit has a one-pint capacity, features a broadband frequency-modulated circuit which eliminates the need for automatic tuning, and is rated at 30 watts average power, 120 watts peak output.

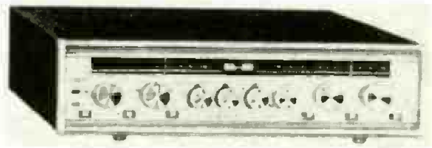


Fused for 2 amps, the generator operates from the 117-volt, 50-60-cycle power line. A 220-volt, 50-60-cycle export model is also available. The cleaning tank measures 3⅝"x 3⅝"x 3" deep. The unit comes in seven decorator colors to harmonize with laboratory, office, store, or plant color schemes.

HI-FI—AUDIO PRODUCTS

FM/AM STEREO RECEIVER

23 **Sherwood Electronic Laboratories, Inc.** is now marketing a compact stereo receiver which combines the firm's FM-AM tuner and a 50-watt stereo amplifier in a single cabinet. Featuring 19 front-panel controls and switches, the unit also offers 9 inputs to provide maximum flexibility.



Known as the Model S-7000, the new unit measures 16¼" x 14" x 4½" and requires only the addition of speakers and a phonograph turntable or changer to complete a stereo center.

The tuner section features two tuning eyes for FM and AM, independent FM/AM tuner operation for stereo simulcast reception, and a.f.c. The amplifier provides 24 watts per channel and has a frequency response of ± 1 db from 20 to 40,000 cps.

TAPE ACCESSORIES

24 **Pro-Tex Reel Band Co.** is offering a series of tape accessories of interest to audiophiles. One unit is a friction-free take-up reel that provides a smooth and tight winding of the tape. A finely embossed designed on the inner surface of both reel flanges reduces reel-to-tape friction by 98% of a solid flange reel with additional reduction attainable on reels with flange ports.

The second item is tradenamed "Sealedreel" and seals tape and film from dust and extremes of humidity. A molded resilient band of patented design snaps and locks into a conforming bead around the periphery of the reel. The third item is a non-magnetic reel clip that snaps over the reel flange to keep the tape from loosening and unwinding. Sizes are available to fit reels from 3" to 20" in diameter and for all widths of tape.

FM-AM STEREO RECEIVER

25 **Lafayette Radio Corp.** is now offering a new all-in-one stereo music center as its Model LA-225.

The new unit features individual FM and AM tuner sections for simulcast stereo reception plus dual 20-watt amplifiers and preamplifiers in a single compact unit.

The FM receiver section includes an output for FM multiplex and achieves a sensitivity of 1.5 μv. for 20 db of quieting with a.f.c. and a.f.c. defeat assuring reception of the weakest signals. The AM section features superhet circuitry with 3 a.v.c.-controlled stages, ferrite-loop antenna, and broad or sharp bandwidth. Both

sections incorporate individual precision tuning meters and flywheel tuning for precise station selection.

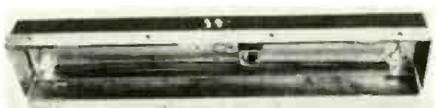
Frequency response is 20-30,000 cps ± 1 db at normal listening level. Hum level is −65 db below full output for low level and −75 db for high level. Channel separation is better than 50 db at 1000 cps.

The instrument is supplied with a brown finished enclosure 16½" x 15" x 5¼".

REVERBERATION UNIT

26 **CBS Electronics** is manufacturing a reverberation unit which is designed to be used with any home music system.

Incorporating a magnetic driver and two ceramic transducers, the Model 3-1-C reverberation unit produces a short delay in the audio signal by causing it to traverse, mechanically, two unequal lengths of a coil spring. A ceramic trans-



ducer at each end of the spring converts this mechanical wave motion back to electrical energy. Differential interference between the two reflected sound waves, caused by driving the spring off-center, produces a natural spatial effect on the reproduced signal.

In order to add the 3-1-C reverberation unit to an existing stereo or mono music system, a simple control amplifier is required. This amplifier delivers drive for the reverberation unit and provides a mixer for the delayed output signal so that any amount of reverb can be added to the program.

COMPONENT CABINETS

27 **The Lane Company**, an old-line furniture manufacturer, has entered the component cabinet field with two units designed to match or complement its regular home furnishings offerings.

"Perception," shown in the photograph, is de-

signed to house stereo or mono audio components and a TV set. The hutch top provides space for storing records or may be used as a bar or whatnot shelf.

The stereo cabinet (908-31) measures 20 x 80 x 31 inches while the companion hutch (908-71) measures 14½ x 72 x 28¼ inches. It comes in oiled walnut with wovenwood panels.

The second unit, "Cameo," has paneled doors which open to reveal stereo, radio, and TV units. A hutch top provides storage space for records. The ensemble comes in cameo walnut with pecan trim and cane door panels. It measures 19 x 79 x 32 inches while the hutch measures

14¼ x 49 x 40¼ inches. This unit is designated 967-31 for the cabinet and 967-71 for the hutch.

AUDIO CABLE FOR STEREO

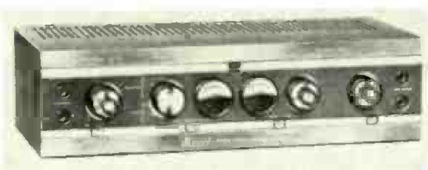
28 Lenz Electric Mfg. Co. has just introduced a double-channel audio cable for use with stereo broadcast receivers, record changers, tape recorders, stereo-conversion equipment, and binaural headphones.

The "Multiplex" Code No. 17555 cable is constructed with two tinned-copper stranded conductors with color-coded insulation. Each conductor has a spirally wound shield that serves as the second conductor of each pair. The spirally wound shield is quickly and easily pigtailed into the lead for the second conductor of the pair.

STEREO TAPE PREAMP

29 Allied Radio Corp. has added a universal stereo tape record-playback preamp to its "Knight-Kit" line of do-it-yourself audio equipment. Designed for use with any good quality 3-head tape transport, the new unit permits both stereo and mono recording and playback, plus such special effects as "echo chamber" recordings, multiple or "sound-on-sound" recordings, channel-to-channel language study, etc.

Featuring concentric, clutch-type record level controls, the preamp permits mixing the mike



and auxiliary inputs on either or both channels. These controls also provide facilities for adjusting each channel individually for making stereo recordings, then regulating master gain during the recording without upsetting stereo channel balance.

Twin vu meters indicate recording and playback levels while a versatile function switch provides instant selection of record or playback on either channel monophonically or both together for stereo. Also included is a 7.5 and 3.75 ips equalization switch which functions in both record and playback.

The kit comes complete with extruded aluminum front panel, wire and solder, and easy-to-follow instruction manual.

BACKGROUND MUSIC AMP

30 Grommes has just introduced a new universal-type, constant-duty 20-watt high-fidelity amplifier that has been specifically designed for background music and voice announcements.

The program selector on this new unit per-

mits choice of tuner, tape, phono, or 600-ohm telephone line. Separate volume controls are provided for mixing microphone with music. Bass and treble controls have protective caps to prevent tampering with the unit. It is catalogued as the Model G22.

BULK TAPE ERASER

31 Rason Manufacturing Company has introduced a new automatic magnetic tape erasure device which is tradenamed the "Jifty-Rase."

The new unit is only 5 inches in diameter and employs an instantaneous "on-off" switch which controls the erasing action. Weighing 4½ pounds and operating from any 100-130 volt a.c. source, the unit may be used on any size tape and film reels. It is effective on paper, plastic, steel, or wire recording materials.

FOUR-TRACK TAPE HEAD

32 **Fidelitone, Inc.** has developed a new, compact 4-track magnetic recording and playback head which it claims is one of the smallest of any current available units of its type.

The head is designed to include a broad scope of electrical connections with a wide range of inductance. These features, along with optional right- or left-hand mounting facilities, are expected to reduce costs for tape recorder makers.

40-WATT STEREO AMPLIFIER

33 **Lafayette Radio Corp.** has announced the availability of a new integrated 40-watt stereo amplifier/preamp which is being marketed as the LA-240.

Engineered for the control and reproduction of all stereo or mono sources, each channel will provide 20 watts of power and is equipped with terminations for both 8- and 16-ohm loudspeakers.

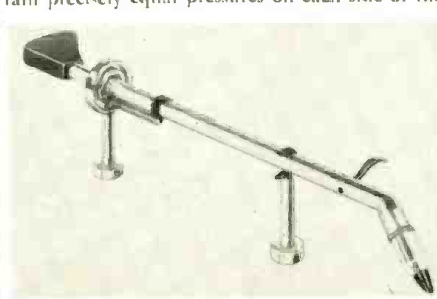
The full range of controls includes: independent concentric bass and treble, continuously variable separation, individual volume-balance,

loudness, rumble filter, mode switching, selector switch, plus individual hum balance controls for each channel, located at the rear. Inputs consist of five stereo pairs while outputs include dual tape out and dual 8- and 16-ohm speaker terminals.

Response is 12 to 100,000 cps ± 1 db at 1 watt and 50 to 70,000 cps ± 1 db at full output. The unit comes complete with enclosure and legs.

TONEARM & CARTRIDGE

34 **Dynaco Inc.** is now marketing the Danish-built **B&O** 16-inch professional tonearm and cartridge, the TA-16. Featuring the "Isodyne" principle of inertial balance to attain true dynamic equalization, the concept is said to maintain precisely equal pressures on each side of the



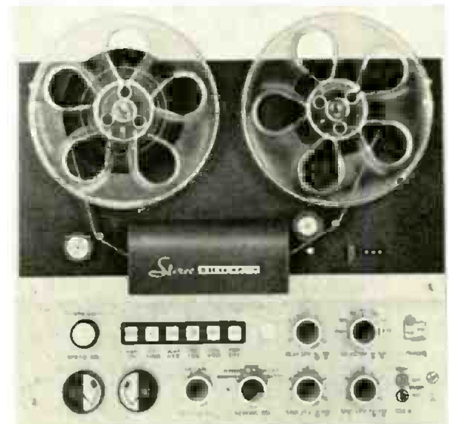
record groove regardless of the frictional forces which tend to make conventional arms slide inward.

Because of this, the makers claim lower record wear, lower distortion, uniform channel balance, precise phase relationships, and uniform channel separation. The gimbal-pivoted arm and removable cartridge assembly can track at a pressure as low as one gram. Tracking error is less than one degree.

The companion cartridge gives flat response from 30 to 15,000 cps within 2 db with 30-db channel separation up to 10,000 cps.

FOUR-TRACK TAPE DECK

35 **Electronic Instrument Co., Inc.** is in production on a new mono/stereo four-track tape deck for professional and home use. The RP-100 includes such features as 14-transistor playback and record amplifier electronics with separate



push-pull bias-erase oscillator and full-wave rectifier; a hysteresis-synchronous capstan drive motor and two heavy-duty 4-pole induction reel motors; and only three mechanical linkages to the deck.

Each head is provided with a 4-point professional head mount and the record and play heads have laminated Mumetal core pieces, inter-channel Mumetal shielding, and Mumetal outer shielding.

Frequency response is ± 2 db from 30 to 15,000 cps at 7.5 ips; noise is 55 db below maximum recording level; and wow and flutter are 0.2%; at 3.75 ips the response is 30 to 10,000 cps ± 2 db with wow and flutter 0.25%.

The unit is available either fully wired and tested or as a semi-kit with the entire tape transport assembled and tested and the electronics in kit form.

STEREO DYNAMIC MIKE

36 **Lafayette Radio Corp.** has introduced a new stereo dynamic microphone, which utilizes two separate dynamic microphone elements within one single compact unit, as the PA-263.

Completely flexible, the new unit eliminates the need for two microphones during stereo recording and is equipped with a switch for stereo or mono operation. The individual elements are equipped with separate transformers to provide a polar pattern which is, in effect, 90 degrees apart for full pickup within a 360 degree area. Frequency response is 50 to 15,000 cps and is essentially flat from 80 to 10,000 cps. Impedance of the mike is 50,000 ohms.

STEREO MUSIC CENTER

37 **Shell Electronics Manufacturing Corp.** has added a combination dual 20-watt amplifier and AM-FM stereo tuner with preamps to its line of audio equipment, as the "Nassau Stereorama."

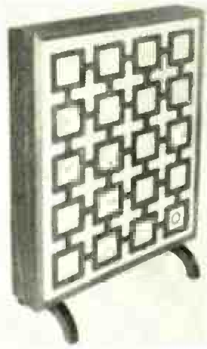
The unit provides 20 watts each channel stereo, 40 watts mono, and 80 watts peak. Response is ± 1 db from 30 to 20,000 cps at rated output and ± 1 db 20 to 50,000 cps at 5 watts. Harmonic distortion is less than 1%, 30 to 10,000 cps, while IM distortion at rated output is less than 2% from 60 to 6000 cps (4:1). There are two speaker outputs (4, 8, 16, and 32 ohms) and a 600-ohm third channel output.

FM frequency response is 20 to 20,000 cps ±1 db while AM coverage is 20 to 5000 cps ±1 db.

The "Stereorama" uses 21 tubes and measures 17¼" x 14⅛" x 6-3/16". It is housed in a hand-rubbed walnut-finished wooden cabinet.

SPEAKER SYSTEM

38 **Rek-O-Kut Company, Inc.** has introduced a new concept in speaker design which has been incorporated in its Audax "Sonoteer." The new unit employs five speakers but measures only 4" thick by 21" x 25". Its radiation pattern is omnidirectional.



The enclosure can be placed on the floor, in a corner, against a wall, or free standing. It can be mounted or hung against a wall if desired. The company suggests its use in stereo systems because of the omnidirectional character of its output.

Housed in an oil-rubbed walnut frame with filagree pattern of matching wood over the beige speaker cloth, the Model CA-70 is the first of a series from this company that will eventually include cabinets of traditional, classic, and provincial design.

Full specifications, including audio characteristics, are available on request.

CERAMIC CARTRIDGE LINE

39 **Sonotone Corporation** has added two new low-cost ceramic units, the "16T" and the "18T" to its line of stereo phonograph cartridges.

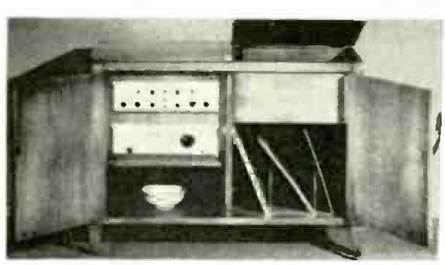
Channels of the new "16T" are separated by a full 22 db and reproduce the entire high-fidelity range. The flat response, ±1 db from 20 to 10,000 cps with smooth roll-off to 12,000 cps, is precisely tailored for RIAA characteristics. The compliance figure, 2.4 x 10^{-6} cm/dyne, allows increased output voltage which ties in with the tracking force of 4 to 6 grams in professional arms and 5 to 7 grams in changers. Voltage output is 0.5 volt.

The "18T" is designed to be used where more output voltage is desired. It is the same as the "16T" except that separation is 20 db and compliance is 1.5 x 10^{-6} cm/dyne. It tracks at 6 to 8 grams in professional arms and 7 to 9 grams in changers and has an output of 0.7 volt.

ACOUSTICAL CABINETRY ENSEMBLE

40 **Rockford Special Furniture Co.** has created a new ensemble of acoustical cabinetry in Italian Provincial design for use with a wide variety of separte hgh-fidelity components.

Decorator styled and acoustically engineered, the new Model 600-601 ensemble consists of a center equipment cabinet and free-standing twin speaker enclosure. The Model 600 equipment cabinet, with lift top, is designed to house amplifier and/or preamp, tuner, any record changer, or most transcription tables, or tape recorders. It has space for 100 LP records. The cabinet is 38" wide, 27¼" high, and 17" deep over-all.



The Model 601 matched twin-speaker enclosures provide proper stereo separation yet are free-standing for further separation or positioning. Each is designed to house up to 12" speaker. Each enclosure measures 17" wide, 27¼" high, and 17" deep.

The ensemble is being offered in fruitwood or oiled-walnut finish. It is available on special order in hand-rubbed mahogany, blonde, or ebony finishes.

FOUR-TRACK STEREO RECORDER

41 **North American Philips Company** has announced the availability of a new lightweight version of its "Continental" tape recorder which has been specifically modified for high-fidelity applications.

Designated as the "Continental 200," the unit operates at 7.5 ips and incorporates a narrow-gap, 4-track record/playback head for full frequency response of 50 to 14,000 cps. The unit will play standard 4-track streo tapes through an external hi-fi system and will record and play back on the four separate tracks through the unit itself or through an external sound system.

(*Continued on page* 120)

Completely self-contained, the system includes a tape-drive mechanism, recording/playback preamplifier, power amplifier, wide-range speaker, and a quality microphone.

STEREO HEADPHONES

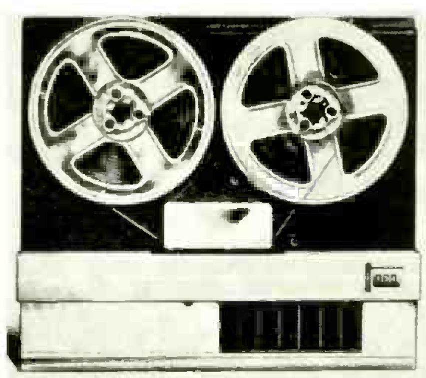
42 Lafayette Radio is offering a new set of stereo headphones designed for direct connection to amplifier output.

Designated as No. F-618, the phones contain two 2½" dynamic speakers with a frequency range of 30 to 15,000 cps. The special lightweight

aluminum casings are designed for comfort with foam rubber ear and head pads. Each earphone is rated at 8 ohms for stereo operation or 4 ohms for monophonic use. A seven-foot cord, with a two-circuit phone plug, is standard equipment.

TAPE TRANSPORT

43 Allied Radio Corp. is now marketing its new stereo tape transport as the "Knight" KN-4000. Featuring two-speed operation, handy keyboard controls, and three heavy-duty motors,



the new unit has been engineered to professional standards but with the average user in mind.

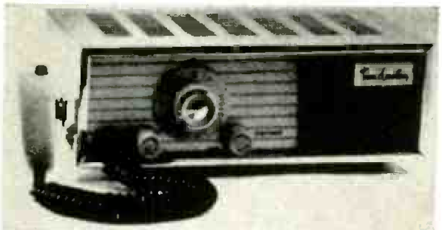
There are three separate heads—erase, record, and playback-monitor. The unit plays 4-track stereo and mono tapes through any stereo hi-fi system. It also provides recording of 4-track stereo or mono tapes when used in conjunction with the company's Model KN-4001 stereo tape record-playback preamp. In addition, the 3-head design permits professional-type "echo chamber" recordings, multiple or "sound-on-sound" recordings, plus A-B monitor switching.

Seven handy keyboard controls select any desired operating function including a choice of 3.75 or 7.5 ips speed.

CB-HAM-COMMUNICATIONS

SIX-CHANNEL CB TRANSCEIVER

44 **Utica Communications Corp.** is now offering its all-new six-channel Citizens Band transceiver, the Custom Model MC 27. The circuit features dual crystal-controlled double-conversion superhet receiver, crystal-controlled 1st and 2nd conversion oscillators, double-gated noise suppression circuit, equal response on all channels, a.v.c., positive linear squelch, operation on 6 and



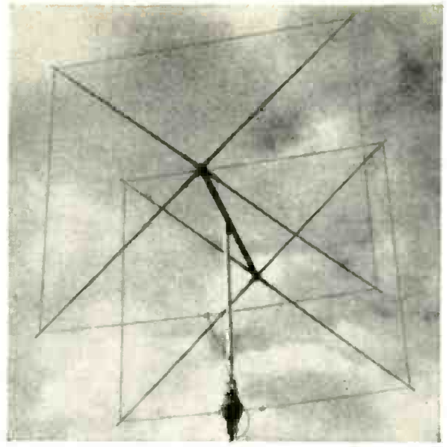
12 volts d.c. and 117 volts a.c. and press-to-talk ceramic microphone.

This new "Town & Country" unit measures 4" x 11⅞" x 7" and weighs 11 pounds.

BEAM ANTENNA FOR CB

45 **Cubex Company** is now introducing what is claimed to be the first cubical quad-type beam antenna designed specifically for Citizens Band service.

The Model CBQ offers high performance for both transmitting and receiving. High gain (up to 10 db), high front-to-back ratio, light weight, and small physical size make this an ideal directional antenna for CB, according to the manufacturer.



Two models are available, the standard and the deluxe which uses Fiberglas spreader arms. Details are available in free brochure "C."

BASE-STATION CB ANTENNA

46 **GC Electronics Co.** has developed a new end-fed dipole antenna which is designed specifically for CB base-station applications. The unit consists of a full half-wave, two-section aluminum radiator 17 feet long that is fed at the bottom high-impedance point through a special quarter-wave launcher-matcher section of RG-8/U cable. This matcher section transforms the high impedance presented by the end of the vertical radiator to 50 ohms; impedance match at the input connector is excellent over the wide bandwidth of 26 to 28 mc.

CRYSTAL FILTERS

47 **Collins Radio Company** has announced a new line of crystal filters for a broad range of applications in single sideband, telemetering, missile guidance, radar and navigation equipment, and other communications and electronic uses.

Crystal filters over the 10 kc. to 30 mc. range are now available in quantity. One of the new units is a 5-mc. filter in a thumb-size ⅜-cubic-inch case. Other of the new filters show comparable improvement in size reduction over earlier models.

MINIATURE CB UNIT

48 **Globe Electronics** is offering a new two-way miniature transceiver which operates on the CB frequencies without licensing of any kind.

Weighing only 13½ ounces, the "Pocketphone" measures 1⅝" x 2⅝" x 6¼" and is capable of transmitting and receiving at distances up to one mile.

The unit can be used as a paging system or in pairs for two-way communication. The transceiver is powered by a built-in "Power-Pak" rechargeable battery. The microphone and speaker are built in. The retractable antenna is extended for transmitting. The unit comes complete with battery charger.

CB TRANSMITTER TESTER

49 **Seco Electronics Inc.** is marketing the Model 510 transmitter tester which has been designed for use with CB and other low-power transmitters up to 160 mc. The compact unit has a 3-inch meter calibrated for direct reading of

percentage of amplitude modulation on both positive and negative peaks. It has a direct-reading scale for 0-5 watts r.f. as well as a 0-400 ma. r.f. scale. A high-impedance input for use with hand-held transceivers is provided.

A "T" pad attenuator is available as an accessory which adapts the unit for use with transmitters rated up to 50 watts input. Measuring 6¾" x 5¼" x 2¼", this compact tester permits modulation and power output checks without removing the transmitter chassis from the cabinet. The unit comes complete with all necessary cables and adapters for field, laboratory, or installation checks.

LONG-RANGE CB UNIT

50 **Vocaline Company of America** is marketing what is claimed to be the first long-range, self-powered portable CB transceiver with AM broadcast-band coverage.

Designated as the "Commaire PT-27," the new unit uses 18 transistors. Power output is ½ watt on transmission. With a suitable mobile and base antenna installation, the new unit is said to equal the range of 5-watt CB units. This double conversion superhet performance is, in part, attributable to a special receiver design which provides extra selectivity and sensitivity as well as good signal-to-noise ratio.

The entire unit weighs 5 pounds and measures 10" x 4⅛" x 7½" including the handle. The unit comes complete with battery box and built-in charger, antenna, microphone, crystal

for one channel, FCC permit application forms, and operating instructions. The battery is not included.

MANUFACTURERS' LITERATURE

GENERAL CATALOGUE

51 **Pomona Electronics Co., Inc.** is offering copies of its new general catalogue 6-61 which lists the firm's complete line of patch cords, connecting leads, cable assemblies, and test socket tube adapters.

The catalogue also makes mention of the company's solderless molded single and double banana plugs, test socket tube adapters, and socket savers.

CONDENSED TUBE CATALOGUE

52 **Litton Industries** has issued a condensed catalogue covering its 1961 line of electron tubes. Quick reference specifications and photos are provided in the 16-page catalogue which describes the complete line of microwave tubes, display devices, and operational accessories.

Millimeter wave tubes and monitor diodes are also described in some detail.

COAXIAL RELAY DATA

53 **Allied Control Co., Inc.** has published a data sheet listing operating conditions, coil, and coaxial cable specifications for its new low-cost s.p.d.t. coaxial relay.

Featuring low crosstalk and v.s.w.r., the new coaxial relays are designed for use in mobile and stationary radio transceivers, as well as v.h.f., u.h.f., and video studio switching.

AUDIO PRODUCT CATALOGUE

54 **Sonotone Corporation** has just released its 1961 catalogue of audio and electronic products covering a broad line of equipment for the hi-fi and electronic field.

The 8-page publication contains photos of all products plus detailed specifications for each. Included are ceramic phono cartridges, crystal cartridges, tonearms, magnetic equalizers, mono and stereo tape heads, and ceramic microphones. Other products are rechargeable flashlight battery cartridges, loudspeakers, and electronic tubes.

TRANSISTOR TRANSFORMERS

55 **Arco Electronic, Inc.** is offering a single-page two-color data sheet covering a comprehensive line of **Dresser HST** miniaturized transistor transformers which it is prepared to deliver from stock.

Units in the line include interstage, output, input, driver, isolation, etc. in a wide variety of impedances and currents. Minimum performance curves are also included on the data sheet.

HI-FI COMPONENT BROCHURE

56 **Shure Brothers, Inc.** has issued a new and revised edition of its high-fidelity component brochure which should be of interest to audiophiles.

Included are several new components, along with illustrations and specifications of standard models in the firm's line of phono cartridges, tonearms, and other high-fidelity equipment.

Among the new components listed are a tubular stylus and a stereo conversion preamp, along with a professional independent tonearm with cartridge installed.

SOLDERING TIP DATA

57 **Hexacon Electric Company** has published a new catalogue which covers its "Hexclad" and "Xtradur" lines of long-life, iron-coated soldering tips. The new line of "Durotherm" non-sticking iron-coated tips is also shown.

In addition to detailed specifications for each of the three types of tips, Catalogue 603 carries sketches of many different point shapes. Style of point, tip point size, and over-all length for hundreds of different tips are shown in tabulated form. The tabulation also indicates the company's catalogue number soldering-iron each different tip fits.

Use and care instructions are also covered in this publication.

PRECISION POTS

58 **Schweber Electronics** is distributing a four-color, six-page folder which is designed to aid buyers and engineers in the selection of **Daystrom's** line of "Squaretrim" precision potentiometers.

The folder, which is fully illustrated, discusses the construction and applications of these components and gives their specifications in quick-reference, tabular form. —30—

For additional information . . . Use the ELECTRONICS WORLD Reader Service Coupon on Page 128

Answer to Puzzle Appearing on Page 109

B	B	C		Z	A	X	I	S		R	F	C
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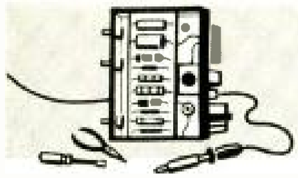

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MISCELLANEOUS

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Mac's Service Shop

(*Continued from page* 58)

the input of the amplifier, the tuning being done with selsyn motors, when I got another idea: why not replace the loop with a shielded antenna transformer and feed a signal from a remote antenna to the input of this transformer through a shielded coax cable?"

"I can see some problems," Barney observed.

"I soon ran into them. First off, I couldn't find a transformer that would tune the broadcast band with the tuning capacitor used in the tuner and that had a 52-ohm input. After leafing through every catalogue in the joint, I finally dropped a letter to a coil manufacturer and explained my problem. He wrote back promptly and suggested I use a transformer with an ordinary high-impedance primary but that I disconnect this primary from the terminal lugs, remove the tiny ceramic capacitor connecting the 'hot' ends of the primary and secondary windings, and substitute a new primary of about eight turns of No. 22 wire wound between the unused primary and the secondary. That solved one problem."

"I'm waiting to see how you matched any kind of a remote broadcast-band antenna to that 52-ohm coax," Barney said with a wicked grin.

"That worried me, too. A center-fed half-wave antenna was entirely out of the question, for we didn't have room to put up even a Marconi. Finally I borrowed a stunt from you mobile hams. I designed a base-loaded whip antenna. The whip was a wire running down from the top of the forty-foot wooden pole. The loading coil was a ten-inch length of two-inch-diameter coil stock with spacing that permitted small clips to be fastened to individual turns. This was housed in a weatherproof box at the base of the pole, and the bottom of the coil and the shield of the coax were grounded.

"The center conductor of the coax and the bottom of the whip wire were connected to small clips. The coax clip was fastened to the third or fourth turn from the bottom of the coil, and the whip clip was connected near the top of the coil. With the AM tuner set to the frequency of the weakest out-of-town station it was desired to receive, both clips were moved from turn to turn until the maximum signal, as indicated by maximum a.v.c. voltage, was obtained.

"The arrangement sounds rather Rube-Goldbergish, but it was low in cost and worked fine. A whip antenna with a loading coil has a narrow tuning range, but this presented no problem because the three out-of-town stations fell very close together near the center of the broadcast band. While the local station was, frequency-wise, some distance away, its signal was so strong that it brute-forced its way right on in. Quiet reception was had on all four stations."

"Well," Barney commented, "it makes me feel good to see that you had to do some second-guessing, too."

"I do a lot of it," Mac admitted. "In this business it's very easy to jump to a wrong conclusion about a cause of trouble or the best solution of a problem; and it's human nature not to want to give up an idea of your own once you've got it. Actually, you *shouldn't* give up until you have investigated far enough to uncover strong evidence you're on the wrong trail. On the other hand, there's nothing wrong with second-guessing. Ralph Waldo Emerson put it pretty well when he wrote: 'A foolish consistency is the hobgoblin of little minds. . . .' " —30—

HAMFESTS SCHEDULED

THE Hi-Plains Amateur Radio Club will hold its Twelfth Annual Hamfest on Sunday, May 21st at Plains, Kansas.

Nine states were represented at last year's affair.

For program details, contact Florence Hachenberg, KØCJM, Kismet, Kansas, secretary of the Club.

* * *

THE Northeast Ohio VHF Group has picked June 18th for its Sixth Annual Picnic to be held at Sunset Park, Route 619, near Alliance, Ohio.

The committee hopes to exceed last year's record of 1000 attendees.

D. E. Butcher, K8NZU, 347 Wall Street, Ravenna, Ohio can supply details for those interested in attending. —30—

ADVERTISERS' INDEX JUNE, 1961

Advertisers listed below have additional information available on their products in the form of catalogues and bulletins. To obtain more detailed data, simply circle the proper code number in the coupon below and mail it to the address indicated. We will direct your inquiry to the manufacturer for processing.

The coupon below can also be used to obtain additional information on the new product items shown on pages 112 through 122 as well as on the ads as listed above.

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NEW PRODUCTS & LITERATURE

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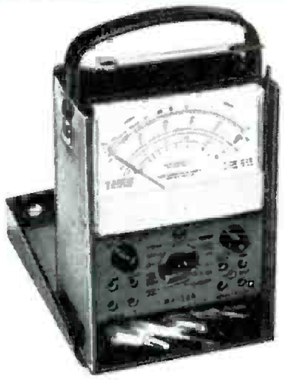

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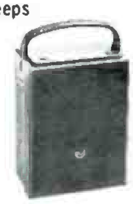

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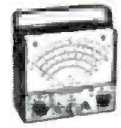

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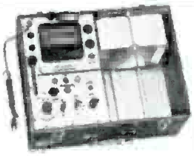

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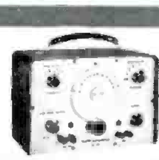
GENERATORS



NEW! WA-44C AUDIO GENERATOR

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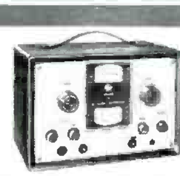

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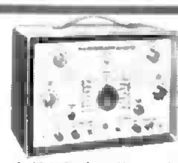

WR-69A TELEVISION/FM SWEEP GENERATOR

For visual alignment and troubleshooting of TV rf/if/vf circuits and other electronic equipment IF/video frequency ranges 50 Kc to 50 Mc, TV channels 2 to 13, plus FM range—88-108 Mc. Sweep width continuously adjustable to 12 Mc or more.
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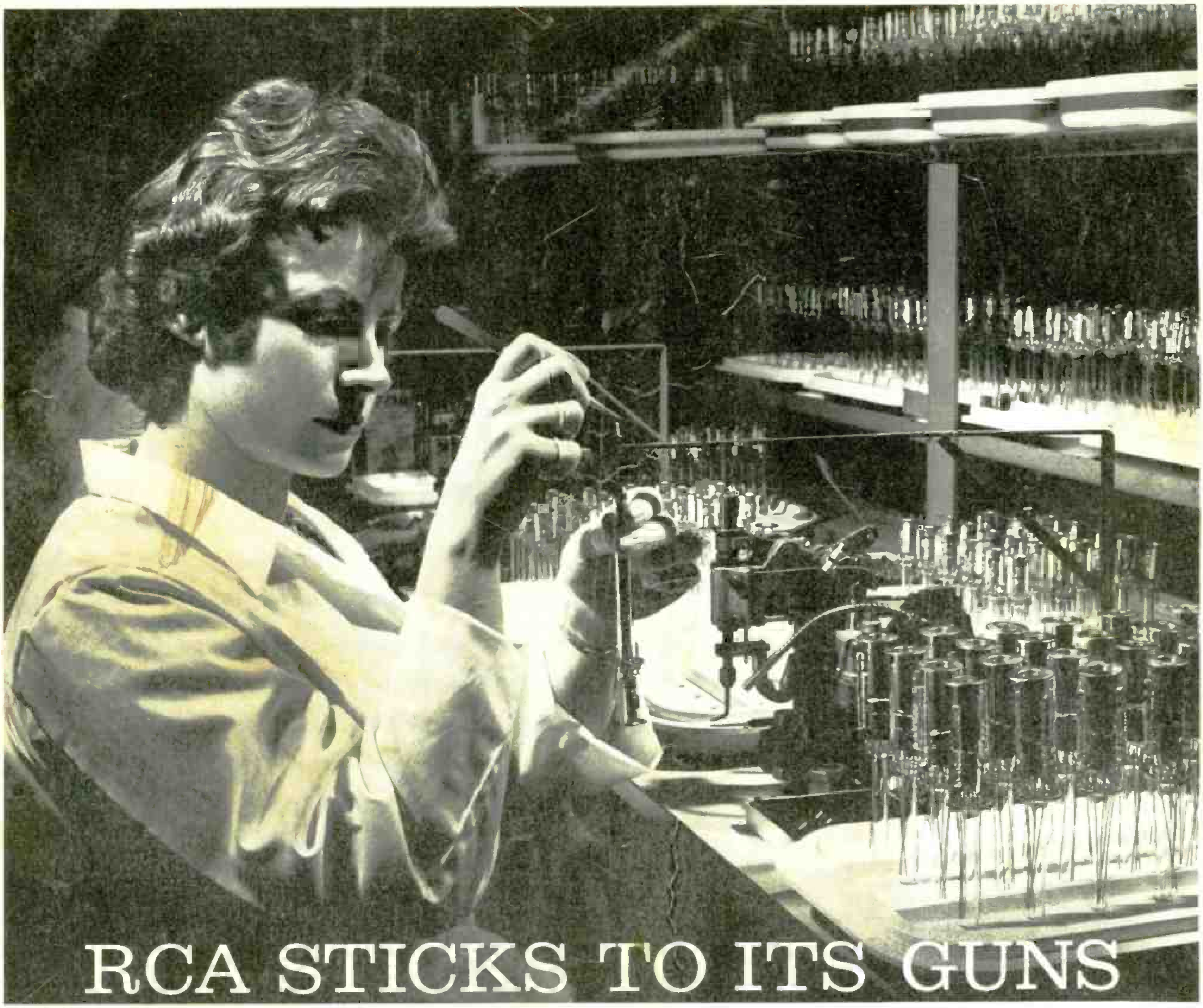

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