Electronics World

MARCH, 1962

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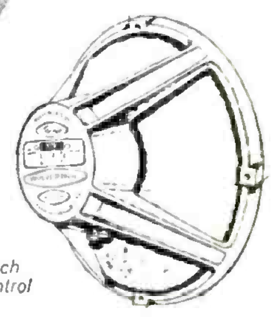
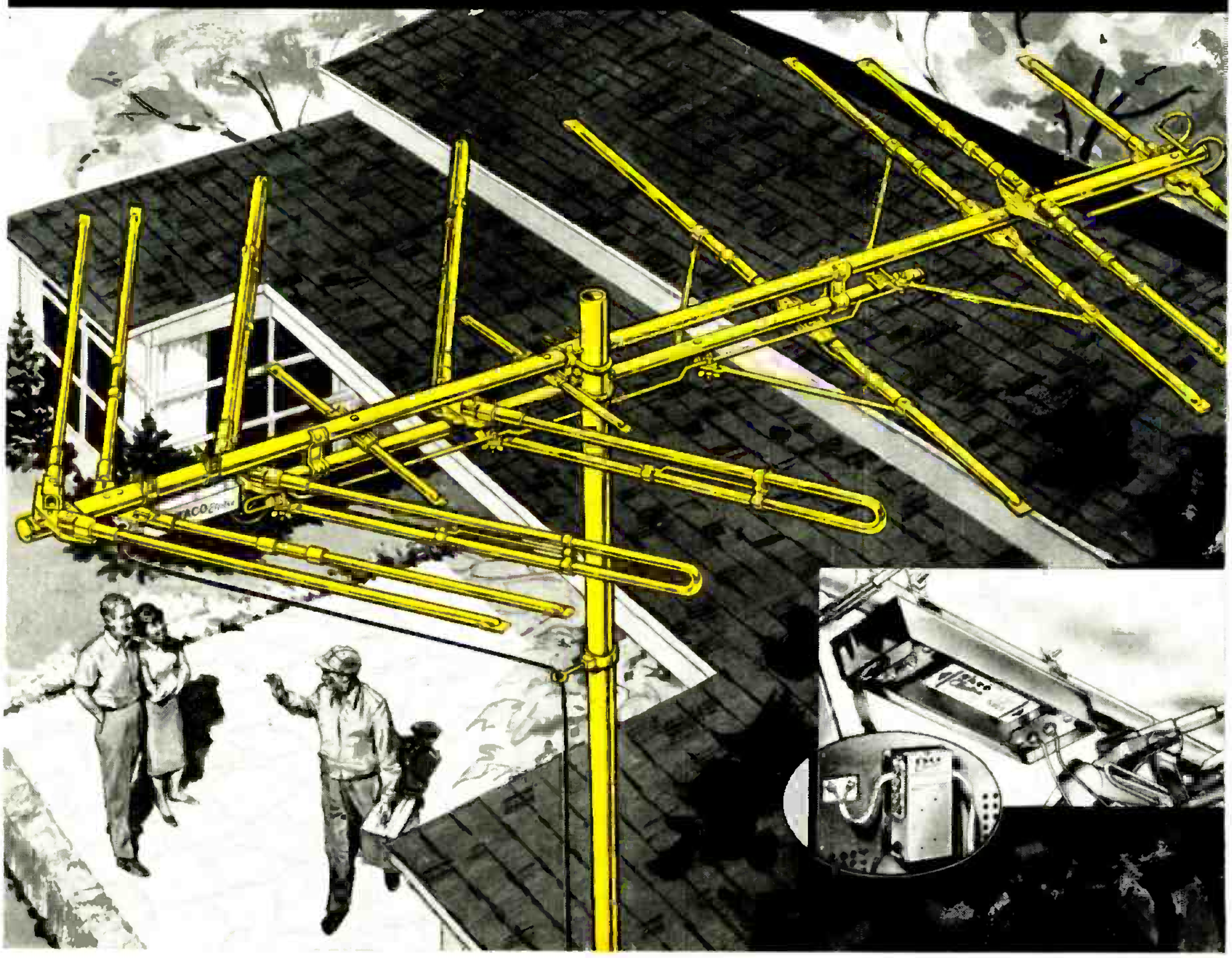


Three-position switch provides positive control of tonal balance



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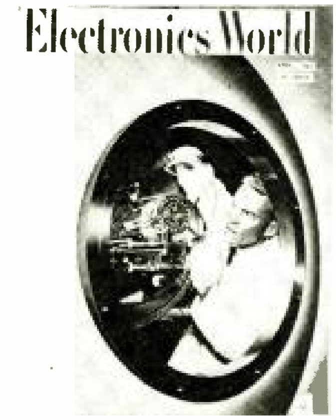

COMING NEXT MONTH

ELECTRIC ENGINES FOR OUTER SPACE
Space engines using high-speed ion beams and plasma jets will provide the necessary thrust for travel between planets. These engines are about to be tested in actual flight. Here is how they work and what can be expected from them.

REVERBERATION IN AUDIO REPRODUCTION
What is reverberation and how important is it in obtaining realistic hi-fi reproduction? The author covers design and operation of various reverb devices used with both professional and home-entertainment equipment.

TRANSISTORIZED TRANSMITTER FOR CAMPUS STATIONS
More and more colleges are installing their own broadcasting stations. Here are details on a micro-power transmitter that needs no license and can eliminate many of the headaches of bigger and more elaborate installations.

DYNAMIC TESTS WITH A SERVICE SCOPE
The oscilloscope's blanking pulse, externally applied to a resonant circuit, displays component condition visually. This provides quick, positive testing for many radio and TV inductors.

DYNAMIC TRANSISTOR BRIDGE
Input impedance and beta of several transistors bearing the same type number may vary considerably from nominal values yet these factors can affect stage gain. This article covers the design and construction of a bridge for determining these parameters with an a.c. test signal and permits selection of transistors for best in-circuit performance.

TROUBLESHOOTING TRANSISTORIZED DIGITAL CIRCUITS
The printed, plug-in cards and standardized circuits make specific techniques possible for locating defects. The author goes through common digital configurations with step-by-step checks and readings used to isolate breakdowns.

RC EQUALIZATION CURVES
An accurate graphic method, for the audio technician, of charting any equalization curve. The method is described in detail with examples of the technique worked out.

All these and many more interesting and informative articles will be yours in the April issue of ELECTRONICS WORLD . . . on sale March 22nd

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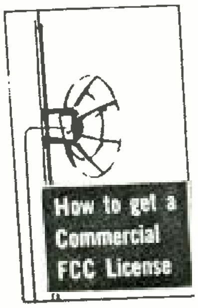

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CHARLES C. ROBERSON
Cheyenne, Wyoming

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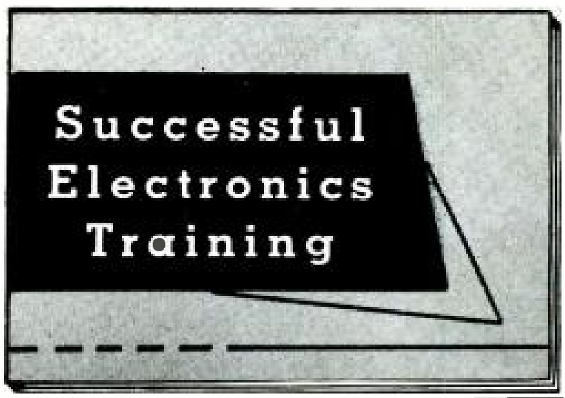

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RN-63A

...for the Record

By **W. A. STOCKLIN**
Editor

ELECTRONIC SALES TO REACH $10.8-BILLION IN 1962

DESPITE keen competition among producers of electronic equipment and a serious shakeout in the pricing structure, particularly evident in the semiconductor area, the electronic industry has passed all previous records with factory sales reaching $10.15-billion for 1961. This is a growth of 4.1% over the previous year.

This increase was achieved almost entirely because of continued expansion of military and industrial markets which together accounted for 71% of total sales. Consumer-products sales declined 4.7% from $2.1-billion to $2-billion while replacement-component sales showed an increase of 5.6% from $.9-billion to $.95-billion. Industrial products increased 8.6% from $1.75-billion to $1.9-billion. Military-product sales increased 6% from $5-billion to $5.3-billion.

According to Mr. L. Davis, President of the Electronics Industry Association, it is reasonable to assume that a larger gain in total electronics output will be forthcoming in 1962 with present predictions estimating an increase of 6.4% over 1961. Sales in 1962 should be stimulated by the ever-increasing need for more advanced weapon systems, expanding space and missile programs, a continuing rise in plant modernization and automation, and increasing consumer spendable incomes. In the industrial electronics field, sales are expected to increase throughout the next decade with computing and data-processing systems, testing equipment, microwave apparatus, and navigational aids holding predominant positions.

Despite serious price-cutting in transistor items, the semiconductor industry showed a remarkable gain in units sold. For the first 9 months of 1961, the industry sold 136,490,332 transistors, which is an increase of 51% over the 90,263,352 units sold for the same period in 1960. Dollar sales did not reflect this spectacular increase since sales only increased 2.2% from $222,198,961 to $227,002,035 for the first 9 months of 1961. However, with new semiconductor devices emerging, such as solar cells, infrared sensors, thermoelectric, and similar components, the over-all semiconductor industry is without a doubt a growth area.

Raymond W. Saxer, Vice-President, Marketing, *RCA Sales Corporation*, recently predicted that the domestic radio industry will sell 12 million home sets in 1962, breaking all records for previous years. The peak home radio year was 1947 when 17,360,000 sets were sold. Sales dipped to just under 13 million in 1948, and then fell below the 10 million mark until 1960 when 10,705,000 receivers were sold. Although figures are not available as yet, 1961 sales are expected to surpass the 1960 level.

Panelists at a recent seminar sponsored by the EIA's military marketing data committee look forward to an impressive increase in the sales of radar equipment. Their predictions are that: heavy surface radar sales will increase from a current level of about $500-million to $775-million in 1970; radar for manned aircraft and drone sales will increase from about $127-million at present to $215.4-million in 1970; and shipboard radar sales will increase from $110-million in 1961 to $150-million in 1970.

Walter W. Slocum, President of *International Resistance Company*, recently pointed out that the electronics industry enters 1962 far more optimistically than it did in 1961. Although the industrial activity was declining a year ago at this time, the economy is now continuing to gain ground after turning upward around mid-year, and he looks for 1962 to show continued improvement barring any serious unforeseen foreign development.

Although foreign trade is vital to the well-being of the United States' electronics industry, he did point out that a segment of our industry today faces a very real threat from imports from low-wage countries. Mr. Slocum went on to say, "These imports were tiny, insignificant clouds on the horizon back in 1955; but today they have become ominous for many firms, and particularly for the small ones whose lack of diversified lines makes it difficult for them to ride out extended spells of rough weather. In 1955, for instance, the value of Japanese radio imports into the United States totaled little more than $230,000. By the end of 1960, that little white cloud had billowed into a startling $70-million. The figure has continued to grow rapidly since then until today more than 60% of transistor portable radios sold in the United States are Japanese."

Like in any industry, there are always a few turbulent conditions to overcome but, in viewing the electronics industry as a whole, all signs point to not only a prosperous 1962 but a progressive future. For technicians, engineers, and scientists employed in electronics, the future looks bright, and there is still a great need for qualified personnel—men who are sincere in their work, loyal to their companies, and technically qualified. ▲

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√ IT MUST be one that can be completed successfully in a matter of WEEKS, not a course that goes *on and on!* Time is worth money. Every extra week which a "long course" may require is money *out of your pocket!* It costs more than tuition... it costs you real dollars! Let nothing delay YOU in preparing for your FCC license. Select a school that values YOUR TIME!

√ IT MUST be *reasonable* in cost! The best test of the *true worth* of a product or service is in WHAT YOU GET FOR YOUR MONEY. Select a course that is sufficiently reasonable in cost *so that you know you won't have to drop out before you complete it!* Select a school with conservative tuition fees – but, *be sure it does something for you.*

√ IT MUST gain recognition for you. Don't be satisfied with the mere promise of some sort of *diploma!* Be sure the course will qualify you for a nationally recognized measure of electronics knowledge – a FIRST CLASS Commercial FCC License. Remember: This is a U. S. Government license. No school can issue it, nor *promise it* to you! Select a school whose graduates consistently PASS the FCC exams.

√ IT MUST be a mature course of training... for mature men... not a mere "memory" course or one in which you are expected to cram your way through by "brute force." IT MUST not be one that leaves you "on your own." Select a school that affords you personalized instruction. Select a course from a school that reflects maturity, dignity, and integrity.

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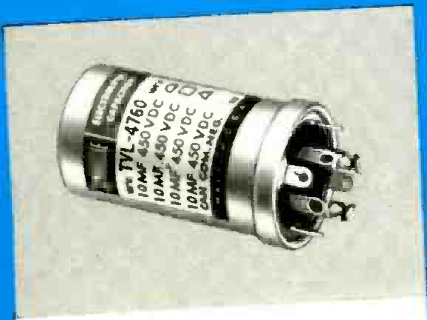

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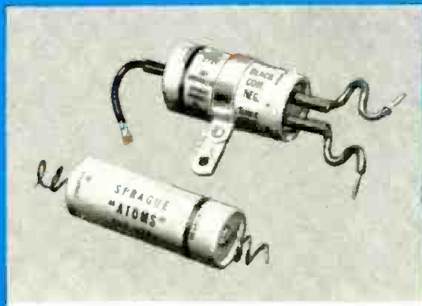

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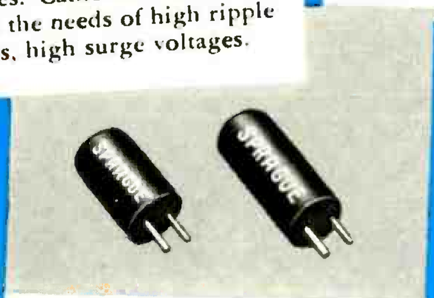

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LETTERS FROM OUR READERS

STEREO PREAMP

To the Editors:

Ever since 1946 I have been a reader of RADIO NEWS and its ensuing progeny. You are to be complimented on your ever-increasing scope of coverage in the field of electronics and your treatment of the subject in a manner designed not to insult the intelligence of the pro, yet, on the other hand, not to "snow" him with higher math.

I enjoy your technical reviews of commercial hi-fi equipment, but I would appreciate more construction articles for this type of equipment. A case in point is the two-tube stereo amplifier described in your September 1959 issue. I built this little two-tuber and it has graced our living room ever since.

How about running a sequel to the old RADIO & TV NEWS preamp which appeared about 10 years ago. That one did yoeman service for many a recording curve in the hectic transition from 78's to LP's.

MILES A. SNYDER
Snyder Industrial Photographic Service
Western Springs, Illinois

Readers like the above who are interested in hi-fi construction projects will be glad to know that we have planned for an early issue a stereo preamp that might very well be considered the sequel to the old RADIO & TV NEWS *preamp. As a matter of fact, this stereo version was designed by Charles Boegli, who worked on the original mono circuit.—Editors.*

* * *

SILICON AND SELENIUM RECTIFIERS

To the Editors:

Recently I have been getting in some hi-fi amplifiers for servicing. I notice that many of these amplifiers use new, small silicon power rectifiers for "B+" along with selenium rectifiers for bias. How can these semiconductor diodes be checked to make sure that they are working properly? Do you have any idea of the approximate front-to-back resistances as measured with an ordinary, service-type v.o.m.?

RICHARD A. SHAW
Ames, Iowa

An ordinary v.o.m. can be used to measure front-to-back resistance in these diodes in order to check whether they are defective or not. Be sure to connect the v.o.m. lead that is polarized positively to the anode of the semiconductor diode and the negative lead to the cathode for a forward-resistance measurement. Then simply reverse the leads to measure back resistance.

Typical values that we have measured recently on a number of 750-ma. silicon diodes are in the order of 1000-2000 ohms forward resistance and over 20 megohms back resistance. This represents a back-to-front ratio of about 20,000 to 1, far in excess of back-to-front ratios obtained with selenium diodes. In the case of selenium rectifiers, forward resistance measures around 5000 ohms to 50,000 ohms, depending on the diode's current rating, while back resistance measures from .1 to 1 megohm. Back-to-front ratios are in the order of 20:1 to 200:1.

These measurements were taken with a v.o.m. having an internal 1½-volt battery.—Editors.

* * *

MEDICAL ELECTRONICS

To the Editors:

I was very interested in the article "Advances in Medical Electronics" by Walter H. Buchsbaum in your November 1961 issue. I would like to compliment you for harmonizing the field of medicine with electronics.

WALTER A. TOPINKA, M.D.
Burien Eye Medical Center
Seattle, Washington

To the Editors:

Your article summarizing recent developments in medical electronics was very interesting and illuminating.

ESMAIL KOUSHANPOUR
Michigan State University
Dept. of Physiology & Pharmacology
Lansing, Michigan

The excerpts above are typical of many letters we have gotten from our readers complimenting us both on the presentation and appearance of the article referred to.—Editors.

* * *

LOUDSPEAKER RESPONSE MEASUREMENTS

To the Editors:

In your issue of October, 1961 there are test reports on two speaker systems—the *Dukane* DuK-30 and the *Hartley* "Holton." I believe these are excellent speakers, but in your tests, their frequency response was measured in a room of 12 feet by 30 feet, and 11 feet by 30 feet respectively. Does not room testing to loudspeakers give a false response, and if so, why print such reports?

It is interesting to note that on page 44 of the same issue, no less an authority than Edgar Villchur states: "Sometimes attempts are made to get a rough indication of speaker frequency response by taking microphone measurements in an ordinary room. Such a method does not even give rough results because there will be far more variation caused by the room and by the particular posi-

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tions of the speaker and microphone than the performance characteristics of the speaker itself."

ARTHUR GONTY, M.D.
Menominee, Michigan

One objection to the use of room measurements is that one particular microphone location may give completely untypical performance results. However, it is our practice to use an average response taken with microphones at no fewer than eight locations in a room. What is more, we also frequently change the location of the speakers being tested and average out the results. By taking the average of a large number of measurements in a typical listening room, we obtain valid and useful results.—Editors.

* * *

MILITARY TECHNICIANS

To the Editors:

I appreciate your stand for the electronic technician in your October editorial. It's quite time a line was drawn between the different skill levels.

As for myself, I am in one of our largest groups of technicians, a member of the United States Air Force. I guess we have to be excluded from the industrial and consumer-products service technician groups, but I am sure that the present technician in the Air Force will stack up to the best. In the first place, the Air Force does not give a man the job title of "technician" until he reaches the higher skill level as determined by testing, training, and supervisor recommendations. This generally takes from five to ten years of experience in the field along with several years of schooling.

LARRY G. OWEN, S/Sgt., USAF
Biloxi, Mississippi

Certainly the military electronic technician is important. However, he too may be classified as "design technician," "service technician," or "operating technician" as was mentioned in the editorial.—Editors.

* * *

IMPEDANCE MATCHING IN AUDIO

To the Editors:

Due to a printing error in my article "Impedance Matching in Audio Circuits," in the December issue, a portion of one sentence was deleted or left out by accident.

On Page 70 under the heading "Output Matching," the second sentence should read as follows: "If the tube were completely linear, as it is for very small signals, we could represent it as having a constant open-circuit output voltage and a constant *output* resistance r_p. *Then maximum power would be delivered to a load equal to* r_p and distortion would be no problem."

JOEL H. LEVITT
New York, New York

The portion of the text that we omitted from Author Levitt's article has been italicized in the above letter. We are sorry that we seem to have lost about two lines of copy somewhere along the line.—Editors. ▲

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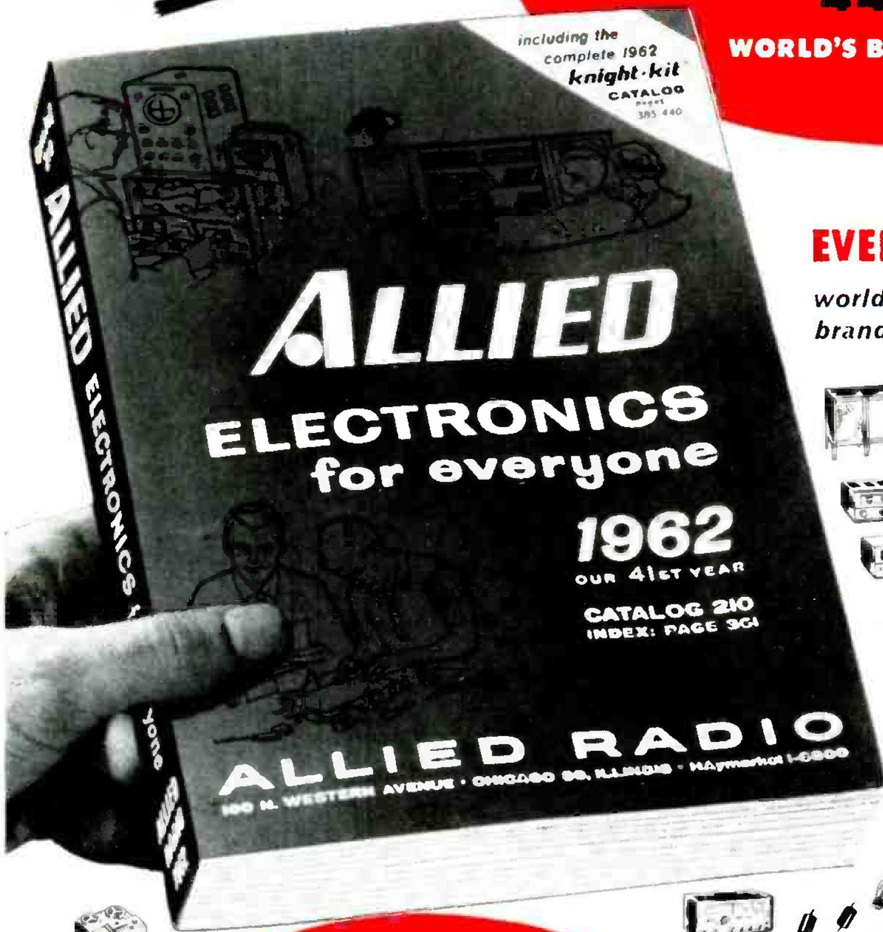

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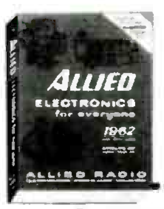

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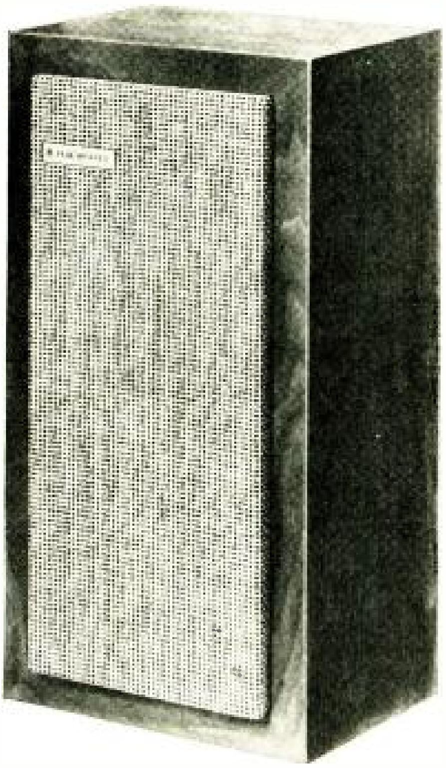
Superex Model ST-M Stereo Phones
CBS Laboratories STR-100 Stereo Test Record
Lafayette Model TE-20 Signal Generator

H. H. Scott Model S-3 Speaker System

For copy of manufacturer's brochure, circle No. 57 on coupon (page 118).



THE *H. H. Scott* S-3 is a true bookshelf speaker system, measuring approximately 24" x 12" x 10" deep and weighing about 35 lbs. Like the larger and more expensive *Scott* S-2, it is a three-way system, using a 10" low-resonance woofer, an acoustically isolated mid-range speaker, and a small high-frequency tweeter. Separate level controls are provided for the mid- and high-frequency speakers, allowing the user to tailor the over-all response to his own taste.

The instruction booklet gives little technical information on the speaker system, other than the fact that its nominal impedance is 16 ohms. To our ears, the crossover frequencies appeared to be about 1000 and 3500 cps. We found the recommended level control settings to be perfectly satisfactory to our ears, and the centers of the suggested ranges were used in our tests.

The frequency response of the S-3 was measured in the same manner as all other speakers we test, in a live room with two different speaker locations and eight different microphone locations. It must be realized that this does not give any sort of absolute frequency response, and therefore response curves are not shown but rather to us it shows trends, relatively free from room resonance effects.

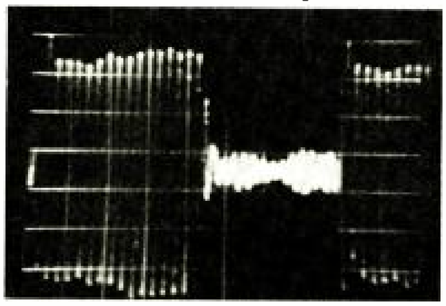
The response of the *Scott* S-3 proved to be exceptionally smooth over-all. It is within plus or minus 7.5 db from 32 cps to over 12 kc. Its general shape is quite smooth particularly in the 100 to 200 cps region, with a somewhat higher output in the upper middles and highs. The S-3 has very low bass distortion for a speaker of its size and price. It never exceeds 5% down to 20 cps, even at the considerable acoustic levels generated at our 10-watt test input level.

The tone-burst response of the S-3 system shows it to have excellent transient response, quite free from hang-over or spurious frequencies at any point in its range.

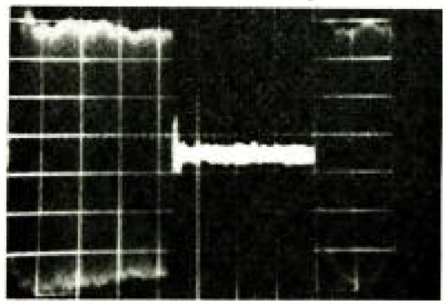
Listening tests proved once again that the tone-burst test offers an excellent clue to the listening qualities of a speaker. The S-3 has an exceptionally clean, balanced, and transparent sound. Although it is appreciably smaller than other speakers in its price range, it holds its own handily by comparison to them. In fact, it compares very favorably to other systems costing two to three times as much. We liked its true, musical sound immediately on hearing it for the first time, and it continued to please us with continued use.

The *Scott* S-3, in an attractive oiled walnut cabinet, sells for $129.95. ▲

450-cps tone-burst signal.



5000-cps tone-burst signal.



Superex Model ST-M Stereo Phones

For copy of manufacturer's brochure, circle No. 58 on coupon (page 118).

MOST GOOD-quality stereo phones are dynamic types, resembling miniature loudspeakers rather than the usual headphones having a flat metal diaphragm and fixed coils. The *Superex* Model ST-M phones are basically dynamic units, but are unique in being two-way systems. Each phone is a miniature coaxial speaker, with a cone-type woofer and a ceramic tweeter. The crossover networks (one for each phone) are in a separate plastic control box, connected to the headset by a six-foot cord. Each tweeter has its own level control, enabling the user to adjust the frequency response to his liking. The nominal crossover frequency is 2200 cps.

The *Superex* phones are designed to be driven from an amplifier's voice-coil outputs. The impedance is not critical—anywhere from 4 to 16 ohms being satisfactory. The phones are quite sensitive, only about 10 milliwatts being needed for a good listening level. The crossover network and coupling system incorporated in the control box result in a sufficiently low sensitivity so that hum and noise in the amplifier output are no more apparent than they would be when using loudspeakers. Certain other types of stereo phones require attenuators between phone and amplifier because the high sensitivity of the phone makes amplifier noise audible, but this not the case with these phones.

We found the most pleasing sound to occur with the tweeter level controls at their maximum position. The audible response of the phones extends to at least 15 kc., and possibly beyond, although we cannot be sure how much our own hearing falls off above 15 kc. At the low end the response sounds uniform down to about 80 cps, with a roll-off below that point. Fundamental output can be heard, with little distortion, down to 35 cps. Low-frequency response in earphones is largely a function of the tightness of the seal between the phone and the ear. These phones use a foam plastic surround and do a good job.

The over-all sound of these phones is

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Many kits use a one color instruction book. Hermon Scott decided to continue to use full color to insure factory-built performance, even at the hands of a novice.

Important Scott engineering extras like the all-aluminum chassis, DC operated preamp heaters and unique hum-null balancing could have been eliminated. Hum would have been audibly higher and distortion at levels normal to many kits, but Hermon Scott felt that the kit builder was entitled to the same performance he has come to expect from Scott factory-wired units.

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smooth and clean, with very good highs. The lows and middles can sound a little muddy if the level is increased too much, but at normal listening levels they are comparable to good quality speaker systems. The effect when listening to stereo *via* phones is totally different from loudspeaker reproduction, and must be heard to be appreciated. The listener is transported to the concert hall, with startling realism. Although these phones are bulky, they are surprisingly light and are very comfortable to wear for extended periods of time. (*Editor's Note: The manufacturer advises us that all phones now have a new headband that is lighter, less bulky, and more comfortable than the one formerly used. The photo shows the new-model stereo phones.*)

Their performance compared to loudspeakers is very evident when listening at reasonably high volumes, for the loudspeaker sound can be heard across the room even when the phones are being worn. The wearer, however, is completely isolated from room sounds.

The price of the *Superex* ST-M phones is $29.95. ▲

CBS Laboratories STR-100 Stereo Test Record

For copy of manufacturer's brochure, circle No. 59 on coupon (page 118).

THE most practical way to test a stereo phono cartridge (other than listening to it) is to play a test record and measure its output or simply listen to it. A number of stereo test records have been issued, most of them rather restricted in their usefulness. A few are strictly laboratory tools intended for measurement of frequency response and channel separation. These discs, which are used by many cartridge manufacturers to check their products, are not usually available through retail outlets and are relatively expensive.

A second category of test records is aimed at the hobbyist. They may con-

(*Continued on page* 20)

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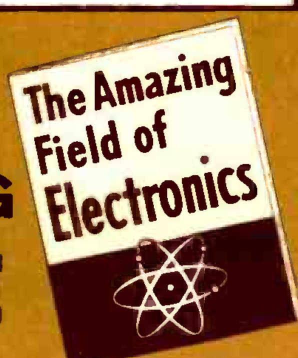

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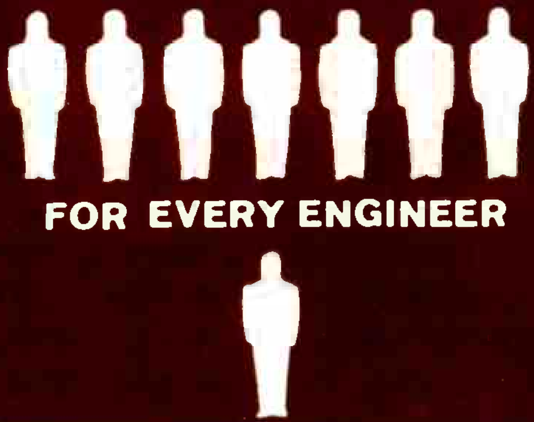

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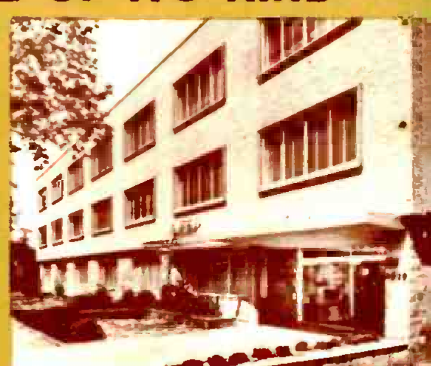

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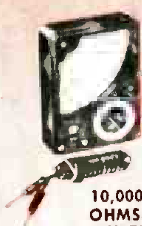

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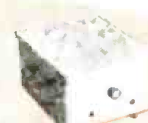

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City ______________ Zone ______ State ______ tain bands for checking phasing, several musical selections, a limited number of spot frequencies for checking response, and perhaps left- and right-channel signals at a single frequency for checking channel separation. These records are of limited value to anyone wishing to make thorough and complete measurements of cartridge performance.

The *CBS Labs* STR-100 test record combines many features of both types of records, with a few innovations of its own. For example, there are left- and right-channel sweep frequency bands, each covering 40 to 20,000 cps in 65 seconds. They are specifically designed to be used with the *General Radio* Type 1521-A Level Recorder, which can produce a graphic plot of frequency response and crosstalk for both channels, automatically, in about six minutes. These bands can be very useful to persons without a level recorder as well. The usual spot-frequency bands on test records may not coincide with sharp peaks or holes in the response of a cartridge but, by listening or watching the output of the cartridge on a meter or oscilloscope, such irregularities are easily detected. There is no simple method of determining the frequency at which these effects occur without the *G-R* Level Recorder, whose chart drive is synchronized with the record's sweep.

The new record also has spot-frequency bands, each containing 29 frequencies from 20 to 20,000 cps. These are recorded, like the sweep bands, with constant amplitude below 500 cps and constant velocity above that frequency. Each band is preceded by a voice announcement of frequency. These bands may be used to measure frequency response and crosstalk if no recorder is available, as well as to give a rough idea of the audible range of a phono system.

A pair of sweep-frequency bands, extending from 200 cps down to 10 cps, serve to check tonearm resonances in this range. They are recorded at a 3-db higher level than the other sweep bands, causing any appreciable resonance to show up as audible buzzing or even loss of contact with the groove. These bands, too, are synchronized with the *G-R* recorder for automatic measurements.

A unique feature of this record is the two groups of five bands for checking vertical and lateral compliance. These are recorded at 100 cps, with peak amplitudes from 0.001 cm. to 0.005 cm. One group is recorded with vertical modulation; the other with lateral modulation. The stylus force is adjusted to the smallest value which will allow one of the bands to be tracked without buzz-

ing or distortion. A simple formula, included in the instruction details, permits computing the vertical or lateral compliance from the tracking force and the peak recorded amplitude. The user is cautioned that the lateral compliance measured in this manner may differ from the value given by the pickup manufacturer, due to the effects of arm friction and mass. These bands are also convenient as speaker-phasing signal sources.

We checked the STR-100 test record by measuring the performance of a cartridge with it and also measuring the same cartridge with two other widely used test records. The *CBS Laboratories* record covers a wider range of frequencies than either of the other records, but there was good over-all agreement on both frequency response and crosstalk. This is the only test record we have seen which can be used for checking both these parameters over the full 20-20,000 cps range.

The sweep bands disclosed a couple of response irregularities which did not show up in any steady-state measurement of the cartridge. The compliance measurements indicated both vertical and lateral compliance values much less than the cartridge's ratings. Bearing in mind the limitations of this sort of measurement, we would consider this record to be useful for comparative rather than absolute measurements of compliance.

The new STR-100 stereo test record is a valuable tool for the hobbyist, the serious audio experimenter, and the well-equipped laboratory involved in phono-cartridge measurements. Priced at $8.50, it is available at *Columbia Records* dealers and distributors or the Audio Products Dept., *CBS Laboratories*, Stamford, Conn. ▲

Lafayette Model TE-20 Signal Generator

For copy of manufacturer's brochure, circle No. 60 on coupon (page 118).

THE Model TE-20 is an inexpensive, wide-range r.f. signal generator that can be used on the service bench for r.f. and i.f. alignment. A separate, variable-amplitude audio output permits audio-circuit troubles to be traced. The low cost of this Japanese-made, factory-wired and tested instrument, $27.95, brings it in the price range of many r.f. signal generator kits.

The generator covers a frequency range from 120 kc. to 260 mc. in six separate bands. Frequencies up to 130 mc. are covered by fundamentals, while the range from 120 mc. to 260 mc. is covered by scale-calibrated harmonics. An internal audio oscillator modulates the r.f. signal, if desired, and audio is also available sepa-

(*Continued on page 96*)

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Voltage

6 AC and DC ranges from 0 to 1000 volts on both VTVM and VOM
6 peak to peak ranges from 0 to 2800 volts peak to peak on VTVM
Zero center scale on VTVM

Resistance

6 ranges from 0 to 1000 megohm on VTVM
2 ranges from 0 to 1 megohm on VOM

Current

one easy reading scale from 0 to 1000 milliamp on VOM

Batteries

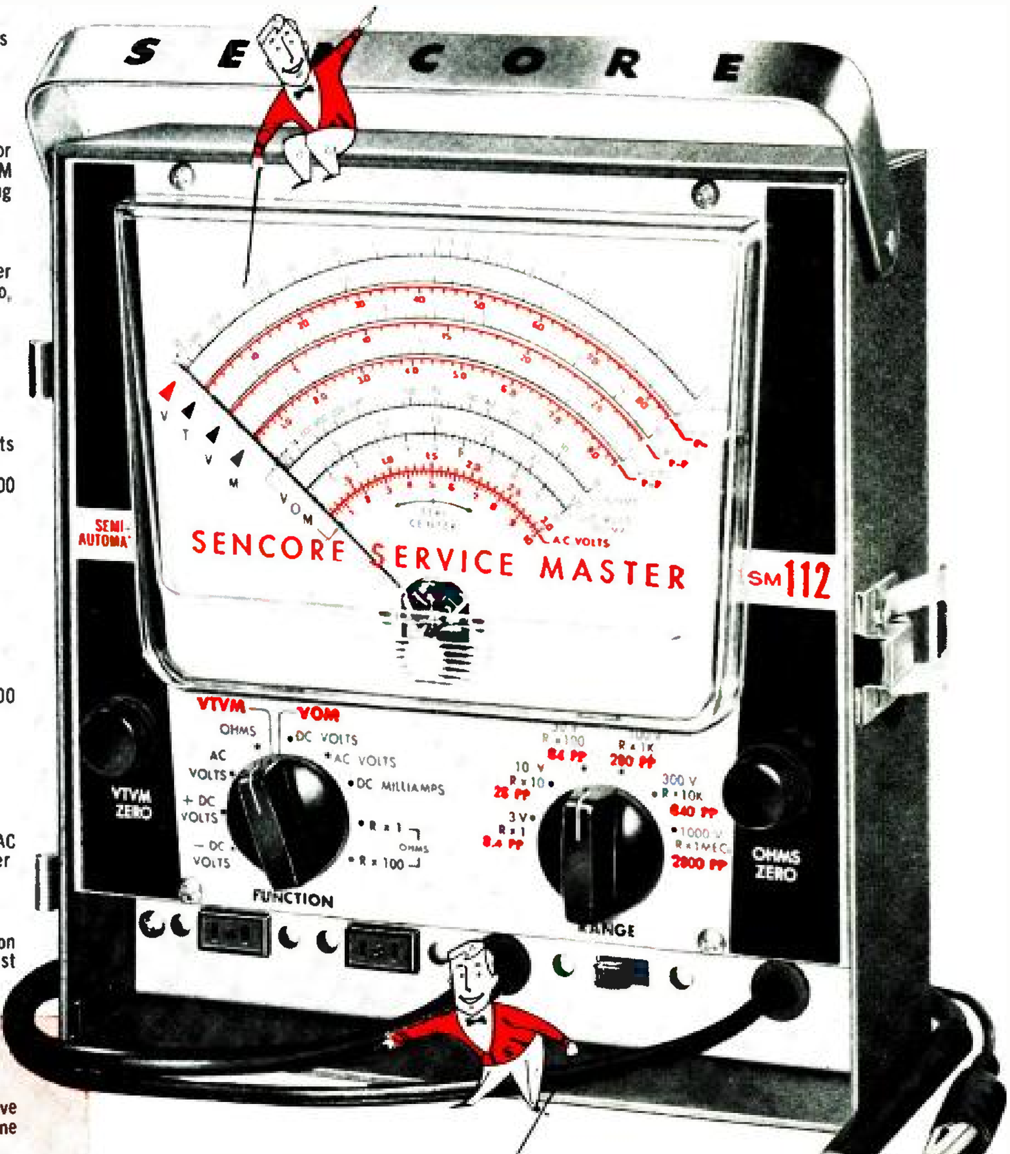
one 1.5 volt "D" cell

Accuracy

3 percent on DC volts; 5 percent AC volts with a 6 inch, 200 microamp, 2 per cent meter.

Circuit Loading

10 megohms on VTVM, 15,000 ohms on VOM low range, 5 megohms on highest range.



You'll like this! One permanent test lead for every job. Even the Hi-voltage probe fits on the end of it. And look at this storage compartment for test lead and line cord. The two 115 volt AC outlets sure come in handy on service calls!

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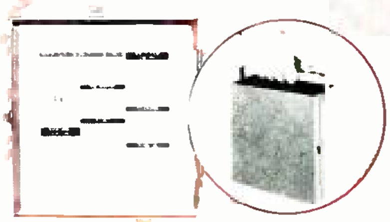

Inside the cover is a real surprise: short cut technical data to make every job easier and faster . . . standard transformer lead color code, fuse resistor burn out voltage, transistor testing guide, etc.

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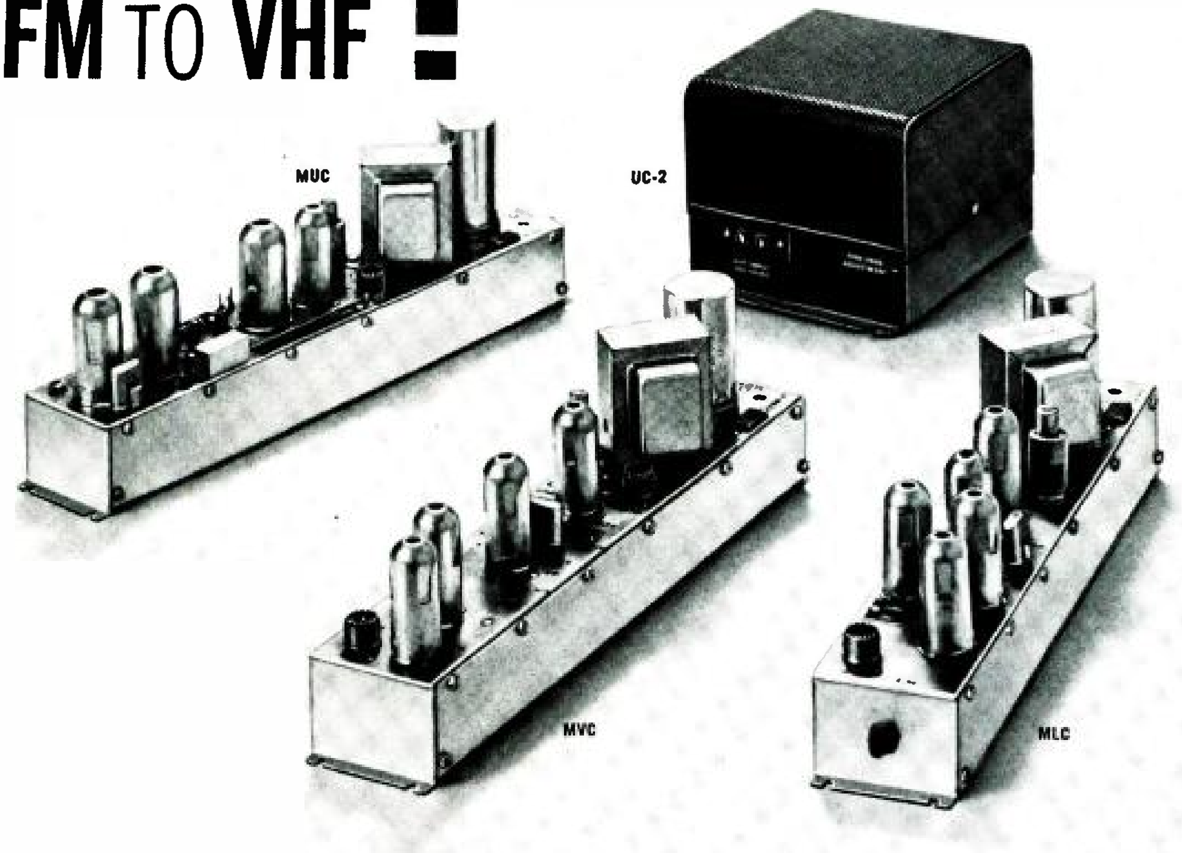

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MODEL	DESCRIPTION	GAIN	IMPEDANCE INPUT	IMPEDANCE OUTPUT	FEATURES	LIST
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MUC	UHF to VHF converter	15db to 30db	300 ohms	75 ohms	Crystal controlled. Dual output mixing network.	387.50
CO-3 (not illus.)	UHF to VHF converter	1db to 5db	75 ohms	75 ohms	Crystal controlled. UHF pre-amp	558.00
UNIVERTER (not illus.)	VHF to VHF converter	—	75 ohms	75 ohms	requires external power supply	143.25
MLC	Lo to Lo VHF converter	20db to 40db	75 ohms	75 ohms	Crystal controlled. Dual output mixing network.	400.00
MVC	Hi to Lo VHF converter	33db	75 ohms	75 ohms	Crystal controlled. Dual output mixing network.	400.00
CO-2 (not illus.)	VHF & sub channel converter	up to 20db	75 ohms	75 ohms	Crystal controlled. (FM to VHF available, list 615.00.)	403.00

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All over the country, the new Channel Master Golden Crossfire is bringing primary area picture quality into difficult fringe areas.

The Crossfire delivers the sharpest, clearest pictures you've ever seen... even at great distances. It's perfect for either color or black and white. And the Crossfire is an excellent FM antenna, too...a fact that gives you *extra* sales potential.

The case against all-in-one "transistorized antennas"

A booster can't replace an antenna...or compensate for an *inefficient* antenna. In order to get peak fringe area reception with a booster, you must start with the highest-gain antenna you can get...and that antenna is the Channel Master Golden Crossfire!

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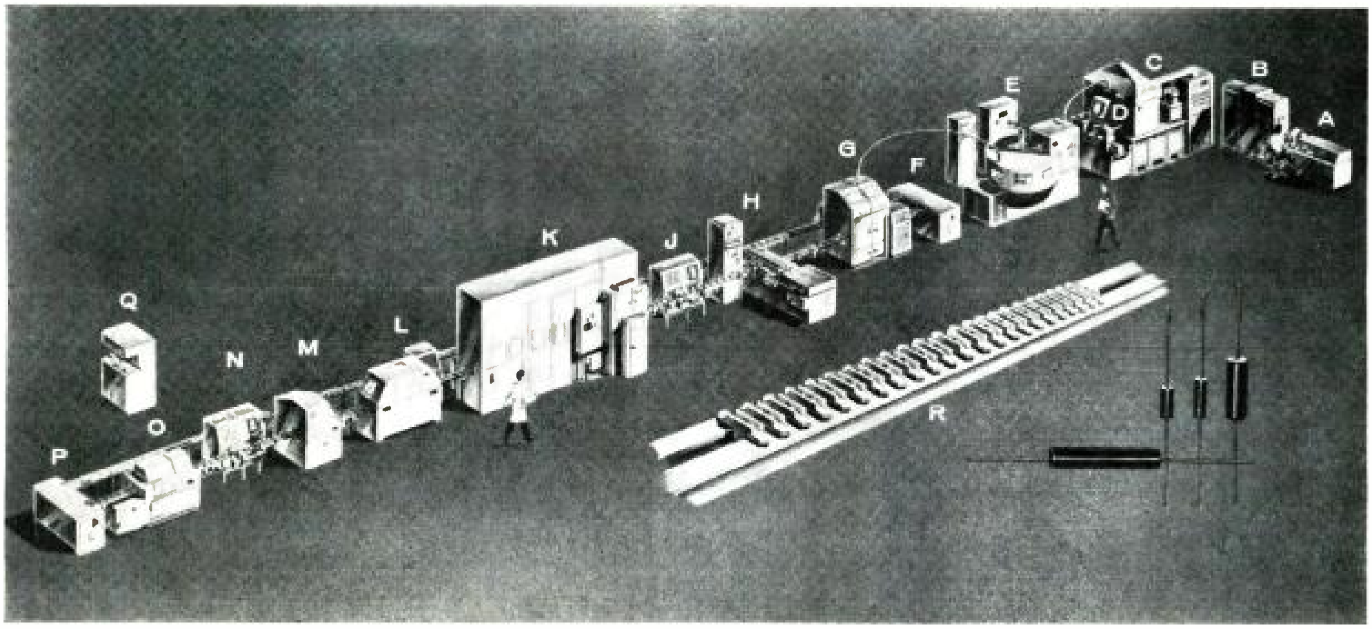
New Improved JETRON Booster with built-in AM interference filter.

This powerful transistorized booster mounts on antenna or mast. It cleans up snow and adds miles to TV and FM reception...dramatically improves the performance of any antenna... new or old. The Jetron has the lowest noise figure of any booster. Separate in-the-home power supply also serves as a 4-set coupler.



LEGEND
A. COMPUTER
B. OUTPUT-INPUT CONTROL STATION
C. COATING STATION
D. FIRST INSPECTION STATION
E. TERMINATING STATION
F. CONVEYOR CONTROL EQUIPMENT
G. CAPPING STATION
H. HELIXING STATION
J. SECOND INSPECTION STATION
K. ENCAPSULATING STATION
L. LEAK DETECTOR STATION
M. MARKING STATION
N. THIRD INSPECTION STATION
O. PACKING STATION
P. CONVEYOR CONTROL EQUIPMENT
Q. CAP-LEAD WELDING MACHINE
R. DETAIL OF CONVEYOR LINE

Three technicians, working under the guidance of an engineering associate and with minimum assistance from the development engineers, are now operating and maintaining the nation's first fully automatic resistor production line shown here. The legend identifies the various line stations through which the high-reliability, ultra-stable, precision resistors pass.

The dawn of the computer and automation era is opening up more and more opportunities in this field.

Engineering associates at *Western Electric* are a group of technical employees used as part of the engineering team. They are generally college graduates who hold non-engineering degrees, former engineering students who left college prior to obtaining a formal degree, or graduates of trade schools with experience in various specialized fields. Specialists range from electronics, mechanics, chemistry, math, computer service, and programming to vacuum-system experts. These employees, assigned to projects according to their past experience and training, are relieving the shortage of professional engineers by permitting them to spend more time in formulating new ideas and concepts for future projects. Careful assignment of technical help in an engineering organization not only helps to get the job done, but gives the technician or engineering associate a chance to broaden his experience and training.

COVER STORY

THE COVER photo shows our author, G. L. McClamrock (right), engineering associate in the manufacturing development engineering organization, and John D. Miller, mechanical technician, discussing the operation of the resistor-terminating machine at the North Carolina Works of Western Electric Company in Winston-Salem.

The terminating machine is used to apply a gold band to the ends of the deposited carbon resistor blanks using a process known as "sputtering." Sputtering takes place when a high accelerating voltage is applied to a solid gold cathode enclosed in a high vacuum atmosphere back filled with argon gas. The gold being bombarded under these conditions causes an effect similar to secondary emission in a vacuum tube.

The unit shown is one of a group of machines developed by manufacturing development engineers and operated and maintained by technicians. These machines, when tied together with a conveyor and computer control system, form a fully automated production line.

The production line, now in operation at the Western Electric plant, is capable of producing ¼-, ½-, 1-, or 2-watt deposited carbon resistors in a wide range of values at the rate of one resistor every three seconds. These resistors are high-reliability, ultra-stable, precision components used in the electronics equipment required for our missile program.

(Cover Photo: Western Electric Co.)

Technicians' Functions

Any idea that is to be engineered into an actual product must pass through four phases. The idea must be developed, a working model constructed, a prove-in period must take place, and then, finally, the new process or machine must function under actual operating conditions. Skilled technical assistance is proving invaluable to the professional engineer during all phases of this work.

During the development or planning phase of any new process, considerable time is consumed in making prints and sketches covering the proposed idea. Both the engineering objective and the idea must be clear and solid in the development engineer's mind. Then he is ready for technical assistance in taking over and helping to express the idea on paper. By working from rough sketches and information supplied by the engineer and designer, the technician can go ahead with the basic trial and testing of the new concept. Relieving the engineer of this time-consuming job helps accelerate the task by allowing him more time for refining his ideas and spotting potential trouble before it arises. Electrical and mechanical sketches, both rough and finished, must be made to permit an evaluation of the idea or process from a practical standpoint.

If the idea proves to be a new, more practical, faster, or better way of doing a job, it is then ready for the second, or construction, phase. A working model is necessary to demonstrate and prove the capabilities of any machine. The construction of a prototype model requires many decisions as to what types of material and components should be used. This usually involves the testing and evaluation of several types before a final decision can be reached.

Procurement of component parts is also a problem, but the real challenge lies in the actual construction of the model. It is not always possible for the engineer to express an idea on paper so completely that it can be transformed into a working model. It is generally necessary for him to build breadboard electrical circuits and experimental mechanical apparatus for evaluation and study. Here is where efficient use can be made of technical assistance.

A technician, either mechanical or electrical, can take the rough sketches and information supplied by the engineer and, with minimum assistance, build the apparatus. The technician or engineering associate, being experienced in shop practices and procedures, can offer help in determining construction limitations and machine capabilities. He can also point out weak or potential trouble spots and suggest possible alternatives. By allowing competent, skilled craftsmen to do the actual construction and wiring, the engineer is free to concentrate on refining the plans and solving construction problems as they arise.

During the third, or prove-in, phase, the job approaches reality. At this point the idea has been developed into a prototype machine or process. Now it must be debugged and evaluated. This is the time to pinpoint the weak spots, make design changes, and refine plans to insure a trouble-free working model. Failure of any part must be studied and analyzed to determine the reason for its failure and a replacement part that can handle the job must be found. A thorough debugging or prove-in is a time-consuming job which can be effectively handled by skilled technicians.

By the time the prototype is finished, the engineer and technicians are thoroughly familiar with all parts and can work together to make the machine or process a success. During this period, while the technician is making improvements and modifications, the development engineer can be completing his plans and drawings for the production model. The technician or engineering associate, now thoroughly familiar with all phases of the process, can assist the construction department in building a production model. He can correct drawings and, in general, assist the development engineer in making the final transition from an idea to a useful tool.

After initial prove-in comes the task of starting up production and proving that the equipment can do what it was designed to do. This phase of the development job can be handled almost exclusively by technicians. The development engineer, by serving only on an advisory basis, is left free to develop maintenance programs and operating procedures for utilizing the new equipment with maximum efficiency. There will also be minor modifications necessary to make the equipment compatible with the process. If the equipment is of a complex nature, such as the automatic production line for deposited carbon resistors recently developed by *Western Electric,* operators must be trained.

Since computer-controlled automatic equipment is so complex, high-grade, skilled, and specially trained technicians are used as operators. The very nature of the equipment makes it necessary for the operator to be thoroughly familiar with all of the machine functions and to be able to operate and maintain any part of the equipment.

Three technicians, working under the guidance of an engineering associate and with minimum assistance from the development engineers, are now operating and maintaining the nation's first fully automatic resistor production line.

The Future

In this era of computers and automation, more and more opportunities will be available to the technician. Computer operation, programming, and maintenance is a wide-open career field. The use of computers to control complex machines and processes is just coming into its own but promises to become an increasingly active field within the next few years. Well-trained technicians are in great demand to fill the many positions created by the introduction of equipment too complex for the average operator to control.

Increasing automation calls for a new kind of maintenance man—a highly trained engineer-technician—to cope with complex electronic control systems. In many plants today the maintenance man is one of the most highly skilled workmen who is employed in the shop.

Keeping production flowing is vitally important in an automated factory because of the capital tied up in automatic equipment and the losses which accrue when a continuous process is interrupted by a breakdown. Immediate, on-the-spot troubleshooting and repairs are necessary to minimize the losses resulting from breakdown. The operator-maintenance man must be alert and capable of spotting troubles before the process becomes bogged down.

The technician has always played an important role in industry but with automation and remote-controlled equipment the technician is beginning to receive recognition commensurate with the importance of his job. The "support" part of many teams sometimes goes unnoticed, but no one can deny its importance to the success of that team. ▲

This automatic inspection station (line station J) plays an important role in the automated manufacture of deposited carbon resistors. Feedback control and self-correction of the helixing machine (which cuts a spiralled groove in the carbon film to produce required resistance) are based on computer-controlled analysis of values inspected. Bad units are rejected automatically.

Our author, G. L. McClamrock, demonstrates the starting up of the fully automatic line for a day's production. Engineering Associate McClamrock is seated at the operating console of the general-purpose digital computer at station A on production line.

Offset printing techniques are employed at line station M in the automated production line. This technique is used in the computer-controlled marking machine which stamps on the wattage, resistance value, production lot number, and the date. A planetary gear arrangement is used to mount the blanket roll and inking rolls and permits the type head to remain stationary. ▶

By LEE CRAIG

Keep in constant communications by Citizens Radio, a radio-signaling transmitter, and a pocket-paging set.

PRIVATE RADIO SIGNALING

"IF I AM not on time, I am early" is the slogan of a professional photographer who uses electronics to build his business. He has found that by being available almost anywhere at any time, his services are in demand.

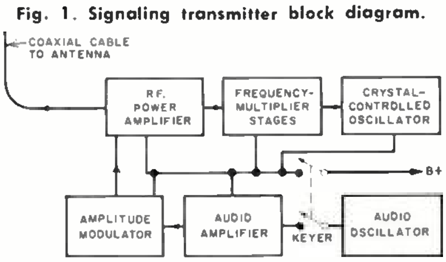
But, to be there at the required time, immediate communication is a must. And, communication he has.

His station wagon is equipped with a *Bell System* mobile telephone, a Citizens Radio, and a radio-signaling transmitter. In his pocket he carries a "Pagemaster," a radio-signaling receiver similar to the telephone company's "Bell Boy."

When within Citizens Band range, his office can reach him direct by CB radio if he is in his station wagon. When he is beyond CB range, his office calls him by mobile telephone, which is equipped for two channels—one served by the telephone company base station in Newark, N.J. and the other by the New York City station.

As long as he is in his station wagon, anywhere in the New York City-Northern New Jersey metropolitan area, he can be reached by mobile telephone. But, until he installed his radio "beep" system, he was out of reach of his office whenever he left his station wagon. Now, he takes his "Pagemaster" with him so he can be reached when having lunch or taking pictures.

Fig. 1. Signaling transmitter block diagram.



When he leaves his station wagon, he leaves the mobile telephone turned on, and throws a switch to connect his radio-signaling transmitter to the telephone bell.

When the mobile telephone bell rings, a relay turns on the radio-signaling transmitter which radiates a tone-modulated signal. This signal is picked up by the "Pagemaster" which issues an audible "beep."

Whenever the photographer hears the "beep," he rushes out to the station wagon to answer the mobile telephone. If the caller has hung up, the mobile service operator rings the caller back to complete the call.

The signaling transmitter, which operates on 27.255 mc., is a modified *Link* FM mobile transmitter to which an outboard tone modulator has been added, as shown in the block diagram of Fig. 1. The audio input to the original phase modulator is shorted out. Amplitude modulation is obtained by injecting the signaling tone into the grid-return circuit of the final r.f. power amplifier stage as shown in Fig. 2. The grid-return circuit of the final r.f. power amplifier is broken at "X," and the modulating tone signal is developed across R_1. While plate modulation will provide greater power output, grid modulation is good enough, and less costly, to satisfy the photographer's needs.

The plate and screen voltages to the final r.f. power amplifier have been reduced, by a dropping resistor, to a value that prevents operation at more than 30-watts input to that stage, the maximum permitted by the FCC.

The audio oscillator is tuned by adjusting the core of L_1 (a *UTC* variable inductor) to 256 cps. The oscillator produces a fairly pure sine-wave and is quite stable.

The values of C_1 and L_1 depend upon the tone frequency of the pocket receiver. In this case, the "Pagemaster" is equipped to respond to a 256-cycle tone. By using a variable inductor, it is possible to tune the oscillator to this frequency. The values of C_1 and L_1 for any frequency may be determined by referring to an impedance chart.

A relay, installed by the telephone company, closes its contacts when the mobile telephone rings. These relay contacts are connected to the circuit where the press-to-talk microphone circuit is usually connected.

Relay RL_1 in Fig. 3 is energized when the transmitter "on-off" switch is closed. This switch is normally turned "on" and the transmitter's tube heaters are kept warmed up. When the mobile telephone bell rings, relays RL_2 and RL_3 are energized. Relay RL_2 applies power to the input of the transmitter's dynamotor which, when running, energizes the transmitter and the audio oscillator. During the time that RL_3 is energized, the transmitter radiates a tone-modulated signal only when the mobile telephone is ringing. However, once the "Pagemaster" is tripped by the tone-modulated signal, it continues to issue a tone until its reset button has been pressed.

Sometimes the first ring doesn't trip the "Pagemaster," if it is in a dead spot. Since the photographer moves about when doing his work, the second or third ring will usually trip his "Pagemaster" if the first one doesn't.

The FCC has authorized the photographer to operate his transmitter as a class C Citizens Radio station in the manner described.

Besides normal transmitter tune-up, the only adjustment that has to be made is tuning of the tone generator by adjusting the core of L_1 until the "Pagemaster" trips. This adjustment requires two people since the "Pagemaster" should be at least 50 feet away from the transmitter to avoid overdriving the receiver.

The range of the signaling system varies with the locale. When the station wagon is in the parking lot at Bergen Mall in Paramus, N.J., for example, the photographer can be signaled when inside a steel-frame department store. The range in such a case is about 1000 feet. When in a frame building or out in the open, the range is considerably greater.

This kind of signaling system can be used by a TV service technician or anyone else who has a mobile telephone. The signaling transmitter can be at a fixed location or in a vehicle.

Equipment Required

The "Pagemaster" is made by the *Stromberg-Carlson* division of *General Dynamics/Electronics*. It fits neatly in a pocket and operates for months without requiring a change of its self-contained mercury-cell battery.

The receiver, as shown in the block diagram of Fig. 4, employs a superregenerative circuit. The receiver output feeds a vibrating reed frequency-selective decoder. It is normally mute. But, when it receives a radio signal modulated by a tone of the right frequency, the decoder trips an audio oscillator and the "Pagemaster" issues a tone that can be heard several feet away.

These receivers are available with a single-tone decoder or one that requires a combination of tones to trip it. If you have several pocket receivers and want to signal each one individually, you'll probably want the multi-tone type, each receiver set to respond to a different code. For most small establishments a single-tone type of receiver will suffice, particularly if only one man is to be signaled.

At the shop you will need an AM transmitter and a tone modulator. You can license the transmitter in the Business Radio Service if the transmitter has FCC "type acceptance." When licensed in the Business Radio Service, you have a choice of five frequencies: 27.235, 27.245, 27.255, 27.265, and 27.275 mc. You can drive the final r.f. power amplifier stage at up to 30 watts input.

Or you can license your radio-signaling transmitter as a class C Citizens Radio station. You won't need a type-accepted transmitter. You can build your own or modify an existing transmitter, provided power input to the final stage is kept to 30 watts or less, and the transmitter is crystal-controlled.

However, if licensed as a class C Citizens Radio station, you can use 30 watts (input) only if you operate on 27.255 mc. If you operate on any of the other class C Citizens channels, power input to the final is limited to 5 watts. You'll need 30 watts if you want to get maximum range. Since the receiving antenna is self-contained and close to the body, it isn't as effective as a regular mobile antenna. You'll need as much transmitter power as you can legally use.

Range also depends upon the transmitting antenna. If licensed in the Business Radio Service, and the transmitter is at a fixed location, there is no limit on antenna height, except when the antenna is a hazard to aircraft. But, in the Citizens Radio Service the tip of the antenna must not protrude more than 20 feet above the surface to which the antenna support is mounted, be it the ground or roof of a building.

If you build your own transmitter, you can get some design ideas from amateur handbooks and magazine articles since the transmitter is almost the same as a 10-meter transmitter for radio amateur use.

The FCC requires that the transmitter be crystal-controlled and its frequency stability must be 0.005% or better. Or, you can modify a second-hand FM transmitter as was done for the photographer. Be sure to check with your local FCC office or the FCC Rules and Regulations to make sure that the installation will meet all legal requirements.

Alternate Methods

Instead of tone signaling, you can use voice paging. Several belt and pocket FM receivers for the 25-54 mc. and 144-172 mc. bands are available. To use these receivers it will be necessary to use an FM base transmitter which can be licensed only in the Business Radio Service, and which must be FCC type-accepted. It is a very complicated procedure to get approval to use a home-made transmitter in the Business Radio Service.

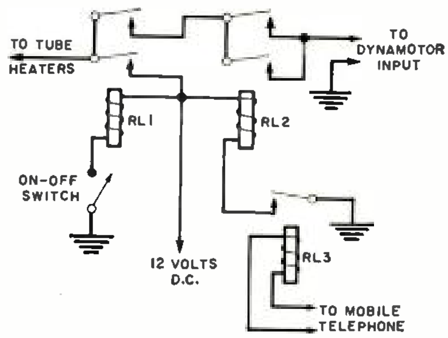


Fig. 3. Control circuit used by author.

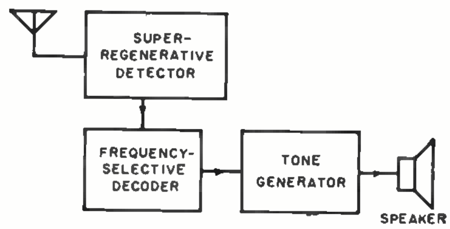


Fig. 4. Block diagram of pocket receiver.

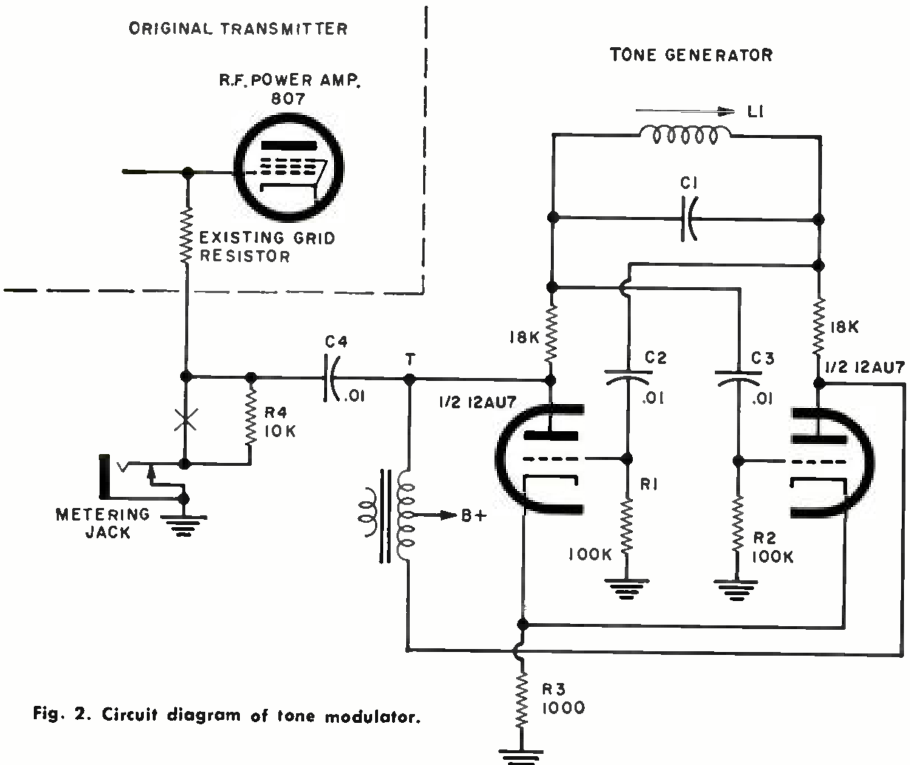


Fig. 2. Circuit diagram of tone modulator.

You can use AM portable transceivers and a Class D Citizens Radio unit as a base station, but the range will be short since transmitter power is limited to 5 watts.

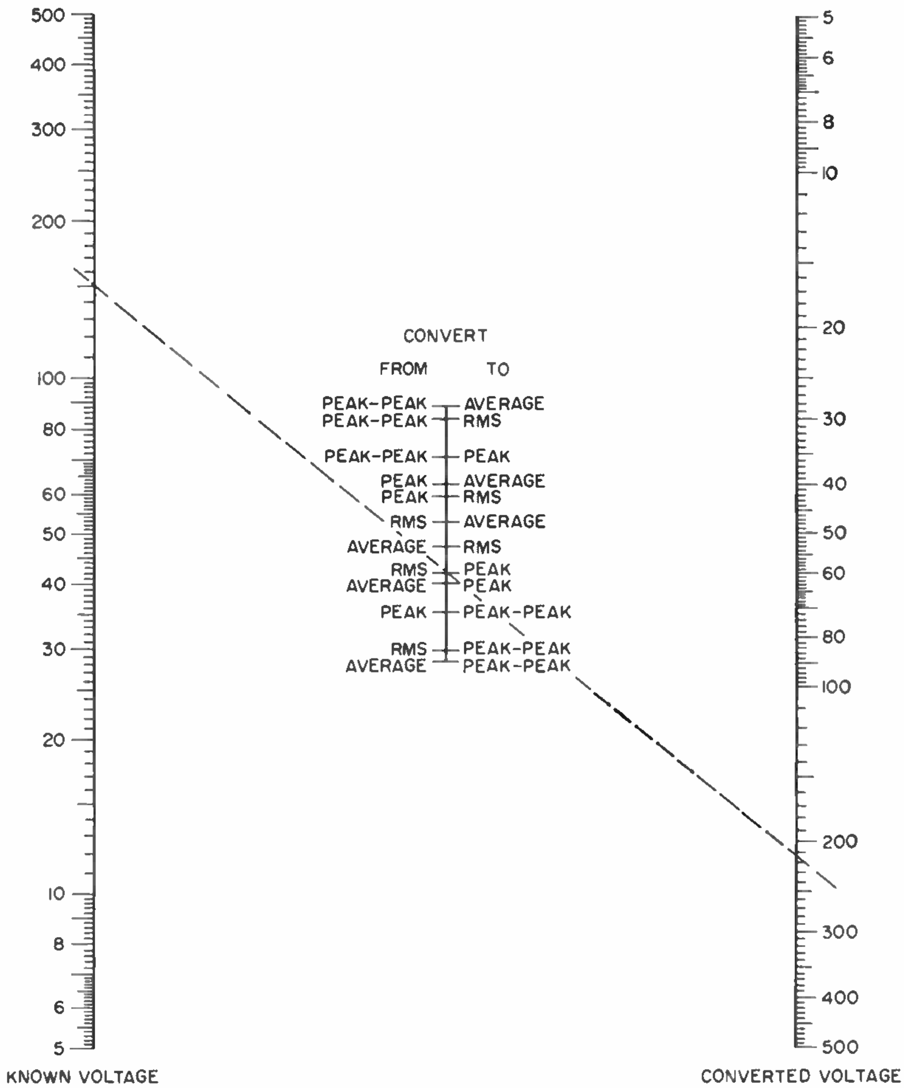
Another alternative is to use a 30-watt AM voice transmitter, licensed in the Business Radio Service along with pocket paging receivers. But you will have to hold the receiver to your ear at frequent intervals to determine if there is a call for you.

Tone signaling is more practical because you will not have to monitor all transmissions to intercept calls. The pocket receiver is turned on at all times and "beeps" only when you are being signaled.

You can buy a used 30-40 mc. base transmitter for around $100. You should budget at least $50 more for modification of the transmitter, construction of a tone modulator, and an antenna. The pocket paging receivers cost about $125 each. ▲

VOLTAGE-CONVERSION NOMOGRAM

By **DONALD MOFFAT**



Technicians will find this chart helpful in changing sine-wave voltages and currents to average, effective, peak, and peak-to-peak values by use of ruler.

THERE are four ways to express an a.c. voltage and each is advantageous in certain applications. For instance, when a voltage is used to heat tube filaments we are interested in its heating or effective (r.m.s.) value, but when it is used to calibrate an oscilloscope, we want its peak-to-peak value. The nomogram makes it convenient to convert from any value to any other equivalent value.

For example, suppose you have a transformer with a 300-volt center-tapped secondary and want to know the maximum d.c. you can obtain by using it in a full-wave power supply.

The maximum voltage will be obtained when very little current is drawn, at which time the filter capacitors will charge up to the peak voltage. Therefore you want to know the peak equivalent of 150 volts r.m.s. (the known voltage measured to one side of the center-tap).

From 150 on the first scale, draw a straight line through "RMS-Peak" on the center scale and extend the line to cross the last scale, as shown dotted on the chart. At the crossing on the last scale, read the equivalent peak value of 212 volts.

Extending the Scales

The range of the scales can be extended indefinitely by moving the decimal point the *same* number of places, in the *same* direction, on *both* outside scales. If you are working in the region of 10,000 volts, move the decimal point three places to the right on both scales and then the 10 on each outside scale becomes 10,000.

Because the same conversion factors apply, this nomogram can be used for the conversion of sine-wave current as well as voltage.

One caution, however. The relationship between any two methods of specifying a voltage is a function of the waveshape, duty factor, and other characteristics. Because a sine wave is the waveform which is most often expressed in different ways, this nomogram has been prepared for sine waves only. ▲

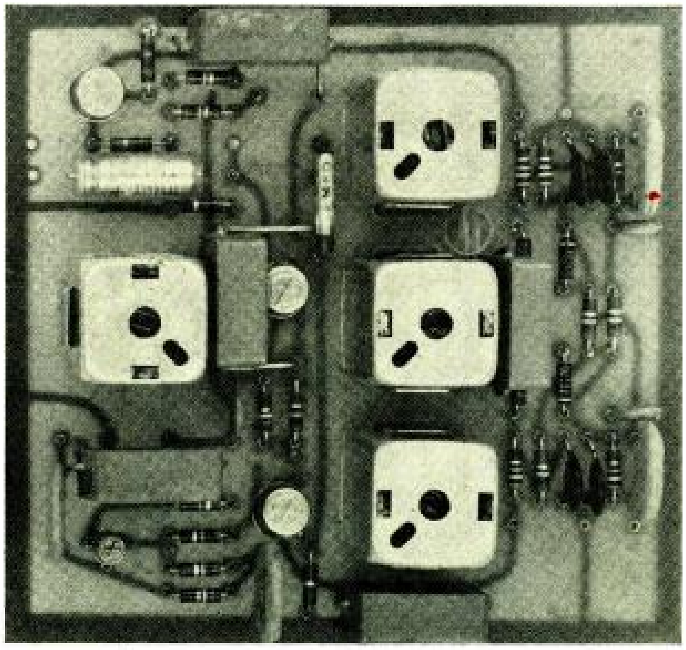


Fig. 1. Top view of the completed FM-multiplex adapter shown practically full size in this photograph.

TRANSISTORIZED FM-MULTIPLEX STEREO ADAPTER

By LARRY BLASER / Fairchild Semiconductor

Design and construction of a simple adapter using new silicon planar transistors in a switching-type circuit.

THE ideal stereo multiplex adapter is one which can be incorporated into the tuner or hi-fi console as though it were originally designed for it. A transistorized adapter can most closely meet this ideal because of its small size and simple power requirements.

Transistors used in the multiplex adapter to be described are planar *n-p-n* silicon types. They give high input impedance, high breakdown voltage, withstand high cabinet temperatures, and assure long trouble-free service.

Such *n-p-n* silicon transistors are no longer too expensive for entertainment use. Formerly they were high priced and restricted almost exclusively to military equipment, but during 1961 prices declined considerably to make them very attractive for use in commercial and industrial equipment.

The transistorized adapter described in this article and shown in Fig. 1, was built by the Applications Section of *Fairchild Semiconductor*. It occupies a space of only 4" x 4" x 1½"; yet despite this small size, its simplicity, and modest power requirement, it has a performance comparable to or better than many of the larger, more complicated, and costly adapters now available commercially. This adapter, which requires no switching to receive both multiplex and monophonic FM broadcasts, has no external controls to add to the operating complexity of the high-fidelity system.

Multiplex Demodulation Systems

Multiplex adapter designs use one of two basic systems. The more common is the matrix system in which the subcarrier channel and the main channel are separated, a synchronous 38-kc. signal is added to the subcarrier channel, and this subcarrier signal, along with the re-inserted carrier, is demodulated, then added to and subtracted from the main channel in a matrix. In the other system, which is used in this transistorized adapter, the composite multiplex signal is sampled at a synchronously controlled rate of 38 kc.

Before analyzing and comparing the two demodulation techniques, it would be well to briefly review the multiplex

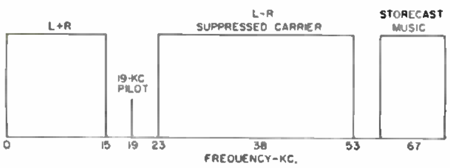
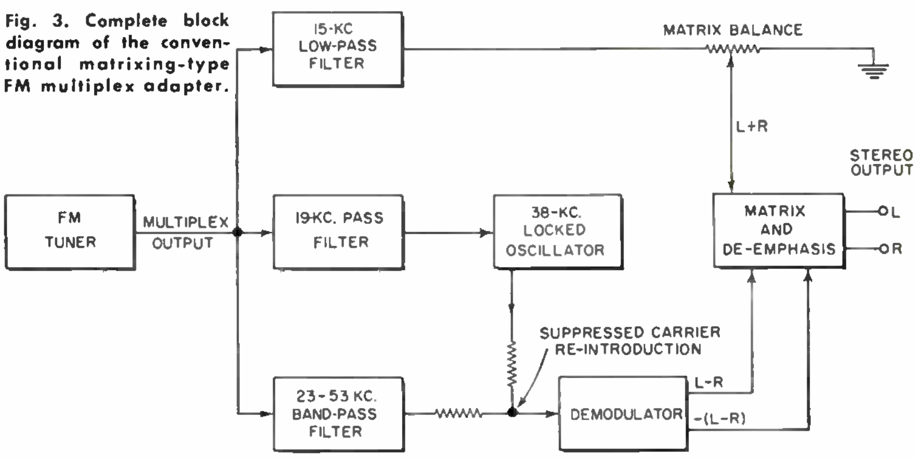


Fig. 2. Complete frequency spectrum of an FM broadcast station transmitting stereo.

Fig. 3. Complete block diagram of the conventional matrixing-type FM multiplex adapter.



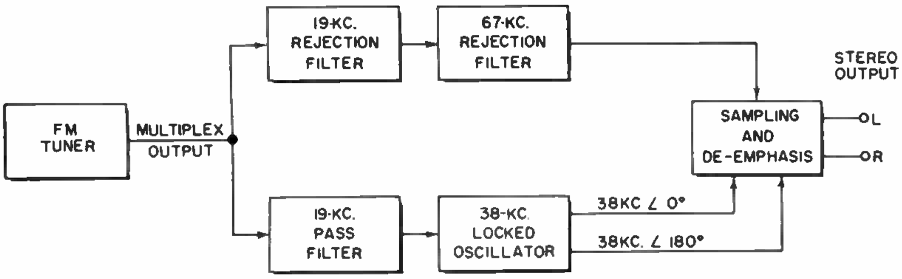
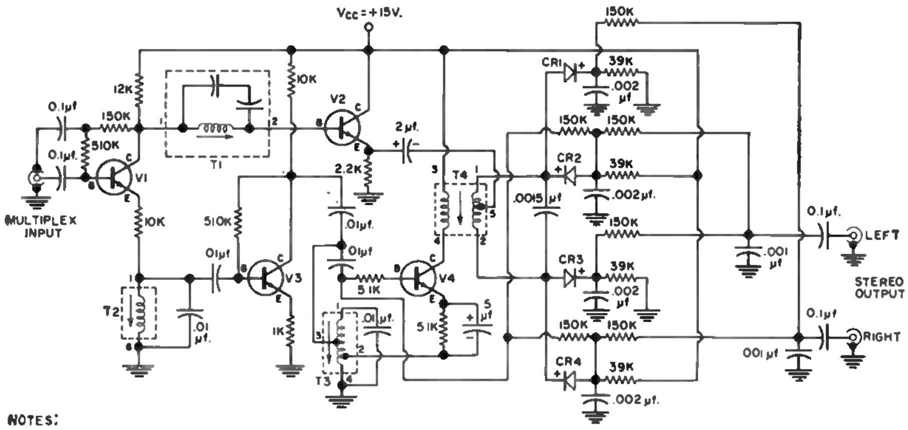


Fig. 4. Complete block diagram of the time-multiplex type of adapter described here.



NOTES:
T1 -MILLER 1352 (67KC.)
T2,T3- " 1354 (19KC.)
T4 - " 1355 (38KC.)
V1 -FAIRCHILD S-3330
V2,V3,V4- " S-3320
CR1,CR2,CR3,CR4 -FO100 OR EQUIVALENT

Fig. 5. Complete schematic diagram of transistor multiplex adapter. The transistors used are special low-cost silicon planar types. These are available from Fairchild Semiconductor distributors at $2.75 each. Specifications for these transistors are also available from the distributors or directly from the company at 545 Whisman Rd., Mountain View, Calif. The manufacturer may also be contacted for the names and locations of his distributors. Standard transistor types that may be substituted for the ones indicated in the diagram are the following higher-priced units: for V_1, 2N957; for V_2, V_3, and V_4, 2N910, 2N911, 2N1711, 2N1973, 2N1974, and 2N1983. The four crystal diodes are Fairchild silicon planar computer types. But these are not too critical and general-purpose video-detector diodes may be used here.

system that was approved by the FCC in April 1961.

Multiplex Transmission

Stereo multiplex broadcasting requires that there be two channels for carrying information. For such a system to be compatible with monophonic receivers, that is, receivers without multiplex adapters, it was decided that the main channel which the monophonic listener hears should contain the sum of the left and right stereo channels, L + R. The subcarrier channel is modulated with the difference between the two stereo signals, L − R. The carrier frequency of the subcarrier channel is suppressed to avoid transmitting a large signal that carries no information. However, to detect a suppressed carrier signal it must be possible to reproduce the carrier at the receiver in the correct phase relationship. To do this, a small pilot signal of half the subcarrier frequency and of a fixed phase relationship to it is added to the composite multiplex signal.

The FCC has approved, in addition, a second subcarrier at 67 kc. to be used for commercial background music. The complete multiplex spectrum is shown in Fig. 2.

Matrix Adapters

In the matrix system the main channel, the 19-kc. pilot signal, and the 38-kc. subcarrier channel are separated from the composite multiplex signal by filtering. The 19-kc. signal locks an oscillator having a 38-kc. output. This 38-kc. signal, which must be in-phase with the original 38-kc. suppressed carrier, is reinserted into the subcarrier channel. The subcarrier is then demodulated into audio signals of L − R and −(L − R). Finally these two signals, L − R and −(L − R) are added in a matrix to L + R to obtain stereo outputs of 2L and 2R. A block diagram of a matrix-type adapter is shown in Fig. 3.

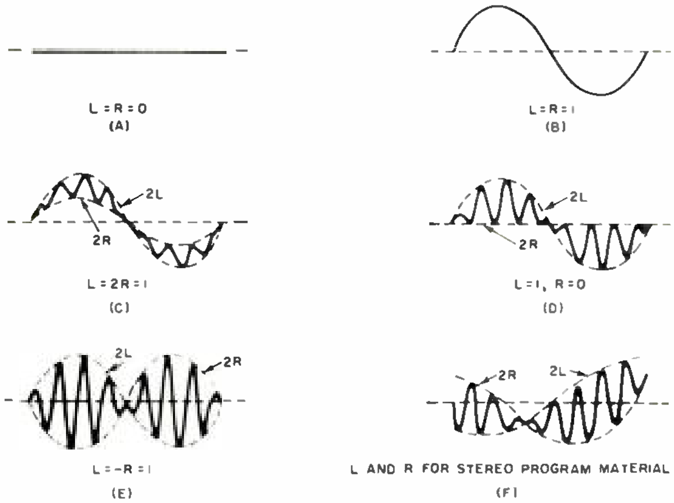
Time-Share Adapters

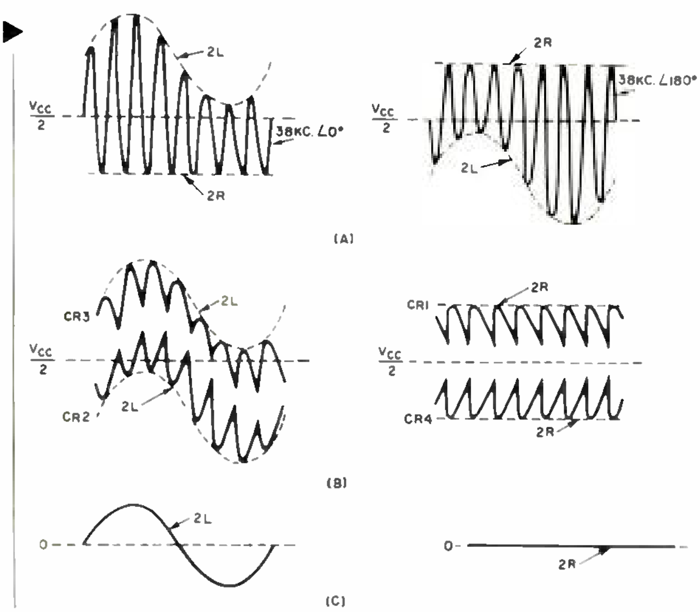
Although time-multiplex or time-share sampling techniques of demodulation are less obvious and therefore less widely used at present, they do offer advantages over the matrix system. In the time-share system, neither a 23-kc.–53-kc. bandpass filter nor a 15-kc. low-pass filter is required and the problem of balance in the matrix is eliminated.

To better understand the time-multiplex system it will be instructive to examine a number of multiplex signals at the receiver detector output for special cases of left and right stereo signals. To simplify the illustrations of Fig. 6, the 19-kc. pilot signal, which is normally a part of the composite signal that is

Fig. 7. Waveforms that illustrate how time-sharing takes place when the applied signal is the same as shown in part D of Fig. 6. ▶

Fig. 6. A number of multiplex signals at the output of the receiver detector for special cases of left and right signals.





transmitted, is not included here.

In the time-multiplex system, the composite signal, less the 19-kc. pilot, is alternately sampled by a left and right circuit at a 38-kc. rate. As in the case of matrix demodulation, the 38-kc. sampling must be in-phase with the original 38-kc. suppressed carrier signal of the subcarrier channel.

Note that if L and R are zero, as in Fig. 6A, L+R=0 and L−R=0 and since the subcarrier is suppressed, the output from the tuner detector is zero (except, of course, for the 19-kc. pilot signal which has a constant amplitude and is independent of L and R signals). If L and R are equal, as in Fig. 6B, there is no 38-kc. component in the multiplex signal and 38-kc. sampling by two circuits will yield identical outputs. If, however, L and R are different, as in Figs. 6C, 6D, 6E, and 6F, the multiplex signal will contain a 38-kc. component that has envelopes of 2L and 2R.

In the time-multiplex system, the composite multiplex signal is sampled at a 38-kc. rate in such a manner as to recover these envelopes from the composite multiplex signal. Fig. 4 is a block diagram of such a time-multiplex adapter.

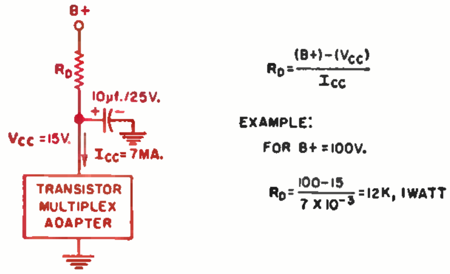


Fig. 8. Series-dropping resistor calculations.

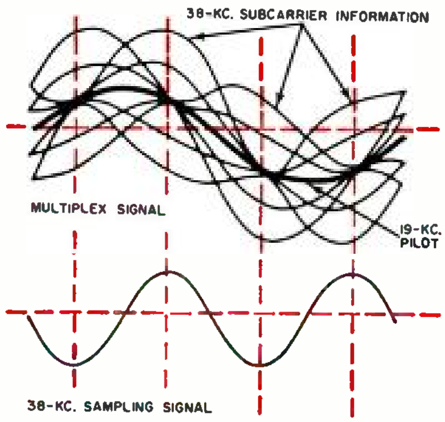
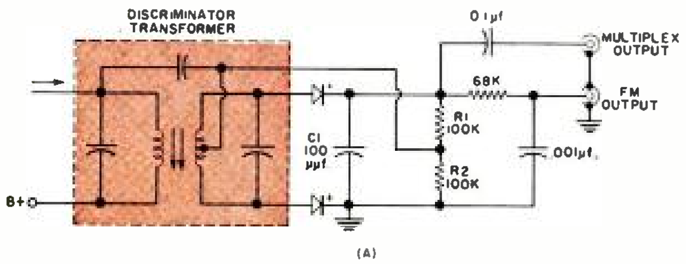
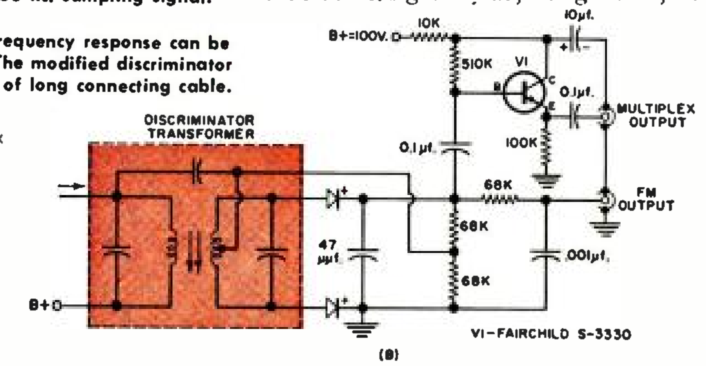


Fig. 9. Phase relations between the multiplex signal and the 38-kc. sampling signal.

Fig. 10. (A) Typical Foster-Seeley discriminator whose frequency response can be improved so that it may be used with the adapter. (B) The modified discriminator circuit along with an emitter-follower to permit the use of long connecting cable.





Time-Multiplex Adapter

Fig. 5 is the circuit diagram of an adapter which uses the time-multiplex system of demodulation. V_1 provides a high-impedance input with a 19-kc. resonant tank in the emitter. This tuned circuit makes the impedance in the emitter circuit of V_1 high at 19-kc., thereby rejecting the 19-kc. component of the multiplex signal in the collector circuit of V_1. The 67-kc. storecast music subcarrier, if present in the multiplex spectrum, is rejected by the tuned circuit of T_1. V_2 is an emitter-follower to provide a low-impedance voltage source to the time-share circuit associated with T_1.

The 19-kc. signal across T_2 is amplified by V_3 and locks the oscillator-doubler circuit of V_4. The composite multiplex signal, less the 19-kc. pilot signal, is superimposed on the synchronous 38-kc. balanced output of T_4. Diodes CR_1 and CR_4 produce one stereo output and CR_2 and CR_3 the other. To illustrate how time-sharing takes place, refer to Fig. 7. This shows the signal of Fig. 6D where L = 1 and R = 0 superimposed on the 38-kc. balanced output of V_4. These two signals are rectified by diodes CR_1, CR_2, CR_3, and CR_4. The outputs of each diode are shown in Fig. 7B.

The voltages of Fig. 7B are applied to the 150,000-ohm resistors in the deemphasis network and the resultant stereo output for L = 1 and R = 0 is shown in Fig. 7C.

Separation of the adapter is about 25 db at 1 kc. The 19-kc. rejection is greater than 20 db and 38-kc. rejection greater than 30 db below one volt. The required signal-level input is 0.5 to 1 volt r.m.s. corresponding to 100% modulation. The adapter input termination is about 250,000 ohms shunted by 20 µµf. Current drain is only 7 ma. so that power can be supplied from a tube receiver "B+" supply through a dropping resistor, as shown in Fig. 8, or from a self-contained battery.

Alignment of the Adapter

Connect the adapter to the multiplex output of an FM tuner that has a detector output of 0.5 to 1 volt r.m.s., corresponding to 100% modulation, and a frequency response to 53 kc. The connecting cable should be short, preferably less than 18 inches, in order to avoid a high cable capacitance which could attenuate the high-frequency components of the multiplex signal. Tune to a station that is broadcasting multiplex stereo and with any general-purpose oscilloscope, observe the 19-kc. pilot signal at terminal 1 of T_2. Carefully adjust T_2 until this signal has a maximum amplitude. Next attach the oscilloscope input to terminal 4 of T_1. Synchronize the oscilloscope with the 19-kc. pilot signal at terminal 1 of T_3. Lock the oscillator output to the 19-kc. pilot and obtain a maximum amplitude 38-kc. signal by adjusting T_3. Adjust T_1 until this signal most closely resembles a sine wave.

Finally, vary the phase of the 19-kc. pilot by a slight re-tuning of T_2 to put the 38-kc. sampling signal exactly in-phase with the original suppressed carrier of the subcarrier channel. This can be done by listening to the left and right outputs of the adapter and adjusting T_2 for maximum separation. A more precise method of making this adjustment is to alternately observe the phase relation between the multiplex signal at the emitter of V_1 and the 38-kc. sampling signal at terminal 4 of T_4 while

(*Continued on page* 73)

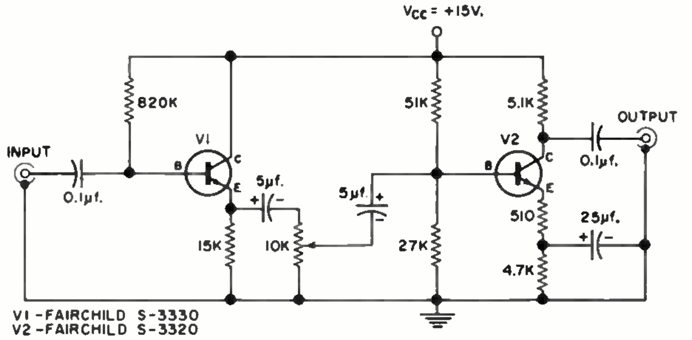
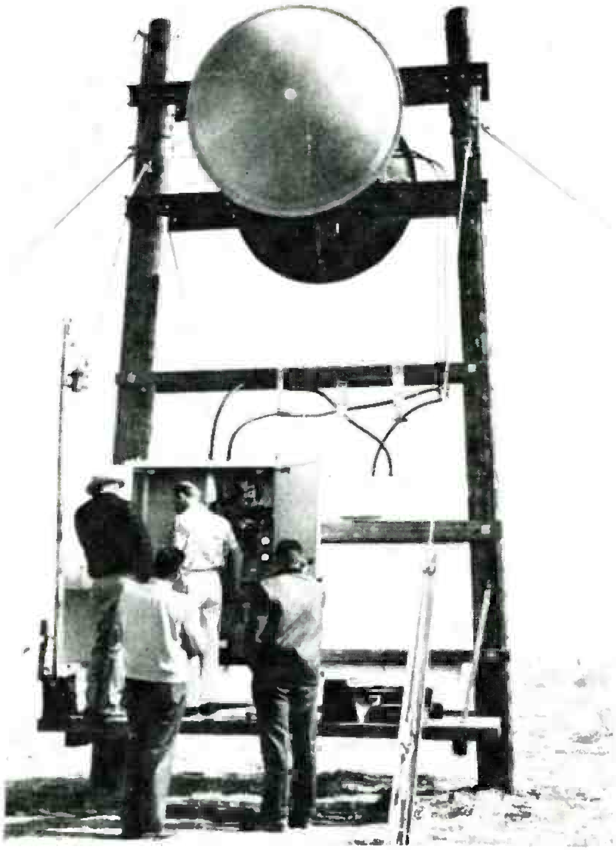


Fig. 11. An amplifier that may be utilized with low-output tuners.

Low-Cost Microwave System

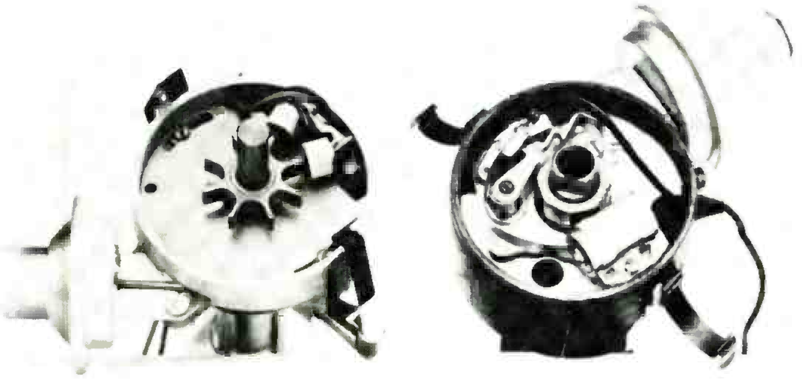
This microwave relay station near Billings, Montana is part of the first installation of the new TL microwave system being produced by Western Electric. The system was developed as a low-cost, light-traffic system to meet telephone companies' needs for more economical transmission over distances up to 200 miles. The radio relay will be used for transmitting voice, data, and teletypewriter messages over short routes. The system will handle up to 240 simultaneous telephone conversations over two terminal stations and up to nine intermediate relay stations spaced at intervals averaging 15 miles. TL is expected to be especially useful in lightly populated areas and for providing temporary or emergency transmission services.



RECENT DEVELOPMENTS IN ELECTRONICS

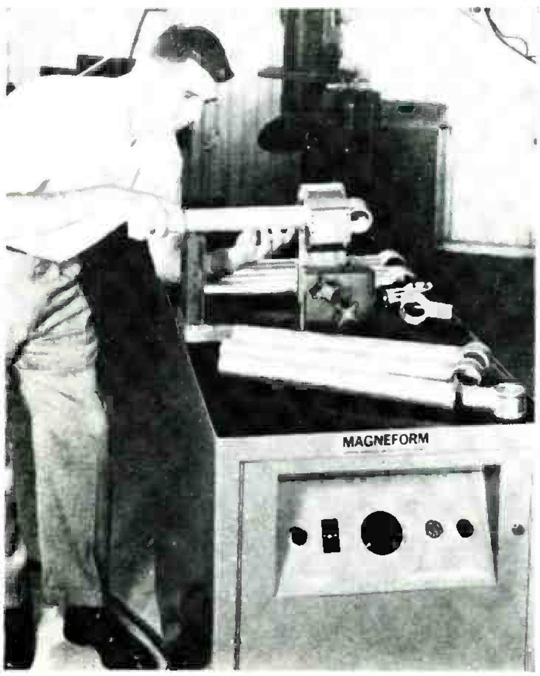
Electronic Ignition System

An electronic ignition system for cars and trucks was unveiled recently by Motorola. The new system completely eliminates the breaker points and capacitor in the distributor (shown at right in photo) and replaces them with a small magnetic pulse-generator (shown at left) which will last the lifetime of the automobile. Since no contacts are made and broken in the pulse-generator, there is no wear or adjustment needed. A transistor pulse amplifier is also used. The new system is being tested by several car manufacturers.



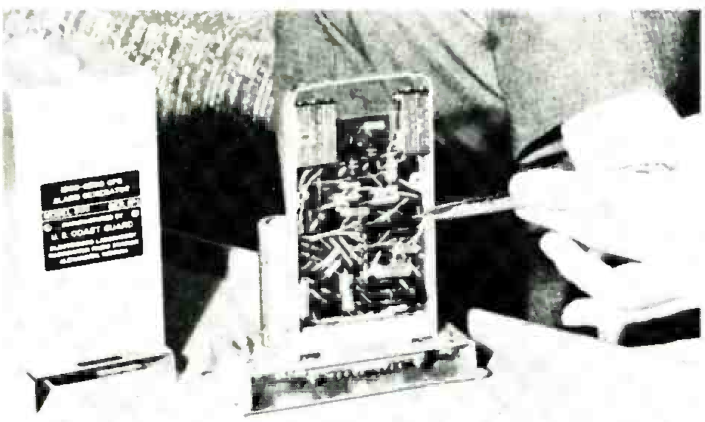
Electromagnetic Metal Former

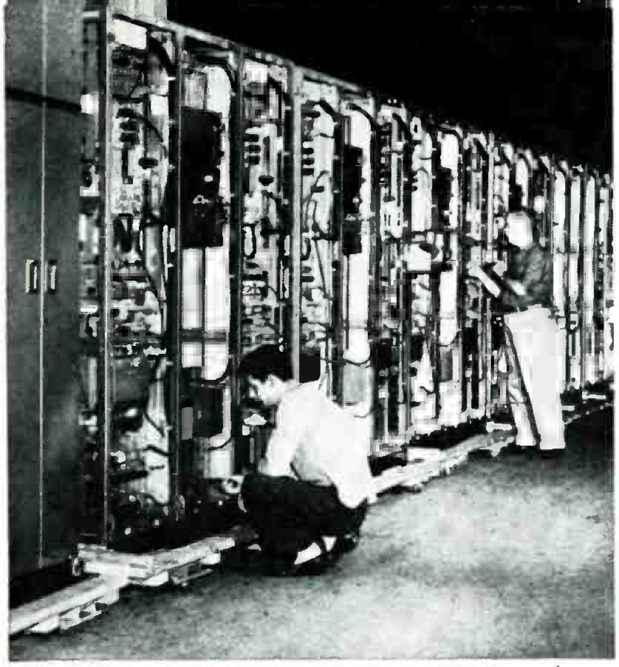
The first electromagnetic metal-forming machine has been developed and placed on the market by General Dynamics. The machine employs a magnetic field whose powerful impact is applied to the metal work piece in pulses of 10 to 20 microseconds with pressures of more than 50,000 pounds per square inch. Sections of aluminum tubing shown in photo are joined when placed in a special coil through which a high-current pulse flows. The giant pressures produced can be used to compress tubing and to attach terminals onto cables.



Coast-Guard Alarm Generator

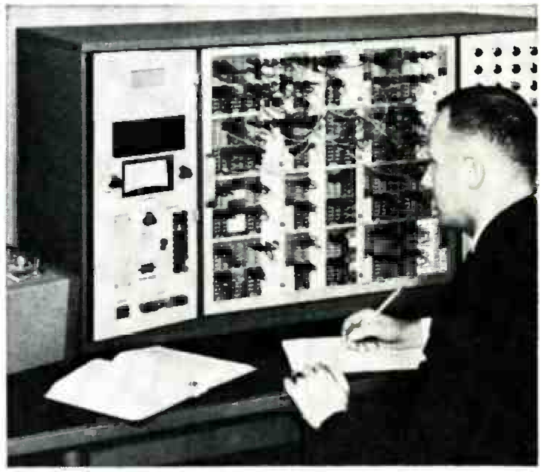
The new Coast Guard $1\frac{3}{4}$-pound alarm-signal generator for the radio-telephone distress frequency, 2182 kc., is shown below. This generator, recently installed in San Francisco and New York, is used to alert all stations that a distress message is about to be transmitted and that all non-distress traffic is to stop at once. The distinctive sound of the alarm signal consists of two tones at 2200 and 1300 cps which alternate four times each second. The Coast Guard is interested in receiving reports on the reception of the alarm signal.





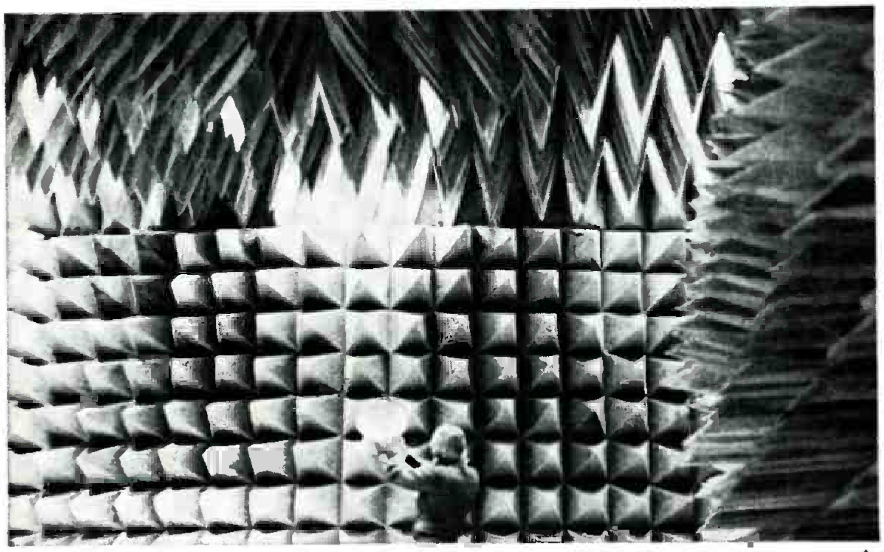
Long-Distance Radio Relay

Microwave equipment, capable of handling 2.4-million words per minute, is inspected at RCA's *Camden, N.J. plant prior to shipment for installation in* Western Union's *5300-mile transcontinental microwave radio relay system. Each of the system's 236 repeater stations will be equipped with two of the transmitter-receiver racks like that shown in the foreground.*



Desk-Size Analog Computer

A new entry in the computer market is this general-purpose analog computer introduced by Electronic Associates, Inc. *The new unit has sufficient capability and accuracy to solve complex engineering and research problems, yet is of such size that it can be placed on a desk or a cart in a lab. It is completely transistorized and requires no special environment or power supply so that it can be moved easily. The new computer is housed in a single cabinet which measures 47" long, 25" high, and 20" deep. It weighs 275 pounds. In addition to its use in industry, the desk-size computer should be useful as a training or research tool for technical schools or colleges.*



Radio-Frequency Darkroom

This microwave darkroom is in use at the Air Force Special Weapons Center, Albuquerque, New Mexico to help develop space-probe telemetry and nuclear weapons fuze systems. The anechoic r.f. chamber is 46 x 21 x 16 feet in size. Walls are covered with 26-inch long pyramidal sections of rubberized hog hair impregnated with carbon for maximum absorption. Design prevents antenna pattern distortion and simulates space-transmission environment.

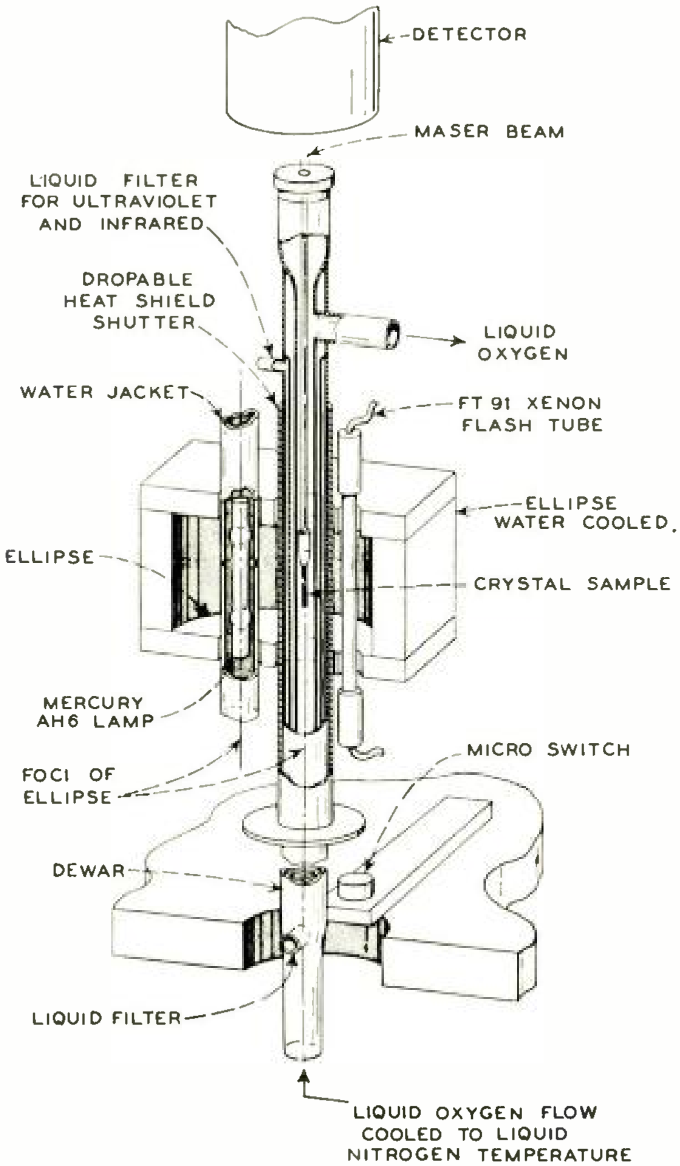
High-Temperature Resonators

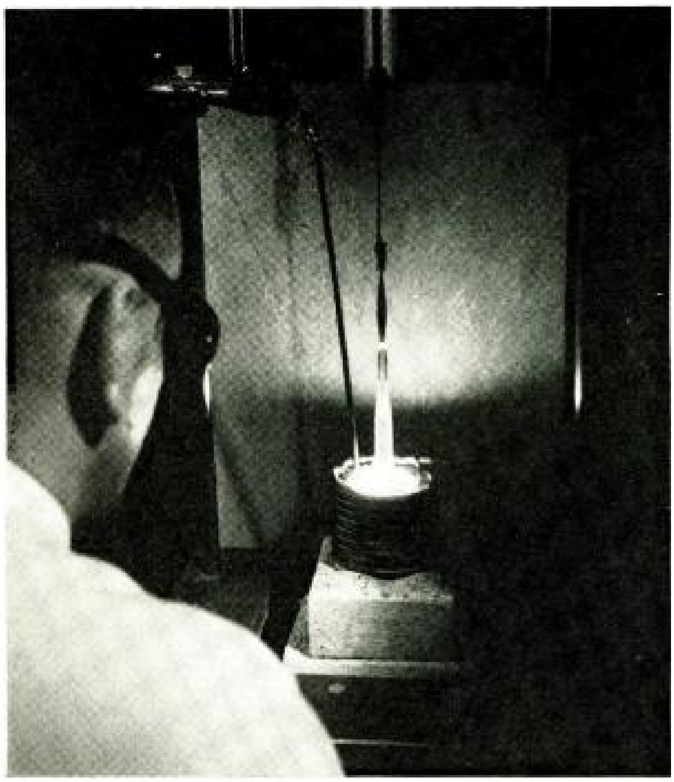
Bell Telephone Laboratories' *scientist is shown placing a quartz crystal into a furnace for electrolysis treatment. At least 500 volts per cm. is impressed across the crystal as it is kept at a temperature of 500°C for 24 hours. The electrolyzed quartz is then cut into wafers which can be used as frequency-control resonators at temperatures higher than is possible with ordinary quartz.*

SOLID-STATE OPTICAL MASER OPERATES CONTINUOUSLY

Steady milliwatt oscillations produced by the use of neodymium-containing crystals with low power threshold.

Optical maser configuration. When in place, neodymium crystal is at one focus of elliptical cavity, pump lamp at other focus.





Neodymium in calcium tungstate crystal used in continuously operating optical maser is shown being pulled from the melt.

SCIENTISTS at the *Bell Telephone Laboratories* announced recently the achievement of continuous operation in a solid-state maser. The active medium is a single crystal rod of calcium tungstate containing the rare metallic element neodymium. The maser radiates in the infrared portion of the frequency spectrum. At present, the power output is in the milliwatt range. However, substantially higher powers are anticipated.

The new development removes the restriction of a pulsed, intense pumping light, and optical maser oscillations are maintained continuously. The experiments open up the possibility of combining prolonged operation, hitherto possible only with the gaseous optical maser, with high output power, attainable more easily in solids. Calcium tungstate containing neodymium is particularly favorable for continuous operation because of its low power threshold, or point at which optical maser action commences.

The recent experiment was conducted using an optical system consisting of a special housing for the maser rod. This is an elliptical cylinder whose walls are silver plated and highly polished. Placing a high-power d.c. lamp at one focus of the cavity serves to concentrate the pumping light on the maser crystal placed at the other focus. The apparatus also contains a system to remove heat from the crystal and an optical filter to exclude unwanted ultraviolet light.

Maser action is obtained when power fed to the d.c. lamp exceeds 900 watts. In the experiment, continuous oscillation, with no detectable decrease in amplitude, was observed for five minutes and there is every reason to believe that it could have been continued for substantially longer.

In a solid-state maser, electromagnetic oscillations at a visible or infrared frequency are generated through the process of stimulated emission. The crystal rod, whose ends are highly polished to a slight convex curvature and silvered, is excited by the pumping light from a bright lamp. The result is a coherent optical wave which travels up and down the rod, some of it escaping from the partially reflective ends. Until now, the power requirements of the pumping light have been so severe that they could only be met by use of a flash lamp, permitting the solid-state optical maser to oscillate for only a few milliseconds.

Optical masers (sometimes called "lasers") may be used in the future to generate carrier signals that will handle many communications channels for outer-space transmissions. ▲

SIMPLE TAPE RECORDER REPAIRS

Unless you're a specialist, even a popular unit is baffling. This basic troubleshooting guide will get you headed in the direction of the fault on a common home recorder in all but a few cases.

By **WALTER H. BUCHSBAUM**
Industrial Consultant, ELECTRONICS WORLD

IF YOU are a service technician who gets an occasional tape recorder to work on, troubleshooting may be a problem. To the specialist in this line, however, most repairs may be just as routine as those on a TV set are to you. After all, most TV receivers try to produce the same, general result: a satisfactory picture with its accompanying sound. Inevitably then, most sets will have more similarities than differences and you will use the same, general methods. Since all tape recorders have a common purpose, a similar rule can be applied to them, especially the non-professional machines intended for home use.

The tape-recorder specialist, like his opposite number in TV, not only is adept at common problems but has progressed to familiarity with the peculiarities of individual designs. He will be ahead of the material treated here. For the non-specialist, it is cheering to note that most home recorders share many common features and therefore common types of defects. Even without considering trick circuits and esoteric mechanisms, he can handle all but a few, rare defects with a generalized understanding.

Before considering defects, let us consider the major functional parts of any recorder. In Fig. 1, we have divided the mechanical portions into the tape transport or drive and head assemblies. Electronic portions are the audio and bias-erase sections. This division is convenient because it is usually quite simple to identify a defect within one of these four areas before pinning down the exact trouble spot.

The tape transport system includes a motor (perhaps two), various drive belts, wheels, brakes, clutches, springs, and other mechanical parts. Their primary functions are to move the tape past the heads during recording or playback at a controlled rate, from supply reel to take-up reel, to stop tape motion when desired, and to reverse the direction of tape travel—usually for rewinding tape back to the supply reel at increased speed with no contact between tape and the heads.

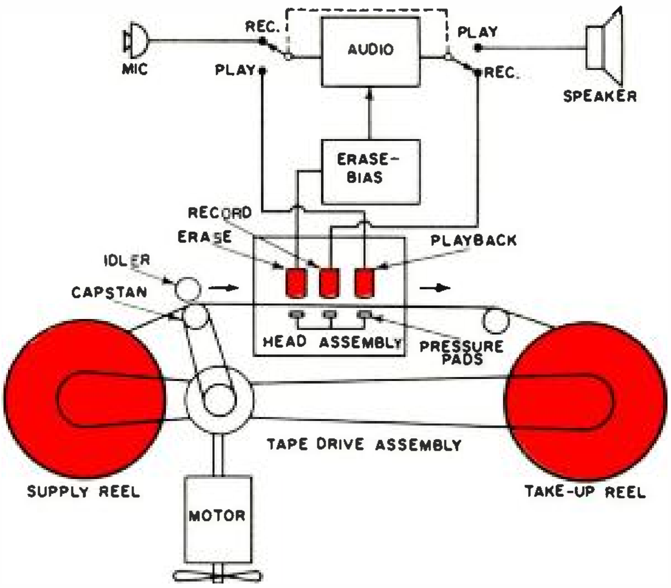
The capstan, here shown driven by a motor through a belt, controls the rate of tape motion. The idler, although it is not driven, presses the tape against the capstan so that there will be no slippage at this point. If the two reels were driven at constant rotational rates, the speed of tape travel past the heads would vary. This would happen because the amount of tape on a reel increases or decreases, and thus the effective diameter of the reel changes. Consequently a certain amount of slippage is permitted in driving the reels, usually by allowing some slack in a drive belt. The reels can then accommodate their rotation rate to the fixed speed established by the capstan. Not shown in Fig. 1 is an additional drive wheel that is brought into play mechanically to reverse the direction of motion during rewinding.

Although the head assembly shows three units, some recorders use only two: a single head may be used alternately, with appropriate switching, for recording and playback. The pressure pads simply press against the moving tape to keep it in good contact with the heads.

In the electronic portion, the heart of the erase-bias section is a supersonic oscillator that, during recording, drives the erase head and is also applied to the record head as an a.c. bias that prevents distortion. This circuit performs no function during playback.

The audio stages provide signal amplification during recording and playback. As a rule, the same circuitry is used in either mode. Input and output connections (Fig. 1) are switched, as

Fig. 1. Principal sections in all types of tape recorders.



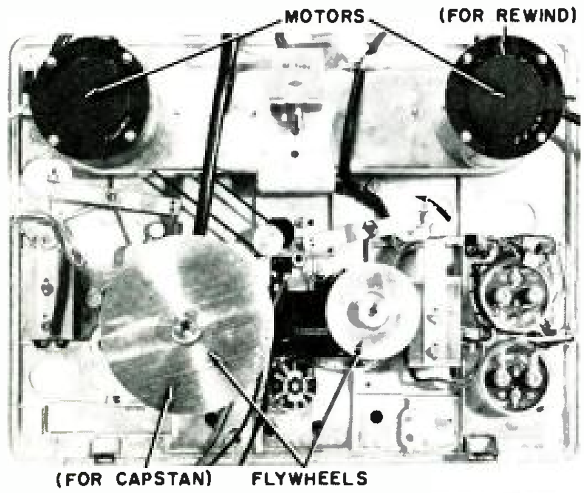


Fig. 2. The drive system in this Magnecord, more elaborate than most home machines, uses two motors and two flywheels.

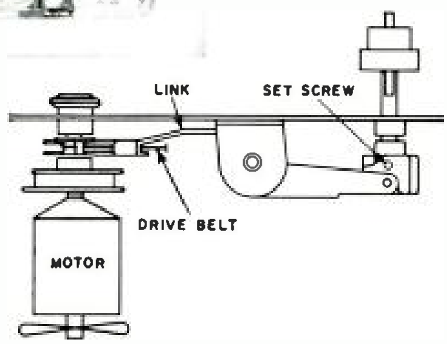


Fig. 4. To avoid re-assembly problems, it is wise to make a rough sketch, like the one here, showing only those parts involved in their relation to each other.

well as the different compensating networks used in the two positions.

Tape Transport Defects

Tape-drive failures may be obvious even to the non-technical owner. If, for example, the take-up reel is not turning or not turning fast enough and tape piles up instead of being wound onto the reel, the latter's drive belt or perhaps a friction spring that may be holding it is probably loose or broken. Sometimes the shaft for the reel is frozen or stuck in its bearings. Similarly, if malfunction occurs only during rewind, the reversing wheel or the cam driving it is defective or is not being brought into position properly. Such diagnoses are simple—but repairing the defects are more difficult. The problem is less that of taking equipment apart and locating the faulty member than of ending the job with all parts put back in place *properly*.

Part of a typical, relatively simple drive mechanism is shown in Fig. 3. One belt goes from the main motor shaft to the flywheel mounted on the capstan shaft. This belt will be relatively taut to prevent slippage. The flywheel improves smooth, steady operation of the capstan. Indirectly driven by the motor, through coupling that is not shown in this view fully, is another belt for driving the take-up reel, with a controlled amount of slippage. The latter is affected by adjustment of the tension idler. The shaft that drives the second belt also rotates the supply reel through a rim-friction drive that resembles the rim-drive method used in many phonograph turntables. In the illustrated unit, the reversing mechanism for changing direction and speed of this rim drive is out of sight under the mounting plate.

A rear view of another recorder, in Fig. 2, gives some notion of the diversity that may be found. Nevertheless, all drive systems are the same in principle, and functional identification of corresponding parts can be determined by observation of action during operation.

To replace a belt, adjust a spring, or even lubricate a part, some disassembly may be necessary. And here is where trouble can begin. Removing a spring, "C" washer, or locking pin is easy, but correct re-assembly will not be automatic. Does the washer go over the flywheel or under it? Does the spring clip into this hole or around that lug? Which end of the locking pin goes where? The penalty for an error may be improper operation or even damage. We can turn a simple, mechanical assembly into a nightmare. But we can also do the opposite by following a few rules.

The manufacturer's service data is obviously an important aid. If available, it should be consulted before a screwdriver is touched. If it cannot be obtained readily or is less than fully adequate, we still have two tricks left, either or both of which can be used. One involves making a rough, simplified sketch only of those parts that will be dealt with and labeling them. Fig. 4 shows how this was done with part of a drive mechanism that had to be taken down and disconnected from the motor.

The second method involves taping parts together, clearly positioned with respect to each other, as they are removed. For example, screws and springs can be taped directly to the holes in which they belong with small strips of masking tape. This does more than give us a good idea of how things fit together again—it also avoids time lost in hunting for small parts.

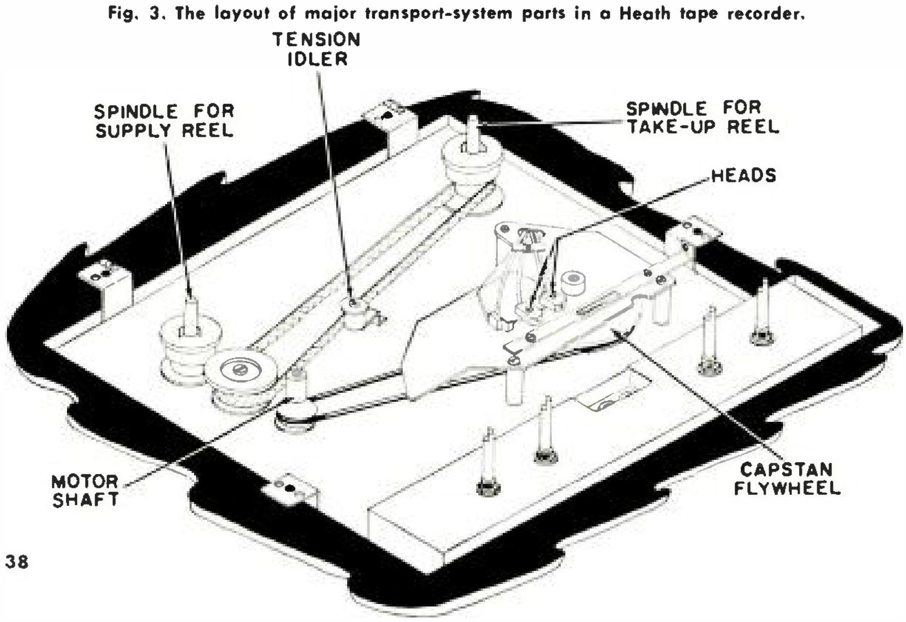
So much for general procedures and obvious malfunctions. There are many other types of drive troubles that are both common and not peculiar to just some machines:

1. *Tape tends to break.* Too much tension is being applied to the tape by some drive member other than the capstan-idler combination. There may be too much drag on the supply reel (not enough slippage) or too much pull on the take-up reel. The belts or wheels driving these may be too tight. If friction clutches or springs are used, they may also need adjustment. Worn pressure pads or freezing of a roller shaft reel spindle may also be responsible.

2. *Tape piles up at one reel.* This can occur at either the supply reel or take-up reel. Drag or braking action on the affected reel is improper. Depending on particular conditions, it may be excessive or insufficient. Friction applied to the reel shaft may need adjustment. If a drive belt is used, it may need tension adjustment or replacement. If pile-up occurs only when the drive mechanism is turned off, a braking element that is applied to one wheel mechanically by the turn-off mechanism needs adjustment.

3. *Speed changes during play.* If speed increases, the take-up reel is providing too much pull as it becomes fuller. If speed decreases, the supply reel is providing too much drag as it empties. While reel tension can be involved, the trouble is most likely in the capstan drive system. It is not acting as the main tape drive, permitting reel action to take control of speed. The capstan belt may be loose. There may not be

Fig. 3. The layout of major transport-system parts in a Heath tape recorder.



enough pressure on the capstan from its pressure idler or roller.

4. *Mechanical noise.* Usually this is heard as a hum or rumbling in one mode of mechanical operation. If it appears, for example, only during rewind, the problem is obviously confined only to the drive elements used in this function. Adjustment and lubrication are more likely to be needed than part replacement. It is sometimes hard to localize the noise to a specific shaft, belt, or gear. A general lubrication and adjustment is often the easiest remedy. Another reason for this recommendation is the fact that, if one part shows a need for lubrication, there has been a general drying out and other parts will probably need it soon.

Some notes about lubrication procedures and lubricants are in order here. The use of manufacturer-issued data, if possible, is of considerable importance in this area. Different companies often recommend very different lubricants. For example, the *Heath Co.* seems to prefer *Gulfcrest* #41 or any #20 motor oil, whereas *Revere* calls for any #10 oil and *Webcor* prefers "Liqui-Moly" *NV* grease for all sliding parts.

These general preferences may be of some assistance if service data is not available, but they are not likely to provide full answers to all lubrication problems. Sometimes more than one grade of oil is used on different parts in the same machine. Larger moving parts may require a heavier grease whereas a small roller may take a light oil. Some parts should not be lubricated. Many motors are of the permanently lubricated type. Many gears and other drive elements are made of nylon or other plastic. These may suffer some harm from lubricants. In addition, there are portions of any recorder that should never be touched by oil because slippage or other interference with tape motion will result. These include surfaces with which the tape will make contact during its passage and the contact surfaces of driving elements, where operation depends on maintaining good friction.

Head Assembly Defects

A record, playback, or erase head consists of an electromagnet whose core has a minute air gap, measurable in thousandths of an inch, across which the coated side of the tape is moved under pressure. Since just one typical, 7-inch reel may involve 1200 to 3600 feet of tape travel, wear of the heads due to abrasion is quite a factor, and they must sometimes be replaced. In addition, the head must be properly aligned with respect to the position of the tape.

The angle or azimuth adjustment is important here. With misalignment, there is a general loss of signal amplitude and especially a loss of high frequencies. In addition to the angular relationship between head and tape, the height of a head with respect to the tape must be adjusted so that the former will fall directly over the recorded track, especially where more than one track is involved.

Note the arrangement in the *Heath* TR-ID in Fig. 5, which has a dual playback head for twin-track stereo recording but records monophonically on one track at a time. The *VM* 722 (Fig. 6) uses a quarter-track erase head in conjunction with a combined, quarter-track record-play head. This is designed to handle four tracks in the form of two dual tracks for stereo. An extra half-track head enables playback of two-track stereo recordings. Normally, tracks 1 and 3 are recorded (or played) at the same time; then, when the reel of tape is turned over, tracks 2 and 4 work together. Arrangement of the *Webcor* 2008, another 4-track machine, is somewhat different (Fig. 7) to accomplish the same results. Instead of an extra head for two-track operation, the height of a single, quarter-track head is physically shifted. In Fig. 7A,

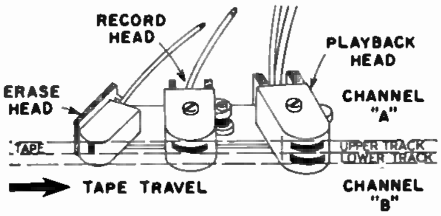


Fig. 5. Head-tape alignment on Heath's TR-1D tape machine.

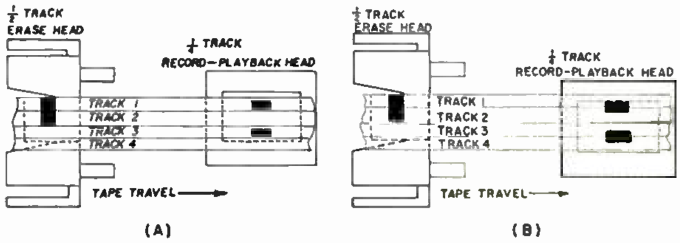


Fig. 7. Heads on the Webcor 2008 shift mechanically from 2- to 4-track operation.

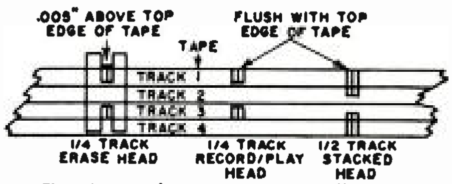


Fig. 6. Another arrangement allowing 2- or 4-track operation, used by VM.

the record-playback head is in position for 4-track operation. In Fig. 7B, it has been shifted down to line up for two tracks, one overlapping 1 and 2, the other overlapping 3 and 4.

Alignment is obviously much more critical on quarter-track heads, especially since crosstalk between adjacent tracks is to be avoided. Heads are adjusted by small screws associated with them. These procedures may be performed with recorded tapes of known quality, but special alignment tapes are the best to use. Recorded on these are single-frequency tones. The adjustment screw for head tilt or azimuth is rotated to produce maximum level while a signal of relatively high frequency is being reproduced. This may be performed by ear, but the built-in meter or tuning eye or a good a.c. v.t.v.m. across the speaker terminals gives better indication. The head height or alignment adjustment is performed with alignment tape or pre-recorded multiple-track tape. The aim here is maximum over-all level and no crosstalk between one track and any other. After adjustment, each screw should be locked in place with a small drop of cement—enough to maintain alignment but not enough to make future adjustment difficult.

While head alignment is important, cleaning of the heads and other transport elements is required more frequently. Due to abrasive action, ferromagnetic particles from the tape deposit not only on the head surfaces but also on the capstan, pressure pads, and tape rollers or other guides. Often surprising quantities can accumulate before the owner is aware that sound quality is affected. Sometimes more than one application of head cleaner to affected parts is necessary.

Many commercial head-cleaning fluids are available for this purpose. Alcohol will also serve for most machines, but carbon tetrachloride or detergents should be avoided. The fluid should also be confined only to the contact surfaces that are immediately affected, on the chance that the solvent may have adverse effects on cements or other materials in the system. Cleaner may be applied with a small wisp of absorbent cotton wrapped around the head of a toothpick or other small stick. Never use a sharp instrument directly on the heads.

In addition to head alignment, cleaning, or replacement, installation of new pressure pads is sometimes required. These are generally small, felt rectangles glued to brass or aluminum arms, and they can wear out in time due to continued friction. They can be ripped off easily with a pen knife and tweezers. New pads should be glued on securely, but not with so much cement as to saturate the felt and make the pad hard enough to damage tape.

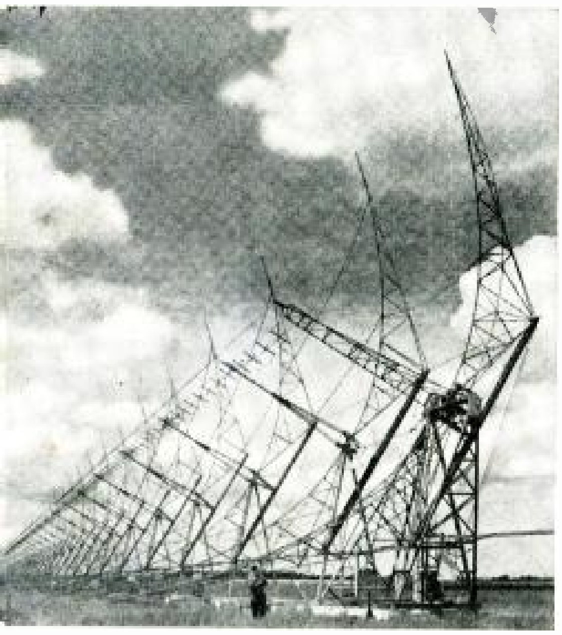
Another periodic requirement to keep the heads at peak performance is demagnetization, although this will not usually have to be done as frequently as cleaning. A relatively high background noise and perhaps some distortion may indicate the need for this operation. It is performed with a commercially available demagnetizer or a choke that may be plugged into the household a.c. line. When the instrument is placed across the air gap of the head, the a.c. field removes any permanent magnetization the head may have acquired. The demagnetizing coil should be withdrawn slowly, to a distance of several feet, reducing the field around the head before coil current is interrupted. Otherwise a turn-off transient in the demagnetizer may induce some residual, head magnetization.

(*Continued on page* 106)

BRITAIN'S NEW RADIO-TELESCOPES

By PATRICK HALLIDAY

Description of some of the latest overseas installations along with the work they are doing in probing the universe.



Fixed antenna of the Cambridge-Mullard radiotelescope extends to the horizon.

MANY important discoveries have been made by the pioneer radio astronomers since the day in 1932 when Jansky first detected radio signals from space. But none is more fundamental than the attempts now being made to learn how the world began.

Recently the writer was able to see the extremely powerful radiotelescopes located near Cambridge, England where much of this work is being carried out by Prof. Martin Ryle, Dr. Graham Smith, and their colleagues. These telescopes have positively identified radio sources out to more than 7,500,000,000 light-years distant. Each light-year represents some 20,000,000,000,000 miles.

Although cosmoslogists throughout the world are still hotly debating the results thus far announced by Martin Ryle—who directs the work of the *Mullard* Radio Astronomy Observatory of the University of Cambridge, England—most authorities agree that these have dealt a hard blow to those who have believed in the "steady-state" theory of the origin of the universe.

The steady-state theory, first put forward in 1948, holds that matter is being constantly created everywhere throughout space, while the universe remains unchanged. This theory thus directly opposes the belief of many other cosmoslogists that the world started as a highly concentrated primeval "atom" which blew apart and has been expanding like an atom bomb ever since.

Ryle firmly believes that the radiotelescope observations so far made are incompatible with the steady-state theory but would seem to agree with the theory of the expanding universe.

Role of Radio Astronomy

How is it possible for radiotelescopes to play a vital role in this work?

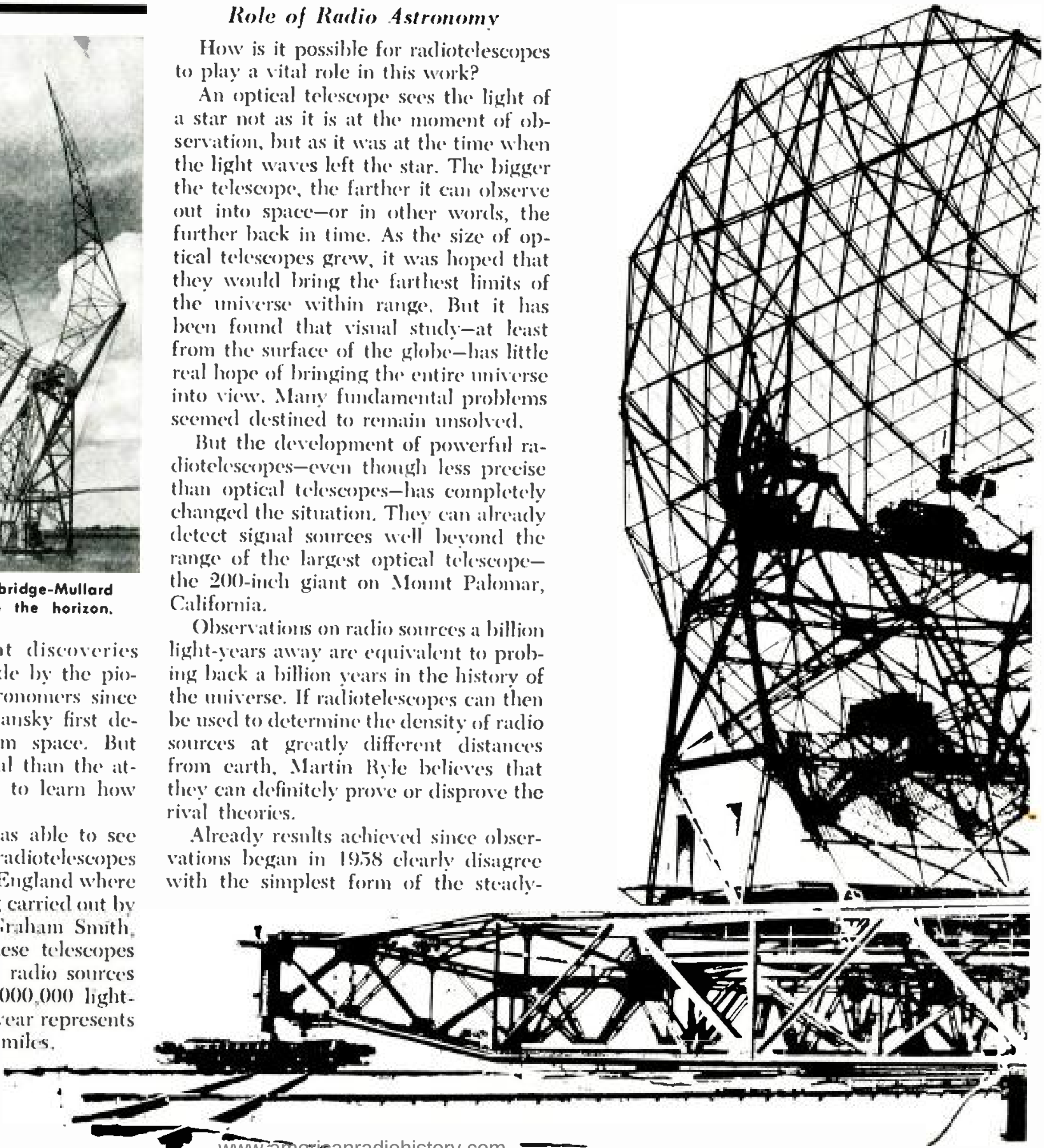
An optical telescope sees the light of a star not as it is at the moment of observation, but as it was at the time when the light waves left the star. The bigger the telescope, the farther it can observe out into space—or in other words, the further back in time. As the size of optical telescopes grew, it was hoped that they would bring the farthest limits of the universe within range. But it has been found that visual study—at least from the surface of the globe—has little real hope of bringing the entire universe into view. Many fundamental problems seemed destined to remain unsolved.

But the development of powerful radiotelescopes—even though less precise than optical telescopes—has completely changed the situation. They can already detect signal sources well beyond the range of the largest optical telescope—the 200-inch giant on Mount Palomar, California.

Observations on radio sources a billion light-years away are equivalent to probing back a billion years in the history of the universe. If radiotelescopes can then be used to determine the density of radio sources at greatly different distances from earth, Martin Ryle believes that they can definitely prove or disprove the rival theories.

Already results achieved since observations began in 1958 clearly disagree with the simplest form of the steady-state theory, although it is admitted that many questions still remain to be answered.

Ryle—internationally recognized as one of the great pioneers of radio astronomy—has been working in this field since the end of World War II. Like many other workers in radio astronomy he has long held a ham call, G3CY, and the writer recalls working him on 40-meter c.w. He considers that an important turning point came in 1952 when his coworker F. Graham Smith, in conjunction with Walter Baade of the Mount Palomar optical telescope, identified the position of an intense radio star as being in the constellation of Cygnus. Baade was able to photograph what is believed to be a pair of galaxies in collision—500 million light-years away. The significance of this event was that it finally proved that intense radio sources were relatively few and far between. Ryle foresaw that this implied that there was good prospect of gathering useful data from ever

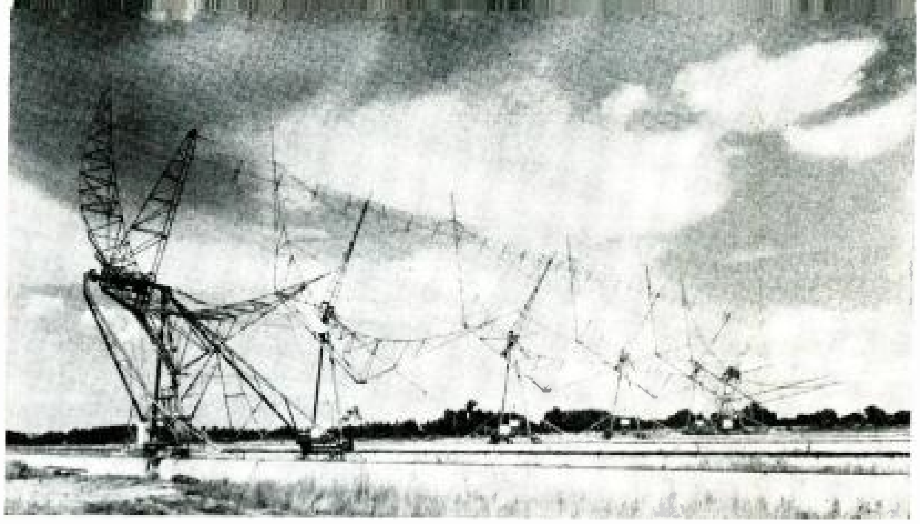


more remote radio stars without the signals being obscured by a multitude of nearer signal sources. All that was needed was a radiotelescope more powerful than any then available.

Cambridge-Mullard Radiotelescope

A new Radio Observatory was planned and built some six miles outside Cambridge, England. This half-million-dollar project was financed partly by Cambridge University and the British Department of Scientific and Industrial Research aided by a contribution of $280,000 from the electronics firm of *Mullard*. The radiotelescopes then erected—although much simpler to build than the huge 250-foot, 800-ton steerable parabolic reflector of Britain's best-known radiotelescope at Jodrell Bank—were designed to have extreme resolution and signal collecting power.

The two main radiotelescopes consist of one broadly tuned to 38 mc., equivalent to a parabolic array some 2000 feet in diameter; the second—on which much of the work on the origin of the cosmos has been carried out—is designed for 178 mc. and uses the techniques of an "interferometer" combined with "aperture synthesis."



The movable section of the Cambridge-Mullard installation operates on rail tracks.

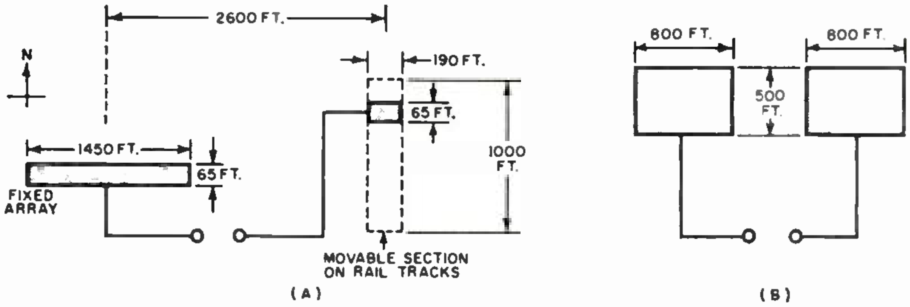
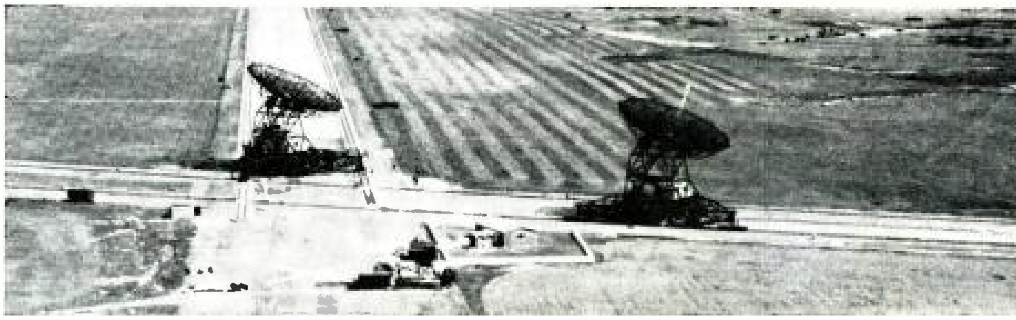
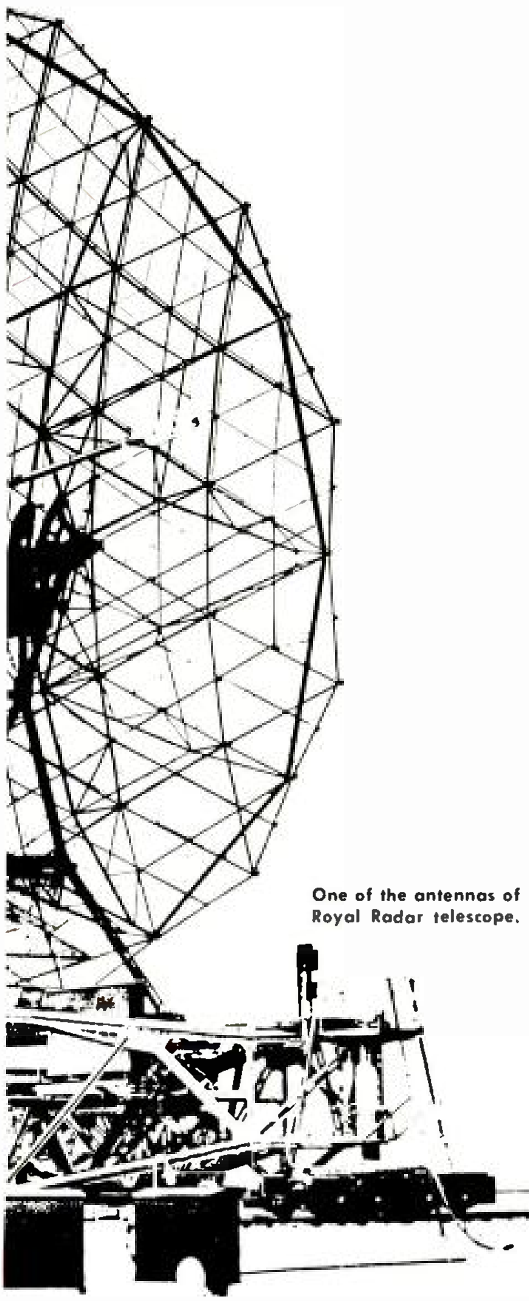


Fig. 1. (A) Layout of the 178-mc. Cambridge-Mullard radiotelescope antennas. (B) Equivalent antenna sizes if technique of aperture synthesis were not used.



Both parabolic antennas of the Royal Radar Establishment telescope are on tracks.



One of the antennas of Royal Radar telescope.

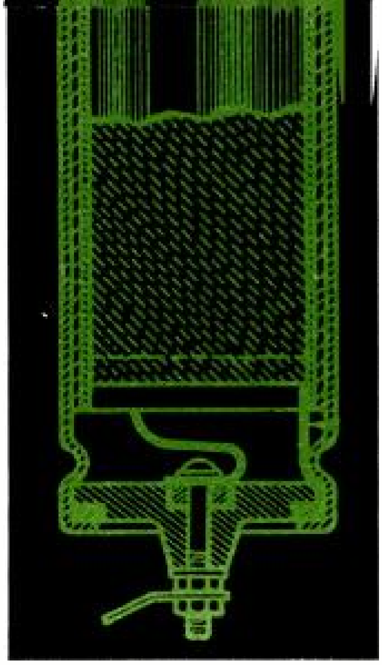
The interferometer principle has been widely used in radio astronomy. When two separated antennas are connected, the radiation pattern consists of a fan of narrow beams—the width of each beam becomes narrower as the spacing between the two arrays is increased. That is to say that an interference pattern is superimposed on the main lobe of the array. The angular discrimination of the combined antenna is thus greatly increased over that of a single array. Extremely accurate measurements of angular positions are possible on isolated signal sources.

At Cambridge a further refinement was introduced for the first time: the technique of aperture synthesis. This depends on the use of a relatively small movable section of antenna which can take up, in turn, a series of positions relative to the main fixed section of the antenna. By taking observations and then shifting the movable section next day and repeating the process, the final results—obtained by vector addition—are equal to those which could be obtained with a very much larger array. The resolution corresponds to that which would be achieved by exploring the sky with a very narrow beam produced by an antenna array of dimensions comparable with the widest spacing. The 178-mc. interferometer telescope at Cambridge provides results which, for many purposes, are equivalent to those which could be obtained from two 800-foot by 500-foot arrays. Yet the actual antennas consist only of one long 1450-foot by 65-foot fixed array in conjunction with a 190-foot by 65-foot movable section which moves along railroad tracks (see Fig. 1). Both sections are cylindrical parabolas with 65-foot apertures.

The advantages of this technique are flexibility and economy. Even though the

(*Continued on page* 93)

Value Checker for Electrolytics



By A. A. MANGIERI

A simple principle permits a modest circuit to meter capacitance without a bridge or other nulling device.

HAVE YOU ever wondered about the condition of the electrolytics in a circuit? Are they drying out and losing capacitance? Here's a handy, compact instrument which provides a measurement of capacitance directly on a meter. Furthermore, in-circuit measurements can be made in many cases, thereby avoiding the necessity of disconnecting the capacitor from the circuit. The range of 5 to 200 microfarads covers most of the capacitors found in typical power supplies and filter networks. The tester can be assembled in one evening from readily available parts.

Although lacking the range and precision of an *LCR* null bridge, it is much more portable and easier to use. The test circuit applies a relatively low d.c. polarizing voltage to the capacitor, thereby avoiding a shock hazard from the instrument or charged capacitors.

Circuit Operation

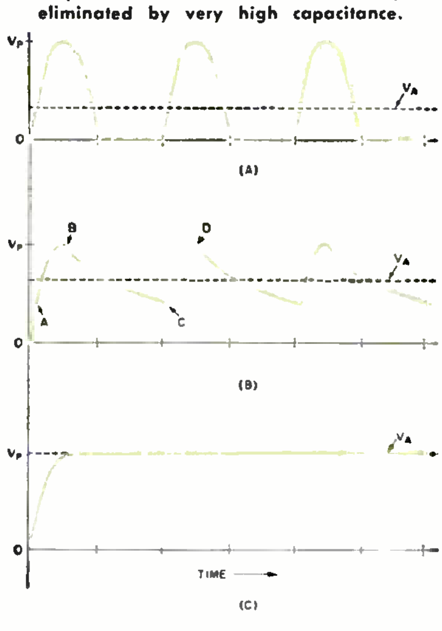
Operation of the circuit is quite simple. As shown in Fig. 2, step-down transformer T_1 connects to half-wave rectifier CR_1 and load resistors R_1 and R_2 in series. C_x is the capacitor to be measured. When C_x is zero (no capacitor present), the waveform across R_2 is a half-wave sinusoid as shown in Fig. 1A. The waveform has a peak value of V_P and an average value of $.32V_P$. This waveform has a considerable a.c. component, which passes readily through d.c. blocking capacitor C_1 and is rectified by the meter rectifier, CR_2 through CR_5. The d.c. milliammeter M_1 responds to the rectified average of the current passing through C_1. R_2 and R_1 are effectively in series with meter M_1, and R_1 is adjusted so that M_1 reads full scale when C_x is zero.

Now, if we place a capacitor, C_x, across R_2, C_x will receive a charge during a portion of the conducting half-cycle (interval *A-B* in Fig. 1B), charging the capacitor to voltage V_P. From *B* to *C*, the capacitor discharges exponentially through R_2. The positive half-cycle again recharges the capacitor during interval *C-D*. The average value of the waveform (V_A) is now higher, but the ripple voltage is much reduced.

The drop in capacitor voltage from *B* to *C* is dependent on the circuit time constant, R_2C_x. If C_x is made very large so that the time constant is much greater than 1/60 of one second, the capacitor will lose little voltage on its discharge cycle. Ideally, the waveform will approach a straight line as shown in Fig. 1C. Here, the a.c. ripple is zero and consequently meter M_1 is not deflected. The average value is now equal to V_P.

These idealized waveforms neglect the effects of series resistance in the rectifier and R_1. But such effects do not invalidate the general principle involved: the ripple voltage is still a function of the value of C_x, being maximum when C_x is zero and minimum when C_x is infinite. The circuit is essentially a half-wave d.c. power supply followed by a metering circuit which responds only to a.c. ripple voltage. We can thus calibrate the meter in terms of known capacitance. The markings on the meter scale will appear reversed, as zero capacitance will deflect the meter to full scale, but this is not of great importance.

Fig. 1. With no capacitor (A), output of half-wave rectifier is unfiltered. As capacitance is increased (B), ripple amplitude is reduced and (C) finally eliminated by very high capacitance.



Construction

A plastic meter case was used to house the components. Fig. 3 shows the completed instrument connected to a capacitor under test. A front panel of aluminum was used to support the meter and power transformer, as shown in Fig. 4. A fiber board was mounted directly on the meter terminals to support the meter rectifier diodes. Insulated lug strips were mounted on the bolts supporting the transformer to serve as tie points for other parts.

Transformer T_1 provides 26 volts a.c. at 200 ma.; however, a 12-volt transformer may be used. Meter M_1 has a sensitivity of 2 ma., but meters of higher sensitivity are satisfactory. As later explained, for any given combination of parts differing from those specified, a value of R_1 is selected so that the meter reads full scale when C_x is zero. Rectifier CR_1 was a 1N91 germanium rectifier selected because of its small size. If space is available, a larger selenium rectifier having a rating of at least 100 ma. may be used. In fact, a 350-ma., 130-volt a.c. rectifier was tried and found to work well. Since the transformer voltage is only 26 volts a.c., a low-voltage rectifier having two plates may be used to conserve space. CR_2 through CR_5 form a full-wave bridge rectifier having a current rating at least equal to that of the meter. Because they were on hand, four 1N69 crystal diodes were used here, but it may be preferable to use packaged selenium or copper-oxide meter rectifiers.

Resistors R_1 and R_2 are 5-watt wire-wound units and may even be rated at ten watts. The higher power rating results in a low temperature rise, thereby avoiding changes in resistance.

Electrolytic capacitor C_1 should be a good, low-leakage unit as its purpose is to block the d.c. voltage appearing across R_2 from passing through the meter. However, the voltage across C_1 is about 12 volts d.c. when C_x is made very large; so the leakage through C_1 is negligible.

Rheostat R_4 is adjusted by means of a screwdriver and is preferably wirewound for smoother control. Mount the control so that it can be adjusted through a hole in the panel or, if preferred, use a component that has a shaft and mount it on the panel.

The line cord and test leads pass through two grommets mounted on the panel. A red test lead is connected to the positive end of R_2 and a black lead to the negative end. Before proceeding with final construction, it is wise to make a temporary hook-up using clip leads and run a calibration curve as described below. Any circuit modifications, such as use of a 12-volt transformer or a more sensitive milliammeter, can be checked out beforehand.

Calibration

Calibration of the instrument requires that known values of capacitance be available so that a graph of capacitance *versus* meter indication can be drawn. The graph is then used to mark the meter scale plate or it may be used as it stands. It is not possible to rely on the labelled values of ordinary electrolytics. Tests on a number of units show that the values tend to run considerably higher than the ratings. The preferred procedure is to measure a group of electrolytics on a capacitance bridge and label each accordingly. Oil-filled paper units can be used for lower values. Because capacitors in parallel can be used for higher values, it is only necessary to measure about six or seven components ranging from 4 to 130-μf.

To proceed with the calibration, energize the circuit and adjust R_4 so that meter M_1 reads full scale. If you have made any substitutions for T_1 or M_1, however, temporarily substitute a 10,-000-ohm pot for R_3 so that you may determine the correct value for the latter. This value should be such that R_4 is at its mid-position when M_1 reads full scale.

Next, starting with the lower values, proceed to connect capacitors across R_2 and make a table of capacitance *versus* meter indication. Plot this data on graph paper and draw a smooth curve through the points. If necessary, take a few more measurements to fill in any large gaps. This curve can be used with the meter to measure capacitance. However, it is quite simple to mark the meter scale plate in microfarads for direct reading.

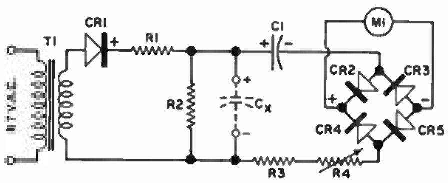
From the graph, the scale can be marked in integral capacitance values. If a two-inch meter is used, convenient markings can be made every 5 μf. from 0 to 100 μf.; in steps of 10 μf. from 100 to 150 μf., and in 25-μf. steps from 150 up to 200 μf. Whatever method for altering the existing scale plate or adding a new one is used, markings should first be made lightly with pencil. After accuracy, appearance, and arrangement have been checked, they can be inked in. Numbers can be lettered in or decals, if available, can be used.

Testing Electrolytics

The instrument can be used to check capacitors having a peak voltage rating greater than 12 volts. Correct polarity of the test leads should be observed, although it is doubtful that any component damage will result if they are improperly connected across higher-voltage electrolytics. Accidental shorting of the leads will not damage the instrument because R_1 limits short-circuit current to a safe value.

In-circuit measurements can be made if the resistance across the capacitor is much greater than the 120 ohms of R_2. Accuracy is not affected if this resistance is 10,000 ohms or more—in fact, error will not be excessive if shunt resistance is only 5000 ohms. In the case of a multi-section filter network, the other capacitors in the circuit may influence readings if isolating resistance between them is not high enough. Where a filter choke is used, it will provide sufficient isolation between capacitors to permit measurement of each in the circuit.

A shorted electrolytic will indicate infinite capacitance, as no deflection will result on the meter. One that is dried out will indicate little or no capacitance. However, a capacitor that measures up to its rated value may still be defective if it has excessive leakage at its rated voltage.



R_1—50 ohm, 5 w. wirewound res.
R_2—120 ohm, 5 w. wirewound res.
R_3—3000 ohm, ½ w. res.
R_4—500 ohm, ½ w. rheostat (screwdriver adj.)
C_1—20 μf., 100 v. elec. capacitor
CR_1—1N91 diode rectifier
CR_2,CR_3,CR_4,CR_5—Full-wave meter rectifier or four 1N69 diodes
T_1—Step-down trans. 117 v. pri., 26 v. @ .2 amp.sec. (such as Allied 61-G-476)
M_1—0-2 ma. d.c. milliammeter

Fig. 2. Value of unknown capacitor determines filter ripple applied to meter.

For leakage testing, the builder may choose to construct a more elaborate instrument that includes, in addition to the circuit described, additional facilities. Or else he may use a separate, variable, power supply with a milliammeter, as does the author.

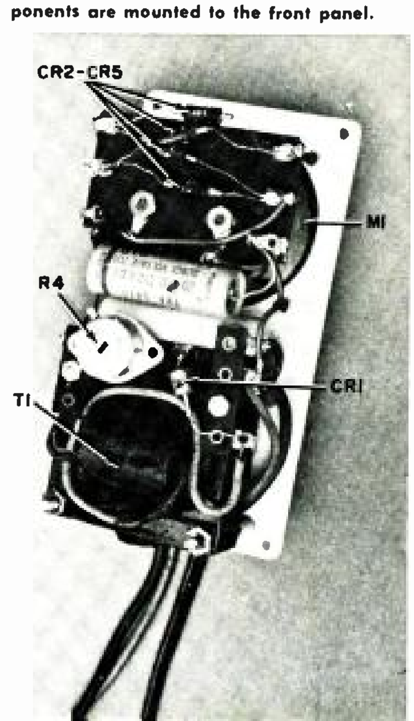
The arrangement is simple. Connect a 25,000-ohm potentiometer, a 50-ma. milliammeter, and the capacitor in series across a voltage source equal to the rated voltage of the capacitor. To protect the meter against the high initial charging current or possible leakage current, make sure that the potentiometer has been pre-set to maximum resistance. Gradually reduce its setting to zero resistance, if possible, but never to the point where current exceeds the 50 ma. that the meter can read full scale. Leakage current is the reading obtained when the meter has settled down to indicate its lowest, steady value.

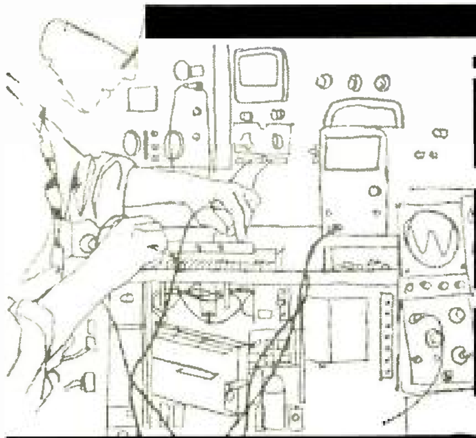
As an approximate guide, leakage should not exceed .5 ma. per microfarad for electrolytics above 8 microfarads in the 300- to 500-volt range. As a rule, a good capacitor will show less than .1 ma. per microfarad. Concerning this rule of thumb, note that, at .5 ma. leakage per microfarad, a 100-μf. capacitor would have a leakage current of 50 ma. This may or may not result in excessive voltage loss in the power supply or overload of the rectifier or transformer. Thus any evaluation of leakage should take the particular circuit into account.

In conclusion, it is well to remember that checks of both leakage and capacitance are generally required to determine the condition of an electrolytic. A leakage test alone is certainly not conclusive, as a dried-out capacitor may pass such a check but still fail to provide adequate filtering. On the other hand, a direct check of capacitance alone will often suffice. It is often possible to conclude, from such indications as the fact that d.c. voltages are entirely normal, that leakage is not excessive. ▲

Fig. 3. The completed instrument is compact and, with no external adjustments necessary after calibration, easy to use.

Fig. 4. A rear view of the meter removed from its case shows how all components are mounted to the front panel.





MAC'S ELECTRONICS SERVICE

By JOHN T. FRYE

MEASURING THE DOSE

MAC stopped short in the doorway of the service department. Barney, his assistant, was sitting with his elbows propped on the service bench squinting at the bench light through a little yellow tube about four inches long and a half-inch in diameter.

"Is that all you can find to do?" Mac asked in sarcastic disapproval. "I didn't know you went in for those 'girlie telescopes.' Guess you're still pretty adolescent."

"Wanta look?" Barney asked with a quizzical smile as he held out the little metal tube.

Still frowning, Mac put the instrument to his eye and looked toward the bench light. Instantly the corners of his mouth turned upward as he exclaimed: "Milliroentgens, huh? I apologize. So this is a dosimeter! First one I ever saw. Where did you get it? How does it work?"

"Whoa now! as you say to me," Barney replied. "As it says there on the case, it's a Model CD V-138 dosimeter made by *Bendix* for CD work. A CD official gave it to me when I attended an area meeting. I work in CD communications, you know. The official is not a technician; so he couldn't tell me much about it; but I was curious and boned up on the subject and can tell you how it works if you're interested."

"I'm interested in *anything* electronic I don't understand; so quit stalling," Mac ordered.

"This simple-looking little tube has lots of guts," Barney began. "It reminds me of that radio commercial: 'Who put those eight great tomatoes in that little bitty can?' But we'll take it a piece at a time.

"You're familiar with the operation of a gold-leaf electroscope. Well, this little cylinder contains a very sensitive and rugged cousin called a *quartz-fiber electroscope* that's made like this: First, one end of a conducting wire supported by excellent insulating material is bent into a U-shape like the business-end of a buttonhook. This U-shape is called the 'frame' of the electroscope. Next a fiber only .0001 inch in diameter drawn from quartz has its surface metallized to make it conducting. The ends of this fiber are connected to the tip and shank of the buttonhook while the free center portion of the fiber follows the U-shape and lies flat against it.

"Suppose a charge is fed on to the conducting wire of the frame. It flows on to the frame and also on to the metallized fiber. The like charges repel each other, and the very flexible loop moves away from the frame the way you can pull the wire jaw of a mousetrap away from the board. The distance it moves depends on the amount of the charge, but don't think the fiber loop flaps back and forth like the bail on a paint bucket. When the charge falls from 160 to 100 volts—the useful range of this instrument—the fiber only moves a very small distance; but the movement is observed through a two-lens microscope that magnifies the movement seventy-five times. Between the eyepiece and objective lens of this 75X microscope is placed a glass scale marked from 0 to 200 milliroentgens. The small portion of the fiber that falls in the field of view of the microscope is seen as a vertical hairline moving across the scale.

"The electroscope is mounted inside a small electrically conducting plastic enclosure called an *ion chamber* which is extremely well insulated from the electroscope. A capacitor connects between the electroscope conductor and the conducting wall of the ion chamber so that any charge on this capacitor appears between the two. At the end of the dosimeter opposite the eyepiece, a charging pin is supported by a translucent plastic bellows a short distance away from the conducting wire of the electroscope. When pressure is exerted on the outside end of this pin, it is forced back into contact with the wire, and any voltage applied to the pin appears on the capacitor. When the pressure is removed, the pin moves forward away from the wire and leaves the charge trapped on the capacitor. You still with me?"

"I think so. The capacitor can be charged to a value that will make the fiber move into position at the '0' end of the glass scale as seen through the microscope. As the charge leaks off, the fiber moves toward the frame and the fiber image, or hairline, moves up the scale. Right?"

"Exactly right. 160 volts puts the hairline on zero. At 100 volts the image falls on '200' milliroentgens. But now comes the interesting part: how radiation affects this voltage.

"When a high-energy *gamma* ray penetrates the wall of the ion chamber and collides with molecules of air trapped inside that chamber, it knocks negative electrons loose from their positive nuclei. Under ordinary circumstances these differently charged particles would be attracted to each other and recombine into neutrally charged molecules, but inside the ion chamber the negative electrons are attracted to the positively charged electroscope, and the positive ions are attracted to the negatively charged wall of the ion chamber. As each charged particle is absorbed by the electroscope or the ion chamber, its individual charge subtracts from the total charge on the capacitor."

"I get it!" Mac interrupted. "The decrease in charge is a function of the radiation received. Since the glass scale is linear, I assume the movement of the fiber over the range used is a linear function of radiation. But the capacitor and other components must have darned good insulation. Otherwise the loss of charge would be the result of leakage rather than radiation."

"It is. Electrical leakage is guaranteed to be less than 1.5% of full scale in twenty-four hours. It's really much less. I zeroed this instrument five weeks ago, and you can see it now reads only 8 mr."

"Less than 1% of full-scale leakage a week!" Mac exclaimed.

"Actually it's considerably less than that. Normal dosage from cosmic rays and natural radioactivity is considered to be about .3 mr. every twenty-four hours, and you can see this alone would account for more than our 8 mr. in five weeks. Incidentally, the dosimeter is so well protected it can be submerged in water without damage. If we want to increase the range of the instrument so it will record a higher dosage, all we have to do is increase the size of the capacitor. If the capacitor is made ten times greater, it will take ten times as much radiation to reduce the voltage from 160 to 100 volts, and our full-scale value would be 2 r. instead of 200 mr."

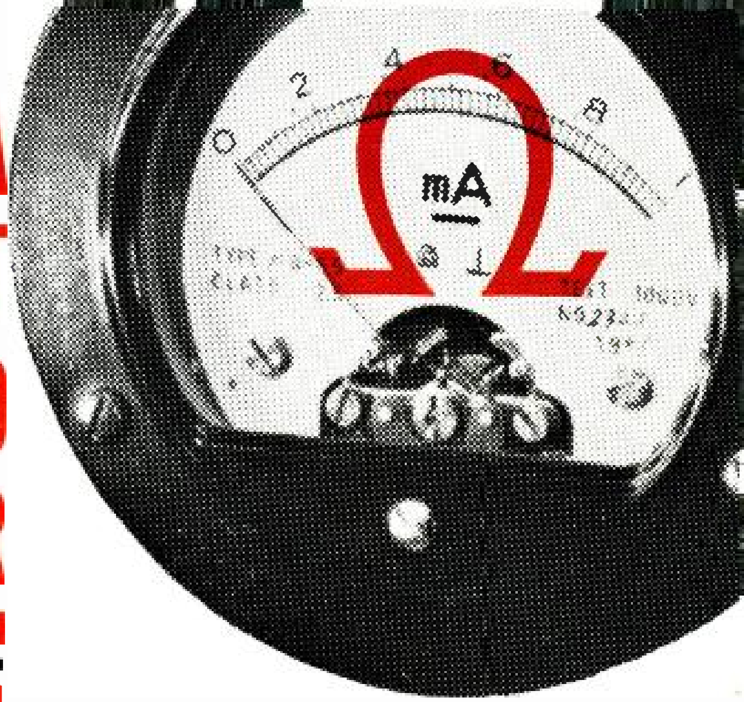
"How do you charge the thing?"

"That's what I asked myself. I'd been warned that punching around the charging pin with a sharp-pointed instrument would ruin the dosimeter. Then I found the *Heath Company* was selling a Family Radiation Measurement Kit consisting of a 0-600 r. dosimeter, a 0-120 r./hr. rate meter, and a transistorized charger for zeroing all such instruments. I needed a charger, and I wanted other instruments with different ranges; so I bought the kit.

"The charger uses a transistor powered by a single flashlight cell as a blocking oscillator working into the primary of a transformer. The stepped-up transformer secondary voltage is rectified by a selenium rectifier and filtered

(*Continued on page* 116)

A 50-VOLT TRANSISTORIZED MEGOHMMETER



By DALE HILEMAN

Two primary cells, stepped up to 50 volts, power a compact instrument that reads from 1 to 2500 megohms.

THE high-range ohmmeter described here was designed primarily to measure the back resistance of silicon transistors and diodes; but a number of other possible uses include checking for leakage in a coupling capacitor, between tube elements, or across the surface of a questionable insulator. An unusual power supply operating from two ordinary penlight cells provides a test potential of 50 volts, but there is no danger of electrical shock. A simple but highly linear d.c. amplifier permits accurate readings from 1 megohm to 2500 megohms. The entire unit consumes less than 10 ma.

An attractive feature of the instrument (Fig. 1) is that it is planned around parts that are inexpensive and widely used. Thus, even where there is not a well-stocked junk box, construction should involve little trouble or cost. For example, although the device was designed about a 1-ma. meter movement, it will accept any having a full-scale deflection of 5 ma. or less without requiring circuit changes. Since other components are not critical, substitutions can be made freely in most cases, as noted under the discussion of "Design Considerations."

Circuitry was kept as simple as would permit satisfactory performance, as may be noted in Fig. 2. It would be feasible to add switching for more meter ranges, meter zeroing, capacitor fast-charging, or for additional functions such as voltage and current measurements. However such refinements are left to the imagination of the builder.

Theory of Operation

The instrument consists basically of a 50-volt source in series with 50 megohms and a 1-microampere meter. Zero resistance under test, then, yields full-scale deflection; 50 megohms, half-scale.

The power supply is unusual in that it produces a high d.c. step-up factor but uses no transformers nor moving parts. Also it is relatively simple and unusually economical, consuming only 3 ma. at 3 volts.

Its circuit is a refinement of the "buzzer-type" supply. Operation depends on the voltage "kick" obtained when the current flow through a choke is interrupted. Transistors V_1 and V_2 constitute a free-running multivibrator, with choke RFC_1 in the collector circuit of V_2. Transistor V_2 conducts for 190 microseconds, during which period energy is stored in RFC_1. At the instant C_1 has discharged to a point that starts base-current flow in V_1, the multivibrator switches and V_2 cuts off.

Then, as the field around RFC_1 collapses, a high-voltage negative pulse appears at the collector of V_2. The pulse charges C_2 through CR_1, providing a high d.c. output voltage for the ohmmeter circuit. The pulse is about 10 microseconds wide, and its trailing edge cuts off V_1 to initiate another cycle.

This type of power supply, incidentally, recommends itself for any application requiring a moderately high voltage but low current as in Geiger counters, portable test equipment, and photoflash units. Given an appropriate choke, the only limit to obtainable voltage is the transistor's collector-base breakdown voltage. Using special silicon transistors, the author easily obtained an output of 150 volts from a circuit similar to that shown and also powered by two penlight cells. Further information regarding the power supply is found under "Design Considerations."

Metering circuitry consists of a cascaded emitter-follower amplifier and a meter. Given any movement of 5 ma. or less (preferably 1 ma.), current gain of the amplifier is adequate for a full-scale reading of 1 microampere, corresponding to the test potential of 50 volts across 50 megohms (R_4, R_5, and R_6).

Capacitor C_3 bypasses stray a.c. components that may otherwise affect the base current of V_3.

Transistor V_6 provides negative feedback to control gain of the d.c. amplifier and also to enhance its linearity. Screwdriver adjustment of "Feedback" control R_{11} determines the degree of negative feedback and therefore sets gain of the d.c. amplifier. If R_{11} is the coarse gain control, then "Short" adjustment R_9 can be considered the vernier gain control. However, adjustment of R_{11} will affect the zero setting whereas R_9 will not.

Transistor V_6 also provides means for temperature stabilization, explained later.

As R_{11} is adjusted for proper gain, it is in turn necessary to re-adjust "Balance" control R_7 (a screwdriver adjustment) for a quiescent current of zero through meter M_1. Thus R_7 is the coarse zero control, and "Zero" adjustment R_8 is the vernier zero control.

Design Considerations

The builder may desire to make changes and improvements or to use some of the circuitry in different applications. He may therefore find useful the following information regarding choice of values.

Characteristics of choke RFC_1 are not critical except that a higher d.c. resistance results in a lower output voltage. Besides the Type 6310 choke, the author tried two other 50-millihenry *Miller* chokes, a Type 958 and a Type 990. Both of the latter proved acceptable although, due to higher d.c. resistance, the Type 990 provided somewhat lower output voltage—not critical since full-scale deflection can easily be adjusted to compensate for variations in test voltage.

The reader who is familiar with CK722 transistors will probably recoil at the idea of −50 volts appearing on the collector of V_2 and +50 volts on the base of V_1. Nevertheless, the author tried sixteen CK722 transistors each for V_1, and V_2; and in only three cases did breakdown occur. In those cases, V_2 underwent collector breakdown. This produced a ragged output pulse but had no other apparent ill effect.

To the purist, however, is recommended for V_2 the *Raytheon* 2N1954, which is rated at −60 collector volts.

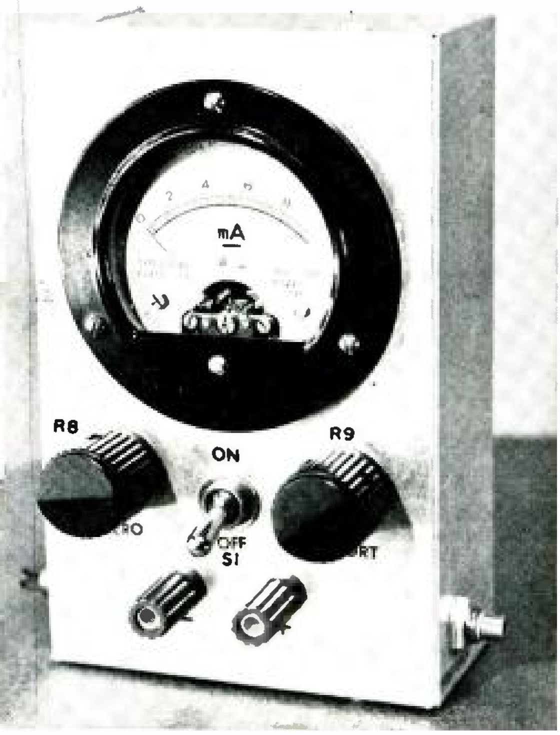


Fig. 1. Completed instrument is small enough to fit in the palm of the hand.

And if required, diode CR_2 (shown in broken lines in Fig. 2) can be added to protect V_1.

As a rule, greater output voltage can be had as the resistance of RFC_1 is made smaller or its inductance larger. Transistors capable of withstanding a collector potential greater than 100 volts, however, become expensive. Where higher voltage is required, the builder might consider instead the advisability of connecting in series the d.c. output from several such supplies. (A controlled rectifier, although expensive, presents one possible means for generating a high voltage with a single pulse-generator stage.)

Increased inductance will not generally provide a higher output voltage if resistance is increased proportionally. The author tried in place of RFC_1 a large iron-core power-supply filter reactor which, because its resistance was several times higher, resulted in performance little different from that provided by the small 50-millihenry r.f. choke.

In fact, the r.f. choke was better: Larger inductance generally requires a lower pulse repetition frequency for the same output voltage. When the large inductance was used, it was found necessary to increase the pulse spacing by a factor of about 3.

The pulse repetition frequency is dependent almost exclusively on the value of R_1. Increasing R_1 lowers the p.r.f.

Operation of the circuit is substantially unaffected by large changes in the value of C_1.

In one variation of the basic circuit, protective diode CR_2 is connected in shunt with the base circuit (diode cathode to emitter) instead of in series. With this change, it was found necessary to eliminate R_1 as well.

Resistor R_3 provides a voltage drop that supplies the collector potential for V_1. In an early experiment, the author used silicon *n-p-n* transistors and in that case found R_3 to be unnecessary, since the forward potential barrier of silicon is much greater than germanium.

A 1N191 or 1N198 is recommended for CR_1, since either one is relatively inexpensive, exhibits high back resistance, and will tolerate a reverse potential of 60 volts. However, any other diode approximating the foregoing conditions will work equally well.

The value of capacitor C_2 is not at all critical; but its leakage resistance should be extremely high. A good paper capacitor will do, but a ceramic disc is ideal.

A tolerance of 5 per-cent for the three series resistors will generally provide good accuracy. Nevertheless five 10-megohm or ten 5-megohm, 10 per-cent resistors will bring the total just as close—probably closer—to 50 megohms. The more series resistors that are used, the better are the chances of individual resistance errors canceling one another.

Capacitor C_3 must be a ceramic disc to preclude polarization. Admittedly, 0.1 µf. in a disc capacitor is not a junk-box item; but the builder may, if he wishes, use a value as low as 0.01 µf., providing he is careful to keep the test leads away from sources of stray 60-cycle energy when he uses the instrument.

Typical current gain of a CK722 transistor is 20, yielding for the cascaded amplifier a possible output of 8 ma. for an input change of 1 microampere. Thus it may be possible to use a movement up to 5 ma. (which might also require increasing the value of R_9). However, a 1-ma. meter is to be preferred for best linearity.

Any movement less than 1 ma. may also be used, in which case full-scale deflection can be limited by the addition of a shunt resistor across R_9. Best value for a shunt, which depends on the resistance of the movement, can be determined experimentally.

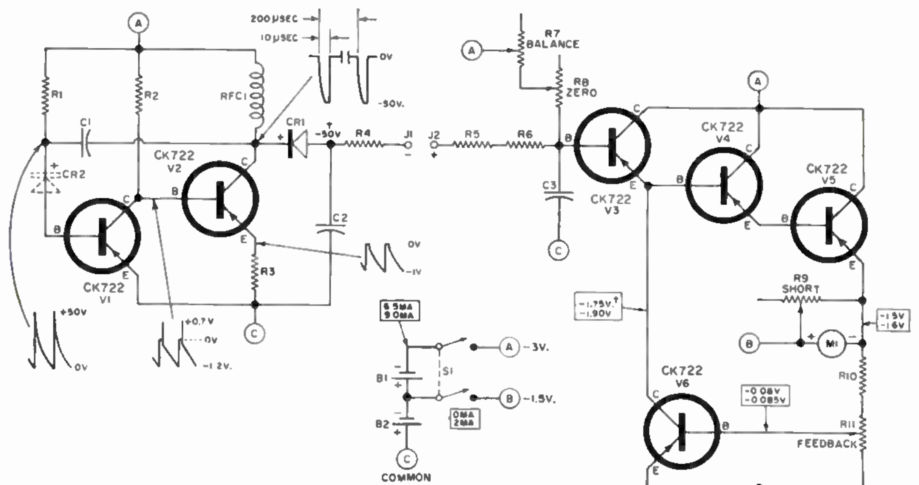
The author used linear controls, but there is no reason the builder cannot try whatever potentiometers are readily available, regardless of taper. Also, the resistance values given for these controls are by no means critical. However, R_{11} should be made no higher than 100 ohms.

A wirewound control was used for R_9 to promote smooth adjustment, but a composition control here works almost as well. A composition control was judged preferable for R_{11}.

Construction

The instrument was built in a 2" x 4" x 6" chassis, which proved not at all too large. Parts placement and lead

Fig. 2. The pulse-output power supply (V_1 and V_2) achieves a large voltage step-up without transformers or moving parts.



NOTE
OPEN AND SHORT-CIRCUIT MEASUREMENTS ARE SHOWN IN BOXES
† INDICATES V.T.V.M. MEASUREMENT

R_1—120,000 ohm, ½ w. res.
R_2—7500 ohm, ½ w. res.
R_3—120 ohm, ½ w. res.
R_4—10 megohm, ½ w. res. ±5%
R_5,R_6—20 megohm, ½ w. res. ±5%
R_7—2 megohm pot.
R_8—100,000 ohm pot.
R_9—100 ohm wirewound pot.
R_{10}—390 ohm, ½ w. res.
R_{11}—100 ohm pot.
C_1—470 µµf. disc ceramic capacitor
C_2—.01 µf. disc ceramic capacitor
C_3—.1 µf. disc ceramic capacitor
CR_1,CR_2—1N191 diode (see text)
RFC_1—50 mhy. r.f. choke, approx. 100 ohms (J. W. Miller 6310 or 958, see text)
M_1—0-1 ma. d.c. meter
S_1—D.p.s.t. toggle switch
B_1,B_2—Standard penlight cell (Ray-O-Vac Type R)
J_1,J_2—5- or 6-way binding post
V_1,V_2,V_3,V_4,V_5,V_6—"p-n-p" transistor (Raytheon CK722, see text)

lengths are not critical, but it is prudent to keep the power supply apart from the d.c. amplifier.

The power supply and d.c. amplifier were each prefabricated, the former on an 8-terminal strip (Fig. 3) and the latter on a 9-terminal strip, with all connecting wires hanging free. These two assemblies were then installed as the last step in assembly (Fig. 4) before point-to-point wiring was begun.

Transistor sockets are strongly recommended because a few trial substitutions or transpositions may prove necessary for best results, as we will indicate.

For insertion in a socket, the transistor leads should be straightened out and clipped about 3/16 inch from the case. Plugging a transistor into a socket may seem difficult at first but becomes easy with practice. If a standard, in-line 3-pin transistor socket is used, the transistor should be so guided that the collector and emitter leads remain more-or-less parallel. Since the base and emitter leads of the CK722 are farther apart than the corresponding socket holes, the base lead should jog toward the emitter as the transistor is pushed home. This bend is desirable because it will make insertion easier next time.

METER INDIC.	RES. (Megohms)	METER INDIC.	RES. (Megohms)
1.000	0	.385	80
.980	1	.357	90
.961	2	.333	100
.943	3	.250	150
.926	4	.200	200
.909	5	.167	250
.893	6	.143	300
.877	7	.125	350
.862	8	.111	400
.847	9	.100	450
.833	10	.091	500
.769	15	.077	600
.714	20	.067	700
.667	25	.059	800
.625	30	.053	900
.588	35	.048	1000
.556	40	.032	1500
.526	45	.024	2000
.500	50	.020	2500
.455	60	.010	5000
.417	70		

Table 1. Dial reading vs indicated resistance when M_1 is a 0-1 ma. movement.

Common conductor (encircled *C* in Fig. 2) of the circuit was purposely not connected to the chassis. The surface on which the instrument is placed may conduct slightly, and if the device to be measured is placed on the same surface, current flow to the chassis could result in an erroneous reading. If that seems far-fetched, consider the author's wooden workbench: on a dry day it measures only 450 megohms across.

(Nevertheless some leakage from the circuitry of the instrument to its chassis is inevitable. Therefore when it becomes necessary to detect or measure resistances upward of about 1000 megohms, both the instrument and the device to be measured should, if possible, be set on a surface known to be free of leakage.)

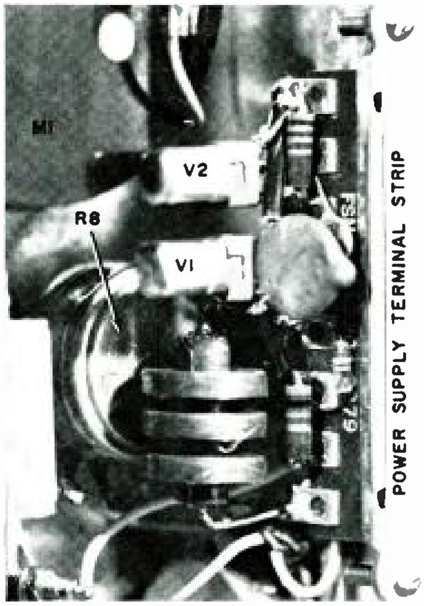


Fig. 3. Detail, from rear, of terminal strip on which power supply is mounted.

Adjustment and Operation

Do not turn the power switch on or connect test leads until directed to do so. First, make sure the cells are both installed correctly with respect to polarity. Then to adjust the instrument, proceed as follows:

1. *Presetting the controls.* Switch S_1 should be in the off position, "Balance" control R_7 about halfway between extremes (assuming a linear pot), "Feedback" control R_{11} also about mid-position, and "Zero" adjustment R_8 halfway between extremes too. "Short" control R_9 should first be turned to minimum-resistance position, then advanced from this setting slightly. This puts a low shunt resistance across the meter movement to protect it during initial adjustment.

2. *Initial Adjustment.* Power switch S_1 may now be turned on. "Balance" control R_7 is now adjusted for zero current, which will correspond to a zero reading. After this is done, "Short" control R_9 may be advanced safely to a point about halfway between its extremes. Doing this may move the meter pointer. If this happens, "Balance" control R_7 is once more adjusted to produce a zero reading.

3. *Checking feedback.* Insert the test leads in J_1 and J_2, short them together, and note the meter reading. The pointer should be expected to swing up-scale, but short of full-scale, because the halfway setting of R_{11} will normally provide too much feedback. If full-scale deflection (or more) occurs in this step, there is a possibility of trouble. Recheck wiring. Try a substitution for V_3. Or else, start the adjustment procedure (step 1) all over again, but with "Feedback" control R_{11} advanced farther than mid-position (with the wiper away from ground).

4. *Adjusting feedback.* Assuming correct indication in step 3, feedback must now be reduced. First make sure that the test leads are no longer shorted and that the "Short" and "Zero" controls are still set halfway. Then proceed as follows:

a. Turn "Feedback" control R_{11} to swing the needle up-scale about 20 per-cent, decreasing feedback.

b. Re-adjust the "Balance" control for zero.

c. Short the test leads together again and note the meter reading. It should be greater than the reading noted in step 3. If it is within 5 per-cent of full-scale, no further adjustment is necessary.

d. If the reading is still considerably less than full-scale, repeat steps 4*a*, *b*, and *c* in order, until shorting the meter leads produces a reading within 5 per-cent of full scale. If the meter needle should slam, feedback has been reduced too much and the appropriate control, R_{11}, should be turned in the opposite direction.

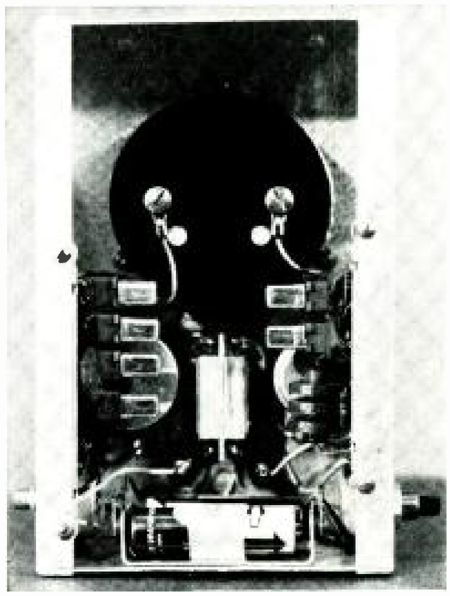


Fig. 4. The compact layout is shown in a rear view of the entire megohmmeter.

The instrument is now ready for calibration and use. To obtain resistance in megohms with a 1-ma. meter, divide 50 by the current indication and subtract 50 from the quotient: $R = (50/I) - 50$. If the builder decides to draw up a resistance scale for the instrument, Table 1 will spare him much tedious arithmetic. Where accurate reading is required, be sure to calibrate carefully.

Remember to adjust the "Zero" control prior to the "Short" control before use, since the former affects the entire meter range whereas the latter has no effect on meter zero.

In Case of Trouble

If output voltage from the power supply proves substantially less than 50 volts (measured with a v.t.v.m.), it is possible that V_2 is either not conducting hard enough or is undergoing collector breakdown during the pulse. In either case, try interchanging or replacing V_1 or V_2. Output with fresh batteries should be 50-60 volts.

(*Continued on page* 79)

TRANSISTOR

With heavy conduction, carriers store up in the
The effect can be used if helpful or eliminated

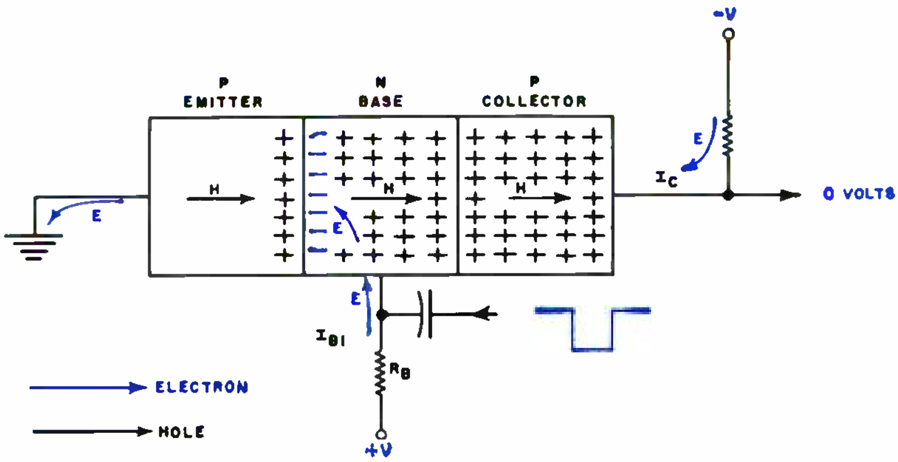
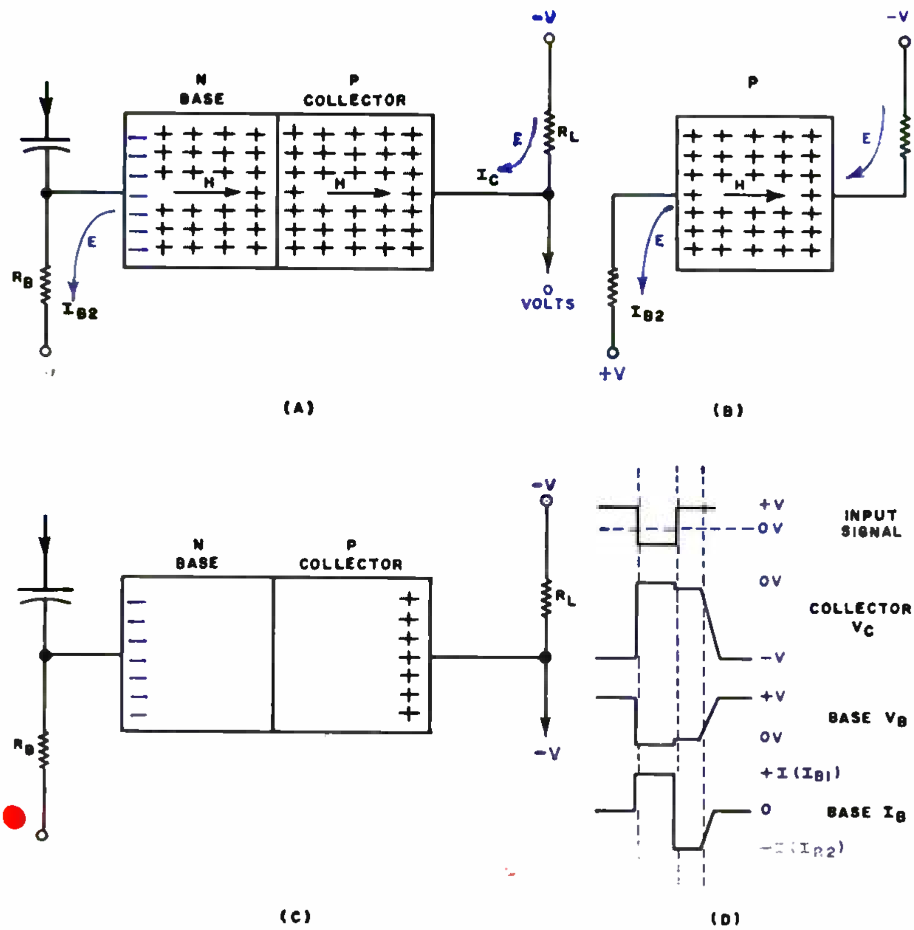


Fig. 1. The disposition of positive and negative charges in a "p-n-p" transistor that has been conducting heavily. The direction of positive carriers or holes is shown by black arrows, electron movement in color. A similar condition, with direction of flow and disposition of charges reversed, occurs in a "n-p-n" device.

Fig. 2. When the drive signal is turned off, conduction in the collector-base diode (A) continues due to stored charges. The diode behaves like (B) a single piece of "p" material. Dissipation of stored carriers (C) restores reverse bias, permitting cut-off. The sequence alters waveform shapes (D) in the circuit.



THE STORAGE of carrier charges, whether they be holes or electrons, by the base of a transistor, is a recognized characteristic. The fact that such a phenomenon exists is sometimes pointed out in books and articles on transistor theory. Nevertheless, its effect on circuit operation remains, for the most part, untold. Since it can be used as an advantage in some applications and minimized in others where it would be a disadvantage, an examination of this phenomenon is worth the small time involved.

Base storage, which occurs when the transistor is conducting heavily, prevents immediate turn-off of collector current when a cut-off signal is applied. Circuits involving large-signal operation are most affected. Normally the collector-base diode is reverse biased; at saturation, however, the collector falls below the base and the diode becomes forward biased. When this occurs, the collector, acting like another emitter, tries to emit to the base. Carriers issuing from the normal emitter, trying to get to the collector through the base, are opposed. The net result is that carriers pile up in the base.

An "on" transistor storing carriers from the emitter is illustrated in Fig. 1. Since a *p-n-p* device is used in this example, positive carriers or holes are shown. The input pulse is negative. The base potential is designated "+V" to indicate its relationship to the collector potential. Electron flow (*E*) is principally from collector to emitter, with some (I_{b1}) from base to emitter. Holes (*H*) move from emitter to collector, except that many of these positive carriers are accumulated in the base. The base, being *n*-type material, would normally exhibit a negative charge; but, with the storing of the carriers, it takes on a net positive charge.

When the positive-going turn-off signal is applied to the base, the emitter-base diode becomes reverse biased and the emitter is no longer an active part of the circuit. However, collector current (I_c) does not stop flowing at once. This is due to collector-base conduction, as illustrated in Fig. 2A. Since both collector and base have a net positive charge, the collector-base diode (at least until the storage charge is removed from the base) may be represented as a single piece of *p*-type material. This is shown in Fig. 2B. With the emitter not active, electron flow is from the negative collector circuit to the base circuit, as shown.

From a comparison of Figs. 1 and 2A, it can be noticed that base current I_b reverses direction with the turn-off signal (I_{b2}) but collector current I_c con-

STORAGE EFFECT

base, significantly influencing circuit operation. if undesirable. / By DONALD E. McGUIRE

tinues in the same direction. The positive voltage applied to the base at turn-off repels the positive, stored charges toward the less positive collector potential. Although electron flow is initially out of the base toward "+V," this external flow decreases proportionately as the number of stored charges decreases, until a point of reverse bias is at last reached, as shown in Fig. 2C. At this point, the collector-base diode is finally turned off, and both I_b and I_c cease to flow.

Waveforms for the input signal, the corresponding base current, and the corresponding voltage waveforms at the base and collector are shown in Fig. 2D. The circuit action just described following application of the turn-off signal can be traced from these. Note that the collector output waveform remains almost constant in amplitude, after the application of turn-off signal, until the storage charge is reduced to the point of reverse bias. The greater the storage, the longer will I_c flow after turn-off signal; the greater the turn-off signal, the faster the storage is reduced. Base storage may cause the collector current to remain on up to 1 microsecond after the turn-off signal.

Using the Effect

The storage effect is used to advantage when one wants a pulse-stretching circuit. Since a pulse of narrow width or short duration applied to the base of a transistor can provide a pulse of considerably increased width at the collector, a stretcher exaggerates this effect by using two or more stages of overdriven amplification, depending on how much stretching is desired.

A typical example is given in Fig. 4. With all transistors initially turned off, each is driven into heavy conduction upon the application of a turn-on signal at the input. However, due to the effects of base storage, each transistor will prolong the duration of the initial pulse in turn before it passes it on to the next stage.

A typical application of the stretcher appears in Fig. 3. In this arrangement, the "and" circuit is to be operated only when the input pulse to the system is of the proper width. Accordingly this narrow pulse (.5 microsecond) is fed to the "and" circuit through a delay line and also fed to a pulse-width detector. Since output of the latter is a very narrow pulse, the latter is passed through a stretcher before being applied to the other input of the "and" circuit. The wider pulse that results (1 microsecond) assures time coincidence of the two inputs to the "and" circuit.

In pulse circuits involving a high repetition rate, there must be rapid recovery after every pulse to allow for the one following. The stretching effect provided by storage would obviously be undesirable here. To avoid it, the most common practice is the use of collector-base clamping. By clamping the collector-base diode at a point short of saturation, large storage is prevented from developing.

Double diode clamping, as illustrated in Fig. 5, is often used for this purpose. A germanium diode, CR_1, is used as the clamping diode and a silicon diode, CR_2, is a biasing diode. In this application, the forward voltage drop across the germanium diode is about 1 volt, whereas the silicon diode drops about 1.2 volts. This will keep the collector-base diode reverse biased by .2 volt when clamping action takes place.

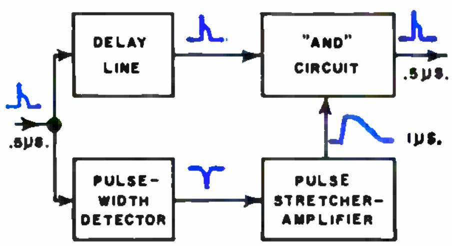


Fig. 3. An application of the stretcher.

All of the input signal is routed through CR_2 to the base prior to the time that CR_1 is forward biased. CR_1 itself will remain reversed biased until the collector falls below the input signal at the base. When the latter occurs, CR_1 conducts. This shunts excessive input signal directly to the collector. Since CR_1 drops .2 volt less than CR_2, the difference between the base and the collector is .2 volt of reverse bias, which prevents saturation and large storage. Thus this undesirable storage is avoided by maintaining reverse bias on the collector-base diode.

Base storage is not only a significant phenomenon, but may have desirable or undesirable effects on circuit operation, as has been shown. An understanding of the effect, its uses, and how it is controlled is important in analyzing circuit action where it appears and using or eliminating it where necessary. ▲

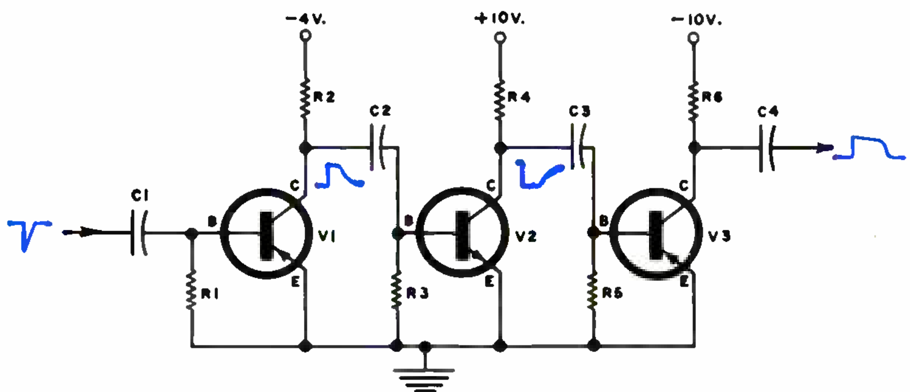


Fig. 4. Using storage effect: narrow input pulses to stretcher are made wider.

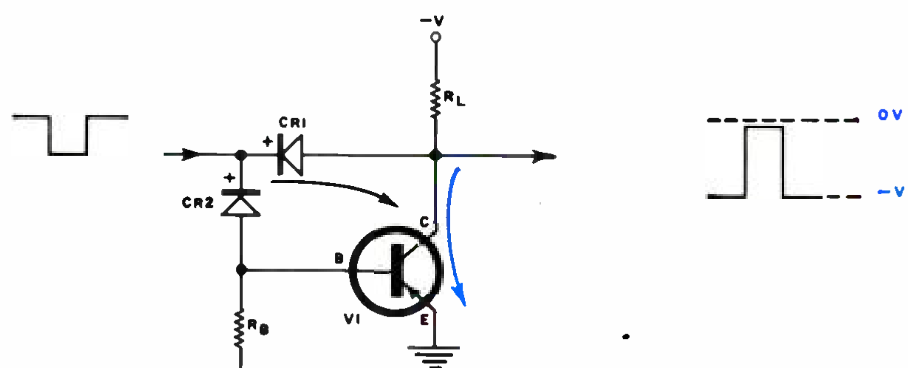


Fig. 5. Minimizing storage: collector-base clamping, achieved here with 2 diodes.

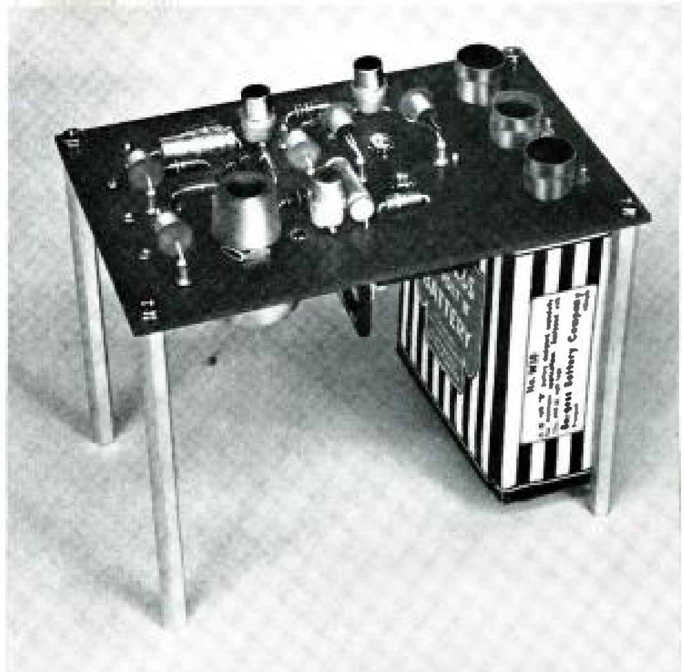
COLLECTOR CURRENT PRIOR TO CR1 CONDUCTION

ADDED COLLECTOR CURRENT DUE TO CR1 CONDUCTION

VERSATILE ELECTRONIC SWITCH

By **C. E. MILLER** / General Radio Co.

Construction of a transistorized circuit that will operate a relay over a frequency range of 16 seconds per cycle to 14 cps. Used for testing and as chopper.



The use of an etched board permits a variety of mounting techniques. Here the unit is shown self-contained with battery.

THERE are many different types of switches used in electrical circuits. Of these, relays are of importance because they are electrically, rather than manually, operated. This makes them particularly suitable for a wide variety of applications. The device to be described consists of a relay, together with electronic circuitry, which causes the relay to open and close over an extremely wide frequency range.

Applications

The applications for such an electronic switch are numerous. Because there is an actual mechanical pressure forcing the contacts together when the relay is energized, the "on" resistance is quite low (generally a fraction of an ohm). This is important if the switch must carry any current. One such application would be as a keyer to flash a lamp periodically. The effects of changes of conditions in many circuits may easily be seen.

Fig. 2 illustrates how to test for the effects of line-voltage changes. In Fig. 2A, the primary of a filament transformer is excited from the line when the relay is energized. The secondary is connected in series between the line and the load. Depending on the phasing of the windings with respect to the line, the secondary voltage either adds to or subtracts from the line voltage. When not energized, the relay must short out the transformer to remove its reactance from the line. The direction and magnitude of the steps may be altered by changes in the phasing and the number of secondaries employed. Fig. 2B shows how the use of a variable autotransformer offers greatest versatility by providing stepless control of amplitude.

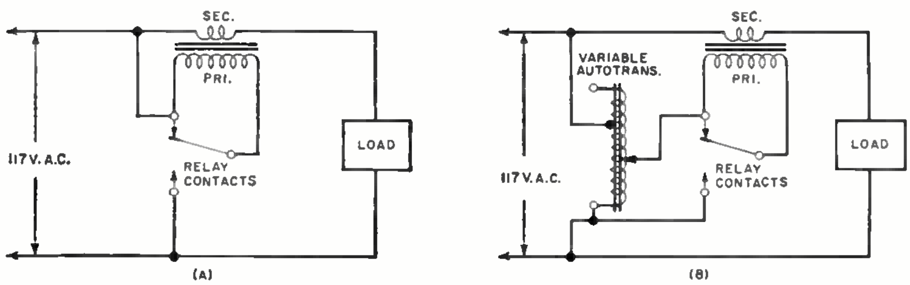
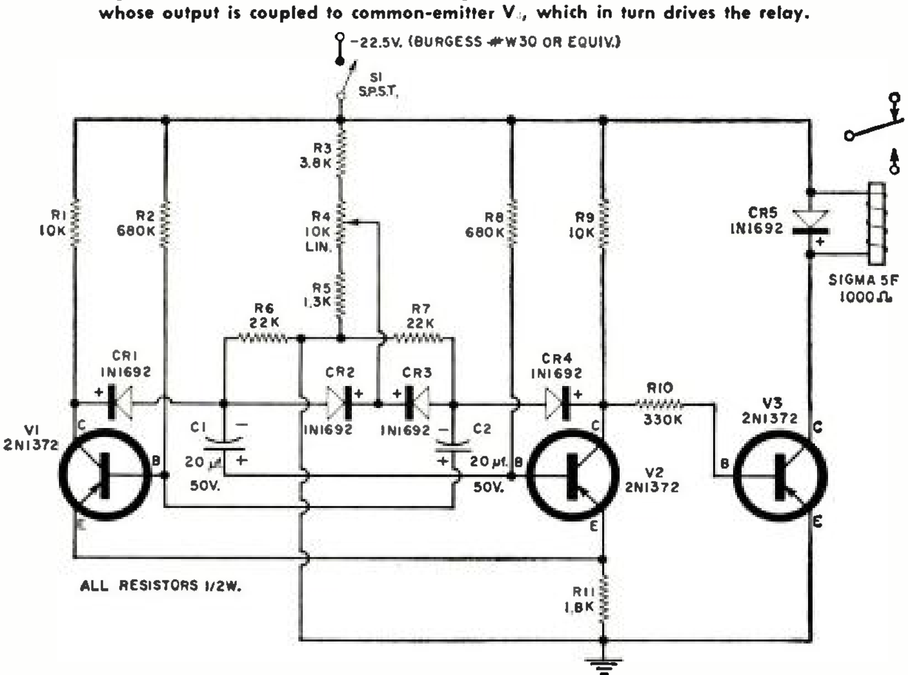


Fig. 2. Test arrangements employed to note effects of line-voltage changes.

Fig. 1. Circuit consists of a free-running multivibrator (transistors V_1 and V_2) whose output is coupled to common-emitter V_3, which in turn drives the relay.



Load variations may be simulated, as shown in Fig. 4. The effects of such changes are very important in circuits employing regulated power supplies, for example.

Another field of applications would be as a low-frequency chopper. This allows a device with an electrical input to be connected alternately to two signal sources. Fig. 3A illustrates how a meter may be used to monitor two different circuit voltages. The same technique may be used to watch two different voltages on an oscilloscope, as shown in Fig. 3B. If in the latter case one of the voltages is zero and the other is a standard, such as one volt as shown in Fig. 3C, the chopper may be used as an accurate scope calibrator.

In the past, such units have suffered from conditions such as limited frequency range, instability, and unequal division of the operating period. This limited their use and thus their desirability. This unit was designed to overcome these deficiencies in order to make it broadly applicable without modifica-

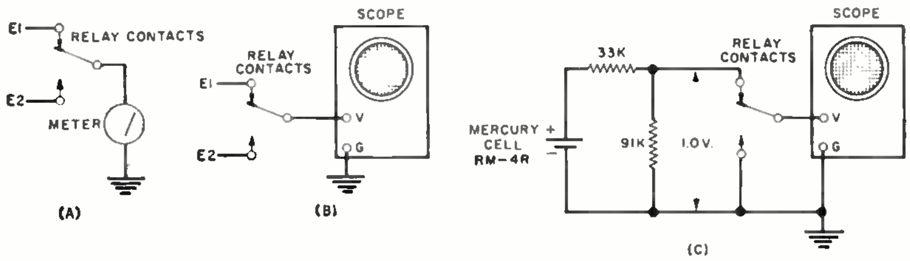


Fig. 3. Test setups illustrating the use of the relay as a low-frequency chopper.

tion. With component values as given in Fig. 1, the unit will operate over a frequency range of 16 seconds-per-cycle to 14 cycles-per-second. This is approximately a 200-to-1 frequency ratio. The corresponding range of periods is 16 seconds to 70 milliseconds. The maximum period is limited principally by the leakage of the cross-coupling capacitors and the transistors. The minimum period is limited by the mechanical response of the relay that is employed.

This wide frequency range is made possible by the method of frequency control and by isolation of the relay from the multivibrator circuit. The relay is driven by a separate amplifier to reduce the problems associated with a change in average current as frequency is varied. It also aids materially in maintraining a stable, equal division of the period. Critical adjustments of the relay contacts are thus eliminated.

Mechanically, the unit was built on an etched-circuit board to facilitate duplication. No attempt was made to hold size to the absolute minimum. Rather, it was felt that the larger board would allow greater physical versatility. For example, four corner holes are provided. This allows the board to be mounted either on a chassis or on four spacers which act as legs. The board is laid out in such a way that power connections may be made either to terminals or directly from a battery. In the latter case, the battery is held to the board by its binding posts.

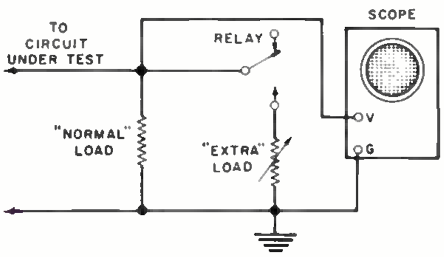


Fig. 4. Observing effect of load changes.

Circuit Details

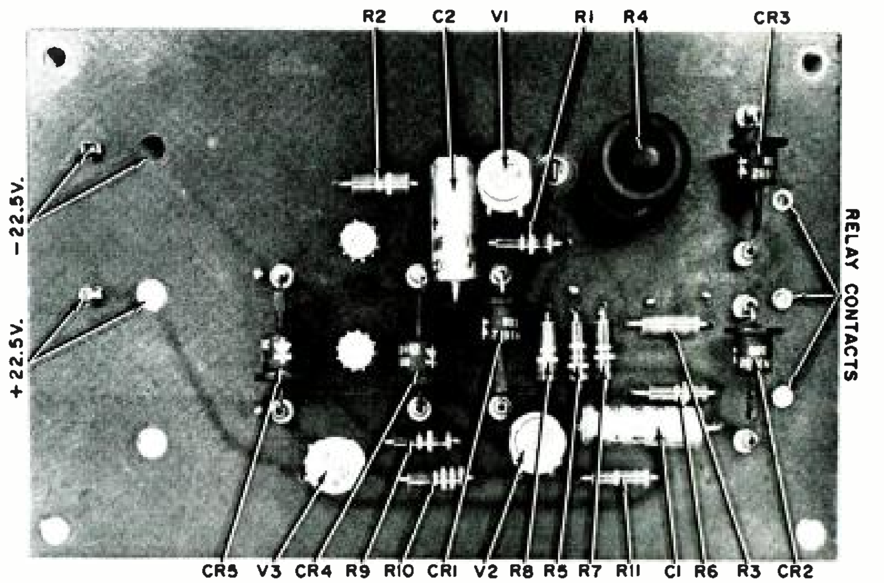
Transistors V_1 and V_2 operate as an astable (free-running) multivibrator. Forward bias is provided by R_2 and R_3. In addition, these resistors, in conjunction with C_1 and C_2, determine the circuit time-constant. The method usually used to vary the frequency of oscillation is to vary either the value of these resistors or the supply voltage to which they are returned. Either method alters not only the frequency but the bias level as well, thus restricting the operating range. In this circuit the bias resistance and potentials remain unchanged. Instead, the magnitude of the *signal* coupled to each base from the opposite collector is varied. This is accomplished as follows.

Resistors R_3, R_4, and R_5 form a voltage-divider circuit. The arm of R_4 picks off a constant voltage depending on its setting. The negative sides of capacitors C_1 and C_2 are tied to this voltage through diodes CR_2 and CR_3. The negative sides of C_1 and C_2 are also connected to the collectors of V_1 and V_2 through diodes CR_1 and CR_4.

To understand the operation of this circuit, assume that V_1 is conducting and V_2 is non-conducting ("on" and "off" respectively). The collector voltage of V_1 is low, while the voltage of V_2 is approximately that of the supply. The negative side of C_1 is at a potential determined by the setting of R_4 and CR_1 is back-biased. Diode CR_4 is forward-biased, and the negative side of C_2 is at the same negative potential as the collector of V_2. The voltage from R_4 is disconnected from C_2 due to the reverse bias across CR_3.

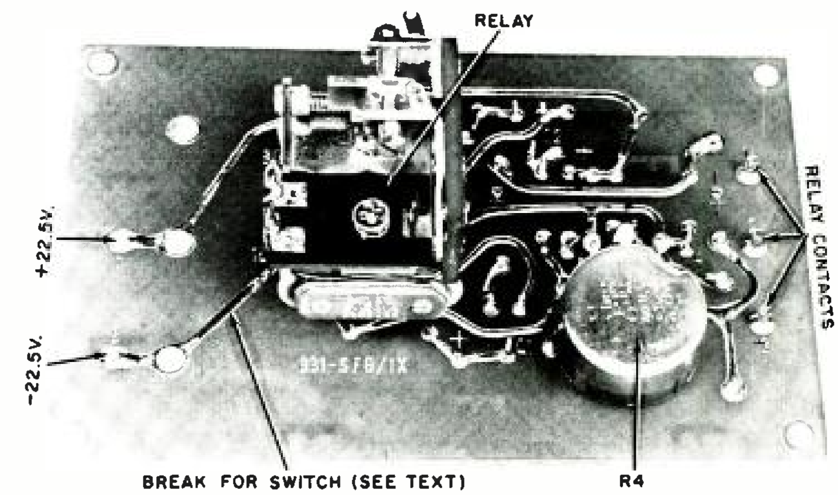
The circuit maintains this state until V_2 begins to conduct (this time-constant is determined by the values of C_1, R_3, and the setting of R_4). As the collector of V_2 becomes less negative, V_1 is driven off, but the negative side of C_2 can fall only

(*Continued on page* 62)



Top view of the printed-circuit board showing placement of the components used.

Under-board view. Relay and potentiometer are mounted after all other parts have been soldered in place. Although a printed board was used by the author for this particular model, ordinary point-to-point wiring techniques may also be utilized.



IT IS certainly no secret that the number of hams in this country is increasing at a steady rate. Furthermore, there is every indication that this trend will continue and, because it is very unlikely that new frequencies will be made available for amateur use, it is quite obvious that the number of "hams per kilocycle" will increase as well.

Even today, far too many contacts are uncompleted because of the terrific QRM. There are four "solutions" to this unhappy situation: (1) quitting entirely; (2) continuing to operate under present conditions with perhaps 50 to 80 per-cent of the QSO's completed; (3) moving up to the *much* higher frequencies, since even the high frequencies are no longer a haven, particularly in the larger cities; and (4) improving present-day communications equipment through new circuit combinations and design. Fortunately (or unfortunately for the rest of the fraternity!), only a

Front-panel view of the author's home-built noise and interference eliminator.

QRM ELIMINATOR for Communications Receivers

By A. W. CROWELL

Construction details and design of a useful receiver attachment that will eliminate just about all interference and static in the c.w. mode of operation.

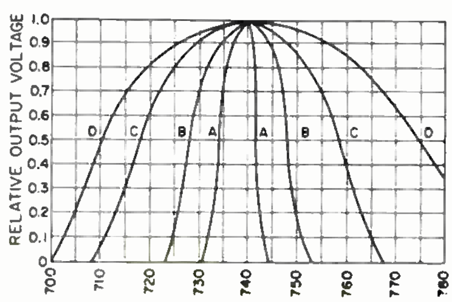
small percentage of hams take the route of the first alternative, with probably the largest percentage falling into the second group. If the issue is faced honestly, only the last two alternatives are "legitimate" since they require experimentation and construction, the real backbone of amateur-radio-type communications.

The new equipment design to be described is strictly for the c.w. operator but those who operate on phone may find the ideas interesting.

In the reception of signals, the crystal filter and those circuits designed for nulling an unwanted signal in both r.f. and a.f. circuits, while in themselves basically sound, do have their limitations by: (1) reducing the strength of the desired signal (which may already be almost too weak to copy if the interference is too close); and (2) handling effectively only one interfering signal. To combat this, the better communications receivers incorporate both crystal and nulling circuits. In addition, those circuits which can be used for nulling are also used for peaking the desired signal, by means of switching, to raise its level above the one or more interfering signals. In this situation, the crystal filter can be used to knock out one undesired signal. None of these circuits, however, will effectively eliminate another type of interference—static, whether it is man-made or natural.

It is well known that the hearing characteristics of the human ear include operation on a logarithmic curve, which is to say that its sensitivity to sound levels increases more than in a direct proportion as these levels decrease. As a result, any interfering signals, even though several decibels below the desired signal strength, will still be heard and make reception of the desired signal difficult, if not impossible. It is evident then that some type of improvement is necessary to eliminate not only interfering signals but various types of static—with only the clear reproduction of the desired signal delivered to the output.

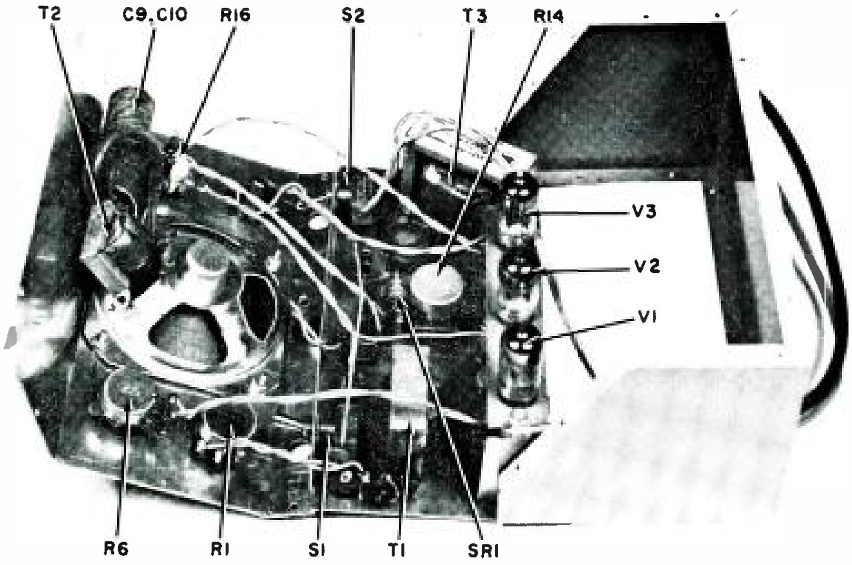
Fig. 1. Wien bridge peaking amplifier selectivity (bandwidth) with four different input voltage levels, as follows: A is for 4.5 mv.; B is for 9 mv.; C, 18 mv.; D, 36 mv.



The Basic Idea

After too many wasted hours listening to weak signals in QRM, dreaming that they were "5 by 9," the basic idea for this equipment finally dawned on the author. It was reasoned that if a first-stage audio-frequency peaking circuit with enough gain and selectivity drove a second-stage audio oscillator, biased to the point where only the resulting voltage level of the desired signal would cancel this bias and permit oscillation, only the desired signal would be heard and the interfering signals and static would be lost by the wayside. The signal to be peaked is obtained by adjusting the variable b.f.o. control in the receiver in the normal manner of c.w. reception.

Breadboarding several types of audio-peaking circuits resulted in the choice of a Wien bridge feedback amplifier adjusted for very little regeneration. At



Interior view of QRM eliminator. A built-in audio amplifier is employed in the unit.

this point there is no signal "ringing" and the selectivity curve is 40 cps wide (half-voltage points) at the peaking frequency of approximately 740 cps. This value was selected as a compromise between interference elimination and excessive selectivity. As the four curves of Fig. 1 show, actual selectivity is a function of input voltage level which is controlled by the operator (adjustment of R_1). The half-voltage point was selected for discussion because interfering signals of this level will not "ride through" the bridge. In addition, no special precautions are required in the mounting of parts, their size is small, and cost is low.

A trial operation showed that the oscillator could not be of the fixed-frequency, free-running type inasmuch as there was enough received audio signal leakage from the first stage (through the intermediate rectification stage controlling bias and therefore actual oscillation of the second stage) to cause two frequencies to be heard. While it is possible to select second-stage circuit values which will result in its frequency being identical to the peaking stage, this is not a satisfactory design because not only will the local oscillator be heard at either edge of the bridge bandpass response, but the received signal as well.

The final answer lay in the selection of the Schmitt trigger circuit. This is a direct-coupled, one-shot type of oscillator whose output frequency is automatically that of its input. With this type of coupling, its operation with a sine-wave input is smoother than that of the more conventional capacity-coupled circuit. Actually, the output is a continuous series of pulses of input frequency for the time duration of each signal period.

Circuit Design

Fig. 2 is the schematic diagram of the author's QRM eliminator. The input is obtained from the "phones" jack of the receiver. With the d.p.d.t. "Bridge-Direct" switch thrown to "Direct," the internal speaker, through its amplifier, will deliver normal receiver output. A "Phones" jack is provided for headphone reception. Throwing the switch to "Bridge" places the unit in operation. The audio signal is coupled to the Wien bridge through transformer T_1. This may be substituted with some latitude of choice. For example, the author used an available low-power modulation transformer with a 10,000-ohm primary to 4000-ohm secondary. Note, however, that the primary and secondary are reversed when connected into the bridge to provide voltage step-up for proper input voltage levels. Since no power is required, any interstage coupling transformer having approximately these impedances should be satisfactory here.

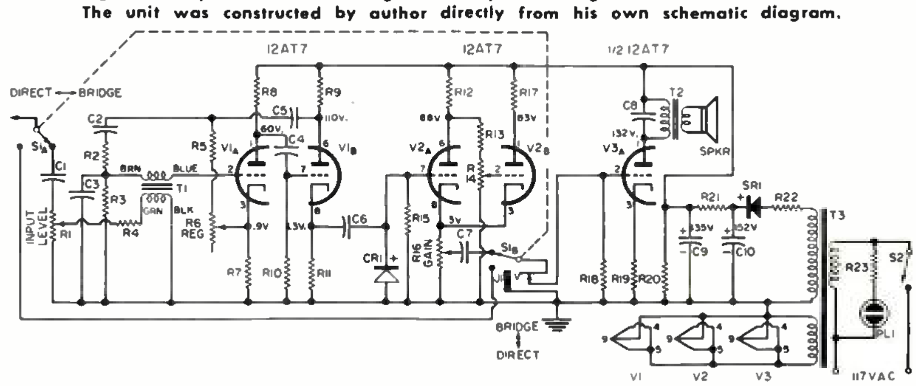
With the "Regeneration" control, R_6, adjusted for slight regeneration, only the desired c.w. signal will be heard as the receiver's b.f.o. control is adjusted for an input frequency equivalent to the bridge-peaking frequency. In the case of those receivers which do not have this control, it must be added since it is impractical to attempt peaking an audio frequency with the main frequency or bandspread tuning dials. These controls are tuning r.f. frequencies and will be much too critical in adjustment.

In operation, the receiver's r.f. and a.f. controls are adjusted for a slightly stronger-than-desired c.w. signal level, but no overloading of the receiver should take place. The tone control is set for treble reproduction to insure absolutely no attenuation of the peaking frequency. The a.v.c. is used to hold a steady signal level.

The "Input Level" control, R_1, is lowered as much as possible while simultaneously varying the b.f.o. control until the frequency output arrives at the center of the bridge bandpass. This will result in only the desired signal being heard clearly and reliably. This control was added to the original circuit, since its adjustment is not as critical as either the receiver's r.f. or a.f. gain controls. This is true because, generally, only a small amount of audio level (knob rotation) is used and r.f. gain reduction is not usually directly proportional to the rotation of the control knob.

Resistor R_1 keeps the bridge "Q" high and, therefore, its selectivity when the unit is used with a low-impedance receiver output. Bridge components R_2 and R_3 should be matched to $\pm 2\%$, as should C_2 and C_3, to obtain best selectivity. Remember this is tolerance be-

Fig. 2. Complete schematic diagram and parts listing for the QRM eliminator. The unit was constructed by author directly from his own schematic diagram.



R_1—20,000 ohm linear-taper pot.
R_2,R_3—200,000 ohm, ½ w. res. (matched ±2%, see text)
R_4—20,000 ohm, ½ w. res.
R_5—2000 ohm, ½ w. res.
R_6—2000 ohm linear-taper pot.
R_7,R_{21}—1000 ohm, ½ w. res. ±10%
R_8—68,000 ohm, ½ w. res. ±10%
R_9—33,000 ohm, ½ w. res. ±10%
R_{10},R_{15},R_{18}—200,000 ohm, ½ w. res.
R_{11}—3000 ohm, ½ w. res. ±10%
R_{12}—120,000 ohm, ½ w. res. ±10%
R_{13}—180,000 ohm, ½ w. res. ±10%
R_{14}—50,000 ohm linear-taper pot.
R_{16}—500 ohm linear-taper pot.
R_{17}—8200 ohm, ½ w. res. ±10%
R_{19}—220 ohm, ½ w. res. ±10%
R_{20}—47,000 ohm, ½ w. res. ±10%
R_{22}—47 ohm, 1 w. res.
R_{23}—47,000 ohm, ½ w. res.
C_1,C_4,C_5,C_6,C_7,C_8—.01 μf. disc ceramic capacitor
C_2,C_3—.001 μf. capacitor (matched ±2%, see text)
C_9-C_{10}—40/40 μf., 150 v. elec. capacitor
J_1—Midget closed-circuit jack
PL_1—NE-51 neon lamp
CR_1—1N34 diode
SR_1—SR200 diode (Sylvania)
S_1—D.p.d.t. toggle switch
S_2—S.p.s.t. toggle switch
Spkr.—4", 3.2-ohm PM speaker
T_1—Mod. trans. 10,000 ohms to 4000 ohms (Stancor A3812)
T_2—Output trans. 4000 ohms to 3.5 ohms (Stancor A3328)
T_3—Power trans. 125 volts @ 50 ma.; 6.3 v. @ 2 amps (Stancor P8121)
V_1,V_2,V_3—12AT7 tube

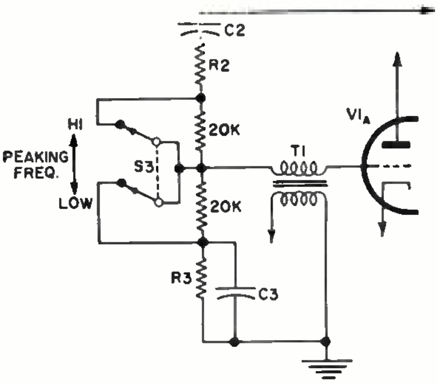


Fig. 3. Partial schematic of Wien bridge oscillator showing addition of two 20,000-ohm resistors for shifting peaking frequency.

tween these components and not the accuracy of the equipment used to make the measurements. Its accuracy can be much lower since it is only necessary to approximate values of 200,000 ohms and .001 μf., respectively. Variation from these values only shifts the peaking frequency proportionally.

The Schmitt trigger fires on a positive-going waveform. Therefore, to use each complete cycle for maximum input signal voltage, a diode (CR_1) is added to clamp the signal to ground. This improves operation materially and the action is shown in Fig. 7.

Disc ceramic .01-μf. capacitors were selected for the equipment since close tolerance is not required, their cost is low, and they are small in size. R_{16} is the "Audio Gain" control and was also added to the original circuit since it was found that the "Input Level" control (R_1) should be used only for determining the best operating point and not for controlling gain as well. The Schmitt triggering control (R_{11}) was made variable (screwdriver adjustment, reached from the bottom of the cabinet) because it is a convenient method for obtaining the best operation of this stage. Its setting is somewhat critical and is best accomplished by making the Wien bridge oscillate temporarily with R_6 and then adjusting for the clearest audio tone.

The power supply is as simple as safety will allow. Approximately 135 volts d.c. and 6.3 volts a.c. are available for "B+" and tube heater use. Regulation is not necessary. Voltage levels, as measured with a d.c. vacuum-tube voltmeter, are indicated on the schematic.

Some operators may wish to add a d.p.s.t. toggle switch (S_3 in Fig. 3) and two 20,000-ohm resistors matched $\pm 2\%$ in the positive feedback circuit so that the peaking frequency can be shifted. They are added to R_2 and R_3 as shown in the diagram. These two choices practically eliminate the possibility of not being able to select the desired signal from interference. To express the desirability in another way, it allows a second frequency choice for those rare instances where the condition exists in which an interfering signal differs from the desired signal by the Wien bridge peaking frequency. With single-frequency peaking, it is impossible to make a separation. If two r.f. signals are on the same frequency, nothing can be done to cut out the interference, except possibly use a direction-finding loop on the receiver and hope that the interference isn't originating from the same or 180-degree direction!

Before contemplating the construction of this unit, the reader is advised to consider carefully whether or not his communications receiver has satisfactory high-frequency-oscillator and b.f.o. stability. Keep in mind that the best bridge-stage selectivity is only about 40 cps wide and that drifting of either of these circuits will mean re-peaking. In particular, the stability of the high-frequency oscillator must be excellent since it operates in both the kilocycle and megacycle frequency ranges where only a small part of a per-cent shift is many cycles. For this reason, it will be impractical to copy satisfactorily any signals which shift noticeably in frequency on the receiver that is used.

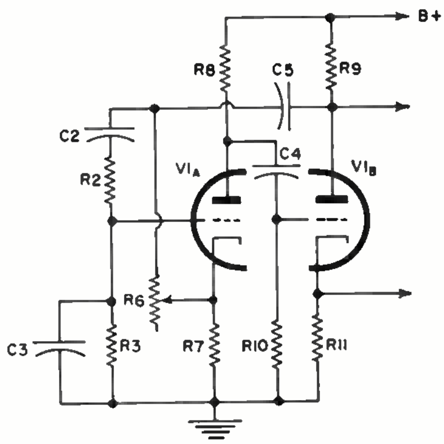


Fig. 4. Basic Wien bridge oscillator.

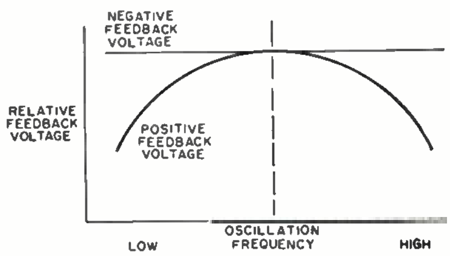


Fig. 5. Wien bridge feedback voltages.

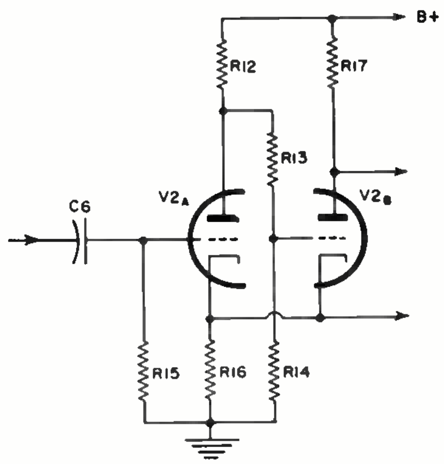


Fig. 6. Schmitt trigger basic circuit.

Theory of Operation

Perhaps a brief discussion of the theory behind the operation of the Wien bridge peaking amplifier and the Schmitt trigger would be appropriate here.

A simplified schematic of the bridge is shown in Fig. 4. Since the output of V_{1A} is coupled to the grid of V_{1B} and its output is, in turn, coupled back to the grid of V_{1A} through C_2-R_2, the necessary positive feedback loop has been established to produce oscillation. For example, as plate voltage is applied to V_{1A} and V_{1B}, a voltage drop is produced across R_7 which results in a negative-going V_{1A} grid. The plate voltage will rise, applying a positive-going voltage to the grid of V_{1B}. This, in turn, increases conduction with a consequent dropping of plate voltage (moving in a negative direction), which couples back to the V_{1A} grid through C_3 and C_2-R_2, thus supporting the initial condition. This swing continues until the voltage change limit has been reached, after which it reverses and both the initial charge and the feedback voltage on the grid of V_{1A} become positive. This swing back and forth is, in effect, oscillation.

Where $R_2 = R_3$ and $C_2 = C_3$, the oscillation frequency can be stated in terms of $1/(2\pi R_2 C_2.)$ To explain this relationship, consider for the moment that a constant feedback voltage to the top of C_2 is varying from a low to a high frequency. At all frequencies below that resulting in successful oscillation, the reactance of C_2 is high, thus putting a relatively low voltage on the grid of V_{1A}. At this time the high reactance of C_3 does not play an active part. At all frequencies above the actual oscillation frequency, the capacitor action is reversed wherein the reactance of C_2 is low, thus attempting to build up the positive feedback on the grids. But since the reactance of C_3 is also low, some of this attempted higher voltage is shunted to ground. This means, then, that the maximum voltage to the V_{1A} grid is possible only when the feedback frequency is such as to be affected in the same manner by the reactance of C_2 and C_3. This voltage *versus* frequency is indicated as the curved line in Fig. 5.

There is also an inverse voltage feedback loop (voltage in opposition), *via* C_5 through R_6, which feeds the cathode of V_{1A}. That is, simultaneously with a negative-going feedback voltage to the tube grid there is the same negative-going voltage feeding the cathode. This, in effect, decreases the grid bias at the same time that the initial current flow through R_7 is building up a bias. Hence the two voltages are in opposition. The adjustment of R_6, then, is made from a high-resistance value (small amount of negative feedback which permits the stage to oscillate) to that lower value just beyond the point of oscillation into slight regeneration. This feedback

(Continued on page 70)

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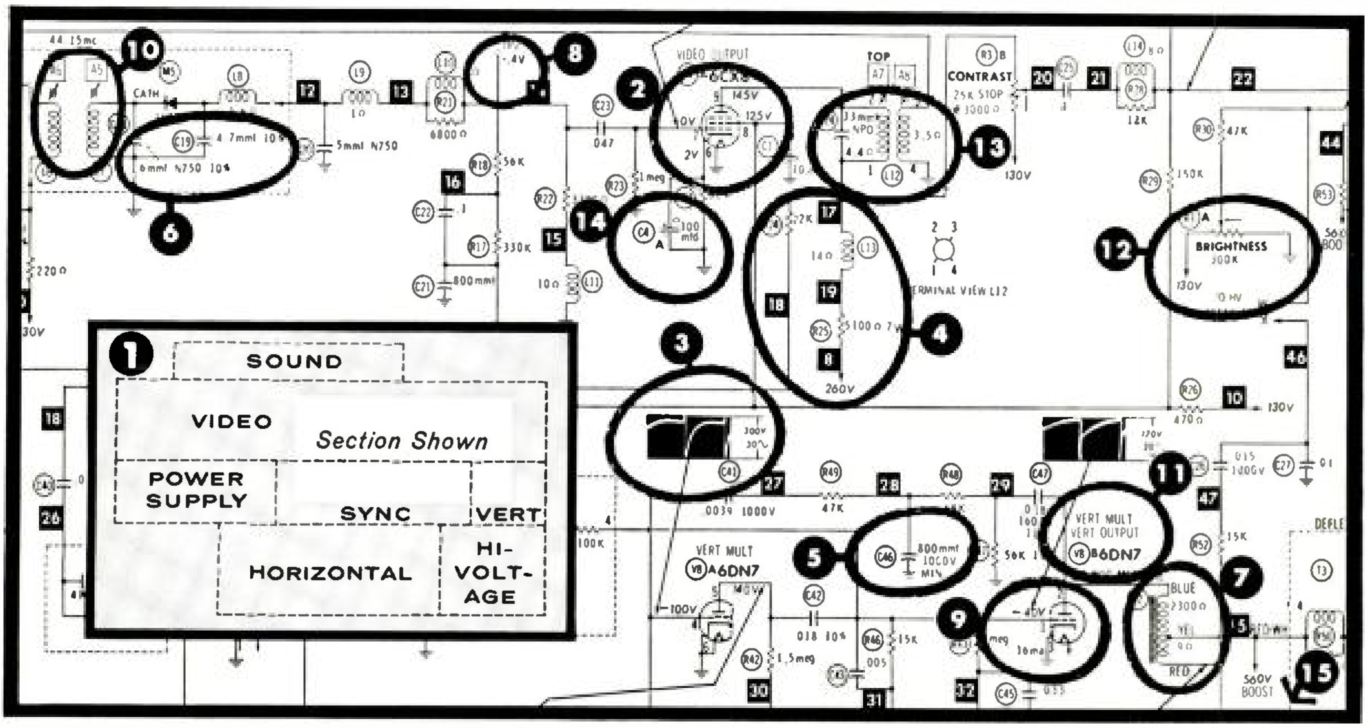

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NEW WESTINGHOUSE TV CIRCUITS

A "re-broadcaster" for private audio, an "instant-on" tube saver, and a combined width-linearity adjustment are some of the noteworthy features of the new TV sets.

OLD HANDS at TV service are wont to say that there is nothing new in the field any more. Sets have fallen into a fairly uniform, unchanging pattern, with a few predictable variations. The same thing has happened to service. For the experienced, troubleshooting is mostly dull routine with few surprises. These claims have just enough truth to make them sound credible.

But every manufacturer has a staff of design engineers who, to earn their keep, must innovate constantly. The result? Even the common table radio, "rigidly standardized" for more than a decade, has crept up on you if you haven't been watching. Tubes with low filament power and multi-function types, reducing the number of tube envelopes, have changed the old line-up. We see printed boards and some trick circuits. And much more of the same happens in TV.

The current *Westinghouse* line is just one case in point. What with new circuits and components, new adaptations of old ideas, and recent changes growing out of earlier changes, there is enough to talk about and keep up with. An example of an old horse pulling a new wagon is the "Remote Radio Speaker" feature, which is a frill added to receivers designed for operation by remote control.

The control system is interesting in itself, although it involves no radical changes. Output from a wireless, ultrasonic transmitter is picked up by a transistorized, remote-function receiver at the TV set. On-off control of the TV set, three fixed levels of audio output, and channel selection are the primary functions. The remote-control receiver, which draws negligible current, may be left on at all times so that the transmitter can turn on the TV circuits. The "Radio Speaker" feature eliminates a problem that sometimes arises with remote-control operation and also adds a convenience apart from this function.

The heart of the added feature is the simple re-broadcast oscillator, located inside the TV cabinet, shown in Fig. 1. The basic notion has been around for years. The phono oscillator, which permits a record changer to be played through a radio in the same room without wire connections, is one version. The wireless baby sitter is another variation.

Here a single *p-n-p* transistor is the oscillator. The filtered cathode of the TV receiver's audio output tube is a convenient source for picking up the required low "B+." Resistors R_3 and R_4 drop the 20 volts down to the 10.8 volts needed at the transistor emitter. The base is reverse-biased from the same source through resistor R_2, so that the stage is cut off most of the time. However positive feedback from the tank circuit, through C_5, provides brief, periodic forward bias to permit conduction during part of each oscillatory cycle. In effect we have a class-C stage. Principal components in the oscillator tank are transformer L_1, tuning capacitor C_6, L_3 (which suppresses harmonic output), and antenna coil L_2.

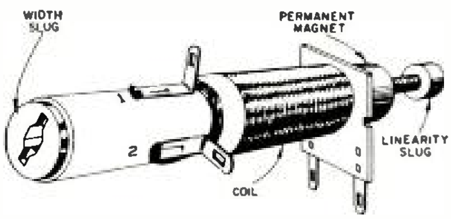


Fig. 2. Single-winding, dual-slug, width-linearity coil permits independent control.

When the detected TV audio signal is applied to the r.f. oscillator through C_1, it amplitude-modulates the output. The latter may be picked up by any AM radio in the same room or over a greater, reasonable distance. Audio may be applied *via* the remote control. In this arrangement, only two fixed levels of sound are provided remotely through the TV speaker instead of three. The third position now cuts out direct TV sound and applies audio signal to the re-broadcast oscillator. A shaft on C_6 permits customer adjustment so that the transmitter can be tuned for a clear spot on the regular, AM band. The design complies with FCC regulations to avoid interference.

Entirely by remote control, the viewer can now select either of two volume levels from the TV speaker or listen only through a chairside radio, through which he has full-range command of level. He can thus keep volume high enough for his own enjoyment but low enough to avoid interfering with people in the room who are engaged in other activities. Better yet, he can pick up through a transistor radio in his shirt pocket. With an accessory earphone, he can have all the level he wants without a whisper going to anyone else. The idea may be old—but who thought of using it this way?

Another familiar figure in new dress is "Instant On," a variant of standby operation used in much broadcast and commercial equipment, featured in the *Westinghouse* V2416 series chassis. A semiconductor diode, X_{403}, is shown (Fig. 3) in the series filament line. With

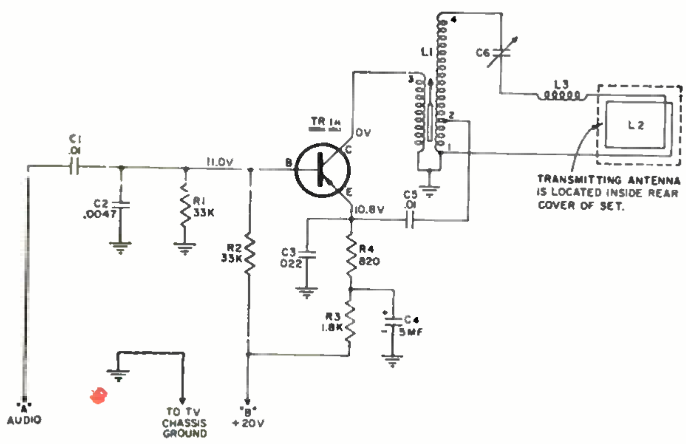
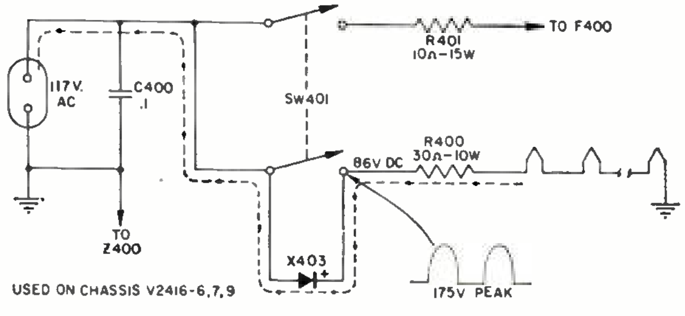


Fig. 1. Single-transistor circuit radiates TV audio to a separate, independently controlled radio near the viewer.

Fig. 3. The diode in series with the filament line in the "off" position rectifies and drops a.c. to keep tubes warm.



on-off switch SW_{101} closed, the diode is shorted out, the receiver is on, and operation is normal.

When the switch is opened to turn the set off, line voltage (broken line) is still applied to the heaters, through the rectifier. However X_{103} serves the purpose of a voltage-dropping device. This is so because its high-ripple, half-wave output has the effective value of 86 volts d.c. across the heater string, instead of the "on" value of 117 volts. With this reduced voltage keeping filaments somewhat alive in the "off" receiver, as long as the latter is plugged into an outlet, the normal warm-up period is eliminated. Picture and sound come right up at turn-on. (A semiconductor voltage doubler provides immediate "B+.") For safety's sake, fusible resistor R_{101} will open in the event of a short or other abnormal overload condition, effectively "pulling the plug."

Effect on Reliability

The "off" receiver thus consumes about 32 watts on a continuous basis, or no more than a modest incandescent lamp. Increased power cost is not prohibitive—but is the convenience provided worth even such a boost? Perhaps not, only from the viewpoint just noted, but there are other factors to consider. Readers may recall some of the promotional "reliability" demonstrations staged at times by various tube manufacturers. A TV receiver is publicly operated, on a continuous basis for, say, 3000 hours, representing perhaps two or three years of normal use time—without a single defective tube at the end of the test period. These demonstrations never fail to be impressive, but they are substantially aided by an important factor. The continuous run does not include the frequent on-off cycles, perhaps a thousand of them, to which a TV set is normally subjected in 3000 hours of home use.

The materials used to make tube filaments are such that a heater behaves like a voltage-sensitive resistor, exhibiting a cold resistance that is many times lower than its hot value. This accounts for the heavy instantaneous current surge when a cold receiver is first turned on. Although the tubes heat to normal resistance and stabilized operating current in only a few seconds, the short-term condition subjects them to severe stress. The cumulative effect of such repeated assaults is heater failure, in addition to other tube defects. Many experts have indicted on-off cycling as the culprit in most tube failures.

With the standby operation provided by "Instant On," long-term tube reliability and performance should resemble the results obtained in the public demonstrations mentioned. Since tube failure accounts, by far, for the greatest number of set defects, an important gain is realized here. In addition, the constant warmth produced by low-power heater operation helps in another way. An important cause of breakdown in many types of components other than tubes is the cumulative effect of humidity absorbed from the air. The development of high-voltage arcing is just one example. Other components are also sensitive to cold-hot changes associated with on-off cycling.

Constant chassis warmth, not enough to be a factor in heat-caused defects, combats humidity and minimizes wide temperature variations. It is too early for a statistical analysis based on field experience, but the over-all contribution of standby operation to convenience, stability, reliability, and reduced maintenance costs should go much further than merely balancing out the slight increase in power costs.

Width and Linearity

As the design of horizontal-output circuits improved over the years, it became possible to build better regulation of raster width and horizontal linearity into the receiver. Soon manufacturers began to eliminate broad-range, continuously variable consumer controls for these factors as being largely unnecessary. Scarcely had they done so when 110- and 114-degree picture tubes came on the scene. The wider deflection angles and CRT geometry combined to magnify slight scanning-circuit deviations whose effects might otherwise have passed notice.

Width and linearity problems were back. Also on their way back now are width and linearity controls. For accurate correction of horizontal raster shape, *Westinghouse* is using a single coil (Fig. 2) with a pair of separately adjustable slugs, one at either end, for independent control of width and linearity. As shown in Fig. 4, the combination coil is in series with the horizontal-deflection windings of the yoke. Adjustment of the width slug produces a fixed change in the coil's inductance. Since this determines what portion of the applied deflection voltage is dropped across the coil, it also determines how much deflection voltage is left for the yoke. Amplitude of the latter establishes width, but has little effect on linearity since the deflection waveshape is not altered significantly.

Non-linearity—and we must deal with more than one type these days—is associated with waveshape. The most familiar, earliest recognized variety, which occurs when deflection current varies as shown in Fig. 5A, is asymmetric non-linearity. Current increase is linear during most of the scanning cycle, but the greater rate of increase at the beginning and the leveling off at the end change the rate of electron-beam movement across the CRT face. The picture is correspondingly stretched on the left and bunched up at the right, a familiar nuisance.

This can be corrected if the rate of change is made uniform, corresponding to the waveform of Fig. 5B. But a static change in the adjustment coil's impedance will not alter waveshape much. The permanent magnet at one end of the combination coil, into which the linearity slug extends (Fig. 2), settles the problem.

The field associated with the magnet acts on the coil to change its normal circuit behavior. Coil impedance is now changed by the amount of current passing through it. In effect, it is a saturable reactor. As deflection current through it increases or decreases during one cycle, there will be an abrupt change in impedance. This non-linear behavior thus affects the rate of current change through the coil and through the deflection windings in series with it. Rota-

(*Continued on page* 76)

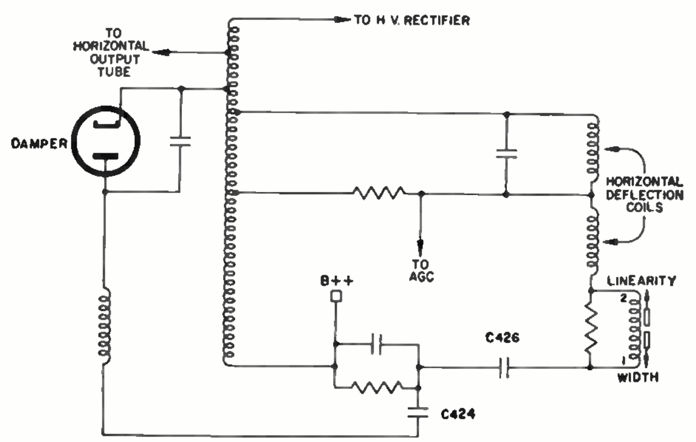


Fig. 4. Horizontal-output circuit using the dual width and linearity coil, in series with the deflection coils. A network for shaping the saw-tooth waveform to compensate for scanning distortion introduced by the CRT includes capacitors C_{421}, C_{426}.

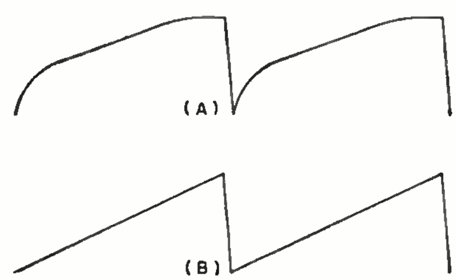


Fig. 5. Saw-tooth producing (A) asymetric non-linearity and (B) good linearity.

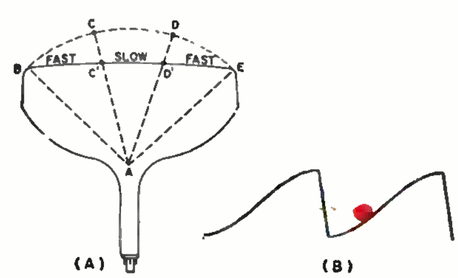


Fig. 6. How a wide-angle CRT (A) causes symmetrical non-linearity and (B) the waveshape needed to compensate for it.

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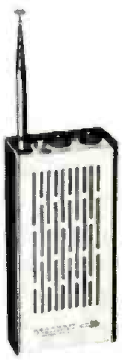

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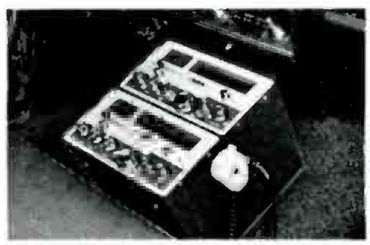

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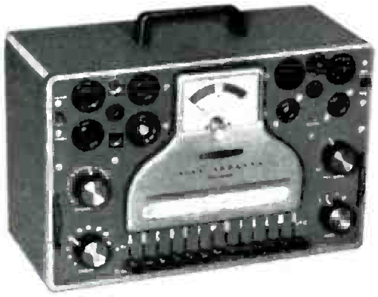

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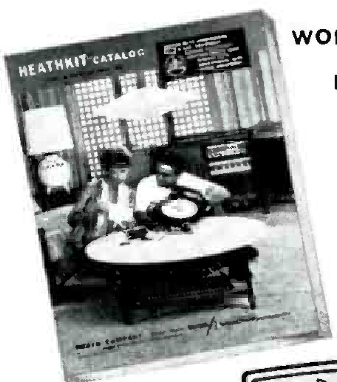

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These units, designated "PistoLasers" because of their double pistol grip, were designed to satisfy a number of diversified applications in the field of optical electronic research and development. In communications research, for example, they can be used to study the characteristics of very narrow beam width optical data transmission. In crystallography, they can be used to study crystal structures using non-linear light transmission. In photography, they can be used for taking pictures of extreme clarity. In biology, their primary use will be in the study of biological responses to high-intensity monochromatic stimulation. In medical research, they can be used to study high-intensity cauterization.

Recently, a laser developed by the *American Optical Co.* was used successfully to destroy a tumor on a patient's retina at the Columbia-Presbyterian Medical Center, New York City. The highly concentrated light beam burned out a tiny piece of tissue on the retina in what amounted to very delicate surgery. Although intense light sources have been used previously for this type of operation, this is the first recorded use of an intense, accurately controllable light beam from a laser.

The "PistoLaser" is a solid-state device which generates electromagnetic waves in a coherent beam. The coherent light output has a wavelength of 6929 angstrom units (red) and the light pulse train duration is approximately 0.2 millisec. Beam divergence is less than 0.3 degree. Its spectral brightness measured in energy per unit wavelength far exceeds that known from any other conventional source. The radiation output of the pulsed ruby laser beam is more than one billion times greater than the corresponding output of the sun within the same frequency band.

The laser is designed to operate either automatically or manually and is equipped with a continuously variable high-voltage power supply. It can be operated by battery or from a conventional 117-volt, 60-cps a.c. outlet.

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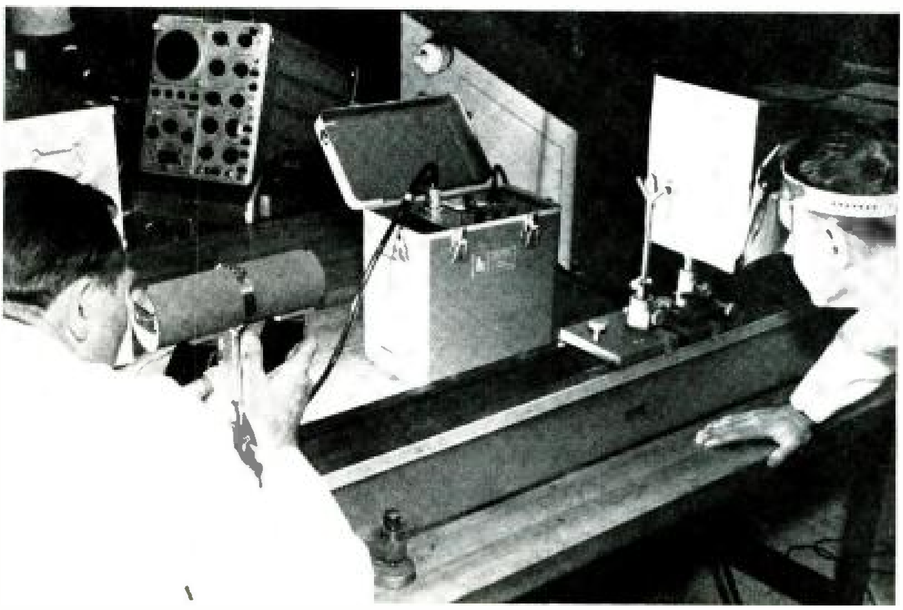
The scientist at the left is aiming the narrow beam of intense coherent red light from the head of the laser unit toward the viewing screen. Triggers in both pistol-grip handles must be operated in order to energize the device. The head unit fits inside a compartment in portable power-supply carrying case shown open on the bench.



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Versatile Electronic Switch

(*Continued from page 51*)

to the voltage level set by R_4. Beyond this CR_1 is reverse-biased and the remaining collector change is not coupled to the time-constant network R_2 and C_2.

After the transition, V_1 is off and V_2 is on, with diodes CR_1 and CR_3 forward-biased and CR_2 and CR_4 reverse-biased. This state is maintained until C_2 discharges through R_2 far enough to allow V_1 to begin to conduct. The setting of R_4 and the diode network control the fraction of each collector voltage change applied to the opposite base. Since the discharge rate is essentially constant, the setting of R_1 determines the time between transitions.

The lowest frequency is obtained when the slider of R_1 is closest to the grounded side of the voltage divider. As R_2 and R_3 are selected for optimum bias current, changes in the lowest frequency should be made by changes in the values of C_1 and C_2. These capacitors should be of equal value to maintain an equal division of the operating period. Resistor R_3 limits the maximum frequency attainable. In the unit described, the value of R_3 was selected so that maximum frequency was just below the capability of the relay. Any desired range may be selected by component choice within the above limits. For example, if C_1 and C_2 are each 5 μf. and R_3 is 6800 ohms, the frequency range will be approximately 0.5 to 7 pulses per second. Some may question the use of electrolytics in this application. However, the leakage in reasonably good-quality units should be low and consistent enough to ensure equal division of the period to within 10%.

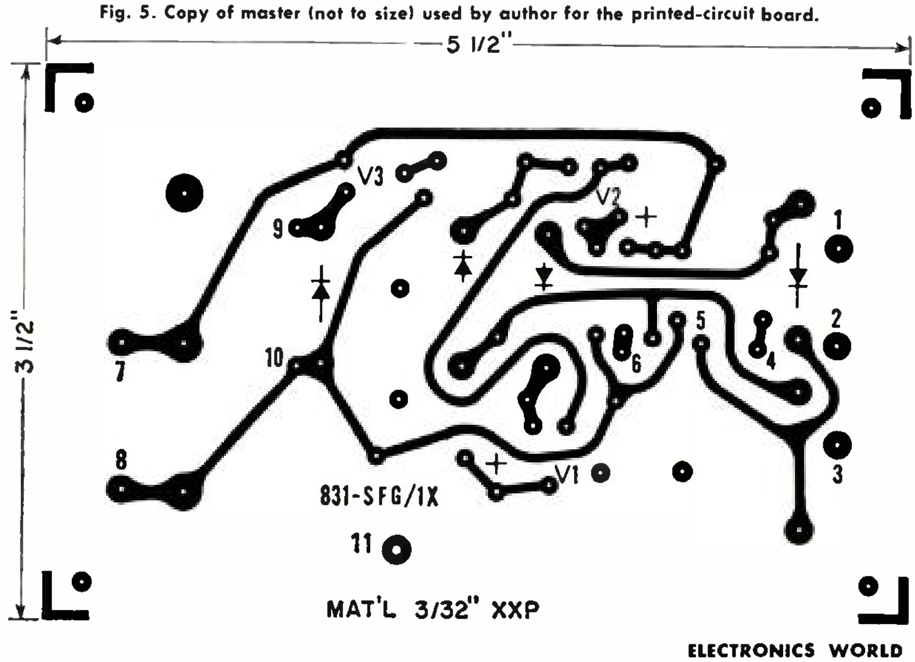
The relay is driven by transistor V_3 operating as a common-emitter circuit. When V_2 is off, its collector voltage is high. This forward-biases the base of V_3 through R_{10}, causing the relay to close. When V_2 turns on, its collector voltage drops. The forward bias on V_3 is reduced and the relay opens. As in any inductive circuit, extremely large transient voltages may be produced across the inductive element when the current through it is interrupted. The relay is capable of storing more than enough energy to ruin V_3 in this manner. Therefore, diode CR_5 is included to dissipate this stored energy and thus protect V_3. Its polarity is such that it is reverse-biased while current flows through the relay. However, it is forward-biased and thus essentially a short-circuit to the voltage induced by the collapsing magnetic field in the relay when V_3 turns off.

Construction

For those who are able to duplicate etched boards, a copy of the master used appears in Fig. 5. The board is 3½"x 5½" and was made on copper-clad phenolic material 3/32" thick. Although this board was produced photographically, the conductors are sufficiently spaced so that almost any of the popular reproduction techniques should be satisfactory. In cases where an etched board is not feasible and hand wiring must be resorted to, a unit of similar appearance and utility may be built on readily available perforated board, such as "Vectorboard." The placement of parts may be determined from the photographs. Stand-off terminals and eyelets were employed on the author's board, but with care in soldering, their use is not mandatory.

The only precaution to be taken is in placement of the leads to the relay contacts. These were twisted and run to the three output terminals, and kept well away from the rest of the components. This minimizes the possibility of pickup in the circuit and erratic operation of the multivibrator. This same criterion would also apply in the case of a hand-wired circuit. Although not employed in the author's unit, a s.p.s.t. switch may be mounted on the board. The conductor should be broken at the point indicated in one of the photos and the switch contacts connected between points 8 and 10. ▲

Fig. 5. Copy of master (not to size) used by author for the printed-circuit board.



Salvaging of Salt-Watered Radios

By **M. G. MASTIN**

MOSTLY in the summer, and in any salt-water area, many people who take their portable radios to the beach and on small boats are surprised by a salt-water drenching. This is not conducive to long life for the radio.

Because most technicians will not attempt to service a portable that has been in salt water, it may be of interest to know that, in general, salvage is relatively easy, since my record of success, so far, is 100%.

The procedure is simple. Turn the hose on the exposed chassis. Care is taken to flow water over all parts, and especially inside the i.f. transformer housings. After this dip it into a bucket containing a dilute solution of baking soda (sodium bicarbonate) in water—one teaspoonful per quart—and then douse it up and down in two rinses of soft water. Hard water leaves conductive residues after drying, but rain water or distilled water gives good results. Excess water should be removed by shaking and by drying with a cloth. Washing and rinsing is done as rapidly as possible. Then, place the radio on a rack above a hot-water heater, if possible, to dry.

The use of baking soda is based on a sound principle in chemistry. Sea water contains magnesium chloride, potassium chloride, sodium chloride, and magnesium sulfate, stated in the order of their ability to pick up moisture from the air. Also, all of the chlorides badly corrode the metals used in radio. Sodium bicarbonate reacts with magnesium chloride to form magnesium carbonate, which is non-hygroscopic and relatively non-corrosive. To some extent the other salts are rendered less active. Therefore a radio which tests okay fresh from the drying stage will remain okay after subsequent exposure to humid air. If traces of magnesium chloride remain, humidity will likely result in excessive leakage coupled with corrosion in such places as the i.f. transformers.

The above procedure may seem drastic to an electronics man, but the risk is small since, if nothing is attempted, the radio is ruined anyway. The probable reason for the success of the method is that components such as capacitors, resistors, transistors and similar items are sealed and that the other materials tend to resist wetting, at least for short immersions. In fact, the first radio I salvaged was a high-quality, *General Electric* transistor set which came to me several months after seawater wetting. The batteries were a thick soup and the terminals were completely eaten away. Fortunately these corrosion products had not reached the chassis. After washing, the set played as good as new and is still playing over a year later. ▲

A TRANSISTORIZED TV COMPENSATOR

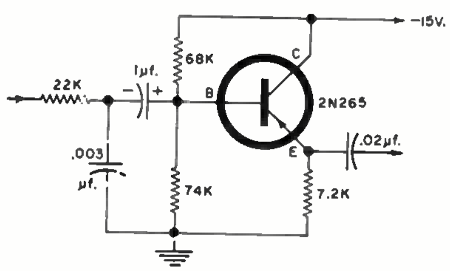
By **RONALD H. WAGNER**

A simple, compensated circuit for hi-fi audio take-off that will work with most TV models.

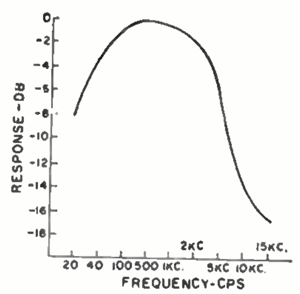
ALMOST every person interested in hi-fi has, at one time or another, decided to connect his television set into the hi-fi system. With this simple, easy-to-build compensator, it is possible to take the sound from the discriminator of almost any television set and connect it to any high-impedance preamplifier input.

The signal is taken directly from the plate of the discriminator tube, so a de-emphasis circuit must also be included. An input control on the compensator will also serve as an additional level control. This will allow the signal level to be matched to other inputs.

As can be seen from the circuit of Fig. 1A, not too many parts are required



(A)



(B)

Fig. 1.

for the compensator. The 22,000-ohm resistor and the .003-μf. capacitor provide de-emphasis. The 1-μf. unit couples the signal to the transistor base. The transistor is a relatively inexpensive *p-n-p* type manufactured by *General Electric*. The two resistors connected to the base are for stabilizing transistor operation and provide the correct bias to the base.

Fig. 1B is the response curve for the complete compensator. Although there is a roll-off in response beginning at 150 cycles, the response is less than 3 db down at 40 cps. Since there are few, if any, programs on television that would have frequencies below this, it was not considered necessary to correct the response to any lower value. On the high end roll-off begins at 600 cps and is 2.8 db down at 2500 cps. In comparison with the pre-emphasis curve, response was up 2.8 db at 2000 cps. At 10,000 cps it is −13.5 db and at 15,000 cps it is −16.25 db. This corresponds to 13.5 and 17 db on the pre-emphasis curve.

The collector supply voltage can be taken from the television receiver or from batteries. The batteries should last their shelf life, because the current drain is only 1 ma.

The internal connections to the TV receiver are indicated in Fig. 2. This type of discriminator is found in *Zenith* television sets and the signal voltage on the plate is about 10 volts on very loud peaks.

For this reason, the compensating circuit can have an insertion loss. However, should any readers have sets that do not have enough signal, the circuit of Fig. 3 can be added to that of Fig. 1A, and signals with levels down to a few millivolts can be used.

It should be noted that in Fig. 1A the only additional change that must take place is that the supply voltage is now a minus 25 volts and there is also a 2200-ohm dropping resistor between the two collectors.

In Fig. 2 the 500,000-ohm level control should be adjusted to give the same output from the preamp as the phono and tuner input. This adjustment will lower the volume that is obtained from the television set, but in most cases this effect is very small and can be ignored.

The physical construction of this unit is not too critical and except for proper soldering technique for the transistors, almost anyone should be able to build it.

Once you have heard this unit you will enjoy television much more and even the commercials will sound better. ▲

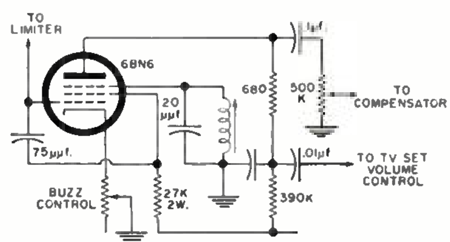
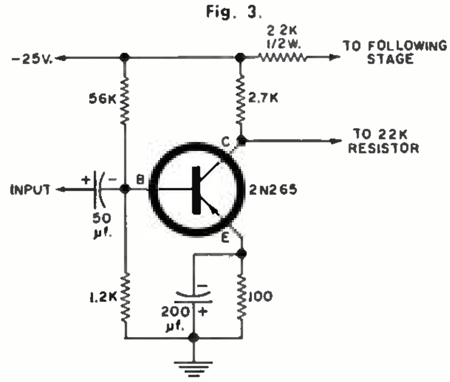


Fig. 2.

Fig. 3.



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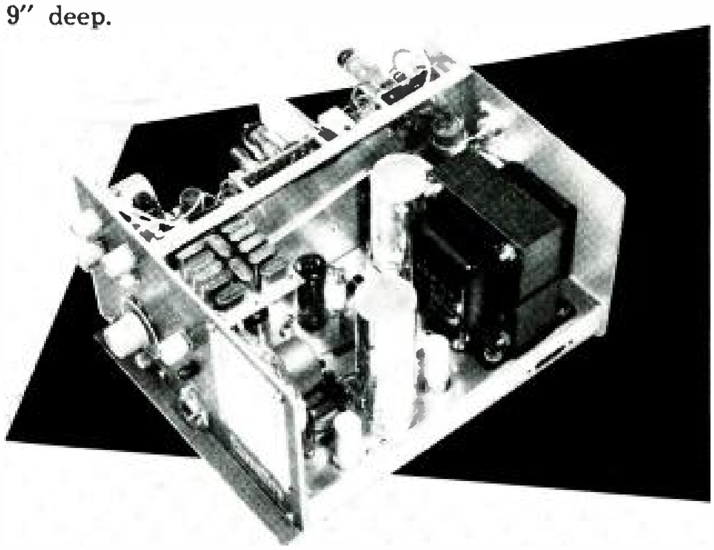

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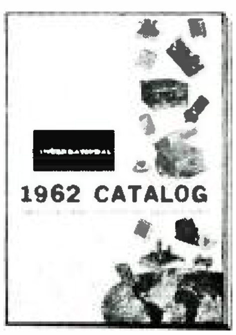

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TRANSISTOR POWER RATINGS & HEAT TRANSFER

By **D. F. JONES**

Excessive heat is the enemy of transistors. Here are some factors that must be taken into account to prevent burnout.

TRANSISTORIZED circuits should, theoretically, have an unlimited lifetime. However, transistors do fail. The cause of failure is often excessive internal temperature, which can be prevented by proper transistor selection and use. The techniques and considerations involved with transistors also apply to semiconductor diodes and photocells.

Designers, technicians, and experimenters should have some knowledge of *transistor power ratings* and *heat transfer*. We can determine whether or not a transistor and its mounting is adequate for its intended use. Sometimes a substitution can be made, either to one less likely to fail or to a cheaper or more readily available one.

Thermal Calculations

Elementary heat transfer principles can be easily grasped by anyone familiar with basic electricity. The schematic of Fig. 1 shows the similarity between heat flow and electric current flow. Heat is generated in the transistor junction proportional to the voltage drop and the current. A current of heat will flow from the hot junction toward the cooler surrounding air through a thermal resistance. In a mounted power transistor, this thermal resistance is composed of the series resistances from junction to transistor case, transistor case to heat sink, and heat sink to surrounding air. In an unmounted transistor, heat is transferred directly from the case to the air; and since the surface area is small, the thermal resistance is much higher. The thermal capacitance shown in Fig. 1 accounts for the time lag between power application and steady-state temperatures.

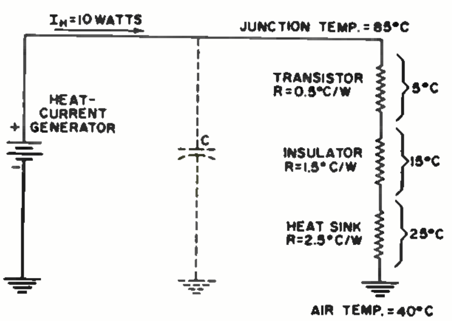


Fig. 1. Thermal equivalent circuit of a mounted transistor with sample heat drops.

Just as electric current through a resistor causes a voltage difference across the resistance, a temperature difference will exist between the transistor junction and the air. The thermal analogy to Ohm's Law is: *temperature difference across a thermal resistance = heat flow × thermal resistance.* For example, a certain power transistor is rated to have a junction-to-case thermal resistance of 0.5 degree C per watt; then if the transistor is dissipating 10 watts, the junction will be 10 × 0.5 = 5 degrees C hotter than the case.

The maximum ambient (air) temperature in which a circuit may be expected to function must be estimated. A poorly designed transistor radio may play for years inside a building, but fail after a few hours on the beach or in a closed automobile. In applications such as this, the temperature of the air inside the equipment case might be expected to reach a temperature of 130 degrees F or more.

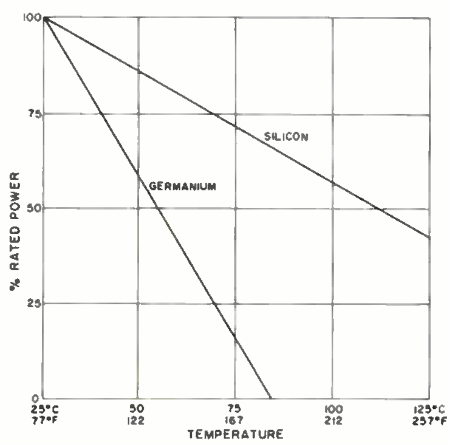


Fig. 2. Temperature derating curve for transistors and diodes. Horizontal scale is air temperature for low-power devices or case temperature for high-power units.

Table 1. Typical thermal resistances.

MATERIAL	RES. (deg. C/watt)
Insulator (mica or teflon)	1.3
Insulator (anodized aluminum)	0.3
Heat sink (aluminum 2" x 2" x 3/32")	10
Heat sink (aluminum 3" x 3" x 3/32")	5
Heat sink (aluminum 5" x 5" x 3/32")	3
Heat sink (finned aluminum 3" x 4" x 1")	2.5

Power Rating

Transistors are assigned maximum power ratings such that, when operated at a given temperature and power, the semiconductor material will not exceed a temperature which would damage it. For germanium this maximum junction temperature is 85-100 degrees C (185-212 degrees F) and for silicon it is 150-200 degrees C (303-393 degrees F). Small, low-power transistors are generally rated for a given power at 25 degrees C (77 degrees F) air temperature. If a germanium transistor is rated at 100 mw., this means that its thermal resistance is such that when dissipating 100 mw. its junction temperature will be nearly 85 degrees C when the air temperature is 25 degrees C. If either the power dissipation or the air temperature were to increase, the junction temperature would exceed the damage level.

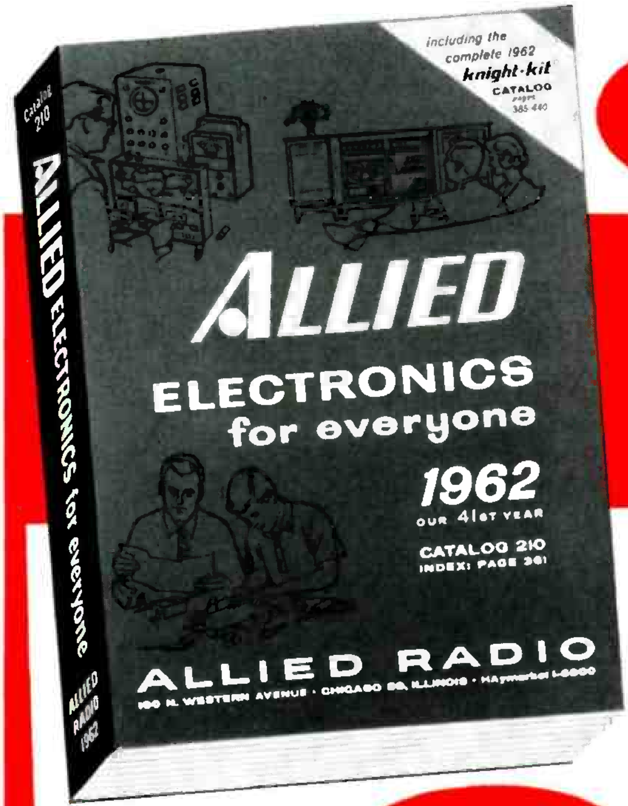
Fig. 2 indicates how much the maximum allowable power must be decreased with an increase in temperature. The 100-mw. germanium transistor can be operated safely at only 50% × 100 mw. = 50 mw. if the air temperature may reach as high as 130 degrees F.

Power-type transistors are generally rated at 25 degrees C case temperature. It should be remembered that the case temperature will be hotter than the surrounding air, the amount depending on the thermal resistance of the heat sink used. For example, it is proposed to operate a 10-watt germanium transistor at 3 watts at a maximum air temperature of 50 degrees C (122 degrees F) using a finned heat sink and mica insulator. Referring to Table 1 for the thermal resistance of the heat sink and insulator, the temperature rise from air to transistor case will be: 3 watts × (2.5 + 1.3) degrees C/W = 11.4 degrees C. So the transistor case will be 50 + 11.4 = 61.4 degrees C. Referring to Fig. 2, at that case temperature the transistor can safely dissipate 40% × 10 watts = 4 watts; so the transistor is adequate for the given conditions.

Thermal Stability

With a resistive load the maximum power a transistor could possibly be required to handle is $V^2/4R$, where V is the supply voltage and R is the total resistance from the emitter and collector to the supply. If this power is within the transistor's capabilities at the highest expected air temperature, the circuit will be safe.

If the load resistance is too low to meet this condition, as is often the case with transformer loads, the d.c. current through the transistor must be limited to keep the power at a safe level. A condition known as "thermal runaway"



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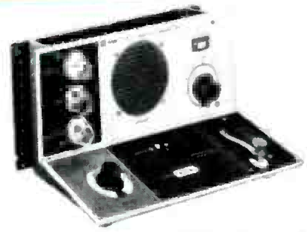

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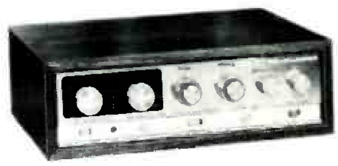

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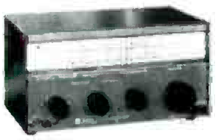

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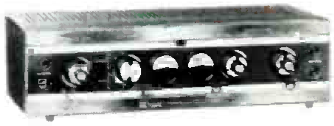

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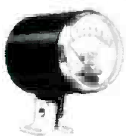

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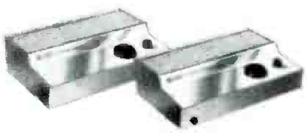

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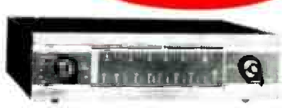

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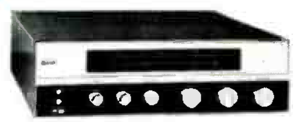

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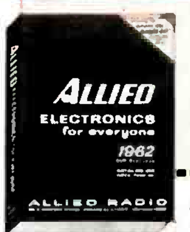

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results when an increase in junction temperature tends to allow an increase in current which, in turn, raises the junction temperature still further until the transistor is destroyed. This tendency can be anticipated by placing the circuit in an oven at the highest expected air temperature and monitoring the collector current for several hours. If an excessive current increase is indicated, it may be corrected by stabilizing the bias—by using a thermistor, for example.

Mechanical Considerations

Proper mechanical design is very important for efficient heat transfer. Low-power transistors operated close to their limits can be protected by clipping them to a metal surface or by using a special clip-on device to increase the surface area.

The surface of the heat sink which touches the transistor or insulator should be as smooth as possible for low thermal resistance. A thin film of silicone grease on adjoining surfaces will aid tremendously in producing better heat conduction.

Heat sinks should be mounted vertically if possible to allow smooth convection currents of air to flow past both sides. Other components should be at least a half inch away from the surfaces to avoid restricting air flow. Sufficient openings in the equipment case should be provided to allow air to enter below the heat sink and escape above it. If the case must be sealed, provision may be made to conduct heat to the outside surface of the case.

By taking into account the several factors enumerated in the paragraphs above, it should be possible to prolong semiconductor life and prevent premature burnout. ▲

PHASE DISTORTION in FM MULTIPLEX

By **ROBERT F. HOOPER** / **Heath Company**

A minimum of phase distortion is required for stereo broadcasts. Here are some of the reasons.

WITH the advent of the FCC-approved multiplex stereophonic FM broadcasting system, the term "phase distortion" has begun to creep into many articles. Let's look at phase distortion and see what it is, when it exists, and why its absence is so important in multiplex stereo.

Phase distortion is a characteristic of an amplifier (or other device through which a signal passes) which delays some frequency waves more than others. It always takes time, even a very short time, for a signal to pass through any circuit from input to output. Phase distortion exists when inductance and capacitance are involved in the circuit in such a way that they can delay some components of a complex wave more than others. Since the various components of the wave at the output end no longer have the original phase relationship, the signal is said to have suffered phase distortion.

It seems contradictory to say that when the phase distortion is zero the phase shift is constantly changing with frequency. The reason, however, is simple. Phase distortion is zero when all components of the wave arrive at their destination delayed the same amount of time. But if we delay a 10,000-cycle wave the same amount of time as a 1000-cycle wave, we have delayed it ten times as many degrees of phase since each degree of phase of the 10,000-cycle wave takes only one-tenth as long as a degree of phase for the 1000-cycle wave. As it turns out, if the phase shift, plotted against frequency on linear graph paper, is a straight line passing through zero phase shift and zero frequency at the same time, the phase distortion is zero.

This is important in the multiplex stereo system. First, we must demodulate the sideband-suppressed-carrier subchannel with low distortion. If the phase relationship between the lower sideband and the upper sideband has been asymmetrically altered, undistorted detection cannot be achieved. Next we must matrix the audio recovered from the subchannel with the audio transmitted on the main channel to obtain the left and right channels by combining their "sum," which has been transmitted on the main channel, with their "difference," which has been transmitted on the subchannel.

To achieve a high degree of separation between channels, the components which are required to cancel in the matrix must be exactly 180 degrees out-of-phase. If there is phase distortion, which has caused the subchannel sidebands to be displaced in time from the components of the main channel, the audio recovered from the subchannel will also be displaced and the phase angle between these components will no longer be 180 degrees. In this case, complete cancellation cannot take place and sounds that should issue from one speaker alone will also be reproduced, to some extent, by the other speaker.

The important thing to remember is that lack of phase distortion simply means that waves of all frequencies needed for the operation of the system pass from input to output with the same time delay. ▲

RESISTOR CROSSWORDS

By **LUTHER A. GOTWALD, JR.**

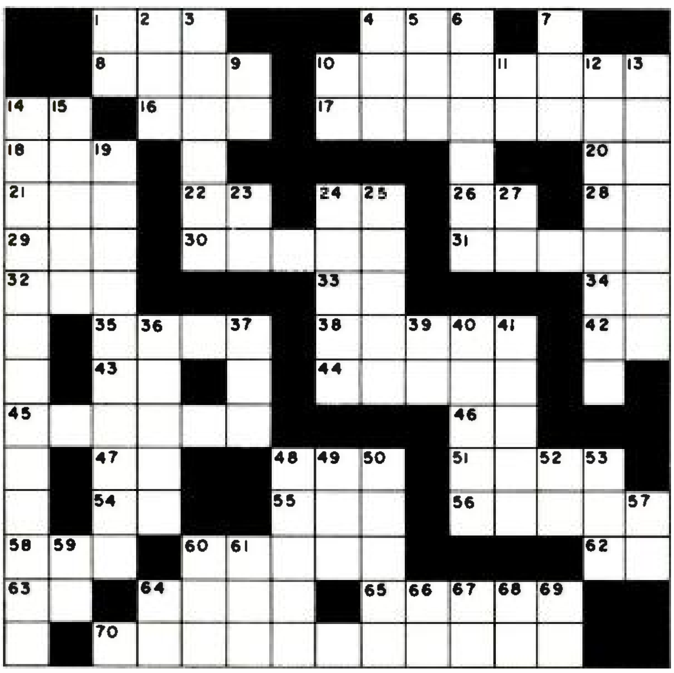
(*Answer on page* 97)

ACROSS

1. A vigilant corps (abbr.).
4. Type of radio (abbr.).
8. One-eighth ounce.
10. Variable wirewound.
14. An afterthought (abbr.).
16. Picture tube (abbr.).
17. Current limiter.
18. Unit.
20. Rare metal (abbr.).
21. Digit.
22. English digraph.
24. Public road (abbr.).
26. Journal head (abbr.).
28. Exists.
29. Unit of work.
30. Near (obsolete form).
31. Slag.
32. Concerned with education (abbr).
33. Pronoun.
34. Rare element (abbr.).
35. Machine's sound.
38. Belonging to a Federal Agency (abbr.).
42. Ego.
43. Slang adverb.
44. Found in potentiometers.
45. Mysterious.
46. Girl's name (variation).
47. In place quoted (abbr.).
48. Standard (abbr.).
51. Boy's name.
54. Signal voltage.
55. Statement of truth (abbr.).
56. Clever.
58. Contraction.
60. Type of taper.
62. Load resistor.
63. Printer's measure.
64. Ancient Persian city.
65. Slave.
70. See 60 Across.

DOWN

1. To adjourn without naming a new meeting date (abbr.).
2. Part of a circle.
3. Used in resistors.
4. An article.
5. Legal term.
6. Frustrate.
7. Legal counsel (abbr.).
9. An elevation (abbr.).
10. One form of transportation (abbr).
11. "Insurance" for oldsters (abbr.).
12. Pertaining to a Greek tense.
13. Bound hand and foot.
14. Variable resistor.
15. Bank.
19. Frequency units.
23. Equals watts (formula).
24. Helps measure current.
25. American inventor.
27. Medical man (abbr.).
36. Draws.
37. Gun (slang).
39. Plate resistance.
40. Under.
41. Hindu Writ.
48. Uses reflected waves.
49. Upon (prefix).
50. From signals out-of-phase.
52. Pronoun.
53. Ocean vessel (abbr.).
57. Female ham.
59. Within an enclosure.
60. Month (abbr.).
61. A republic (abbr.).
64. In the same degree.
66. Heater voltage.
67. Paper measure (abbr.).
68. Six (Rom. num.).
69. Collector voltage.



QRM Eliminator

(Continued from page 54)

voltage is not frequency-sensitive, therefore it is represented as a straight, horizontal line in Fig. 5.

A simplified schematic of the Schmitt trigger circuit is shown in Fig. 6. The "at rest" condition consists of V_{2B} conducting quite heavily due to the fact that its grid has a positive potential of some value, depending on the voltage divider action of R_{12}, R_{13}, and R_{14}. As a result, the output voltage level at the plate is quite low (limiting condition). V_{1A}, on the other hand, is biased off by the voltage drop across the common cathode resistor R_{16} so that its plate voltage level is nearly "B+" (cut-off condition).

As the positive-going input voltage through C_6 to the grid of V_{1A} increases, its action opposes the normal bias, causing tube conduction and a decreasing plate voltage. The positive voltage level on the grid of V_{2B} is lowered through the divider action to a point where the voltage drop across the common cathode resistor R_{16} takes over as an actual negative bias on the tube, thus raising the voltage on the plate. Output may be taken from the plate or cathode, with the latter selected for this equipment.

This temporary condition (V_{1A} conducting heavily and V_{2B} being cut off) begins when the positive alternation input voltage level has reached a certain value. After this input signal has reached its maximum voltage value and decreases to the previous level point, the normal "at rest" condition will again be reached. This is true because at the particular signal level where action starts on increasing input voltage, it also stops on decreasing voltage. At this moment the grid loses enough positive signal to sustain conduction, thus allowing the bias developed across R_{16} to begin cutting off the tube conduction. At the same time the voltage at the plate begins to rise and is followed by a proportional rise at the grid of V_{2B}. This overcomes the cathode bias, causing the beginning of plate current flow and resultant lowering of the plate voltage. This situation continues until the input signal drops to a low-level value, at which time V_{1A} rests in a cut-off condition and V_{2B} remains in a saturation state indefinitely, waiting for the next positive input signal.

Fig. 7 shows the relationship of input and output waveforms. Negative-going input (alternation) signals have little effect on the operation of this circuit because in the "at rest" condition, the grid of V_{1A} is already cut off. It is evident, then, that this circuit provides a positive output pulse for each input cycle, a slave condition that is required in this unit.

Construction

The final version of the original unit is shown in the photographs. The circuit is simple and straightforward so no difficulty should be experienced when building it in any type of cabinet. The one used by the author happened to be the only one available in his "junk box." It measures 4¾" x 5⅜" x 9" and is in two pieces. Parts are mounted in both parts and as much of the wiring as possible done before the two pieces are assembled and the interconnecting wiring completed. At no time during the development and final construction phases of this equipment was it found necessary to use shielded wire within the cabinet. The flexible input lead, however, is shielded mike cable. Naturally, it is recommended that good parts layout practice be followed during the preliminary planning stages. To assemble, the pieces of the cabinet are simply fitted together and held with the two toggle switches and self-tapping sheet metal screws.

This is not the most desirable type of construction, but it enabled the author to use a cabinet he had on hand. Had this not been available, a two-piece commercial aluminum cabinet measuring 6" x 6" x 6" or 5" x 6" x 9" could have been used with a small chassis. All parts should be mounted on one half for ease in maintenance. The chassis size must be selected to permit mounting parts on it and still leave room for mounting the speaker. In the smaller cabinet the speaker can face either side and, in the larger, the speaker could be mounted on the front as well.

A nibbling tool was used to cut out the 2¾" square speaker opening in the front panel and also in the 3⅞" square molding piece. Since the cut is not perfectly smooth, the edges are finished off with a file. The grille is a square piece of plastic or aluminum window screening with fine mesh. This is sandwiched between the panel and the molding. One cabinet surface was painted at a time to permit drying in a horizontal plane to obtain a smooth, run-free finish. Front-panel lettering was done with a lettering guide and India ink.

So, if you have a high-quality communications receiver, spend a few hours in building this unit, and another hour in learning to "twiddle" the right controls properly, the results should be quite worthwhile. One final point, however. Remember that the signal you hear is your own Schmitt trigger, therefore don't report RST 599 to *all* those you "work"! ▲

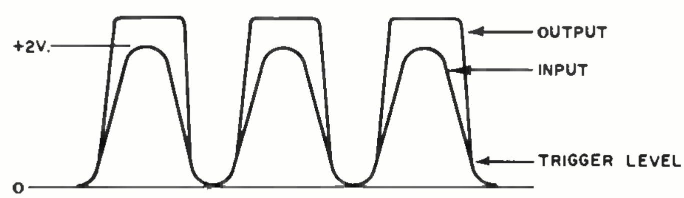


Fig. 7. Relationship of Schmitt trigger input and output waveforms with diode clamping. The actual amplitude of the output waveform is greater than shown.

WWV FREQUENCIES CHANGED SLIGHTLY

Nominal frequencies remain the same, but change affects ultra-precise measurements.

A CHANGE in the broadcast of standard-frequency transmissions has been announced by the National Bureau of Standards and the U.S. Naval Observatory. At zero hours GMT on January 1, 1962 the standard frequencies transmitted were made higher by 2 parts in 1 billion. This is 2 ten-millionths of 1 per-cent. The change is too small to be detected by ordinary radio receivers, that is, the nominal frequencies broadcast will be the same, but it is significant to those using specialized equipment in precise scientific work.

The change is necessitated by irregular variations in the speed of the rotation of the earth. Astronomical observations made at the U.S. Naval Observatory have shown that the earth was rotating at a successively slower speed each year from 1955 to 1958 and that since then the earth has been rotating at a faster speed each year. The cause of this irregular variation is not known.

The need for high precision in scientific measurements, in satellite tracking, in radio communication, and in navigation has made it necessary that frequency be provided with very high precision. Transmissions of frequency are maintained constant to 1 part in 10 billion. This amount corresponds to 3 thousandths of a second per year, which is an appreciable quantity in many scientific applications.

Time pulses and carrier frequencies of the standard broadcasts are locked together. The frequencies transmitted are maintained constant each year with respect to Atomic Time, but are offset from Atomic Time by a specified amount to provide time signals which correspond closely to time as based on the earth's rotation.

U. S. stations whose frequencies will be changed are WWV, Beltsville, Md.; WWVH, Hawaii; WWVL and WWVB, Boulder, Colo.; NBA, Canal Zone; NAA, Cutler, Maine; NPG, Jim Creek, Wash.; and NPM, Hawaii. The transmissions of the East Coast Loran-C radio-navigation system operated by the Coast Guard will also be changed in frequency. The Loran-C transmitters are located at Cape Fear, North Carolina; Martha's Vineyard, Mass.; and Jupiter Inlet, Fla.

The transmissions of time and frequency of the United States are coordinated with those of Argentina, Australia, Canada, Japan, South Africa, Switzerland, and the United Kingdom. This coordination began in 1959. The standard frequency and time transmissions of these countries have also been changed on January 1, 1962 in order to maintain the proper coordination between stations. ▲

CALENDAR of EVENTS

FEBRUARY 27-MARCH 1
Symposium on Application of Switching Theory in Space Technology. Sponsored by Lockheed Aircraft Corp. and AFOSR/General Physics Div. Contact Dr. J. P. Nach, c/o Lockheed, Sunnyvale, Calif. for details.

MARCH 1-2
Eighth Scintillation and Semiconductor Counter Symposium. Sponsored by PGNS, AIEE, AEC, NBS. Shoreham Hotel, Washington, D.C. Program information from Dr. George A. Morton, RCA Labs, Princeton, N.J.

MARCH 7-11
San Francisco Home and High Fidelity Show. Sponsored by Magnetic Recording Industry Assn. Cow Palace, San Francisco. Open to the public. Stereo FM multiplex broadcasting and receiving equipment will be featured.

MARCH 14-16
Twelfth Annual Conference on Instrumentation for the Iron & Steel Industry. Sponsored by Instrument Society of America. Hotel Roosevelt, Pittsburgh, Pa. Details from H. M. Gravatt, Allegheny Ludlum Steel Corp., Research Lab., Brackenridge, Pa.

MARCH 20-25
1962 Los Angeles High Fidelity Music Show. Sponsored by Institute of High Fidelity Manufacturers, Inc. The Ambassador Hotel, Los Angeles. Open to public March 21-25th.

MARCH 26-29
IRE International Convention. Sponsored by all Professional Groups of the IRE. Coliseum & Waldorf-Astoria Hotel, New York, N.Y. Details from E. K. Gannett, IRE Headquarters, 1 E. 79th St., New York 21, N.Y.

MARCH 28-29
Third Symposium on Engineering Aspects of Magnetohydrodynamics. Sponsored by AIEE, IAS, IRE, and University of Rochester. University of Rochester, Rochester, N.Y. Chairman of program committee, George W. Sutton, MIT, Room 3-254, Cambridge 39, Mass.

MARCH 28-31
Eleventh Biennial Electrical Industry Show. Sponsored by Electrical Maintenance Engineers Association of California. Shrine Exposition Hall, Los Angeles.

MARCH 29
Seventh Annual Materials Handling and Packaging Conference. Sponsored by Northern California Chapter of AMHS and the Golden Gate and Central California Chapters of SPHE. Stanford University, Palo Alto, Calif.

APRIL 11-13
1962 Southwestern IRE Conference. Sponsored by IRE, Region 6. Rice Hotel, Houston, Texas.

APRIL 25-29
Western Space Age Industries and Engineering Exposition & Conference. Cow Palace, San Francisco. Information from Lykke-Wilkins & Assoc., 681 Market St., San Francisco 5, Calif.

MAY 2-5
13th National Science Fair-International. Sponsored by Science Service. Seattle, Washington. Details from Science Service, 1719 N. Street N.W., Washington 6, D.C.

MAY 3-4
International Congress on Human Factors in Electronics. Sponsored by the Los Angeles Chapter of PGHFE of IRE. Lafayette Hotel, Long Beach, Calif. Details from Dr. Charles Hopkins, Symposium Chairman, Hughes Aircraft Co., Culver City, Calif.

MAY 8-10
1962 Electronic Components Conference. Sponsored by AIEE, EIA, and IRE. Mariott Twin Bridges Motor Hotel, Washington, D.C.

MAY 15-17
Fourth Annual Meeting of Council on Medical TV & Medical-Dental TV Workshop. Sponsored by the Council on Medical Television, Clinical Center, National Institutes of Health, Bethesda, Md. and National Naval Medical Center, Bethesda. Details from Institute for Advancement of Medical Communication, 33 E. 68th St., New York 21.

MAY 21-24
1962 Electronic Parts Distributors Show. Sponsored by EP&EM, EIA, PACE, WEMA, and ERA. Conrad Hilton Hotel, Chicago. Open only to qualified industry members.

MAY 22-24
National Microwave Theory & Techniques Symposium. Sponsored by PGMTT of IRE. Boulder Laboratories of National Bureau of Standards, Boulder, Colorado.

MAY 23-25
11th National Telemetering Conference. Sponsored by ISA, ARS, IAS, AIEE, IRE. Sheraton-Park Hotel, Washington, D.C.

MAY 31-JUNE 7
International Television Conference. Sponsored by Electronics and Communications Section of the Institution of Electrical Engineers. Institution Bldg., Savoy Place, London W.C. 2, England.

JUNE 11-15
Technical Writers' Institute. Rensselaer Polytechnic Institute, Troy, N.Y. Information on course from Prof. Jay R. Gould, RPI, Troy, N.Y.

JUNE 24-28
Music Industry Trade Show. Sponsored by the National Association of Music Merchants. Hotel New Yorker, New York City.

JUNE 25-30
Symposium on Electromagnetic Theory and Antennas. Sponsored by the IRE. The Technical University of Denmark, Copenhagen. Information from IRE, 1 E. 79th St., New York 21, N.Y. ▲

Transistorized Stereo Adapter
(*Continued from page* 33)

varying T_2. In each case, trigger the horizontal deflection of the oscilloscope by the 38-kc. sampling at terminal 4 of T_1. T_2 is correctly adjusted when the phase relationship between the multiplex signal and the 38-kc. sampling signal is as shown in Fig. 9.

The factory setting of T_1 will generally be satisfactory. However, should there be interference from storecast music (high-frequency buzz), adjust T_1 for minimum interference.

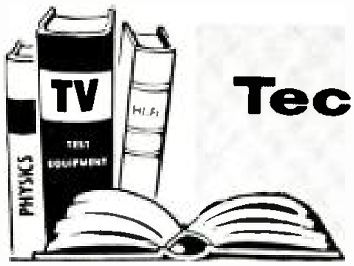
Tuner Limitations

It should be emphasized that for optimum multiplex reception more stringent requirements are placed on the receiving system. The addition of an FM antenna or the use of a more sensitive tuner will often be necessary in the multiplex fringe area. A directional FM antenna is especially desirable if there is a possibility of multipath signal reception. The tuner must be able to pass the complete multiplex spectrum (50 cps to 53 kc.) without amplitude or phase distortion. The recently introduced tuners having wide-band detectors satisfactorily meet this latter requirement.

Other tuners can be improved with some modification. Generally the most serious problem is the poor frequency-response characteristic of tuners having narrow-band, high-impedance Foster-Seeley discriminators. The typical discriminator, shown in Fig. 10A, can be modified to improve its frequency response by reducing R_1 and R_2 to 68,000 ohms and by reducing C_1 to 47 $\mu\mu$f. In addition, an emitter-follower multiplex output is desirable, particularly if a long cable must be used between the tuner and the adapter. A modified discriminator with improved frequency response and a low-impedance multiplex output is shown in Fig. 10B.

Although wide-band tuners are preferred for multiplex reception, some have multiplex outputs which are too low-level to be fed directly to the transistor adapter described in this article. To use such tuners, it will be necessary to amplify the multiplex output of the tuner before feeding it to the adapter. A suitable amplifier, which has a gain from 0 to 10 times, is shown in Fig. 11. This may be made an integral part of the adapter, thus making the adapter compatible with any tuner having a multiplex output level within the range of 50 mv. to 3 volts r.m.s.

The transistorized adapter described above was designed, built, and tested under professional conditions. It is simple to put together and is capable of excellent stereo performance. ▲



Technical BOOKS

"COMPUTER BASICS" prepared by *Technical Education and Management, Inc.* Published by *Howard W. Sams & Co., Inc.*, Indianapolis. Five volumes in slipcase $22.50. Soft cover.

This study was originally developed for the U.S. Navy for training electronics technicians in computer technology and to provide personnel capable of maintaining and operating all types of computer systems. It was presented as a 16-week training program at the Electronics School at Great Lakes, Ill. and is now available to design, development, and maintenance engineers; research scientists; programmers; technicians; students; and trainees or anyone else interested in or concerned with computers.

This series assumes no prior knowledge of computer systems but assumes some background in basic electronics plus a working knowledge of algebra and trigonometry. Since the material was laid out to be presented as a course, the text is progressive and can be used for home study as well as in more formal classroom sessions.

The text provides comprehensive treatment of semiconductor and magnetic elements, waveshaping and wavetrain generation, gating and logic circuits, computer organization and programming, maintenance and troubleshooting, numbering and coding systems, real-time computation, loop and conversion systems, in addition to a complete analysis of installations for analogue, digital, and hybrid computers.

Volume 6 of this series, entitled "Solid-State Computer Circuits," will be published later this year.

* * *

"BASIC MATHEMATICS" by Norman H. Crowhurst. Published by *John F. Rider Publisher, Inc.*, New York. 137 pages Price $3.90. Soft cover.

This is Vol. 3 in this author's current series covering all phases of math and deals with developing algebra, geometry, trig, and calculus as working methods in mathematics. Like its predecessor volumes this is a "pictured-text" presentation designed to facilitate the learning process.

This book takes up orders of magnitude, binary arithmetic, possibilities and probabilities, differentiation, converging series, abstract functions, integration, conic sections, determinants, and systems of coordinates. Those who have worked through the first two volumes of this series or have a basic working knowledge of mathematical processes should have no difficulty in handling this new material. The fourth and final volume in this series will appear later this year.

* * *

"MODERN DICTIONARY OF ELECTRONICS" compiled by Rudolf F. Graf. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 370 pages. Price $6.95.

This is an up-to-date and comprehensive electronics dictionary containing definitions of over 10,000 words and terms in current use by the industry. The most important words and terms are cross-referenced to facilitate locating definitions with a minimum amount of time and effort.

In addition to the text material, over 350 illustrations are included to help further clarify the meanings of a few of the more obscure terms. The format is that of standard dictionary usage with the word or term appearing in a clear, bold-face type and the definition in a thoroughly readable lighter face type. Where applicable, syllabic division and pronunciation is included for selected words.

* * *

"ELECTRONIC COMPUTERS: FUNDAMENTALS, SYSTEMS, AND APPLICATIONS" edited by Paul von Handel. Published by *Prentice-Hall, Inc.*, Englewood Cliffs, N.J. 231 pages. Price $13.50.

This volume has been prepared for those with a background in science but no previous knowledge of computers. It provides an objective analysis of all basic computer types, discussing the inherent properties of digital computers, the analogue computer, and the digital differential analyzer.

Emphasis has been placed on underlying principles rather than specific machines or applications. In addition to the text, this volume includes a comprehensive glossary of computer terms.

* * *

"CITIZENS BAND RADIO MANUAL" compiled by Sams Staff. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 160 pages. Price $2.95. Soft cover.

This is volume one of a new series which covers forty-six 1960-61 Citizens Band transceivers made by *Apelco, Globe, Hallicrafters, Lafayette, RCA, Raytheon, Regency, Vocaline, Citi-fone, Gonset, Heath, Morrow, Radson, Realistic, United, Scientific Labs*, and *Viking*.

As is the case with all of this publisher's "Photofact" service material, this volume includes standard notation schematics, chassis photos, parts lists, replacement data, and alignment data. A special editorial section covers servicing CB equipment, qualifications for servicing CB radio, plus potential market data on sales and service. ▲

IMPROVED RESISTANCE THERMOMETER BRIDGE

Modified Mueller bridge developed by NBS is more stable and more accurate.

CONTINUING work at the National Bureau of Standards to increase the accuracy of temperature measurements has resulted in a redesigned version of the Mueller resistance thermometer bridge. The modified bridge has improved stability and extends measurement accuracy by a factor of ten, presenting dial indications in steps of one microhm. Specifications for this bridge were developed by John P. Evans of the Bureau staff. The *Leeds and Northrup Co.* fabricated the instrument.

A resistance thermometer consists of a sensing element which changes in electrical resistance in response to changes in temperature. In precision thermometry the temperature is computed from the resistance measured by connecting the thermometer as one arm of an accurate resistance bridge. A coil of platinum wire is used as the thermometer winding. Resistance changes in the lower-resistance thermometers are so small that lead resistance and contact resistance would reduce accuracy alarmingly if not balanced out or nearly eliminated. For this reason special measurement techniques have become common in this field.

The newly modified Mueller bridge has an added lower-resistance decade to increase measurement definition to 1 microhm. The instrument's range is 0 to 422 ohms. To reduce switch-contact resistance, mercury-wetted contacts are used on the higher resistance ranges. The four lower resistor decades are switched by means of sets of enclosed wafer switches having brush-type contacts. In addition, two switch wafers are paralleled for each decade to further reduce contact resistance. The new bridge includes a ten-turn adjustable resistor in place of the former slide-wire divider.

The order of accuracy required can be obtained only by closely controlling the temperature of its critical resistors. These resistors are mounted within holes drilled in an aluminum-block heat reservoir. The temperature of the block is maintained at 35°C by means of heating coils and a highly accurate thermostatic control. The modified bridge, like previous forms of the Mueller bridge, is balanced by means of indications on an external galvanometer. The measuring circuits are carefully shielded to permit the use of sensitive electronic null-detection devices. An additional switch section is provided on each resistor-selector shaft for operation of external digital data-recording equipment.

For further information on the new bridge, refer to the National Bureau of Standards, Office of Technical Information, Washington 25, D.C. ▲

New Westinghouse Circuits

(Continued from page 57)

tion of the linearity slug associated with the magnet "biases" the saturable coil so that its non-linear action cancels non-linearity in the waveform itself. Deflection-coil current now follows the pattern of Fig. 5B.

With a "correct" waveform applied, linearity problems appear to be solved. A new villain enters: symmetrical non-linearity, developed in the picture tube itself. Consider that the scanning beam originates from point *A* in Fig. 6A. Of course, electrons actually start farther back in the neck, but point *A*, about where the deflection yoke takes control, is the pivot for scanning. If the picture tube's screen were shaped to conform with beam sweep, it would follow the broken-line arc, *B-C-D-E*, and any line from point *A* to this curve would have the same length as any other. Movement of the beam across this hypothetical screen would be linear, with screen distances being equal if they are included by equal angles from point *A*. Everything fits!

But viewers do not like curved screens. They prefer flat surfaces. The actual screen face, then, is the solid, nearly straight line, *B-E*, which does not follow the angular swing of the beam. Although the three angles at point *A* are equal, lines *A-B* and *A-E* are not equal to lines *A-C'* and *A-D'*. At the same rate of angular rotation, the scanned beams moves over a greater distance from *B* to *C'* and from *D'* to *E* than it does from *C'* to *D'*. Even with a very linear saw-tooth, the rate of physical scan on the flat screen changes to a fast-slow-fast pattern.

Since this effect occurs whenever CRT curvature fails to follow the arc of beam sweep, it is as old as television itself, and older if we think of the CR oscilloscope. With narrow deflection angles, however, the resultant distortion is so unnoticeable that it can be and is ignored. When we make our picture tubes so shallow that we sweep them through more than 110 degrees, the effect is evident. The picture is squeezed in the middle but stretches out on either side.

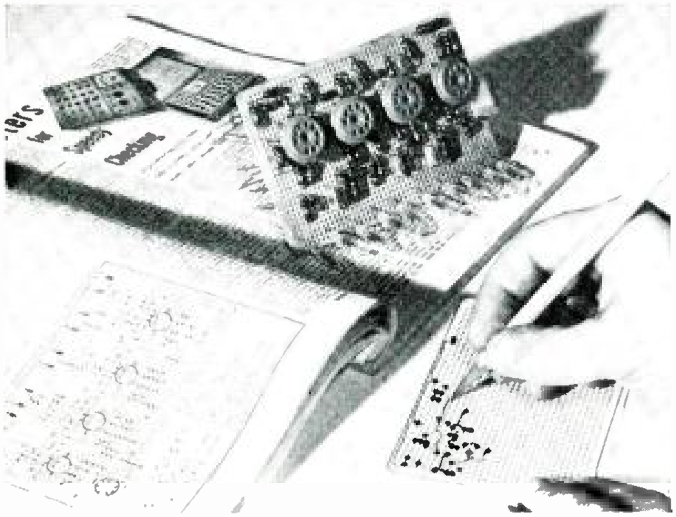
A glance at Fig. 4 tells us how symmetrical non-linearity is laid to rest. Capacitors C_{121} and C_{122} are added to distort the "correct" current waveform. Introducing a mild, integrating effect, they produce the slight non-linearity shown in Fig. 6B. The rate of current rise along the slope now follows a slow-fast-slow pattern—canceling the pattern imposed by CRT construction.

With a knowledge of the circuit, practical correction of non-linearity is simple. If it is asymmetric, start by adjusting the linearity slug ¼-inch out of the coil, which should be close to the right setting. Then adjust width for about an inch of overscan. Touch-up manipulation should take care of the rest. Symmetrical non-linearity is corrected by adjusting the value of C_{122}. ▲

GRID BOARD USED TO BUILD A DECADE COUNTER

By J. G. CURTIS / Sr. Applications Engineer, Corning Electronic Components

New copper-plated glass-ceramic material makes it simple to breadboard experimental electronic circuits.



After components have been arranged properly and temporarily located on grid board, interconnecting leads are drawn in on layout paper.

A UNIQUE tool for electronics technicians and designers, the "Fotoceram" printed-circuit grid-board, helps them to find out how well their experimental circuits work. A designer can make two-sided circuitry on a board in his laboratory or home workshop with an etching process that takes only 20 minutes. To detail the best ways of using a grid board and the pitfalls to avoid, the author used one to construct a 74-component decade counter described in an earlier issue of this publication ("The Electronic Decimal Counter," October 1955 issue of RADIO & TELEVISION NEWS).

Fotoceram grid boards are flat pieces of solid, extremely low-loss glass-ceramic material. The boards are plated on all surfaces with pure copper and are studded with grids of holes for mounting components.

They are made in several shapes and sizes and can be bought separately or in kits from many electronics distributors throughout the country or from *Corning Electronic Components, Corning Glass Works*, Bradford, Pa. The author used a board from the smallest kit (which sells for $8.95) to make the decade counter. This device, which consists of 15 capacitors, 45 resistors, 10 neon lamps, and four vacuum tubes, proved to be as complex as any that could be built on the 3" x 5" board.

Two features of the boards are notable. Because the holes in the grids are through-plated with copper, no eyelets are needed for front-to-back connections or for mounting terminals. And because of the nature of the material, delamination of the boards or separation of the copper is impossible.

The kits are handy because they consist of virtually everything needed to create a printed circuit. They come in plastic boxes that double as etching trays, and contain various numbers of boards along with layout patterns, instructions, liquid and tape etching resists, and etching crystals.

Here is a step-by-step account of how the author used a grid board to make the decade counter.

The first step was to estimate roughly what sections of the circuit were to go where. In the decade counter, each tube requires about the same space because each stage is very similar. The sockets were therefore placed on the grid board to give each one equal space.

The next step was to insert the components in the grid so that the terminals were as close as possible to tube pins and other connection points. The components were re-arranged several times until they were in the best position to minimize mechanical interference, stray capacitance, and the number and lengths of runs and jumpers.

The third step consisted of drawing the circuit pattern on the piece of paper that duplicates the board's grid pattern (see photo). The paper is supplied with the kit. The unetched board, with components in place, was used as a guide. Pads were drawn for all the socket pins and components, taking care that no pad touched an adjacent hole unless a connection to that hole was wanted. Then the interconnecting runs were drawn. Ordinarily, runs should be placed *between* the rows of the holes.

The decade counter circuit used runs on both sides of the board. Making two-sided circuitry was easy, because the copper plating completely covers both sides and the inside of each hole. To draw the circuit pattern for the other side, the paper was held against a window in order to view the front and rear patterns simultaneously.

After the interconnecting circuitry was sketched on the layout paper, pads were added for wire jumpers and for external connections such as "B+," heater power, ground, input, and output. The layout was then carefully checked for accuracy, since this was the last stage where errors could be corrected easily.

It is important to get all the protective lacquer off the board to avoid etching difficulties later. Alcohol or lacquer thinner does the job. The components were removed and the board was swished around in the bath for more than five minutes to make sure that no lacquer is left on the inside of the holes. Then the board was given a second bath in clean solvent.

Using the penciled layout as a guide, the pad and run pattern was copied onto the grid board itself. A soft pencil was used so that errors could be erased. The penciled layout on the board was double-checked before proceeding with the next operation.

Liquid resist is now applied from a tube, supplied with the kit, over the penciled lines. The tube is fitted with a ballpoint applicator that lays down runs of proper width with remarkable ease.

Neatness in laying down the resist is important, since the inked pattern is reproduced faithfully on a grid board by the copper that remains after the etching is done. An accident with resist was repaired easily after it dried by scraping off the error with a razor blade until the copper was bright.

It took 30 minutes at room temperature for the resist pattern to dry. After this a very careful inspection was made for mistakes. Where found, they were scraped away—every bit of each one—until bright copper showed. The fine threads of resist that formed when the tube was lifted from the board were brushed away easily after they dried.

If tape resist from the kit is used, it should be pressed tightly to the board with a fingernail to prevent undercutting by the etching solution. Covering the lap and butt joints with liquid resist insures continuity.

Now the board is ready for etching. The etching solution is made by dissolving one bag of the etching crystals (ammonium persulfate) in a pint of hot tap water. The plastic box that contains the kit made an efficient and convenient etching dish. The action of the ammonium persulfate on the copper helps to generate enough heat to keep the solution warm while the board was being etched. In addition, the container was placed in a pan of slowly circulating hot water to make sure the etching action would continue until the board was completely etched.

The board was gently agitated in the solution with a glass rod (a plastic spoon will also do the job). It was easy to see when the unprotected copper was completely removed; the Fotoceram insulating material showed up as a chocolate brown. The time required for this operation is about 20 minutes.

When the etching is completed, the board should be rinsed thoroughly in lukewarm tap water to remove the chemical. The etching resist was removed with mineral spirits (paint thinner) until the circuit runs and pads were clean and bright. A pencil eraser brightened them even more. The board was washed thoroughly in hot water and ordinary detergent. It is now ready for mounting the components.

As it turned out, the layout for the decade counter was done correctly and component assembly proved to be easy. Soldering was a real pleasure because of the affinity of the copper and solder. Where holes were left plated, capillary attraction actually pulled the solder in solidly around the lead wires. Run lifting was completely absent—in fact, impossible, because the copper isn't fastened to the board with adhesive. No special precautions were observed except to remember that Fotoceram is a form of glass and shouldn't be forced, flexed, or gripped by bare metal of pliers or in a vise.

The decade counter was now completed except for putting in jumpers and external wiring. The device was mounted for use by slipping two edges of the 1/16" thick board into slotted channels and fastening the assembly to a chassis. Materials for such channels can be any kind of insulation that will cushion shock or damp vibration.

Although this project didn't require large components, such as transformers or potentiometers, they could have been accommodated merely by making large pads. Boards as big as 9" x 12" are made by *Corning*. A glass cutter will cut a board from an outside edge, but holes within a board can be cut only with specialized equipment designed to cut ceramics.

Fotoceram glass-ceramic won't absorb moisture, delaminate, warp, rot, burn, or change its shape or electrical characteristics in any way. Therefore, the decade counter the author built on the grid board should last indefinitely. It is now serving as one of three counters in a chronograph, used to measure bullet velocities.

(Editor's Note: The author used the decade counter as an example of conventional circuitry which could be adapted to use with printed-circuit techniques. Unfortunately the October 1955 issue in which the diagram appeared is no longer available from us. Those wishing to duplicate the author's project will have to check second-hand magazine shops, public libraries, or order "Xerography" copies from University Microfilms, Inc., *313 N. First St., Ann Arbor, Michigan. The cost is 20 cents a page with a minimum order of $2.75.)* ▲

A 50-Volt Megohmmeter
(Continued from page 47)

Considerable effort was expended in the design of the d.c. amplifier to make operation independent of differences among transistors. Then from a completely random assortment of CK722's, the author replaced all four transistors seven times over, recalibrating and testing the instrument each time to verify that it would still work properly. Nevertheless there is sometimes tremendous variation from one CK722 to another; so, in case of difficulty, it may prove necessary to replace or interchange one or two transistors.

One possible trouble is inadequate gain, where full-scale deflection cannot be obtained unless feedback is reduced nearly to zero. Try replacing V_3, V_4, or V_5. (Note: *Heat from the fingers causes drift.*)

Another trouble that has been encountered is jitter of the meter needle. Barring loose connections, this trouble is due to an intermittent transistor, most likely V_5 or V_6.

Given a good milliammeter, accuracy of the instrument should be very nearly perfect. To check, connect a number of megohm-range resistors in series to obtain exactly 50 megohms. If this combination reads exactly half-scale, then linearity can be assumed perfect. If not, try interchanging transistors in the d.c. amplifier (that includes V_6).

Temperature Compensation

With a random selection of transistors in the d.c. amplifier, there is likely to be some drift in the meter range as ambient temperature varies. Ordinarily this drift presents no real problem, since the "Zero" control must be adjusted before each measurement anyway. Even if meter zero drifts out of range of the "Zero" control, the "Balance" control can always be adjusted to bring it back.

But it is possible to improve compensation if necessary. The effect of increasing temperature is to make the transistors conduct more heavily. Greater conduction of V_3, V_4, and V_5 tends to shift the needle up-scale; greater conduction of V_6, down-scale. One effect or the other will almost always predominate; but with a lucky selection of transistors the two effects will largely cancel, keeping meter zero within range of the "Zero" control.

The author knows no convenient means for sorting transistors according to thermal characteristics. Therefore if the builder decides to attempt compensation he will probably have to depend on trial and error, replacing or interchanging transistors in the d.c. amplifier until he happens on just the right combination. Perfect compensation is very difficult to achieve. The builder should be satisfied if meter zero can be kept within the range of the "Zero" control within normal excursions of room temperature. ▲

SIGNAL-STRENGTH METER FOR CB

By **FRED BERHLEY, 2W3640**

Complete details on the addition of a simple indicator to a Citizens Band receiver that can be employed to give useful, dependable, and comparative signal reports.

SIGNAL-STRENGTH or "S" meters in one form or another are being used in commercial and amateur equipment to indicate the strength of r.f. carriers at the receiver. Most "S" meters measure the a.v.c. voltages generated within the receiver and these voltages are proportional to signal strength.

In general, an "S" meter report is good enough to give assurance to the transmitting party that his signal is getting out. However, no truly accurate report is possible because there is no generally accepted "zero" level.

The signal-strength indicator described herein and shown schematically in Fig. 1 has been constructed around a sensitive 0-50 μa. meter and will give accurate and dependable readings at all times. This unit will be especially useful to the countless CB transceiver owners who do not have a signal indicator built into their units but who wish to keep their rigs working at maximum efficiency by occasionally exchanging signal reports with other stations in the Citizens Band.

It should be understood that any time we insert a series resistance with a microammeter in the circuit, as shown, we are actually transforming the current meter into a d.c. voltmeter. Using Ohm's Law and the resistance values given, we can show that a 0-50 μa. meter with a series resistance of 200,000 ohms becomes a 0-10 volt d.c. meter, and using the same meter with an 800,000-ohm resistor would give us a 0-40 volt meter.

Some operators prefer to give and receive signal reports in decibels. By establishing a "zero" level or reference point on the lowest voltage range we can set up voltage ratios throughout the meter's range, permitting us to give decibel readings.

Let us select .1 volt as our "zero" level or reference point. This happens to be close to the a.v.c. voltage generated by the no-signal noise level and self-bias encountered in many receivers in an average location. We are not interested in voltages below .1 volt but all readings above this value represent an increase in signal or noise level. Since we intend to use both voltage and decibel scales for our meter, we must first calibrate the lowest voltage range, or 0-10 volts. No special equipment is required; it is simply a matter of converting the voltage readings to ratios compared to .1 volt and converting these ratios to decibels.

Using .1 volt as our "zero" level, assume we receive a signal that reads 5 volts. A voltage ratio of 50 exists between the zero level and the 5 volts we read on the meter. Applying the decibel formula of $db = 20 \log_{10} E \text{ ratio}$, we obtain 20 *log* 50. From log tables or a slide-rule we find the *log* of 50 to be 1.7, and 20 x 1.7 = 34 db. For a 10-volt signal, the ratio would be 100 and the db value would be 40. Using this method we can calibrate the entire 0-10 volt scale in convenient db values.

The 10-volt/40-db scale may not be high enough because many stations will produce signal levels resulting in a.v.c. voltages greater than 10 volts or 40 db. If we switch in our 400,000-ohm series resistance we double our previous voltage range to 0-20 volts and increase the db scale by 6 db, to 46 db. There will be stations, especially those operating close to a receiving set, that will register signal levels in excess of 20 volts or 46 db. Unless we are willing to have our meter needle pinned, we will have to use the third voltage/db range. Using an 800,000-ohm series resistor increases the voltage range to 40 volts and the db scale to 52, which most likely will cover all signal levels without ever having the meter needle pinned against its stop. Note that every time we double the voltage range we add 6 db to the decibel scale.

The switching arrangement shown in Fig. 1 accommodates four positions, including "off," with the 40-volt/52-db position adjacent to the "off" position. This arrangement will prevent damage to the meter if it is in the "off" position, then switched in while a very strong carrier is being received.

Incidentally, the resistors chosen should be as close to the values indicated as possible, preferably within 1 per-cent. We have not taken into account the resistance of the meter in choosing the values of resistors, but this will result in negligible error. Also, rather than using a separate 50-μa. meter, we can use this range on our v.o.m.

When called upon to give a signal report, we switch momentarily to a voltage range that gives a reading toward full-scale for maximum accuracy. Examination of the voltage *versus* db scale will disclose that an error of 1 volt on the high end equals an error of 1 db, while on the low end of the scale an error of 1 volt can mean an error of 6 db or more. Therefore all readings should be taken close to full-scale.

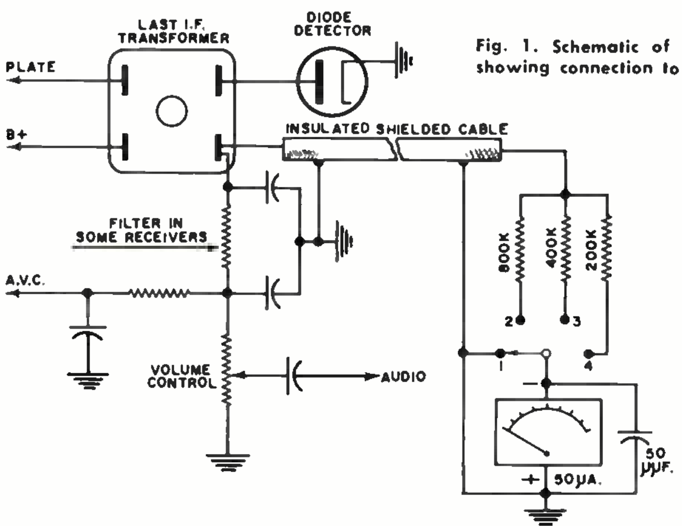


Fig. 1. Schematic of the indicator showing connection to the receiver.

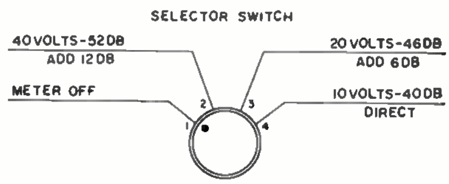
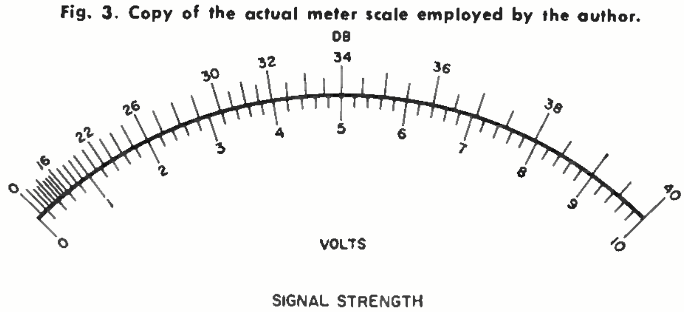


Fig. 2. Suggested marking for the switch.

Fig. 3. Copy of the actual meter scale employed by the author.



The actual meter scale for the signal indicator is shown in Fig. 3. The scale is a copy of the writer's own meter and has been in use for some time. The calibration was restricted to two scales in order to keep the scale easy-to-read. Fig. 2 shows the suggested marking for the selector switch. With the switch in the #1 position the meter is disconnected. In position #2 the highest voltage range of 0-40 volts will be in use; voltage readings as indicated on the meter must be multiplied by 4 while 12 db should be added to the scale reading. With the switch in position #3, voltage readings are multiplied by 2 and 6 db added to the reading. In position #4 all readings are direct, as indicated, with no multiplication or addition required.

The completed meter as described has a sensitivity of 20,000 ohms-per-volt and its insertion loss is low. The signal-strength meter will give excellent accuracy as long as the receiver to which it is connected is kept in good operating condition and does not suffer any loss of sensitivity. Antenna, r.f., i.f., and detector circuits may be checked with the signal-strength meter by occasionally taking a number of readings of known carrier levels thus the loss of receiver sensitivity may be readily detected. ▲

TV GHOSTS?

By H. R. HOLTZ

THE customer thought he had a ghost of the old-fashioned kind—the kind that haunts houses. He told me that his TV set turned itself on during the night! Perhaps there was a bit of skepticism in the look I gave him as my mouth dropped open. He became defensive.

"I know," he said, "it sounds crazy but every night I wake up suddenly and hear that blamed TV blaring away. I come downstairs and there it is—on."

I figured I'd better humor him while I thought of a way to get out of there before he became dangerous. I examined the set. It was a 1958 model Sylvania consolette, metal cabinet, knobs coming out of the top. I checked the "on-off" switch. It proved to be one of those pull-on, push-off types that you can turn on and off without changing the setting of the volume control. I pulled it. After a few seconds, it came on and played normally. I pushed it. It went off. I pulled it on and pushed it off several times, thinking furiously, seeking some way to absent myself from this scene casually.

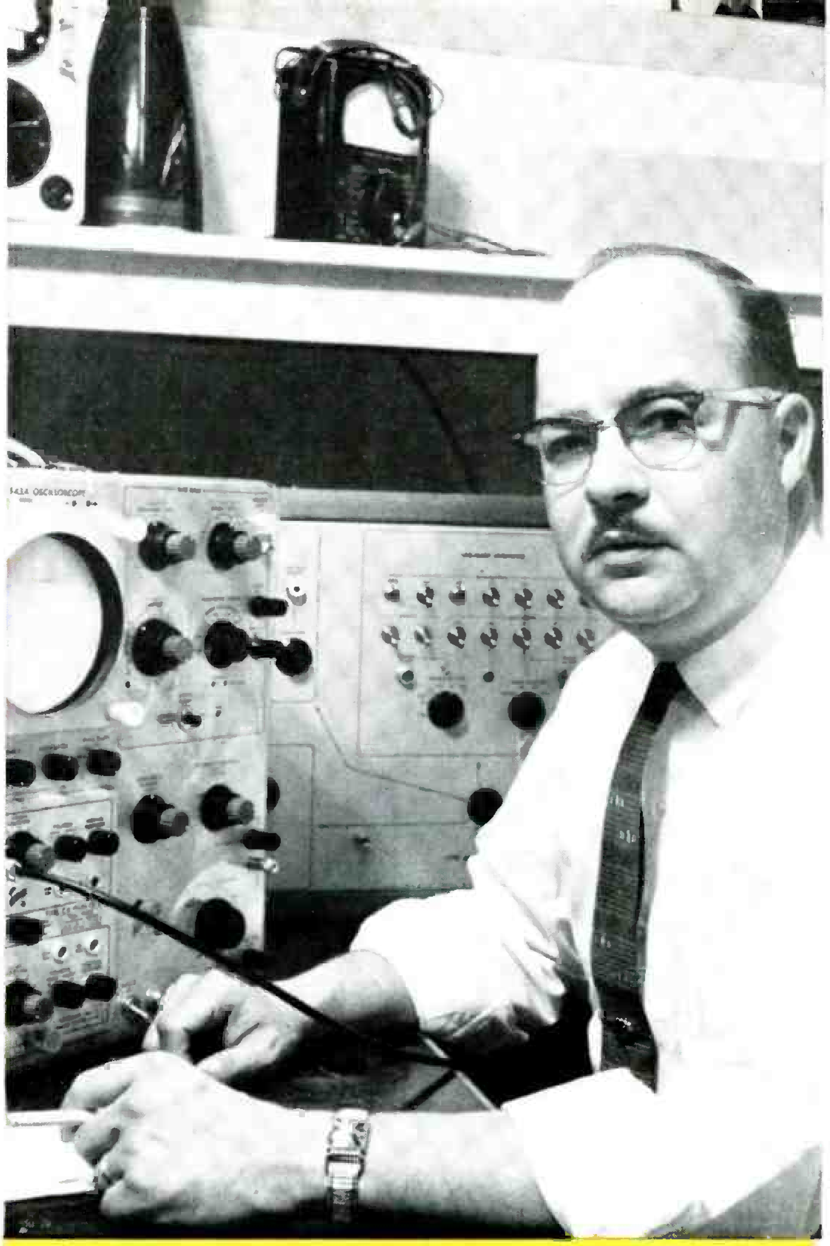
I pushed it a bit too hard. The knob kept going down until the plastic rim of the knob contacted the metal top and dimpled it. I had a sudden idea. I pressed the metal top of the cabinet, several inches from the knob. The depressed metal around the knob sprang back to its normal shape, suddenly, and flipped the knob up hard enough to trip the switch and turn the set on.

Normally, the poor man had been doing this every night when he turned his set off. During the night, the metal finally resumed its shape, naturally, just as I had coaxed it to do.

A plug in the bottom of the knob's control-shaft-recess prevented the knob from traveling so far and prevented a recurrence of the ghostly phenomenon. It also saved my sanity: I wasn't sure which of us was nuts. ▲

are you standing still in electronics while this man advances?

Find out why—and do something about it—if you have the ambition to want a career instead of just a job.



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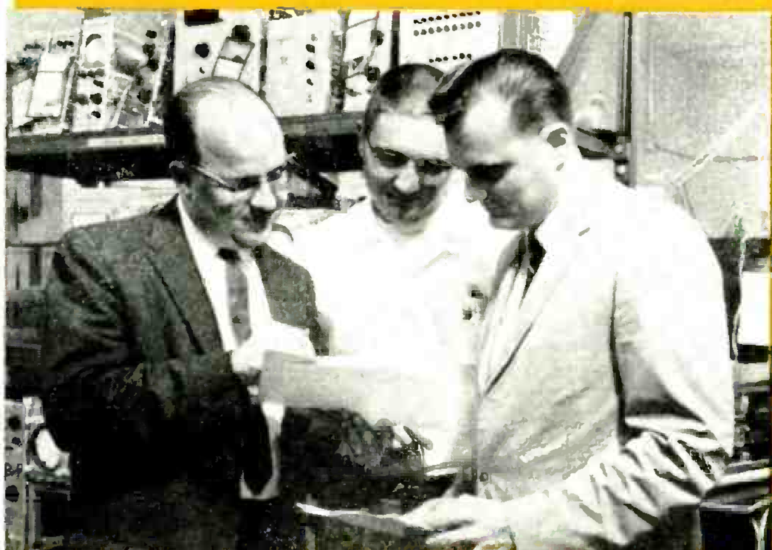

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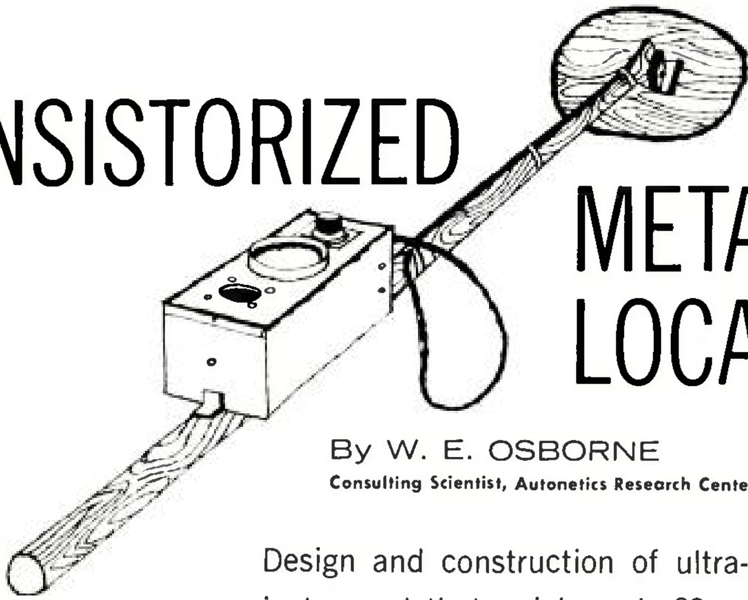
#24

TRANSISTORIZED METAL LOCATOR



By W. E. OSBORNE
Consulting Scientist, Autonetics Research Center

Design and construction of ultra-portable beat-frequency instrument that weighs only 28 ounces with batteries and includes both loudspeaker and output-meter indication.

A RE-EXAMINATION of the metal locator field discloses that as far as the small portable types are concerned there has been no appreciable increase in range for many years. New models have been introduced but the improvements have been confined to reductions in size, weight, and current drain, due to transistorization. Receiver signal-to-noise ratios have, in some cases, been improved by more than 100 per-cent but unfortunately this doubling of sensitivity has but small effect on the range of the instrument since a signal-to-noise ratio improvement of forty or fifty times is needed to increase the range significantly. Other factors, however, enter the picture and are peculiar to the type of circuitry employed.

Types of Locators

Metal locators may first be classified as prospecting, industrial, or military types, and then again divided according to the principle of operation. The first type uses a lightweight, highly portable transmitter (at frequencies ranging upward from around 50 kc.), in which the frequency is varied by any metal within the usable field of the search coil. A meter and/or headphones records this variation.

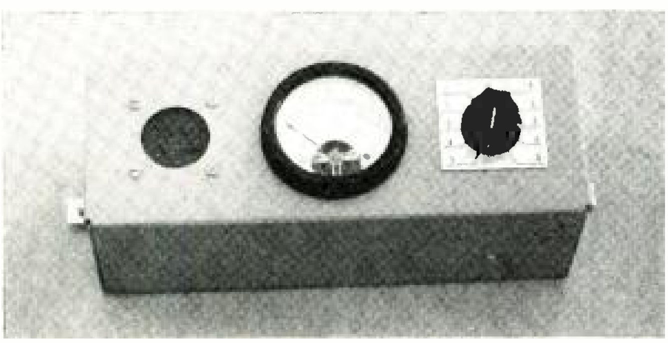
The second type is the more expensive combination of transmitter/receiver with its heavier current requirements and larger proportions of weight and size. Signal-to-noise ratio is most important in this type, as well as minimum direct leakage of signal between transmitter and receiver.

The third category, the beat-frequency type, can possess a sensitivity at least equal to any other in its class if properly designed. The limiting factor here is usually "pulling" of the two oscillators at the mixer stage, but a little care will prevent this, and maximum sensitivity attained by operating slightly to one side (1-3 cps) of zero-beat.

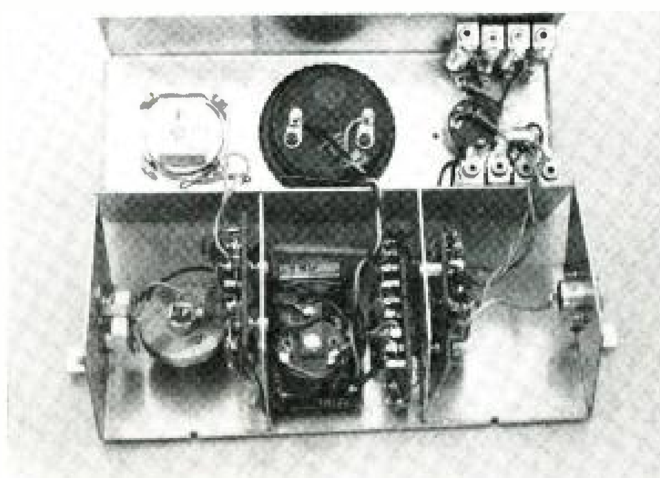
Finally, we have the vehicle-mounted types (truck or airplane), which may be either transmitter/receivers (pulsed or c.w.), or permalloy-strip magnetometer detector/amplifiers, in which the magnetic field of the earth in any location is measured, cancelled out by an opposing field, and any increase due to the presence of metal then recorded. Hydrogen-bottle and other types of magnetometers are also utilized occasionally.

In still another class, not placed in the above four categories because of limited range and lessening use, are the magnetic-bridge types operating at audio frequencies and formerly popular as mine-detectors and pipe locators.

The beat-frequency type of metal locator is described here. It is ultra-portable with case dimensions of only 3" x 3" x 2¾" high, weighs but 28 ounces including batteries, is 100 per-cent transistorized, and includes both loudspeaker and meter indication. The search coil is not included in the weight given as this will vary with the type of pole used. It should be under two pounds. The bat-



Miniature speaker and microammeter provide output indication.



Interior of the metal locator. The two metal shields divide the box into three equal compartments. The center compartment houses the two mixer transistors, the audio output stage, and the meter. The fixed oscillator shares the left compartment with the speaker. The search oscillator, the batteries, and the potentiometer for frequency adjustment are at the right.

teries, which are small No. 912 penlite cells, may be dispensed with if desired and solar cells substituted. These can be attached to the top and sides of the metal box. The schematic and parts list are given in Fig. 1.

Search Coil

The search-coil is hand-wound. The author stripped the wire from an old flat (and oval-shaped) antenna board that had formerly belonged to a small radio receiver. In the slots thus exposed is wound, in basket-weave fashion, 100 turns of No. 24 s.c.e. wire. It may be necessary to lengthen the slots.

The dimensions of the inside turn are 3" x 5¼" and of the outside turn 8¼" x 9¾". Leads of approximately one foot are left at each end. The search coil is then doped and placed between two pieces of plywood, cut to the same shape with an extra ½" to spare all around. Two thin wood screws near the center of the coil hold the whole assembly together. The leads are, of course, brought to the top side through suitable small holes. Mount a swivelled pole (about six-feet long) with wooden blocks as shown in the photo (right), along with a coaxial receptacle to which the coil leads are attached. The inside turn goes to the coaxial frame and is, therefore, "ground." The inductance of the coil is approximately 2½ millihenrys.

Cut about four feet of medium-size coaxial cable and solder a coax plug to each end, with the cable shielding attached to the frame of each plug. After screwing one end to the search pole receptacle, tape the cable to the pole in two or three places.

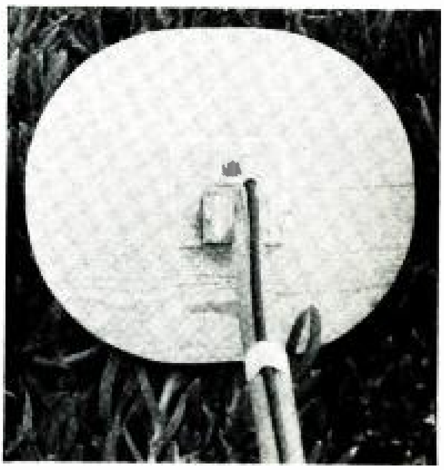
Circuit & Construction

Five transistors, type 2N188A, were used in the instrument. As alternatives, 2N524's will operate without noticeable change in performance. It so happens that in the author's locator an extra transistor of the power variety (2N256) is also mounted. This was used initially as the variable or search oscillator in an effort to increase range by more power. However, the difference was quite small, due mainly to the fact that the efficiency of such a power transistor is extremely low at the 100-kc. operating frequency of this unit.

Use sockets for the transistors to avoid heat damage from soldering. Cut two metal shields, with mounting flanges, to divide the box into three equal compartments. The center compartment houses the two mixer transistors, the audio output stage, and the 100-µa. meter. The oscillators are widely separated, one at each end of the box, to minimize locking or pulling. The one-inch speaker shares the compartment housing the fixed oscillator and its tank coil, while at the other end the search oscillator, whose only inductance is the search coil outside, is installed with its associated potentiometer for frequency compensation. The fixed oscillator coil used by the author was a 4-mhy. low-loss r.f. choke on a ceramic former, taken from an old surplus transmitter.

However, this is not at all critical and a standard 5-mhy. r.f. choke may be used by stripping off turns (usually about 10% of the total) until resonance is obtained with the capacitance values shown.

Colpitts oscillators are used, thus achieving efficiency and stability with only two wires to the search coil. Frequency adjustment of the search oscillator is made with the 2000-ohm potentiometer, rather than with a variable capacitor. Trimming of the fixed oscillator frequency is made initially with a screwdriver-adjusted 15-90 µµf. capacitor and rarely needs further adjustment. This trimmer can be eliminated if necessary, provided the 470-µµf. fixed capacitor (C_9) that is used with the tuned-circuit coil L_3 is increased to 560 µµf.



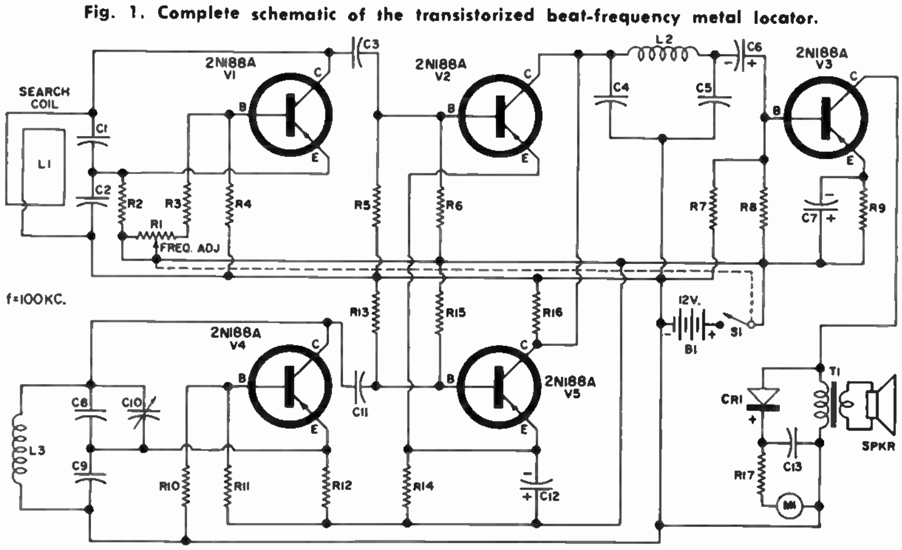
For details on the construction of the search coil, shown here, refer to text.

The mixer and output stages should be wired first as a sub-assembly on a dielectric board. Bring in the two oscillator leads (to the two mixer transistors) from opposite sides of the board and separate these transistors. If there is any appreciable length (over one inch) of input lead to each mixer inside the center compartment, the leads should be shielded.

The use of two transistors for mixing was adopted after tests of "pulling" with only one transistor. The present arrangement is a modified doubler circuit which with separately biased emitters would double two identical input frequencies. However, we modify this for mixing by a common-emitter load and retain the parallel collectors of this doubler. The modification helps somewhat when holding the oscillators close to zero-beat. The output choke (a 25-mhy. *Miller* #757 unit) and its associated capacitors are quite important in the bypassing of unwanted signal frequencies.

Miniature holders of the strip type were used for the small flashlight cells and these were placed (in two sections of four each) in the search-oscillator compartment. The 0-100 µa. meter is optional and this, together with its diode and 100,000-ohm resistor, may be eliminated if so desired. An *Argonne* AR-135 output transformer, together with a 1-inch speaker of the same brand, was used but any standard transformer type with a primary impedance of around

Fig. 1. Complete schematic of the transistorized beat-frequency metal locator.



R_1—2000 ohm pot. with switch S_1 ("Freq. Adj.)
R_2, R_{13}—2000 ohm, ½ w. res.
R_3—1000 ohm, ½ w. res.
R_4, R_9, R_{10}—10,000 ohm, ½ w. res.
R_5, R_7, R_{14}—100,000 ohm, ½ w. res.
R_6, R_{15}—22,000 ohm, ½ w. res.
R_8—15,000 ohm, ½ w. res.
R_{11}—1200 ohm, ½ w. res.
R_{12}—2200 ohm, ½ w. res.
R_{16}—5600 ohm, ½ w. res.
R_{17}—100,000 ohm, ½ w. res. (optional, see text)
C_1, C_3, C_{13}—.001 µf. disc ceramic capacitor
C_2, C_6—.005 µf. disc ceramic copacitor
C_4—.0025 µf. disc ceramic capacitor
C_5—.0015 µf. disc ceramic capacitor
C_8—30 µf., 15 v. elec. capacitor
C_7, C_{12}—50 µf., 6 v. elec. capacitor
C_9—470 µµf. disc ceramic capacitor
C_{10}—15-90 µµf. trimmer capacitor
C_{11}—.05 µf. disc ceramic capacitor
L_1—2.5 mhy. search coil (see text)
L_2—25 mhy. choke (J. W. Miller #757 or equiv.)
L_3—4 mhy. r.f. choke (modified 5 mhy. unit, see text)
M_1—0-100 µa. meter (optional, see text)
CR_1—1N126A diode (optional, see text)
T_1—Output trans. 1000-4000 ohm pri., 1-3 ohm sec. (Argonne AR-135 or equiv.)
S_1—S.p.s.t. switch (on R_1)
Spkr.—1-inch speaker (see text)
B_1—12-v. battery (8 1.5 volt penlite cells, see text)
V_1, V_2, V_3, V_4, V_5—2N188A transistor (see text for alternate)

1000-4000 ohms and a secondary of 1-3 ohms may be substituted for the ones used by the author.

Adjustment & Operation

With the wiring completed and batteries installed, connect the search coil to the other coax receptacle, which should be on the search end of the box. Switch on and rotate the pot for an audio signal, which should go down to zero about the middle of the scale. Trimming of the fixed oscillator may be necessary. If there is no output, the oscillator frequencies may be too far apart and each one should be checked at around 100 kc. with an audio generator and oscilloscope. The coils themselves, the tuning capacitor, and the self-capacity of the coaxial cable are the items involved. A slight change in tuning capacitor value (the smaller capacitor of the two across each coil) will usually be sufficient. Tune the two oscillators to the same frequency, with the pot at center scale. The actual frequency may be anywhere in the range from 80 kc. to 110 kc. When tests are complete, seal up the search coil with plastic wood, apply waterproof stain, and fasten the box housing the circuits to the pole.

Practice is required for successful operation, not only in holding the oscillator just off zero-beat but in maintaining a uniform distance between search coil and ground. With the search coil away from all known metal, but only a few inches above ground, tune for the lowest audible frequency, which will be a deep "growl." Move the search coil slowly and evenly across the ground. Metal is indicated by a change in the audible note, either up or down, depending on the ferrous or non-ferrous nature of the metal, and also upon which side of zero-beat the coil is tuned. The meter should also rise or fall with the variation, but this is not so readily detectable as the audible change heard from the speaker.

The range of the instrument varies, of course, with the size of the metal objects but as an example, a nickel has been found in three feet of dry soil. A small piece of ferrous metal will increase the search coil inductance and decrease the frequency. It is therefore possible to calibrate for ferrous or non-ferrous metals by checking with known metals against a given setting of the frequency dial.

While this circuit is fairly stable, refinements could be added for increased stability. Batteries are much better in this respect than solar cells and insulation of the metal box will help protect the transistors from temperature effects. Oscillator base resistors of the negative-coefficient variety would be a refinement as would the use of the more expensive transistors of the silicon variety.

By and large, however, the circuit as given provides a practical, inexpensive, and dependable little instrument that will be fun to have along on any camping trip and prove a useful accessory on an "expedition." ▲

U.S. ELECTRONIC EXPORTS RISE IN 1961

Most categories included in 33% rise; phonos down.

ACCORDING to figures compiled by the U. S. Department of Commerce and released by the Business and Defense Services Administration, exports of electronic products from the United States increased by 33 per-cent during the first nine months of 1961 over a similar period in 1960. The 1961 nine-month exports totaled $437.4 million reflecting increased sales of electronic computers and test equipment to Japan and Western Europe and substantial gains in exports of electronic components.

Shipments of crystal diodes and transistors increased from $11.7 million to $14.8 million. France and Canada were the principal markets, their purchases approximating $3 million each.

Exports of TV picture tubes went from $13.9 million to $15.3 million, Argentina taking $4.9 million and West Germany $2.4 million. Receiving tube shipments increased from $10.2 million to $12.3 million.

There were also appreciable increases in shipments of capacitors, transformers, resistors, and miscellaneous components and accessories.

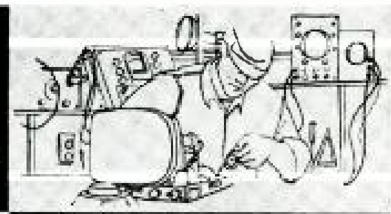
During January-September 1961, the Latin American Republics and Canada were the principal markets for U.S. exports of television receivers and chassis. Of the total exports of television receivers valued at $11.5 million, exports to Venezuela amounted to $3.5 million and to Canada $2.1 million. Shipments of television receiver chassis to all countries were valued at $8 million, those to Argentina amounting to $4.5 million. During the entire year of 1960, exports of television chassis totaled less than $4 million.

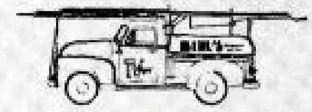
Exports of phonograph records declined substantially—from $7.8 million in the first nine months of 1960 to $5.7 million in the first nine months of 1961; exports of phonographs and parts also registered a decline—from $15.4 million to $14.5 million. The leading market for coin-operated phonographs was West Germany, which accounted for $2.9 million of the U.S. total exports of $9.5 million.

U.S. electronic products are shipped throughout the free world. However, during the first six months of 1961, shipments to 10 countries accounted for 73 per-cent ($147.8 million) of the total exports to all countries valued at $201.9 million exclusive of "special category" items for which data on countries of destination are not available.

These top ten markets were: Canada, $36.8 million; West Germany, $20.0 million; France, $14.7 million; Japan, $14.6 million; Argentina, $14.4 million; United Kingdom, $11.0 million; Italy, $10.7 million; Venezuela, $9.8 million; Netherlands, $8.2 million; and Mexico, $7.6 million. ▲

SERVICE INDUSTRY NEWS





ANOTHER pin goes into place on the figurative map maintained by licensing advocates. It covers the dot identified as South Bend, Indiana. A local ordinance requiring TV service technicians and antenna installers to be licensed and controlled by a newly created Division of TV Inspection passed the city council by a vote of 7 to 2. The position of chief TV inspector has been set up to enforce the law and investigate all complaints. He must be a qualified technician with at least five years' experience. Two technicians appointed by the mayor will be on the examining board, which will also include three members appointed by the city council: an antenna installer, a retailer of TV sets, and a layman.

A grandfather clause permits all persons of good character and habits who have been working in TV service in the city for at least one year prior to enactment to obtain licenses without examination. Excluded from control are hams and set owners repairing their own equipment for their own use. Apprentices not qualified for licenses, if they are registered, can perform work under the supervision of licensed technicians. Fines up to $300 are provided for violations.

"Failure" Pays Off

Those elsewhere who have labored long and apparently without success for licensing may take encouragement from this development twice over. In one sense, any new legislation of this kind increases the probability of passing a law in any other place where it does not already exist. In another sense, the specific circumstances of the South Bend move underscore an interesting moral. The local service group, ARTS of St. Joseph Valley, had striven vainly for a licensing bill in the past—scarcely an unusual experience. However, these "unsuccessful" efforts appear to have made an impact. A member of the South Bend council introduced the ordinance recently on his own initiative, taking ARTS members quite by surprise. (See this space last month, page 70.) Before there was much time for turning around, the ordinance had passed by the substantial majority noted earlier. Surely this could not have happened without previous "failure."

The state-wide group, Indiana Electronic Service Association, hopes that the local gain will serve as a wedge in its continuing drive for such legislation that will cover the entire state.

Bouncing back for another license bout are interested service groups in New York State. Last year's bill, which failed to pass, nevertheless made history. It was the first of its kind in the state ever to have been reported out of committee. In addition, it was passed by the state senate. However, it couldn't get through the assembly.

The bill's course did accomplish something important, its advocates feel: it showed where the opposition lay. A pocket of resistance in the area of New York City became evident. Pro-license forces have been concentrating their efforts on the recalcitrant lawmakers, aiming for passage in the current session. Conferences with the latter legislators indicate that some of them may reconsider their stands.

Advertising Supervision

In common with many other places, the Los Angeles area has been plagued with "bait" advertising of TV service. Caught up in the problem, the "Los Angeles Times" has elected to submit all advertising pertaining to radio and TV service to the local Better Business Bureau for investigation of the firms involved and approval of copy. The California State Electronics Association has been working for this type of protection for some time.

The move falls into a growing pattern that includes the handling of copy for "yellow pages" advertising in many places. The latter type, in fact, has been the subject of a legal test. A service outlet in Kansas City, Mo., sought to force the *Southwestern Bell Telephone Co.* to accept copy for the classified directory that included the word "free" or claims that "you pay nothing" if no tubes are needed. The right of the phone company to restrict copy was upheld.

More on Industry Liaison

Allen Roberts (TSA of Delaware Valley), as quoted in this space in our January issue, page 70, had mixed feelings about the All Industry Conference organized, in part, to iron out conflicts within the industry and also to provide a united voice for representing mutual interests. He endorsed the principle involved wholeheartedly but felt that it was unfair that all of independent service should be represented by NATESA alone.

Additional information throws a somewhat different light on the matter. Independent service is being represented by four individuals, only one of whom (Frank J. Moch) has any connection with NATESA. Other principals are from the east and the west, apparently to provide a broadly representative base. Adding more spokesmen for service would unfairly weight representation by that segment of the industry.

Association Boosts Business

Collective promotional efforts to aid its members on the part of a service group are not new. Advertising under the association name in the yellow pages, in newspapers, and on TV has been tried before, usually with good results. TESA of Greater Kansas City, however, has come up with a new wrinkle. To recover income being lost due to the sag in tube sales by service shops and to cement customer relationships in general, this group is sponsoring a drawing based on a give-away of over $2000 in TV, hi-fi, and transistor-radio sets, records, and other merchandise contributed by TESA members.

Entries are being circulated by mail, by handbill distribution, and through service shops directly to customers. Entries also carry messages concerning tube sales, customer service, and TESA aims, ethics, and membership lists.

Supermarket Give-Aways

TV retail and service outlets in Indianapolis, Pittsburgh, and other metropolitan centers are up in arms over another type of give-away, which appears to be a growing fad. Grocery chain stores are offering appliances, including TV sets and other electronic merchandise, as premiums. To get a "free" TV set, a housewife must keep and accumulate the register tapes or receipts issued by the food store until she has the total amount specified for the receiver or other premium she wishes. In a typical offer, she must buy $4732 worth of groceries for a TV set.

Those who sell the sets in what used to be the normal way are understandably agitated. Concern by those who service only is also legitimate. Even though the customer is actually paying for the set in concealed food mark-ups (an ad by *General Electric* on this gimmick points out that nobody, but nobody, can give anything away), the concept of the "free" set has unfortunate effects on the customer. How much would you be willing to pay for service on something you got for nothing? If the fad goes far enough, it might encourage the manufacture of cheapened sets, which further exacerbates service problems.

However, we feel that the register-check gimmick is likely to hurt the participating set maker more than retail and service people. After all, the scheme is not likely to have much more effect than premium plans based on stamps. It is simply a variation that cuts out the middle-man who sells the stamps. Considering the normal rate of food consumption, sets reaching the public through these plans can only be a small per-cent of those sold normally. But the set makers involved have already begun to suffer because their regular dealers, incensed over the "betrayal," are dropping these lines. ▲

W90R98083

"When does my subscription expire?"

This question is often asked of us by subscribers to Electronics World. You can check the expiration date of your own subscription by reading the code line on the mailing label of Electronics World as follows:

W=Electronics World

90=The month and year in which your subscription started—in this case, Sept., 1960.

R980=(Filing instructions for our use only)

83=The month and year in which your subscription will expire—in this case, Aug., 1963.

VOLTMETER FIELD-STRENGTH ADAPTER

By JAMES E. FREDERICK, JR.

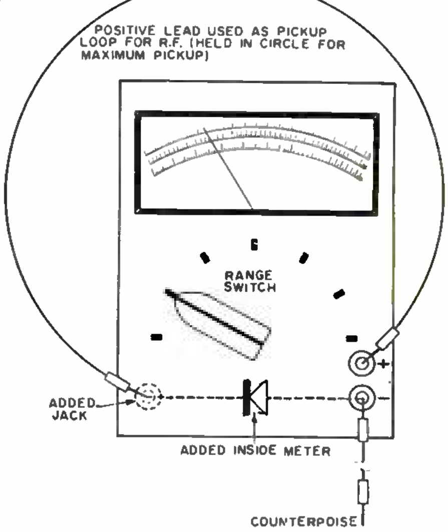
Add a crystal diode to a service instrument to read output from mobile rigs.

THERE are a number of articles covering the construction of field-strength meters for mobile transmitters but here is a method which has proven just as satisfactory as more elaborate meters yet requires only the addition of a crystal diode to any voltmeter or v.o.m.

The diode is connected from the negative terminal of the voltmeter at the test lead jack to the end of the positive test prod. The positive test lead serves as the r.f. pickup loop and the negative test lead serves as a counterpoise.

An additional pin jack may be mounted in the meter in which case the diode is installed internally from the added jack to the negative test-lead jack. The prod on the positive test lead is plugged into the additional jack for field-strength measurements. Polarity must be observed when installing the diode. The cathode connects to the additional pin jack and the anode connects to the negative test-lead jack inside the meter. The diode may be any general-purpose type, such as a 1N34 or CK705. The sensitivity of the unit may be varied by switching to different d.c. ranges on the v.o.m.

This system has been in use for a number of months for obtaining maximum output from mobile communications transmitters and has proven satisfactory. Useful readings can be obtained from a few feet to 50 feet or more, depending on the orientation of the pickup loop. ▲



Britain's Radiotelescopes

(*Continued from page* 41)

long 1450-foot array stretching away into the distance is highly impressive to the visitor, it was erected for a small fraction of the cost of a comparable parabolic reflector. Since the small section has to be moved daily, it requires 25 days to complete the observations on a single 4-degree strip of sky. Admittedly, the signal-to-noise ratio is much worse than if the full-sized equivalent array could be built, but this is not as important as it might seem for this application. The technique of aperture synthesis would not, of course, be suitable for space communications or satellite work which normally call for a steerable radiotelescope. Also, for most accurate results, propagation characteristics should not vary greatly throughout the cycle of observations.

To obtain full information on a single 4-degree strip of sky, some quarter-million separate calculations have to be made. Fortunately, these can be done on Edsac II—the electronic computer at Cambridge University. The output from the radiometer—the term generally used to describe a receiver used in radio astronomy—is passed directly into a unit which produces digital numbers on a punched tape for the electronic computer.

The resulting data from the computer enables the radio astronomers to plot the positions and intensities of all radio sources in the particular 4-degree strip of sky. The entire process is then repeated on the next strip of sky. Eventually the radio maps will cover the entire visible sky.

Since his announcement on the results thus far achieved, Ryle has filed application to build an even larger and more accurate radiotelescope, costing a little over one-million dollars—almost twice that of the original cost of the entire observatory. At present, however, government economies are holding up this work, but approval may be forthcoming.

"Royal Radar" Radiotelescope

Another major radiotelescope observatory, Britain's third, began operation recently to facilitate radio and radar research in space and the upper atmosphere. Located at the Royal Radar Establishment—the government's official radar research center near Malvern, England, the total cost of the installation is in the region of one-million dollars.

The new observatory was opened to the technical press recently and the writer was able to inspect this modern installation too.

It comprises two twin mobile steerable radiotelescopes with 82-foot diameter parabolic reflectors capable of operating throughout the range of 30-3000 mc.

Latest low-noise techniques—including parametric and maser amplifiers—will be used in the radiometers. Each of the two mobile cabins is capable of housing two high-power radar transmitters as well as receiving and other apparatus. The entire structures are driven electrically along T-shaped rail tracks and leveled by means of hydraulic jacks. The base line between the two telescopes is thus continuously variable in direction and distance up to about 3000 feet.

The two 250-ton telescopes can be operated independently or combined to form an interferometer of high angular discrimination. By taking readings with the telescopes in different positions the technique of aperture synthesis can be used if needed.

This installation will work on defense projects as well as being used for fundamental research. Heading the team of scientists working on this project is Dr. J. S. Hey who has been called the "father of British radio astronomy." He first became concerned with radio astronomy when working on measures to protect Britain during the V2 rocket attacks during World War II.

There is little doubt that before long we shall know much more about how the universe began. ▲

Transistor Sales High Again in October

According to figures compiled by the Electronic Industries Association, a total of 18,232,530 transistors, worth $24,018,037, were sold at the factory during October, making that month second only to September in total units sold during 1961.

September sales hit the year's record total of 19,386,202 transistors, valued at $27,220,248. Cumulative sales during the first 10 months of 1961 stood at 154,107,230, or just a shade under 52 million more units than were sold during the same period in 1960. ▲

	Factory Sales (units)	Factory Sales (dollars)
October	18,232,530	$ 24,018,037
September	19,386,202	27,220,248
August	17,130,732	25,075,714
July	11,164,262	17,426,101
June	17,835,879	26,068,836
May	15,065,055	25,033,132
April	15,008,938	27,308,368
March	15,129,273	29,815,291
February	13,270,428	25,699,625
January	12,183,931	22,955,167
Total to 10/31/61	154,407,230	$250,620,519
Total to 10/31/60	102,431,984	$248,144,156

HIGH-PRECISION SOUND-SPEED MEASUREMENTS

New Navy-developed velocimeter provides highly accurate data.

THE U. S. Naval Ordnance Laboratory at White Oak, Maryland has made the first comprehensive high-precision measurements of the speed of sound in sea water and compiled them into a standard reference guide useful for the study of underwater acoustics, thermodynamics, and oceanography. The tables take into account the effects of salinity, temperature, and pressure on sound velocity at all depths of over 99.8 per-cent of the world's oceans.

Recommended by the Navy's Hydrographic Office as containing the most comprehensive and accurate figures to date, NOL's sound velocity tables for sea water are already in use at a number of U. S. Navy installations and in some foreign countries. They are expected to eventually replace earlier tables which are either based on theoretical computation and known to be in error by as much as ten feet per second, or do not take into consideration the effect of pressure on sound velocity in sea water.

NOL performed its sound velocity measurements inside the laboratory with sea water collected from the Bermuda-Key West area where the ocean is about the saltiest. This water was divided into eight samples which were diluted to varying degrees with distilled water to represent the entire range of sea water in all the oceans of the world. Pure distilled water was included in the samples to bring the total number tested to nine.

The actual velocity measurements were made in an NOL-developed velocimeter which is a five-inch-long instrumented test chamber designed to contain the water samples. A sending crystal on one end of this device generated a 5-mc. pulse which was transmitted through each of the samples to a receiving crystal on the opposite end of the velocimeter. The velocity of the pulse was determined by recording the length of time it took to traverse the known distance between the crystals. In this manner, a total of 747 measurements was made in the nine samples at 15 temperatures representing the entire spectrum of the ocean's known temperature range, and at 8 pressures from the surface of the sea down to five miles.

Verification of the precision of NOL's measured data and its final interpolation into a table of comprehensive figures was accomplished on an electronic computer. The completed tables cover the speed of sound in sea water where salinity, temperature, and pressure vary individually and collectively. ▲

INVITATION TO AUTHORS

Just as a reminder, the Editors of ELECTRONICS WORLD are always interested in obtaining outstanding manuscripts, for publication in this magazine, of interest to technicians in industry, radio, and television. Articles covering design, servicing, maintenance, and operation are especially welcome. Articles on Citizens Band, audio, hi-fi, and amateur radio are also needed. Such articles in manuscript form may be submitted for immediate decision or projected articles can be outlined in a letter in which case the writer will be advised promptly as to the suitability of the topic. We can also use short "filler" items outlining worthwhile shortcuts that have made your servicing chores easier. This magazine pays for articles on acceptance. Send all manuscripts or your letters of suggestion to the Editor, ELECTRONICS WORLD, One Park Avenue, New York City 16, New York.

TWO CONTESTS SCHEDULED

EMPIRE Scientific Corp. is sponsoring an exciting new contest whose first prize is a 21-day visit to the great music centers of Europe, August 10 through September 2, 1962.

The object of the contest is to arrange ten features of the Empire "Troubador" record playback system in order of importance. The order of respective importance has been determined by top-ranking music editors and critics who will act as judges for the contest.

Details of the contest are available from Empire dealers who also have the official entry forms. Entry envelopes must be postmarked no later than midnight, June 15, 1962. Winners will be notified by mail not later than 15 days after the close of the contest. If the winner has purchased one of the "Troubador" systems prior to the close of the contest, an additional prize of $500 "spending money" will be included.

* * *

BOGEN-PRESTO is sponsoring a "fish bowl" contest for its hi-fi and sound equipment dealers based on guessing the combined weight of two large fish and the models posing with the catch.

Eligibility to enter a guess is based on sales of any Bogen product, which entitles the salesman to a "fishing permit." Permits are "graded" according to dollar value of the item sold. The contest will end May 1st with the winner being announced at the Parts Show in Chicago on May 21-24.

At stake is almost $5000 in cash prizes plus a $5000 advertising budget and the services of a Madison Ave. advertising agency. ▲

Product Test Report

(Continued from page 20)

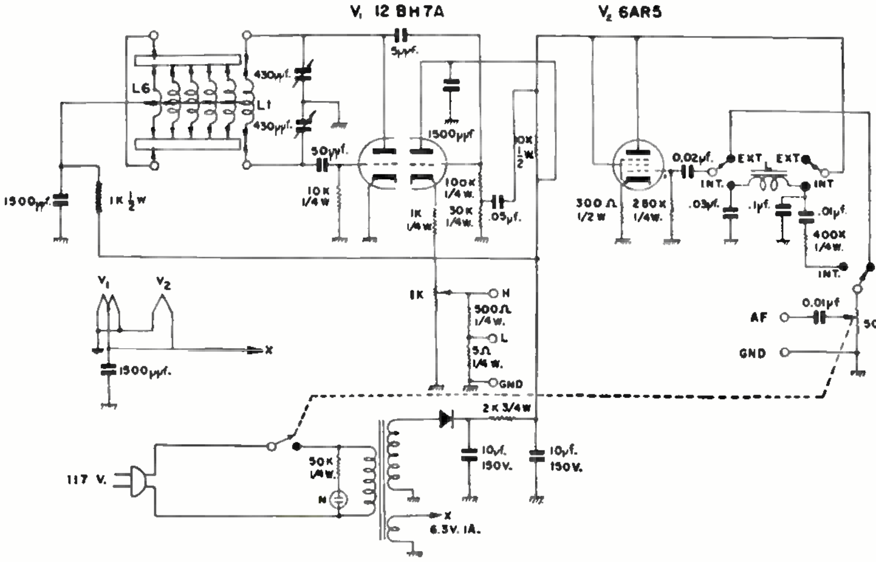
rately on output terminals of the instrument. External modulation may also be applied to the r.f. portion of the unit.

The circuit consists of a 12BH7A, a 6AR5, and a selenium rectifier. The first triode section of the 12BH7A serves as r.f. oscillator with six separate coils being switched in to provide the six frequency ranges. The output of this section is applied to the second triode section of this tube, which serves as the output cathode-follower. A two-step variable output attenuator allows a wide amplitude of output voltage to be applied to any receiver being checked. The 6AR5 is an audio oscillator whose output is applied to the cathode-follower for modulation as well as to a pair of output terminals through a variable-output control. A conventional transformer power supply, half-wave rectifier, and RC filtering supplies about 85 volts of "B+" to the circuits.

Our first test was a quick check of the audio output of the instrument. Loaded only by a scope, we measured 8 volts maximum output at a frequency of 350 cps. Although the waveform was not perfectly sinusoidal, it was certainly entirely suitable for signal injection in troubleshooting audio circuits. We then looked at the unmodulated r.f. output on the three lowest frequency ranges. Maximum signal amplitude was between ½ volt and somewhat over 1 volt, depending on range and frequency setting. Although our scope's frequency response did not permit us to check amplitude and waveform on the higher ranges, there was still plenty of output available for any alignment job. Evidence of this was the loud signals that could be picked up on communications, FM, and TV receivers from the signal generator. The r.f. output on the lowest frequency range was not sinusoidal, but this is not at all unusual for service-type generators and will in no way impair its usefulness for alignment and troubleshooting.

We then switched on the audio modulation and looked at the output signal with our scope. The negative half-cycles of audio were completely cut off while the positive half-cycles caused the r.f. signal to vary between zero and maximum and back to zero again at the audio rate of 350 cps. This large degree of modulation made it easy to hear and measure the audio signal during an alignment procedure.

Finally, we checked the frequency accuracy of the generator at several points on each of the six ranges. This was done by beating the output against broadcast, short-wave, and standard-frequency (WWV) signals of known and accurate frequencies. We found the calibration accuracy of all spot frequencies checked between +.3% and −2%, with most readings around the −1% value. These figures are certainly more than ade-



Circuit diagram of the signal generator. Tube V_1 serves as the r.f. oscillator and cathode-follower output, while tube V_2 is the audio oscillator/modulator stage.

If you've recently changed your address, or plan to in the near future, be sure to notify us at once. We'll make the necessary changes on your mailing plate, and see to it that your subscription continues without interruption. Right now—print the information requested in the spaces below and mail it to: ELECTRONICS WORLD, 434 So. Wabash Ave., Chicago 5, Illinois.

Name Please PRINT!

*Account No.

Old Address

City State

New Address

City Zone State

Mail copies to new address starting with__________issue.

***(Your Account Number appears directly above your name on the mailing label.)**

quate to do a good service alignment job.

As a purely personal preference, we would have liked to see trimmer adjustments on the six r.f. oscillator coils for future re-alignment of the generator should that ever prove necessary. But we must confess that after we have done such alignments on signal generators, we have never had occasion to re-align them even after tube replacement, except where very precise frequency readings were wanted.

All in all, the attractively styled and priced Lafayette TE-20 with its large, etched, circular tuning dial, is a useful addition to any service bench. .... E.W.

Answers to Puzzle Appearing on Page 69

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11TH ANNUAL SSB DINNER

THE SSB Amateur Radio Association will sponsor its eleventh Annual SSB Dinner and Hamfest on Tuesday, March 27 at the Hotel Statler-Hilton in New York City. All hams and their friends are invited. Equipment displays open at 10 a.m. and dinner starts at 7:30 p.m., hosted by Bill Leonard. Tickets are $10 each in advance or $11 at the door.

Checks for reservations should be sent to SSBARA, care of Stan Rosenberg, WA2GFV, 1385 Richmond Court, East Meadow, New York. ▲

S/Sgt. Harry W. Upton, a technician with less than three years military duty, is in charge of internal guidance repair for the Army's Lacrosse missile system at White Sands Missile Range, N.M. A graduate of the electronics school at Redstone Arsenal, the 26-year-old soldier expects to make the Army his career. His job ranges from writing technical reports to providing engineering support and countdown operations for the solid-propellant Lacrosse.

Within the Industry

S. GEORGE LAWSON has been named vice-president and general manager of the semiconductor division of *Sylvania Electric Products Inc.*, succeeding Dr. William J. Pietenpol who has joined *IBM* as manager of component development.

Mr. Lawson is located at headquarters of the division at Woburn, Mass. and will report to Frank J. Healy. He graduated from MIT in 1930 and has been a member of the organization since 1933. He has served in a number of manufacturing and engineering positions with the firm.

* * *

DR. ELMER W. ENGSTROM has been elected president of *Radio Corporation of America* succeeding **JOHN L. BURNS** who resigned . . . **ERNEST SEARING**, retired president and board chairman of *International Resistance Co.*, died recently at the age of 84 . . . **RUAL COGSWELL, JR.** has been named general operations manager of *Estey Electronics, Inc.* He was formerly associated with *Magnavox Co.* . . . **DOUGLAS R. MAURE**, chief engineer for *Telemetrics, Inc.*, has been named vice-president of the Los Angeles firm . . . *Vitro Engineering Company* has appointed **STANLEY K. HELLMAN** to the post of chief nuclear engineer . . . **HARVEY GOLD** has been named vice-president of *Sun Radio & Electronics Co.* and been given responsibility for interdepartmental coordination. He has been with the firm's industrial department for 12 years . . . **BERNARD A. COLER** has been appointed microwave products manager of *Eimac's* marketing division . . . **WILFRED L. GORRELL** is the new manager of plant operations and manufacturing for the *General Electric* cathode-ray tube department . . . **JAMES McLAUGHLIN** has been elected vice-president in charge of marketing at *Webcor, Inc.*

* * *

DR. JOSEPH A. BOYD has joined *Radiation Incorporated* as vice-president and assistant to the president of the Melbourne, Florida firm. He left his post as director of the Institute of Science and Technology at the University of Michigan to assume his new position.

He has also served as consultant for the Institute for Defense Analysis since 1956, consultant for the National Security Agency since 1957, special consultant to the Army Combat Surveillance Agency since 1958, and member and later chairman of the Advisory Group on Electronic Warfare, Office of the Director of Defense Research and Engineering since 1959.

* * *

AUDIO DEVICES, INC. has added a new research and engineering building and a pilot plant to its manufacturing facilities in Stamford, Conn. . . . **FILTORS, INC.** has broken ground for a new "factory of the future" in Huntington, Long Island. The automated plant is expected to be ready for occupancy this fall . . . **COLLINS RADIO COMPANY** will double the size of its present facility in Santa Ana, California upon completion of a 50,000-square-foot addition to its Components Division plant . . . **DURANT MANUFACTURING COMPANY**, industrial counting and measuring instrument maker, has moved into a new and larger plant in Watertown, Wisconsin . . . **MINNEAPOLIS-HONEYWELL REGULATOR COMPANY** has purchased the 146,000-square-foot **THOMPSON-RAMO-WOOLDRIDGE** plant in Denver, Colorado. The new building will be used as manufacturing headquarters for the combined operations of two divisions, the **HEILAND DIVISION** and the **INDUSTRIAL SYSTEMS DIVISION** of the company . . . **SHAFFSTALL EQUIPMENT, INC.** is now occupying its all-new factory building at 5149 East 65th Street, Indianapolis, Ind. . . . Construction has begun on a new laboratory wing for the **ASTRO-ELECTRONICS DIVISION** of **RADIO CORPORATION OF AMERICA** in Princeton, N.J.

* * *

JOHN J. IFFLAND has been elected president of *Acton Laboratories, Inc.*, a subsidiary of *Bowmar Instrument Corporation*.

He comes to his new post from *Raytheon Company* where he was responsible for the systems and design engineering of various missile system radars. Before that he was manager of the electronics section of *ITT Laboratories* at Fort Wayne, Ind. and had served on the research staffs at Harvard, Penn State, and University of Michigan.

* * *

RESEARCH-COTTRELL, INC. has formed an electronics division which will market the firm's custom designed high-voltage equipment to the electronics industry, including power supplies, transformers, control systems, and other special electronic equipment . . . A completely new communications department has been established at the **ALLEN B. DuMONT LABORATORIES** to coordinate and integrate the marketing and systems installations of the firm's two-way mobile radio and industrial TV departments . . . **GENERAL MECHATRONIC CORP.** has been established in Farmingdale, Long Island for the design, development, and construction of specialized machinery including marking devices, electronic heat-sealing equipment, and automatic capacitor crimping machines . . . **HUGH H. EBY COMPANY** of Philadelphia has been acquired by **R.E.D.M. CORPORATION**, Singac, New Jersey electronic manufacturer . . . **THE HALLICRAFTERS CO.** has joined forces with **COMPAGNIE GENERALE DE TELEGRAPHIE SANS FIL** of Paris to form **WARNECKE ELECTRON TUBES, INC.** which will be based in Chicago . . . **R.C.L. ELECTRONICS, INC.**, Riverside, N.J. has been purchased by two former executives of **THE DAVEN COMPANY**. It will produce a line of precision wirewound and power resistors . . . **INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION** has announced the establishment of the **ITT INDUSTRIAL LABORATORIES DIVISION** with headquarters in Fort Wayne, Ind. The new organization will be responsible for facilitating the technical development of the firm's industrial product lines.

* * *

HOLMES D. McLENDON, JR. has been named marketing manager for the commercial microwave department of *Motorola Inc.* He will have total responsibility for the marketing and sale of point-to-point radio communications equipment, systems, and services to governmental, utility, railroad, industrial, and business organizations. He also serves as chairman of the Microwave Section of the EIA.

He joined the firm in mid-1960 after serving *ITT* as manager of industrial products marketing. He has also been associated with *Borg Warner* and *RCA*.

* * *

DONALD G. POWER, chairman and chief executive officer of *General Telephone & Electronics Corp.*, was one of twelve executives who received "1961 American Success Story Awards" presented by the Free Enterprise Awards Association. The 10th Annual Awards were presented at the Savoy Hilton Hotel in New York City . . . **PETER WISH** has been named sales manager for *Recoton Corporation* . . . **JOHN M. MALONE** is the new general sales manager of *Tung-Sol Electric Inc.* He has been with the firm since 1954 . . . *Midwestern Instruments, Inc.* has appointed **BRUCE M. BROWN** to the newly created post of manager, product planning . . . **MILTON HALPERN** has been promoted to chief engineer, special projects, of *Instruments for Industry, Inc.* He was formerly associated with *Kollsman* and *Sperry* . . . **DR. I. MILTON LeBARON** has accepted a post with *Texas Instruments Incorporated's* research staff in Dallas . . . **B. CLETUS KIRCHNER** has joined the thyratron and rectifier division of *National Electronics, Inc.* as production manager. He was formerly associated with *RCA. Electronic, Inc.*, and *Cetron* . . . **HAROLD H. RAINIER,** distributor sales manager for *Sylvania Electric Products Inc.* since 1946, has retired after 35 years in the industry. A testimonial dinner was tendered him at the Summit Hotel by approximately 200 members of the electronics industry.

* * *

JAMES F. RILEY has been named sales manager of *Corning Electronic Components*, a department of *Corning Glass Works*. He had been field sales manager since November 1959. He succeeds C. C. Harwood who has been named manager of the Laboratory Glassware Department of the company.

Under Mr. Riley's management will be factory and distributor sales of electronic components, capacitor market development, reliability and military liaison programs, and advertising and sales promotion.

He has been with the firm since graduating from Lehigh in 1957. ▲

ANNUAL DINNER & HAMFEST

THE EAST Coast V.H.F. Society, Inc. will entertain members and their friends at its Fourth Annual Dinner and Hamfest which will be held Saturday, February 24th at the Swiss Chalet, located at Ramsey Circle, Route 17, Ramsey, N.J., starting at 7:00 p.m. sharp.

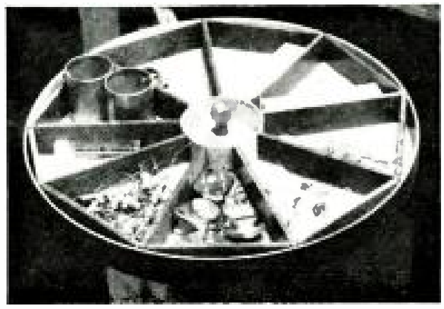
A diversified and entertaining program has been planned by the committee. In addition to the installation of new officers, there will be a presentation of awards, speakers of note, novel entertainment, prizes, etc., all topped off with a good dinner amid picturesque surroundings.

There are ample parking facilities at the Chalet, along with motel accommodations for out-of-town visitors.

If last year's attendance is any criterion, over 400 persons will be on hand for this annual event.

Any information required on this event can be obtained from Jack Tompkins, K2HHS, secretary of the East Coast V.H.F. Society, Inc., at 135 Herbert Terrace, Saddle Brook, New Jersey, or any other member of the sponsoring club. ▲

Tom Lamb, K8ERV, suggests that an old phono turntable can be turned into a handy rotary parts bin by adding cardboard, metal, or Masonite dividers as shown in the photo. A number of these could be stacked, if desired.



RCA Announces 2 NEW HOME TRAINING COURSES to Help You Build a Career in Electronics!

RCA Institutes has created two new home training courses designed to give you the very latest, up-to-the-minute training in the fastest-growing areas of this important field. With the addition of these courses, RCA Institutes now offers you the widest selection in its 53-year history!

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RCA Personal Instruction. With RCA Home Study training you set your own pace in keeping with your own ability, finances, and time. RCA Institutes allows you ample time to complete the course. Your lesson assignments are individually graded by technically trained personnel, and helpful comments are added where required. You get theory, experiment, and service practice beginning with the very first lesson. All lessons are profusely illustrated. You get a complete training package throughout the entire course.

You Get Prime Quality Equipment. All kits furnished with the course are complete in every respect, and the equipment is top grade. You keep all the equipment furnished to you for actual use on the job . . . and you never have to take apart one piece to build another.

RESIDENT SCHOOLS

in Los Angeles and New York City—You can study electronics in the city of your choice.

No Previous Technical Training Required For Admission. You Are Eligible Even If You Haven't Completed High School. RCA Institutes Resident Schools in Los Angeles and New York City offer training that will prepare you to work in rewarding positions on research and production projects in fields such as automation, transistors, communications, technical writing, television, computers, and other industrial and advanced electronics applications. If you did not complete high school, RCA will prepare you for such training with courses specially designed to provide the basic math and physics required for a career in electronics.

Free Placement Service. RCA Institutes graduates are now employed in important jobs at military installations such as Cape Canaveral, with important companies such as IBM, Bell Telephone Labs, General Electric, RCA, and in radio and TV stations all over the country. Many other graduates have opened their own businesses. A recent New York Resident School class had 92.06% of the graduates who used the FREE Placement Service accepted by important electronics companies . . . and had their jobs waiting for them on the day they graduated!

Coeducational Day and Evening Courses. Day and Evening Courses are available at Resident Schools in New York City and Los Angeles. You can prepare for a career in electronics while continuing your normal full-time or part-time employment. Regular classes start four times each year.

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In addition to RCA Institutes Inc. courses, Radio Corporation of America offers a limited selection of basic Resident School Courses in Electronics at three new locations . . . Chicago, Philadelphia, and Cherry Hill, N. J., (near Camden). For complete information, write the city of your preference next to your name on the attached postcard.

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SIMPLE VOLTAGE CONTROL CIRCUIT

Use of a high-gain silicon power transistor permits wide range of control as well as a regulated output.

IN laboratory experiments, electronic-circuit design, testing procedures, and other applications, a variable-voltage source of direct current is often needed. When batteries are used as a primary source of d.c. (for reasons of convenience, isolation from a.c. lines, complete freedom from ripple, or continuity of service), control of the output voltage becomes a problem. Power rheostats offer only limited resolution of adjustment and tend to drift in resistance as they heat up. Also, the output voltage is highly dependent on the load current drawn. A recent issue of *Westinghouse* "Tech Tips" describes an extremely simple voltage control, utilizing a *Westinghouse* WX118 high-gain silicon power transistor, which not only permits wide-range control of load voltage but regulates this output with changes in load current.

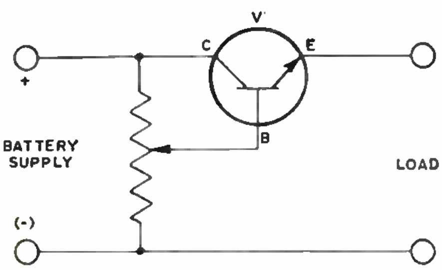


Fig. 1. Schematic diagram of the voltage-control circuit. With a supply voltage of 0-35 volts, use a 100-ohm 25-watt potentiometer and type WX118UA transistor; with a supply voltage of 36-75 volts, use a 500-ohm 25-watt potentiometer and type WX118UB transistor; with a supply voltage of 76-115 volts, use a 1000-ohm 25-watt potentiometer and type WX118UC transistor. Mount the transistor without insulation in the center of a 7" x 7" x 1/4" flat copper plate. Paint the plate with any matte enamel or lacquer finish except in the mounting area. Cover transistor mounting surface with silicone grease. Tighten transistor mounting nut to approximately 25 in.-lbs. torque.

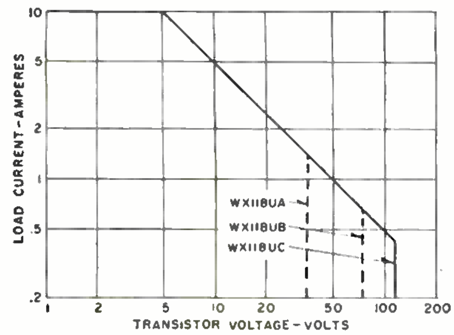
Fig. 1 shows the circuit for this voltage control. The transistor *V* in this control acts as a variable resistance in series with the voltage source. The effective resistance will depend on the setting of the potentiometer and the load current drawn. For all load currents up to rated value, the transistor regulates the load voltage to the same value (less a volt or so) as the voltage appearing between the potentiometer slider and the negative side of the supply. Thus, the load voltage may be varied smoothly from zero to full supply voltage merely by setting the control potentiometer for the desired value. The unusually high gain of the WX118 makes good regulation possible with a single transistor in the simple circuit shown.

In this circuit, the battery voltage may be any value up to about 75% of the WX118 voltage rating (the 25% margin should be used as a safety factor). Currents up to 10 amperes may be drawn provided the transistor dissipation does not exceed 50 watts. Fig. 2 shows the permissible maximum combinations of voltage and current.

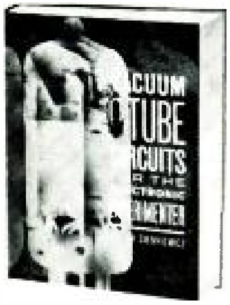
With any given fixed load resistance, maximum transistor dissipation is reached when load voltage and transistor voltage are each one-half of supply voltage. Load dissipation at this point is one-fourth of the load dissipation at maximum load voltage. Since the permissible transistor dissipation is 50 watts maximum, a load which will draw 200 watts at full voltage may be controlled from maximum voltage down to zero voltage without exceeding the allowable transistor dissipation. This assumes, of course, that the maximum supply voltage is no more than 75% of the transistor rating and that the load current does not exceed 10 amperes in this case.

It is important to remember that transistors have very limited thermal capacity and that they cannot be protected against excessive load currents or short circuits by fuses. Therefore, a reasonable amount of discretion in use is necessary to insure reliable operation. If the limits on supply voltage, load current, and transistor dissipation are observed, the unit should have an unlimited lifetime. ▲

Fig. 2. Voltage and current limits.



The most informative books for the experimenter and electronic hobbyist



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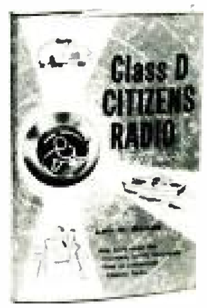
by Julian M. Sienkiewicz. At last in one book—all the basic diagrams, schematics, and other vital information on vacuum-tubes and their circuits. 192 pgs. 100 illus. **$4.95**



CLASS D CITIZENS RADIO *by Leo G. Sands*
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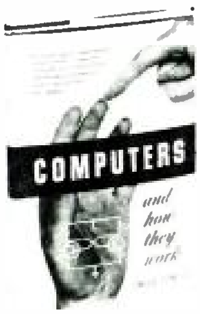

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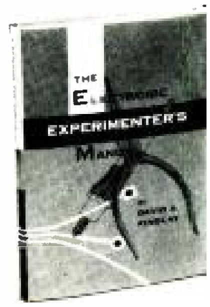

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Simple Recorder Repairs

(*Continued from page 39*)

which may be strong enough to create more noise and distortion than was present to begin with. It may also be so strong that it is hard to remove.

The Erase-Bias Section

Before new material is recorded on used tape, the old material must be removed. Thus tape passes over the erase head before it reaches the record head. Since recording on tape is magnetic, erasure, like head demagnetization, simply consists of applying an a.c. field to the tape, with the field dwindling as tape moves away from the erase head. A frequency above the audible range, usually 60 kc. or higher, is generated by the erase-bias oscillator for this purpose. The high frequency is chosen to avoid any interaction with audio frequencies, since the same signal also serves as an a.c. bias or "carrier" for material to be recorded.

As indicated in the block diagram of Fig. 8, the erase-bias section is only active during recording. Thus a defect in this circuit is indicated when faulty playback is observed only on newly recorded tapes but not on those that were recorded earlier or on tapes known to be good. If oscillator output is low, incomplete erasure will take place, and the old signal is heard through the new, weakly recorded sound. If the oscillator is dead, the new and old recordings will be comparable in level, with the former being noticeably distorted.

Most erase-bias troubles are due to weak or dead tubes, but some recorders provide adjustments that may need some manipulation. These are usually tuning slugs for oscillator coils that are adjusted for maximum output, measured with a v.t.v.m. at a specified point in the circuit. The portion of the erase-bias signal used as a "carrier" for the recorded signal seldom gives trouble in itself. If erase signal is present at the appropriate head, it is generally safe to assume that the bias portion of the circuit is also working.

In rare cases, the erase head (or one of the other heads) may become open. These coils may be checked with an

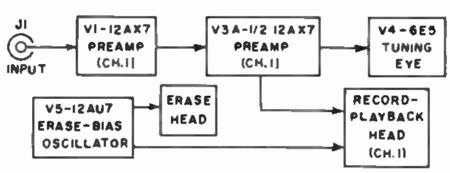


Fig. 8. Record block in Webcor's 2008.

ohmmeter, but a precaution should be observed. Since we are concerned with simple continuity or its absence rather than an absolute resistance value, a resistor should be used in series with the ohmmeter probe. This will keep coil current low from the ohmmeter's internal battery, avoiding excessive head magnetization due to the d.c. field developed in the coil. Head demagnetization after an ohmmeter check is a

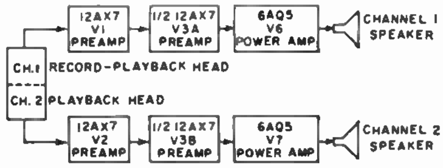


Fig. 9. Playback block in Webcor's 2008.

wise procedure to follow in any case.

The Audio Section

When a defective tape recorder comes into the service shop, many a technician tends to head for the audio section, because it is most familiar. But statistically speaking, aside from tube replacements, this portion is the least troublesome one in the instrument. Since it will be no more difficult to troubleshoot than any other audio amplifier, few suggestions are needed in this direction. However, it is not always so easy to determine definitely that an electronic failure is truly in the audio section rather than some other circuit. Accordingly, some localization procedures are in order:

1. Use the audio section as a conventional amplifier, driving it directly from a microphone, tuner, audio generator, or other sound source. The only elements in the playback chain not checked in this way are the playback head and the equalizing network. If a defect is still evident, conventional troubleshooting techniques are in order. If it sounds good, trouble is probably in the recording function.

2. Before moving to the record system, try playing a tape known to be good. A typical, two-channel, stereo playback system is shown in Fig. 9. If playback is now defective, trouble must be in the head or associated circuit, rather than the amplifier portion. Cleaning, alignment, and possible replacement are to be considered.

3. If playback is correct, move to the recording function. Try recording over a section of previously recorded tape. Play it back, listening for symptoms described earlier that will indicate trouble in the erase-bias section. If nothing is recorded, try recording on virgin tape. If this is successful, but sound output is weak, distorted, or both, trouble is still most likely in the erase-bias section. The recording function may definitely be considered the site of the defect only if a previously recorded tape is properly erased but nothing new can be recorded on it.

In the latter instance, the recording head is probably defective, if a separate one is used. Since other circuits have been checked in preceding steps, little aside from this head is left to suspect. If a combined record-playback head is used, only one portion of the head windings may be defective, or else the problem may be in a switch.

Conclusion

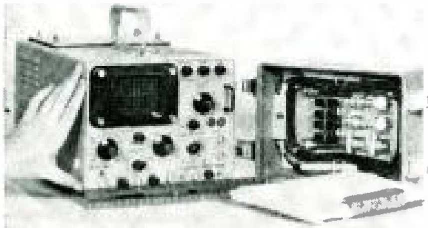
Although only major, universal troubles have been highlighted here, they account for all but a small portion of likely tape-recorder defects. The non-specialist relying on the described techniques can proceed with confidence. ▲

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 118.

TRANSISTORIZED SCOPE

1 **General Atronics Corporation** has received approval for its all-transistorized oscilloscope which meets military specifications. The unit, which weighs only 23 pounds and requires less



than 1/2 cubic foot of space, was developed for the Bureau of Ships.

The scope provides a 10 to 1 reduction in power consumption over conventional units, military approved performance, and reduced heat dissipation. Since it draws only 25 watts, it can be readily adapted for battery use with a converter. The standard high-gain vertical amplifier covers from d.c. to 5 mc. with calibrated scales to provide sensitivity up to 10 mv. per division. Horizontal sweep is calibrated to provide sweeps between .1 second and .1 μsec. per division.

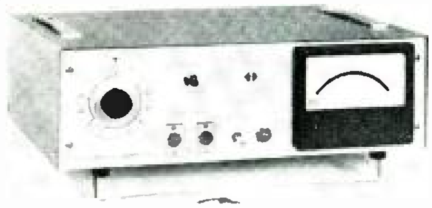
HIGH-CURRENT POWER SUPPLY

2 **Kidde Electronics Laboratories** is now offering an economical high-current power supply with adjustable output voltage for industrial and laboratory use. Designed for applications where close regulation is not required, the Model UPS-10A is especially useful in transistor circuit development work.

With input of 110 to 120 volts, 50-60 cps, the unit provides continuously adjustable output of 0-32 volts d.c. Ripple is .75% maximum at 15 amperes and internal impedance is low. Regulation is 16% maximum at 32 volts, 15 amperes at no load to full load.

DIRECT-READING MILLIOHMMETER

3 **Keithley Instruments** now offers a new line-operated milliohmmeter which is direct reading, requires no balancing, and exhibits no drift.



The Model 503 is suitable for either bench or rack mounting.

The instrument provides ranges from .001 ohm to 1000 ohms full-scale and accuracy of 1% full-scale of meter reading and .5% full-scale of output voltage.

POLARIZED RELAY

4 **Oak Manufacturing Co.** has introduced a new high-speed polarized relay, Type 510, designed for low-level switching and sampling in instrument, integrating, computer, and multiplexing operations.

Among the construction features are ceramic magnets and glass fused-to-metal for all internal insulation and contact supports. Magnetic properties of the ceramic magnet are not affected by temperatures as high as 150 degrees C.

Pull-in and drop-out time is 700 μsec. maximum and 150 μsec. minimum. Noise is at the low level of less than 100 μv. peak-to-peak into 1 megohm with preamplifier bandpass of 8-1000 cps.

D.C. VOLTAGE STANDARD

5 **Dynage, Inc.** is now in production on a solid-state d.c. voltage standard, the Model LVRL. It is designed as a replacement for laboratory-type unsaturated standard cells, is short-circuit proof, and is insensitive to vibration, position, or sudden changes in ambient temperature.

The "Volt-Ref" operates from 117 volt a.c. line voltage (105-129 volts, 60 cps) and provides output between 1.0180 and 1.0195 volts d.c. Initial voltage accuracy is ±0.001%. Stability is ±.01% for ±10% input voltage variation and 15-35 degrees C temperature range.

SMALL-SIZE ENCODER

6 **Norden Division of United Aircraft Corp.** is in production on a new Size 11 encoder which features small size, long life, and high conversion accuracy.

Conversion accuracy of ±27 minutes is guaranteed by the manufacturer. The new encoder specifies 256 counts per turn at temperatures ranging from minus 60 degrees to plus 180 degrees F.

TRANSISTOR-CIRCUIT CAPACITORS

7 **Sprague Products Company** is now marketing a specially selected assortment of its "Verti-Lytic" capacitors to technicians who work on transistorized equipment.

Known as the EK-5 assortment, the new package consists of 30 miniature single-ended electrolytics (two each of the 15 most frequently used ratings) in a compact case. Individually identified compartments keep each capacitor in place, permitting easy selection and removal.

INDUCTANCE BRIDGE

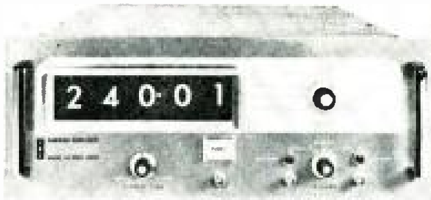
8 **Freed Transformer Company's** Instrument Division is now offering a new incremental inductance bridge, the Model #1110-C, for precision laboratory testing. Direct in-line readings of inductance and conductance of iron-core components at audio frequencies are possible with or without superimposed direct current.

The bridge uses the Owens circuit with provisions for measuring the series or parallel inductance and conductance of the unknown inductor; five precision resistance and capacitance decades are provided to indicate these values. "Q," or storage factor, can be measured as the product of the inductive reactance and the conductance.

COUNTER-TIMER

9 **Ransom Research Division of Wyle Laboratories** is now offering a new electronic frequency counter-timer, the Model 1197.

Designed for general laboratory or production-



line use, specifications on the new unit include a 250-kc. count rate; 5-digit, in-line projection display readout; .25 volt r.m.s. sine or square wave input sensitivity; crystal oscillator time base; 100-kc. clock output; external clock input; .1, 1, and 10-second frequency time gates; and 1, 10, and 100-cycle period sample times.

SMALL TORQUE MOTOR

10 **Beau Electronics, Inc.** is in production on a small torque motor which is designed to operate at a constant tension without vibration, shimmy, or cogging.

Able to stall under continuous duty conditions without burning up, the Type 1001 a.c. motor offers a high constant torque with low power input due to its unique inside-out construction. With an efficiency factor of 2.1 watts per ounce inch, the new noiseless device offers 12 ounce/inches of torque with a power input of 25 watts max.

INDUSTRIAL MULTITESTER

11 **Westmore Inc.** is marketing an industrial multitester, the Model 960, which provides a safe means of checking low-order resistance of transistors in addition to standard multimeter functions.

The instrument reads to 750 volts a.c. in six ranges ±3%; d.c. in six ranges to 750 volts ±2%; and d.c. current in five ranges to 1500 ma. ±2%. Accessories consists of a high-voltage probe and a range-extension multiplier. Self-calibration is an optional feature, available at slight extra cost.

VACUUM INDICATOR TRIODE

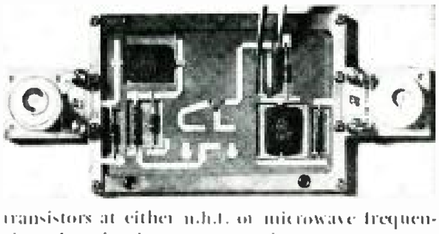
12 **Tung-Sol Electric Inc.** has announced a new subminiature high-vacuum triode with a fluorescent anode designed especially for transistor circuits where its high input impedance will not load the transistors and its small drive requirements are suited to transistor circuit voltages. The Type 6977 can be used to replace indicators such as neon lamps in electronic computers and data processing systems.

Light output area of the indicator triode is in the center of the tube envelope and is approximately .4 inch long and .060 inch wide. The 6977 can be operated from an a.c. or d.c. supply and draws .03 ampere of heater current at 1 volt.

TRANSISTOR CIRCUIT-MOUNT

13 The Microwave Products Department of **Sanders Associates, Inc.** has announced the availability of a new universal transistor circuit-mount in "Tri-Plate" strip transmission line.

Designed for the evaluation of high-frequency



transistors at either u.h.f. or microwave frequencies, the circuit-mount permits accurate measurement of cut-off frequencies, rise time, and other critical circuit parameters. The single module can be used to breadboard almost all grounded-emitter or grounded-base circuits.

NEW TUBE TESTER

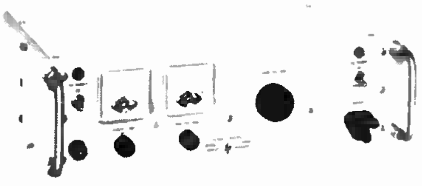
14 **Seco Electronics, Inc.** is offering a completely new tube tester which includes all sockets for the newest tubes. The circuitry incorporates the firm's grid-circuit test as well as a merit test. All information is displayed on a single meter.

The panel includes 86 sockets which are wired through a selector switch and load system. This system extends tube-type coverage by at least four times, with over 2200 types listed. Primarily intended as a portable unit for service calls, the tester can also be used as a bench instrument.

D.C. POWER SUPPLY

15 **Hewlett-Packard Company** has announced the availability of a new d.c. power supply capable of remote programming, remote sensing, and output-current limiting.

The solid-state power supply, Model 726AR,



provides a full 2-amp current capacity and a regulated output of 0 to 15 volts. The output voltage changes less than 2.5 mv. for 10% line-voltage variation and less than 5 mv. when the output current changes anywhere from 0 to 2 amps.

SATURABLE CORE TRANSDUCER

16 **Westinghouse Electric Corporation** has announced the availability of a static saturable core transducer for measuring alternating current or voltage.

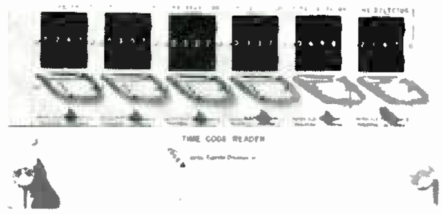
Known as the "Teleductor," output is 0 to 3 ma. d.c. into any load up to 15,000 ohms. The d.c. output is directly proportional to the a.c. input over a wide range of load resistance and temperature. Accuracy is ±1% of full scale with wide variations in output loading or ambient temperatures.

The unit measures 4¼"x 3⅛"x 2¼" and weighs approximately 1 pound.

TIME-CODE READER

17 **United ElectroDynamics, Inc.** is currently offering a new time-code reader which decodes serial IRIG time code for operation of time selectors to provide precise automatic programming of instrumentation and control systems.

A typical on-line application would be automatic control of a test sequence. When used with played-back tape signals, the unit may be used



for automatic editing and programming of data-processing sequences. The selectors may be preset to activate any given function with an accuracy of better than one millisecond. Resolution and range of times selected can be provided to meet specific requirements.

TRANSIENT VOLTAGE DETECTOR

18 **Halmar Electronic Products Company, Ltd.** is in production on an all-solid-state portable transient detection and measurement instrument that has three ranges of 100, 1000, and 10,000 volts. A direct-reading dial and built-in self-calibration and test features eliminate the need for calibration reference charts.

Accuracy is ± 1% for transients to 1 μsec. rise time, down to d.c. Relay output and automatic reset allows external control, indication, and recording on repetitive transient events.

OSCILLOGRAPHIC RECORDER

19 **Sanborn Company's** Industrial Division has developed a single-channel oscillographic recorder with a transistorized phase-sensitive demodulator amplifier and power supply which is useful for testing servo-systems and components.

The Model 302 amplifies and records a difference signal that results from comparing an a.c. error signal with an externally supplied 25-125 volt r.m.s. reference signal. The heated stylus recording unit gives immediate read-out via permanent, inkless traces on 10-division rectangular-coordinate charts.

The complete Model 302 system is housed in a compact, rugged 7"x 10½"x 12" carrying case.

SOLID-STATE SWITCH & RELAY

20 **El-Tek Components Division** is now in production on a new series of solid-state switches and relays which conform to MIL specifications.

Single-pole, single-throw units rated at 1 and 5 amps are available. Both units operate from 28 volts d.c. or a.c. to 1000 cps source which is completely isolated from contacts.

The company is also prepared to offer custom designs with rating to 200-ampere multi-pole a.c. or d.c. output.

LABORATORY POTENTIOMETER

21 **Central Scientific Company** is now offering a low-cost, compact laboratory potentiometer covering a broad field in which the potentiometer method is applicable. The new unit is suitable

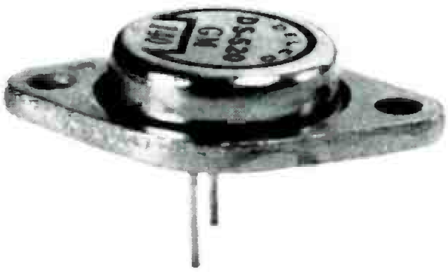
for the calibration of meters, checking standard cells and standard resistances, and measuring temperature by thermocouples.

A printed-circuit switch controls fifteen 10-ohm resistors for maintaining a constant potentiometer current for all positions. A ratio-multiplier switch gives the potentiometer three full-scale ranges: 0-1.6 volts, 0-.16 volt, and 0-.016 volt. The unit weighs six pounds and measures 8½"x12"x 5½".

NEW POWER TRANSISTOR

22 **Delco Radio Division** has recently introduced its DS520 power transistor which is especially suited to replacement applications in auto radio output stages.

The new component has a power rating of 60



watts at 25 degrees C and a collector diode voltage minimum rating of 40 volts. According to the company, it can be used to replace many of the power transistors used in car radios.

SILICON SWITCH

23 **General Electric Company's** Rectifier Components Department has developed a subminiature light-activated "p-n-p-n" silicon switch capable of handling large amounts of power.

Known as the ZJ235, the new device is now available in five voltage grades for sampling purposes. The unit can switch up to 160 watts of load power on a continuous basis or up to 2 kw. for one cycle. The housing is .30 inch long with a diameter of .25 inch and weight of .25 gram. A momentary impulse of light between 80 and 500 footcandles in intensity is sufficient to trigger the device into conduction.

TRANSISTOR CHOPPER

24 **Airpax Electronics, Inc.'s** Cambridge Division is introducing a miniature transistor chopper with a noise level of only 35 microvolts.

Operating on a new principle, the Type 7000 provides isolation between drive and signal circuits with precise switching action. No drive transformer is used, permitting operation from d.c. as well as square waves or pulses. Typically, the unit driven at 400 cps has a noise level of 35 μv. working into a 10,000-ohm load.

Applications include d.c. amplifier stabilization, low-level switching and commutating, modulator circuitry, and servo systems.

MICROMINIATURE TRIMMER

25 **Miniature Electronic Components Corp.** has added another unit to its ¼"-diameter line of microminiature trimmer pots.

Mounting by means of a threaded bushing, the Model MS-7 is especially designed for panel applications where microminiature size and extreme environmental performance are desired. Specifications include standard resistance values from 100 to 10,000 ohms, ¼-watt dissipation, .03 ounce weight, and "Teflon" insulated leads. The housing is anodized aluminum.

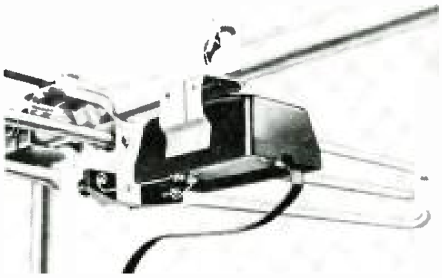
25-VOLT CERAMIC CAPACITORS

26 **Cornell-Dubilier Electronics** is offering capacitance values 50 to 100 times greater than standard ceramic units in its new 25-volt Type HCC "TinyMIKE" capacitor line. The new series features economy, small size, plus good durability and stability characteristics.

The new line is available in four nominal ratings: .01, .05, .10, and .22 μf. with capacitance tolerance of +80 and −20%. Minimum leakage resistance at +25 degrees C will exceed 50 megohms at 5 volts and 2 megohms at 25 volts. The units are especially suited for low-voltage applications in transistor circuitry.

TRANSISTORIZED ANTENNA BOOSTER

27 **Winegard Company** has added a transistorized booster to its line of TV antenna accessories. Designated as the "Tenna Boost" Model MA-300 amplifier, the new unit will fit any antenna and has a rated gain up to 19 db for both TV and FM. A 3-way mount permits mounting on antenna, wall, or mast. The power supply is all a.c., completely shockproof, and is equipped with a local-distant and polarity switch, an a.c. outlet, and a built-in two-set coupler.



SILICON-CONTROLLED RECTIFIERS

28 **Semicon Inc.** is introducing a line of silicon-controlled rectifiers up to 600 volts, designed for use in power control and high current switching applications requiring blocking voltages up to 600 volts. The units are applicable for load currents up to 5 amperes.

Among the features incorporated into the device are a long leakage path that eliminates voltage breakdown between terminal and case, triple-diffused silicon pellet for maximum uniformity and reliability, all-welded construction, and integral terminal-lug construction.

CLOSED-CIRCUIT TV CAMERA

29 **Sylvania Electric Products Inc.** has developed a new closed-circuit television camera designed to operate with either home-type r.f. receivers or special industrial video receivers, thereby offering greater flexibility in use.

The Model V-400 includes electronic self-adjustment to lighting conditions, rugged chassis mounting for protection against shock damage, and turret mounting designed to accommodate normal, wide-angle, and telephoto lenses. The camera measures 7" wide, 12" long, and 6" high.

MINIATURE RELAY

30 **Line Electric Company** has developed a new miniature telephone-type relay which is applicable to a wide variety of uses including communications, computers, programmers, and controls of many sorts.

The Series GF relay incorporates a standard stack insulation which is made from a high grade of phenolic to permit continuous duty at 85 degrees C. The new series is available in a variety of styles: open, dust cover, and hermetically sealed.

TRANSIENT-VOLTAGE SUPPRESSORS

31 **Sarkes Tarzian, Inc.** is now offering a complete line of selenium transient-voltage suppressors. Designated "Klipvolt," these units will reduce transient voltages generated by motors, relays, and swiches. Instantaneous voltage overloads cause silicon rectifier failures, so use of the suppressors will increase reliability.

The suppressors are available in polarized designs for use in d.c. applications and non-polarized designs for suppression of transients in a.c. circuits.

GERMANIUM POWER TRANSISTORS

32 **Kearfott Semiconductor** has entered the field of "p-n-p" germanium power transistors by offering 2N156, 2N158, and 2N158A units in TO-13 welded packages in accordance with new EIA requirements. These devices are electrically interchangeable with the original heavier and larger MM3 package.

HI-FI—AUDIO PRODUCTS

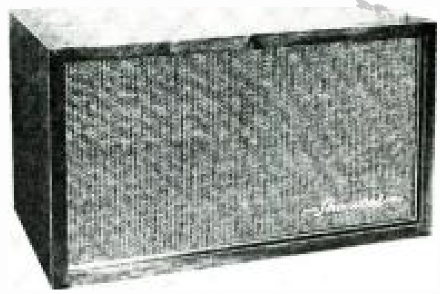
TUNERS FOR FM STEREO

33 **F. W. Sickles Division** is now in production on two new low-cost, miniaturized FM radio tuners designed for FM and combination AM-FM sets and particularly for the new stereo multiplex sets.

The Models 310 and 311 are stable and feature a single tube; compact, rugged construction; gang condenser; and linear frequency coverage from 87.5 to 108.5 mc. nominal. The tuners are available with the tuning shaft at either end. The Model 311 is also available with a.f.c.

THREE-WAY BOOKSHELF SPEAKER

34 **Sherwood Electronic Laboratories, Inc.** is now offering a medium-priced, three-speaker, three-way bookshelf speaker system which is being marketed as the "Ravinia."



The new unit provides smooth response from 45 to 17,500 cps ± 2 db and is essentially flat to 19,000 cps. The system consist of a 12" high compliance woofer, an 8" cone midrange speaker with sealed fiber glass fill backplate, and a 2½" ring radiator super tweeter, also with sealed fiber glass fill backplate. Crossover points are 600 and 3500 cps with 12 db octave attenuation. Level controls are provided for optimum midrange and tweeter balance under all room conditions.

Dimensions are 26¼" x 15" x 13¼". A number of different cabinet finishes are being offered by the manufacturer.

NEW AMPLIFIER TUBES

35 **Amperex Electronic Corporation** has announced availability of the type ECL86 6GW8, a triode-pentode for preamplifiers and power output stages in stereo hi-fi amplifiers.

Especially suited for low-cost stereo, only two of these tubes are needed for a complete two-channel stereo system, with each tube providing 4 watts audio output, class A, per channel. Using only two tubes per channel, or a total of four for a complete higher power low-distortion 3% stereo system, each two tubes will provide 12 watts output class AB push-pull. The triode portion of the ECL86 is equal to one section of a 12AX7 while the pentode portion has a plate dissipation rating of 9 watts and a transconductance of 10,000 μmhos.

RANDOM NOISE INSTRUMENTS

36 **Solitron Devices, Inc.** has introduced two new random noise instruments for checking and evaluating high-fidelity audio systems and acoustical factors without use of auxiliary instruments and featuring the new solid-state "Sonistor" white noise diode.

The Model SA-1 is a random noise analyzer while the Model SA-2 is a random noise amplifier. Both instruments provide a low-level source of white noise of uniform amplitude distribution from 20 to 20,000 cps ± 3 db. In both units considerable output is available above and below these limits. Power is provided by self-contained replaceable mercury batteries.

FM STEREO SIGNAL GENERATOR

37 **Calbest Electronics** is now offering a compact and accurate FM stereo signal generator designed for laboratory use, production testing, and field adjustment of FM stereo adapters and receivers.

The Model MX-625-SG provides composite, stereo, composite stereo modulated r.f. signal, R — L, R — L, or 19-kc. crystal-controlled pilot carrier output signals while an internal FM r.f. signal generator permits complete stereo testing of FM stereo receivers or FM tuners and stereo adapters. Percentage of modulation is read on an indicator meter.

The generator operates from 117-volt, 60-cycle a.c. It measures 11½" high, 15" long, and 7" deep.

AMPLIFIED FM ANTENNAS

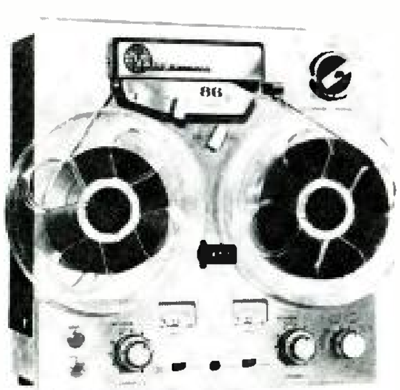
38 **Winegard Company** has added two new amplified FM antennas to its line to meet the requirements of the fringe-area FM listener and those interested in FM multiplex reception.

The PF-8 "Stereo-Tron" yagi is gold anodized and has a minimum gain of 26 db over a folded dipole. It has a flat frequency response of ± ½ db from 88 to 108 mc. It features a built-in TV-FM coupler and has eight elements with a driven element directly coupled to the transistor amplifier.

The PF-1 is also gold anodized and is nondirectional with 16 db gain in all directions over a folded dipole. It has a 300-ohm output.

STEREO TAPE RECORDER

39 **Viking of Minneapolis, Inc.** is now offering its Model 86 "Stereo-Compact" tape recorder which incorporates new recording and playback electronics giving it a range of 25-18,000 cps, plus a special heterodyne filter designed to permit distortion-free FM multiplex recordings.



While the tape transport mechanism is the same as in the previous version of this model, this new unit has completely new electronics and a brushed aluminum faceplate, edged in gold, with head cover and controls accented in black. Three models are currently available: the ERQ half-track stereo or mono recording with half- or quarter-track stereo or mono playback; RMQ quarter-track recording, stereo or mono and quarter- or half-track playback, stereo or mono; and ESM half-track only recording and playback, stereo or mono.

NEW COLUMN SPEAKERS

40 **Atlas Sound Corporation** has added a new line of sound columns as the "Columnair." The units enclose a vertical stack of six adjusted-range cone speakers that produce a fan-shaped, broad horizontal, narrow vertical pattern which effectively covers areas where adverse conditions of reverberation and acoustic feedback exists.

Currently two models are available: a 20 watt unit measuring 5"x5"x28" and a 40-watt model measuring 8"x6"x12". Units may be rear, side, or corner mounted, using an all-purpose bracket supplied with the enclosure. The enclosure itself is of heavy gauge steel, lined with "Fullflex" acoustic padding to prevent resonance.

MANUFACTURERS' LITERATURE

SEMICONDUCTOR CATALOGUE

41 **International Rectifier Corporation** has issued an up-to-date 24-page catalogue which lists over 2550 semiconductor devices including glass zener diodes, silicon controlled rectifiers and SCR triggers, silicon small power, medium power, high power and super power rectifiers, and zener reference elements.

Ratings, characteristics, and descriptive data on these and many other devices are covered in a condensed tabular format. Also included is a comprehensive listing of JEDEC rectifier types, with a cross reference to device classification, rating, and page number.

DIELECTRIC MATERIALS

42 **Emerson & Cuming, Inc.** has issued a condensed catalogue covering an extensive line of anechoic chambers, casting resins, plastic and ceramic foams, plastic rods and sheets, plastic surface coatings, adhesives, cements, sealants, impregnating resins, ceramic dielectrics, shieldings, etc.

Pertinent specifications are provided on each product grouping with additional technical information available from the manufacturer on request.

INSTRUMENT RECORDERS

43 **Amprobe Instrument Corporation** is offering a four-page data sheet providing details on its new precision recording instrument which features small size, light weight, and low cost. The new recorder is being offered in several versions for use as a voltmeter, ammeter, or temperature recorder. Applications are illustrated and technical specifications supplied on all 8 versions of the instrument.

RECTIFIER DATA

44 **Semicon, Inc.** has issued Bulletin No. S-105 which provides complete details on its silicon control rectifiers. The brochure includes graphs and charts illustrating maximum allowable ratings, electrical charcteristics, reliability specifications, quality assurance provisions, V-I characteristics, acceptance requirements, mechanical data, and suggested applications.

INSTRUMENTS HANDBOOK

45 **Forster/Hoover Electronics, Inc.** has just published a 12-page, fully illustrated electronic instruments handbook which provides complete data on a line of equipment for use in the fields of nondestructive testing, magnetic field measurement, material research, and dimension measurement.

SPECTROFLUOROMETER DATA

46 **Farrand Optical Co., Inc.** has prepared a new brochure covering the features and operation of its improved "Spectrofluorometer." Among the improvements is a new attachment which permits the measurement of transmission or absorption of the sample.

INDUSTRIAL ANALYZERS

47 **Weston Instruments Division** has issued a 4-page bulletin discussing the features and specifications on four models of circuit analyzing instruments made by the firm.

The testers, all designed as portable instruments, are completely described. Specifications include data on accuracy of various models in all ranges, applications, and available accessories. The bulletin has been designated No. 06-207.

PRINTED CIRCUIT KITS

48 **Micro-Circuits Company** has released an 8-page catalogue covering its entire line of research kits and electrically conductive coatings. The publication contains descriptions and complete price schedules on three research and development kits and on a wide range of silver paints, special-purpose electronic shielding paints, aircraft anti-static paints, and resistor paints covering the resistance range from below .01 ohm per square to 10,000 megohms per square.

POWER-SUPPLY MODULES

49 **Trio Laboratories, Inc.** has issued an 8-page, 2-color illustrated catalogue describing its new line of "Custom Power" prefabricated, regulated power-supply modules designed to provide, in a wide variety of combinations, power supplies to custom specifications, assembled from off-the-shelf units.

Ten basic modular "building blocks" are included in the line and described in detail in this new publication.

FLEXIBLE PRINTED CIRCUITRY

50 **Garlock Electronic Products** has released an 8-page engineering manual entitled "Flexible Printed Circuitry with Teflon F.E.P." The bulletin discusses in detail the three basic components of the company's process—the insulator, the conductor, and the circuit. Complete technical data on the standard insulating material, conductor materials, relationship of conductor widths, weight, and resistance, insulator thickness, terminations, and tolerances are included.

PROFESSIONAL TEST EQUIPMENT

51 **B&K Manufacturing Co.** has issued its general catalogue No. AP18 which covers a complete line of test equipment for the professional technician. Included are electrical and mechanical specs on an extensive assortment of tube testers, v.o.m.'s, v.t.v.m.'s, circuit analyzers, signal tracers, etc.

SERVO-AMPLIFIER DATA

52 **M. ten Bosch, Inc.** has issued a handy pocket-sized brochure on its new "Tramp" amplifiers and auxiliary components. The publication describes these servo-amplifiers in detail and outlines applications for such devices. Auxiliary devices, such as a surge limiter, regulated power supplies, demodulators, and miniature transformers are also described.

U.H.F. PREAMPS

53 **Community Engineering Corporation** is offering a 4-page, 2-color bulletin describing its new line of u.h.f. ultra-low-noise preamplifiers for single-channel reception from channels 14 through 83. General specifications and particular model specifications for each of the six models in the line are included in the bulletin.

VOLTAGE REGULATORS

54 **Electric Regulator Corporation** is now offering a four-page condensed catalogue covering its "Regohm" voltage regulators. In addition to information on functions, features, output voltage levels, specifications, and comparative data there is a table providing full electrical and mechanical specifications plus prices.

COPPER-CLAD LAMINATES

55 **Synthane Corporation** has issued a new brochure listing all grades of its copper-clad laminated plastics corresponding to NEMA and MIL specs. Outstanding characteristics of each grade are described and typical property values listed. The brochure also discusses bonding of metal foils to laminates, and quality control checks employed on all copper-clad materials.

DELCO SPEAKER SYSTEM

56 **Delco Radio** has issued a single-page data sheet covering its No. 6868 two-way speaker system. Included is information on the 12" woofer, the 2"x 6" tweeter, and the crossover network used with the system. A recommended hookup diagram is included. ▲

HANDY FLASHLIGHT PROP

By GLEN F. STILLWELL

WHEN working behind a TV or radio console, in a dark corner, or under an instrument panel, a flashlight is generally used to light the work. To prop up such a light so that its beam can be directed onto the work, a piece of corrugated cardboard (available anywhere) can be used.

Simply cut a hole the size of the flashlight barrel in the top side of the sheet of cardboard. Insert the flashlight and this will prop it up in the exact position desired, leaving both hands free to make any adjustment necessary. ▲

Citizens Radio Service License Serial Numbers

IN THE Citizens Radio Service, the registered serial number appearing on each station license document is required by the Federal Communications Commission's rules to be used also as the radio station call-sign. In the past these serial numbers have been made up of an arbitrary arrangement of one or two digits, one or two call-letters, followed by a four-digit serial number. Because these serial number—call signs bear no resemblance to call signs issued in accordance with international agreement, it has been decided that all future serial numbers of CB stations will be taken from the international call-sign series available for assignment to stations of the U.S. However, currently licensed stations will continue to use the call-serial numbers issued to them from the old series until such time as each license is renewed, modified, or superseded. Licenses will not be modified solely for the purpose of changing the call-sign.

Effective July 1, 1961 for class A stations and January 1, 1962 for class B, C, and D stations, the call-signs (serial numbers) assigned to stations licensed in the Citizens Radio Service consist of three letters followed by four digits. As before, the digits will be assigned in numerical order from 0001 to 9999 following each three-letter prefix. Examples of such complete call signs are KCB-1526 and KQP-2345.

The first letter of each prefix in the call sign-serial numbers will be the letter "K" to indicate that the station is licensed by the United States. The two letters which follow will have various uses for record and enforcement purposes of the Commission, and may indicate the class of station involved (class A, B, C, or D), the approximate date of issuance of the license, and the Radio Inspection District in which the licensee has his mailing address. Serial numbers beginning with KAA through KAF will be assigned in sequence to class A stations and may be re-assigned to the same stations, indefinitely, upon proper application for renewal or modification. This call-sign continuity, however, will not be possible in the case of class B, C, or D stations, where the large number of applications and licenses has forced the Commission to adopt streamlined administrative procedures in order to handle the workload.

During the calendar year 1962, all class B station license serial numbers will be identified by the prefix KAG, all class C by the prefix KAH, and class D stations in the various Radio Inspection Districts by prefixes KBA through KJE. ▲

SIGNAL CORPS MEASURES GLACIER BY RADIO SOUNDING

A RADIO-sounding technique being developed by the U.S. Army Signal Corps to plumb polar ice has been successfully used to measure the depth of a massive glacier, 20 miles south of Ellsmere Island in northern Canada.

The radio-sounding method entails measuring the fraction of a second it takes for signals to penetrate icy depths and return to a receiver after reflecting off the underlying soil, rock, or water. The velocity though the ice is about half the 186,000 miles-per-second at which radio waves travel through the atmosphere. The speed of the new method makes it especially promising for obtaining a better picture of the geographic features hidden by the ice in vast stretches of the antarctic.

The work was done by Amory H. Waite, Jr., a veteran engineer explorer of the U.S. Army Signal Research and Development Laboratory, who pioneered radio sounding of ice, along with Dr. Gernot M. R. Winkler and Stanley J. Schmidt, of the Labs. ▲

USSR TECHNICAL GRADUATES TOPS U.S. BY 200-300%

A MAJOR analysis of Soviet education published recently by the National Science Foundation indicates that the Soviet Union is producing two to three times as many scientific and technical professional graduates yearly as is the United States.

In addition, Soviet production of science and engineering professionals is seen as accelerating throughout the 1960's, reflecting the total Soviet commitment to developing science and technology as economic and political weapons of the state.

The extent of the orientation in Soviet higher education toward science and technology is measured by the fact that about 57 per-cent of all 1959 graduates at the bachelor degree level were in engineering, sciences, and selected applied science fields, compared with 24 per-cent in the U.S.

The professional instruction provided these graduates, although extensive in fundamentals of sciences and engineering, was found to be directed toward narrowly defined specialties with the main purpose of equipping the individual student to perform a specific task.

It was also noted that support of education is strong, and upwards of five per-cent of the gross national product is currently spent by the Soviet Union on education (as compared with about 3.6 per cent in the United States).

With only half as many higher education graduates as the U.S., the Soviet Union has a greater number of professionals in scientific, engineering, and other applied science fields, and the Soviet rate of growth in these fields is more than twice that of the United States. While we produce about 90,000 engineering, science, and applied science professionals each year, the Soviet Union's production is currently 190,000 annually. Projections indicate that during the decade of the 1960's the Soviet rate will reach 250,000 annually.

The study also evaluated the quality of Soviet higher education and concluded that although qualitative variation in the Soviet effort is substantial, Soviet professional higher education in most scientific and engineering fields is at least equivalent to, and sometimes more extensive than in United States or West European institutions of higher learning. To develop high competence and to select students for professional training, early exposure to the sciences and mathematics in Soviet secondary schools is mandatory. One-third of the curriculum is devoted to these subjects. ▲

LORAN APN-4
FINE QUALITY NAVIGATIONAL EQUIPMENT

Determines exact geographic position of your boat or plane. Indicator and receiver complete with all tubes and crystal.

INDICATOR ID-6B APN-4, and RECEIVER R-9B APN-4, complete with tubes. Exc. used **$49.50**

Receiver-Indicator as above. BRAND NEW **$88.50**

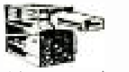
INVERTER POWER SUPPLY for Loran. Made by Eclipse—Pioneer Div. INPUT: 24 V DC @ 7.5 A. OUTPUT: 115 V AC @ 10.5 Amps. 800 cycles. Complete with two connecting plugs. BRAND NEW $49.50

12-Volt Inverter Power Supply, Like New .... P.U.R.
Shock Mount for above $2.95
We carry a complete line of spare parts for above.

LORAN APN/4 OSCILLOSCOPE

Easily converted for use on radio-TV service bench.
LIKE NEW! Supplied with 5" Scope, type 5CPI only **$14.50**

LORAN R-65/APN-9 RECEIVER & INDICATOR



Used in ships and aircraft. Determines position by radio signals from known xmitters. Accurate to within 1% of distance. Complete with tubes and crystal. Exc. used.
Value $1200.00. Our Price **$79.50**
Used, less tubes, crystal and visor, but with 3BP1 C.R. tube $29.50

INVERTER POWER SUPPLY. INPUT: 24 V DC. OUTPUT: 115 V AC. BRAND NEW $49.50

12-Volt Inverter Power Supply, Like New .... P.U.R.
Shock Mount for above $2.95
Circuit diagram and connecting plugs available.
We carry a complete line of spare parts for above.

BC-433 RADIO COMPASS RECEIVER

200 to 1750 Kc in 3 bands. 28 V DC power supply required. Complete with 15 tubes. BRAND NEW **$21.50**

ASB-5 'SCOPE INDICATOR

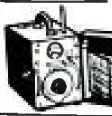
BRAND NEW, including all tubes, **together with 5BP1 'Scope Tube.** Originally used in Navy Aircraft RADAR equipment. Easily converted for AC operation.
VALUE $250.00!
OUR LOW PRICE **$15.95**

APN-1 FM TRANSMITTER-RECEIVER

420 to 460 Mc Aircraft Radio altimeter equipment. Tubes: 4-955, 3-12SJ7, 4-12SH7, 2-12H6, 1-VR150; Complete with tubes, brand new **$9.95**
APN-1 exc. Used $6.95

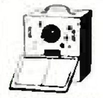
ARN-5-C AIRBORNE Equipment, to give vertical guidance during landings. 11 tube superhet circuit. Tubes: 2807, 12SR7, 2-12SN7, 7-6AJ5. Crystal Controlled on 6 channels. Like new $12.95

BC-906 FREQ. METER—SPECIAL



Cavity type, 145 to 235 Mc. BRAND NEW, complete with antenna. Manual and original calibration charts included.
OUR LOW PRICE **$10.88**

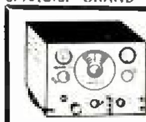
BC-221 FREQUENCY METER



SPECIAL BUY! This excellent frequency standard is equipped with original calibration charts, and has ranges from 125 Kc to 20,000 Kc with crystal check points in all ranges. Excel. Used with original Calibration Book, Crystal, and all tables—LIKE NEW!
Unmodulated .... **$72.50** Modulated **$99.50**
RA-133 original A.C. power supply made for govt. For use with BC-221. Wired and tested **$18.95**

BC-638A FREQUENCY METER 100-156 Mc. Xtal controlled. Rack mounting. For 110V AC operation. Less crystals. BRAND NEW **$29.50**

TS-16 APN TEST SET



For aligning and calibration of radio altimeters. May be used to check calibration of count or circuits and modulator sweep freq. and bandwidth of transmitter. Audio oscillator range: 340 to 7250 cycles. 13/14 V.DC input. Complete with tubes, connecting cables, instruction summary. **BRAND NEW** **$11.95**

AN/ARN-6 RADIO COMPASS EQUIPMENT

Highly efficient airborne direction finding system. Frequency: 100 to 1750 Kc in 4 bands. 26.5 DC V Power input. LIKE NEW. **$79.50**

MICROPHONES

Model	Description	EXC. USED	BRAND NEW
T-17	Carbon Hand Mike	$4.45	$6.95
RS-38	Navy Type Carbon Hand Mike		4.75

HEADPHONES

Model	Description	Excellent Used	BRAND NEW
HS-23	High Impedance	$2.19	$4.49
HS-33	Low Impedance	2.69	4.59
HS-30	Low Imp. (featherwt.)	.90	1.65
H-16 U	(High Imp. (2 units)	3.75	7.95

TELEPHONICS—600 ohm Low Impedance HEADSETS. BRAND NEW, PER PAIR $3.25
CD-307A Cords, with PL55 plug and JK26 Jack .... .99
Earphone Cushions for above—pair .... .50

SCR-625 MINE DETECTOR

Complete portable outfit in original packing, with all accessories. Brand New **$27.50**

BC-603 FM RECEIVER

20 TO 27.9 MC.
Like new **$18.95**
BRAND NEW **$22.50**
10-channel, pushbutton or continuous tuning. Complete with speaker, squelch, and ten tubes: 3-6AC7, 1-6J5, 2-12SG7, 1-6H6, 1-6V6, 2-6SL7.

EXTRA SET OF 10 TUBES FOR ABOVE brand new in original boxes $3.95

FT-237 MOUNTING BASE for BC-603 Revr and BC-604 Xmitter, Brand New **$5.95**

12 or 24V Dynamotor for Above. Exc. Used $4.25 .... Brand New **$5.50**

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4-Section Antenna for BC-603, 683 Receivers. Complete with mounting base. BRAND NEW $4.95

BC-604 TRANSMITTER—Companion unit for BC-603 Revr above. With all tubes, BRAND NEW $6.95

4-Section Antenna for BC-604, 684 Transmitters. Complete with mounting base. BRAND NEW $4.95

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SPECIAL! BC-603 FM RECEIVER

CONVERTED FOR FREQ. RANGE 35 to 50 Mc. BRAND NEW! Checked out, perfect working condition, ready for operation. Continuous or Push-button tuning in 35 to 50 Mc. range.
SPECIAL **$32.50**

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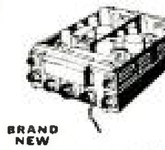
Terrific buy! VHF Transmitter-receiver, 100-156 Mc. 4 channels. Xtal-controlled. Amplitude modulated voice. They're going fast! Excellent condition. SCR-522 Transmitter-Receiver, complete with all 18 tubes, top rack and metal case.
COMBINATION. Like new **$29.50**

FAMOUS BC-645 TRANSCEIVER

15 Tubes 435 to 500 MC



BRAND NEW

Can be modified for 2-way communication, voice or code, on ham band 420-450 mc. citizens radio 460-470 mc. fixed and mobile 450-460 mc. television experimental 470-500 mc. 15 tubes (tubes alone worth more than sale price!): 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE-316A. Now covers 460 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton.
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UHF Antenna Assembly 2.45
Complete Set of 10 Plugs 5.50
Control Box 2.25

SPECIAL "PACKAGE" OFFER:
BC-645 Transceiver, Dynamotor and all accessories above. COMPLETE, BRAND NEW. While Stocks Last **$29.50**

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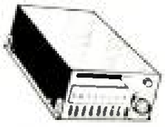
ARC-3 RECEIVER!



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Like NEW **$21.50**
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Crystal-controlled 17-tube superhet, tunes from 100 to 156 MC., AM., on any 8 pre-selected channels. 28-volt DC power input. Tubes: 1-9002, 6-6AK5, 1-12SH7, 3-12SG7, 1-9001, 1-12H6, 2-12SN7, 1-12SL7, 1-12A6.

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Wired, Tested, Ready to operate **$19.95**

AN/ART-13 100-WATT XMTR

11 CHANNELS
200-1500 Kc
2 to 18.1 Mc

$69.50 exc. used

Complete with Tubes

Famous Collins Autotune Aircraft Transmitter, AM, CW, MCW. Quick change to any of ten preset channels or manual tuning. Speech amplifier/clipper uses carbon or magnetic mike. Highly stable, highly accurate VFO. Built in Xtal controlled calibrator. PP811s modulate 813 in final up to 90%, class "B". A Real "HOT" Ham buy at our low price! Orig. cost $1800.
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Same as above less meter 39.50
We carry a complete line of spare parts for above.

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ALL COMPLETE WITH TUBES

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BC-454	Receiver 3-6 Mc	10.45	12.45
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Marine Receiver	1500-3000 KC Brand New		$16.95

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case, instructions **$7.95**
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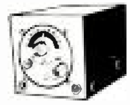
BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal, BRAND NEW **$9.75**
BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal. BRAND NEW **$9.75**
T19 TRANSMITTER 3/4 m.c. complete with all tubes and crystal. Exc. Used **$9.95**
BC-456 Modulator .... **USED 3.45 NEW 5.95**
MO7 Modulator, Like New $9.95
ALL ACCESSORIES AVAILABLE FOR ABOVE

BC1206-C BEACON RECEIVER



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Model DM35

Input 12V DC. Output: 625 V DC @ 225 Ma. for press-to-talk intermittent operation. Shpg. wt. 14 lbs.
OUR LOW PRICE. BRAND NEW **$10.95**

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	28V 7A	540V .25A	1.95	3.75
DM-34D	12V 2A	220V .080A	4.15	5.50
OM-53A	28V 1.4A	220V .080A	3.75	5.45
DM-64A	12V 5.1A	275V .150A		7.95
PE-73C	28V 20A	1000V .350A	8.95	14.95
PE-86	28V 1.25A	250V .050A	2.75	3.85

DM-42A DYNAMOTOR. Input 12 V DC @ 30 Amps. Output 515 V DC @ 215 Ma. and 1030 V DC @ 260 Ma. Wt. 38 lbs. BRAND NEW, each $6.95

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Mac's Electronics Service

(Continued from page 44)

with an .01-μf. capacitor. A rheostat varies potentials on the transistor so the output voltage can be changed smoothly from a low value up to 200 volts. When the dosimeter is pushed into a special socket on the charger, the positive voltage is fed through a contact to the dosimeter charging pin, and the dosimeter case is connected to negative ground.

"A mild pressure on the dosimeter closes a switch that turns on the oscillator and lights a flashlight bulb beneath the socket so the instrument may be read by means of light shining up through the barrel. Increased pressure shoves the charging pin up against the conducting lead of the electroscope and applies the charging voltage to the capacitor. The rheostat is varied until the hairline is resting on zero; then the dosimeter is withdrawn."

"What's the difference between the rate meter and the dosimeter?"

"I figure there's actually no basic difference in construction of the *Heath* instruments. The 120 r./hr. rate meter is a 0-2 r. dosimeter with a different scale. It actually has two scales: 0-120 r./hr. and 0-12 r./hr. If radiation is high, you take a reading on the higher scale one minute after the instrument has been zeroed. A full-scale reading would mean you received a dosage of 2 r. in a minute; so the *rate of dosage* would be 60 × 2 or 120 r./hr. If the radiation is lower you take a reading on the 0-12 scale ten minutes after the instrument has been zeroed. A full-scale reading now would indicate a dose rate of 6 × 2 or 12 r./hr. The rate meter is useful for comparing the rate of radiation being received in different locations and so would help in finding the safest comparatively 'cool' spot in a contaminated area. The dosimeter, if worn on the person, would keep track of the total accumulated dosage received by the wearer."

"How much radiation can a person take?"

"There's little agreement about that. The standard limit is set at .3 r. a week; but the instructions that come with the *Heath* kit give the following as probably acute effects of short-term whole-body exposure: 0-100 roentgens, no obvious effects; 100-200 r., minor incapacitation; 200-600 r., sickness and some deaths; over 600 r., few survivors. Notice this does not take into account long-range effects such as shortened life span, decreased resistance to disease, genetic changes, etc. It's interesting to note you get a dose of 1 to 3 r. per film out of a chest x-ray, and a full-mouth dental x-ray gives you about 0.18 r."

"Sometimes I see fall-out readings given in 'counts.' Is there any relation between counts and roentgens?"

"Yes, 1000 counts-per-second is about equal to 10 mr./hr., but this depends somewhat on the energy of the radiation and the type of detector. Say, I'm glad and a little surprised to see you so interested."

"Anyone not interested in the detection, measurement, and effect of radiation these days has ostrich blood in his veins," Mac said firmly. "Ignoring danger is a poor way to cope with it. Even if there is never a nuclear war—and God forbid there should be—we must learn to live with the radiation fall-out of nuclear bombs already exploded. Space travellers must be shielded against deadly cosmic ray radiation. Technicians must learn how to work safely around the atomic-powered machines of the immediate future."

He stopped and then went on with a twinkle in his eye: "On top of that I'm delighted to know a capacitor *can* be built to have practically no leakage. I'm glad to learn there is an accurate voltmeter that draws absolutely no current from the source being measured and yet is so rugged it can be dropped or even submerged under water without damage. Above all, it tickles me to know this voltmeter, this capacitor, and a high-powered microscope can all be crammed inside a little tube four inches long and a half-inch in diameter—the whole thing weighing an ounce and a half! That's engineering!" ▲

USAF MARS BROADCASTS

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Each program is taped for broadcast at 2 p.m. (EST) on its assigned Sunday. Programs last an hour and are followed by "live" on-the-air question-and-answer periods.

Schedule for the broadcasts for the months of March and April are as follows:

March 4: "Tunnel Diodes—What They Are and What They Can Do," by R. L. Watters, W2RDL, Research Laboratory.

March 11: "Tunnel Diode Circuitry," by Eric Gottlieb, Semiconductor Products Department, Syracuse, N. Y.

April 1: "The Advantages of Compactron Multi-Function Tubes in Electronic Equipment," by Leo T. Bowles, W1JPQ and C. D. McCool, Receiving Tube Department.

April 8: "What Computers Can Do," by Ed Wolff, General Engineering Laboratory, Schenectady.

April 15: "Latest Trends in Military Type Transistors," by David T. Geiser, Light Military Electronics Department, Utica. ▲

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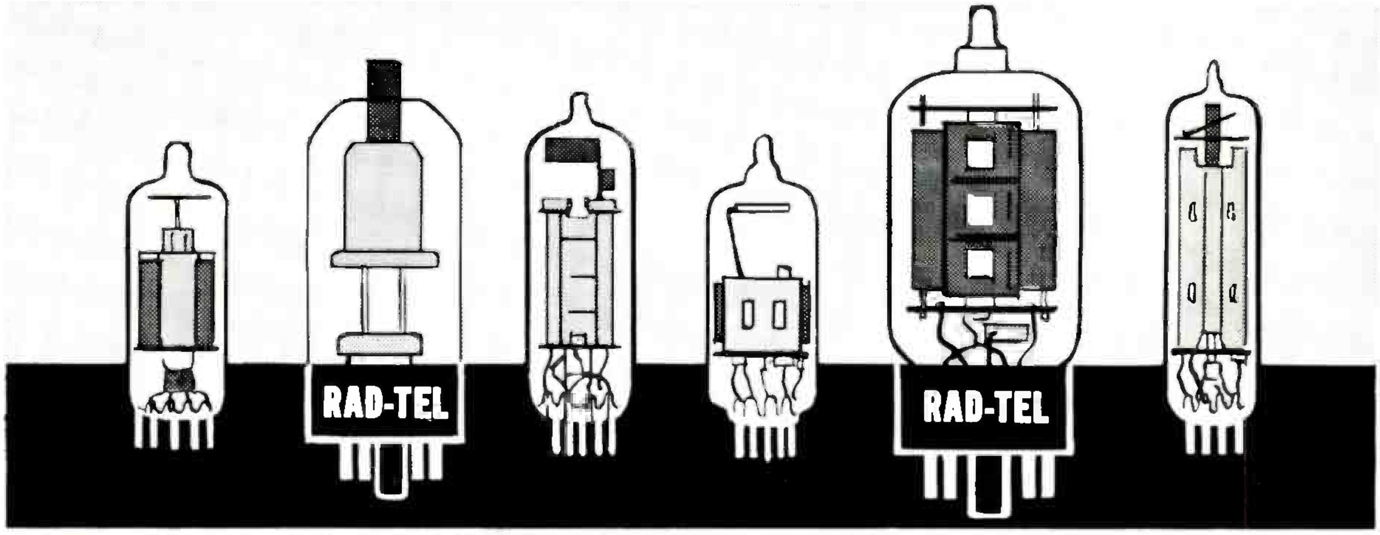

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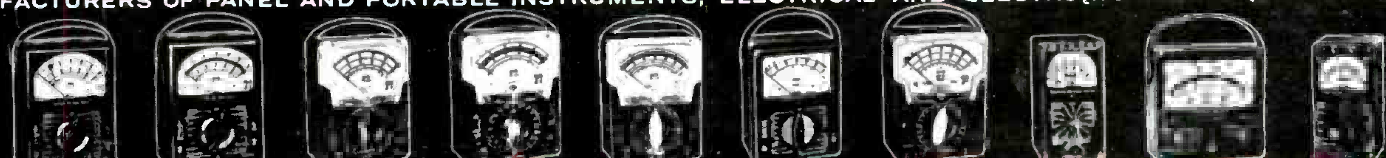

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