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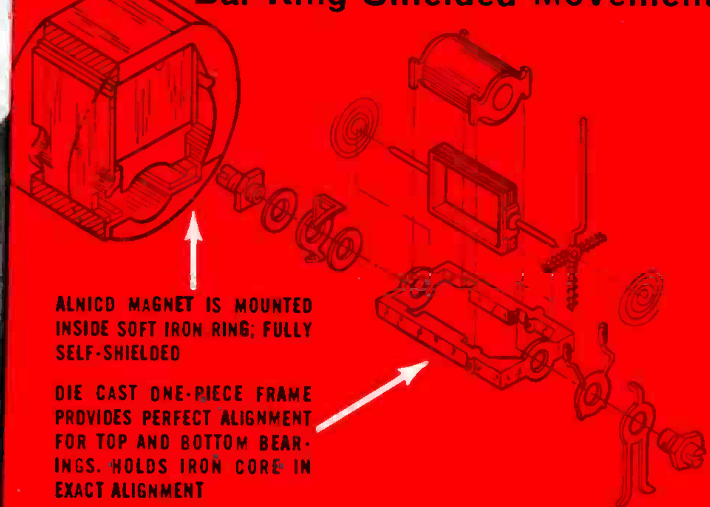

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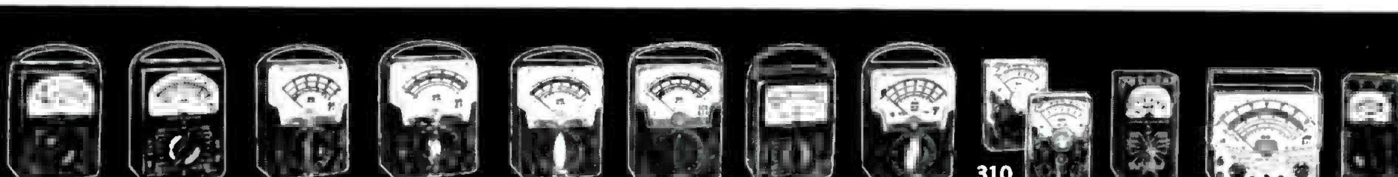

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For additional information on the Type SK-1 Suppressikit, see your Sprague Electronic Parts Distributor.

GS-341 R2

Scott Stereo Tuner Kit Wins Rave Reviews from every Leading Hi-Fi Expert!

Just one year ago Scott introduced the LT-110 FM Stereo Tuner Kit. High Fidelity Dealers built this superb kit themselves, examined its many features, and recommended it without reservation. Enthusiastic kit builders deluged us with mail. Now the verdict is in from all the leading technical experts. Never before in the history of the industry has a single kit received such unanimous praise. We reprint a few excerpts below.

from POPULAR ELECTRONICS

"No commentary on *Scott Kits* would be complete without first mentioning that this company pioneered new areas in the hi-fi kit market and brought forth several (then-radical) innovations. One of them continues to fascinate all purchasers of a *Scott Kit* — the full-color instruction manual. . . . Scott also pioneered the Kit-Pak — a shipping container which serves as a temporary workbench and storage box . . . a test model of the LT-110 was wired at POPULAR ELECTRONICS in just under five hours. Another 40 minutes was used for careful alignment and the tuner was "on the air." . . . The LT-110 met or exceeded all the manufacturer's detailed specifications on sensitivity, distortion, output level, a.c. hum, and capture ratio . . . the audio response is excellent, being within ± 1 db, from approximately 20 to 16,000 cycles. . . . Channel-to-channel crosstalk is particularly excellent both in terms of uniformity and the fact that it holds up well above 10,000 cycles. . . . Frequency drift of the LT-110 from a cold start is extraordinarily low — less than 5 kc. The a.c. hum level (referred to 100% modulation) is low and exceeds the manufacturer's rating by 5 db. . . . It's difficult to imagine a kit much simpler to assemble than the LT-110. The full-color instruction book eliminates just about the last possible chance of wiring errors. . . . From a plain and simple operational standpoint, the LT-110 *works well and sounds good.*"

Popular Electronics, Oct. 1962

from ELECTRONICS WORLD

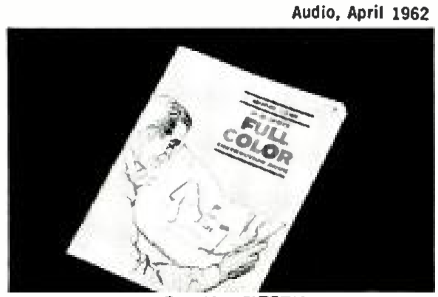
"Construction time for the unit we tested was 6½ hours, without alignment . . . in listening tests, the tuner showed its high useable sensitivity to good advantage. Using an in-door antenna which produced marginal signal to noise ratios on most other tuners we were able to get noise-free, undistorted stereo reception. It's quite non-critical to tune, hardly requiring the use of its tuning meter."

Electronics World, Nov. 1962

from AUDIO

"The LT-110 (is) so simple to build that we unhesitatingly recommend it for even the novice. . . . We found that the useable sensitivity (IHFM) was 2.1μv . . . a fine stereo tuner and an unusually easy kit to build."

Audio, April 1962



from RECORD GUIDE

"It seems to me that every time I turn around I am building another of H. H. Scott's kits. And each time I end up praising the unit to the skies.

The Scott instruction books should be a model for the industry. They feature full-color, step-by-step, illustrated directions. Each resistor or other component is shown in the progressive phases in its color code and in its proper position. . . .

There is no audible drift in the LT-110 whatever. You can shut the tuner off on a station and pick it up the next day, perfectly tuned, without touching the tuning dial. No AFC circuits are included in this tuner and none are needed.

This tuner kit has to be ranked on the same plane as H. H. Scott's factory-wired units. It is an excellent product, and because of its conservative parts very likely to give long, trouble-free service."

American Record Guide, Sept. 1962

Now Sonic Monitor* Added

Scott's unique Sonic Monitor has now been added to the LT-110. This fool-proof stereo signaling device tells you audibly when you are tuned to a stereo station. Just turn the switch to "Monitor", and tune across the dial. When you hear the monitor tone from your speakers you know you've tuned to a station broadcasting new FM Stereo. Now switch the Monitor knob back to "Listen" to enjoy perfect stereo sound.

LT-110 $159.95 (slightly higher West of Rockies.)

*Patent Pending

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DECEMBER 1962 / VOL. 68 NO. 6 **Electronics World**

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FM Multiplex Signal Generator—A "must" for every audio service shop and hi-fi salon which handles stereo equipment, this article provides complete construction details on a carefully engineered instrument which incorporates all of the features needed by professional audiomen. A spare-time project for the shop.

V.L.F. LOOP ANTENNA
The increasing popularity of the low-frequency band has spurred a need for a low-cost, sensitive antenna for receiving such broadcasts. The author describes a home-built loop antenna which is ideal for this service.

WIRELESS STEREO CONVERTER
A unique and interesting project for the home builder. A phono oscillator which transmits one stereo channel to a small broadcast-type receiver permits an inexpensive mono record player to operate as a "stereo" unit.

FCC ANSWERS OUR QUESTIONS ON BUSINESS RADIO
Official answers to thirteen important questions regarding the Business Radio Service—who is eligible? what equipment? what licenses are required? how good is the coverage? All these questions—and others—are answered completely and authoritatively.

POWER TRANSISTOR SPECIFICATIONS
What are the important mechanical, electrical, and thermal characteristics that the technician must recognize when working on transistorized equipment? John R. Gyorki of Burroughs Corporation outlines the important parameters and explains why they are important.

RC COUPLING NETWORKS—A PRACTICAL VIEWPOINT
The network consists merely of a capacitor and a resistor, but slight changes in either component can have far-reaching effects on circuit operation. Pointers to keep in mind when a defect occurs or when one of these components must be changed are covered in this practical article.

PROBLEM OF TUBE-SHORT TESTING
What is meant by the sensitivity of a tube checker's shorts test? What different types of tube shorts can occur and how are they detected by the various test methods employed? Anyone who has occasion to evaluate tube condition should understand the problems outlined by A. Overstrom of Westinghouse.

All these and many more interesting and informative articles will be yours in the January issue of ELECTRONICS WORLD . . . on sale December 20th.

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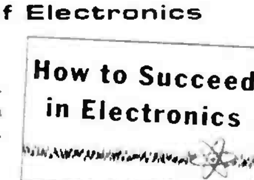

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...for the Record

By **W. A. STOCKLIN**
Editor

Transistors for Hi-Fi?

WITH the closing of the New York Hi-Fi Show on October 6th, the high-fidelity component industry has concluded another successful year of show activities. The main theme, as one would expect, was FM-stereo multiplexing, and some 32,000 visitors were pleased with what they saw and heard.

There were many new and interesting products, but my own thoughts were confined to ideas and trends that would help us predict what the future has in store for our industry. It seemed quite evident, at least I have no doubts, that the next phase is the complete transistorization of hi-fi components. It might take 1, 3, 5, or 10 years, depending entirely on how fast the industry moves. But, regardless of time, the change from tube to semiconductor designs is inevitable.

Most engineers agree on one point—that to convert simply because of the glamour of semiconductors is ridiculous, and only when transistorized equipment can provide a real advantage in sound reproduction, should transistors be used. This is an ideal philosophy, and the only one to follow to create not only a healthy, progressive industry, but one that will give dollar/performance advantage to the consumer.

Of course there are design problems today, but we are convinced that, from a technical viewpoint, transistor designs offer many advantages over tubes in hi-fi amplifiers—wide frequency response (d.c. to 100,000 cycles or more), much better transient response, less phase shift, much higher damping factor, hopefully less maintenance, and all this with comparatively low values of distortion.

Most people agree that transistorized amplifiers sound different, and those who have been involved with their design claim that, without a doubt, the quality of reproduction is much superior to equivalent tube versions. From others, not too close to present developments, one gets mixed reactions. Some claim that the difference is simply a new form of distortion, while others have a "wait-and-see" attitude.

The fact that we can eliminate all audio transformers overcomes many limitations of tube designs. We can now have much better transient response with less ringing and overshoot. One can argue that a very wide passband is not important, since we are only interested in the audible range. But we know it does help, though it may only be a by-product and simply an indication of a quality design.

Much work must yet be done, not only on amplifiers and tuners, but on other components. Speakers and cartridges, for example, must be reviewed. Present speakers can be used, but to achieve ultimate performance, there must be further development work done. In view of the much better transient response of transistorized equipment, speakers must be further improved to handle these sudden excursions and, at the same time, with much less distortion.

Cartridges, too, will have to be redesigned for use with transistors. Although present cartridges are good, let us not forget that transistors are low-impedance devices. Were cartridges redesigned for closer impedance match, improved performance would result.

As far as preamplifier, power amplifier, and tuner components are concerned, there are minor circuit problems that must be solved. None of them seems to be too serious or insurmountable.

We saw a number of transistorized designs at the Hi-Fi Show, *Harman-Kardon, Heath, Scott, Sherwood, Lafayette, Omega, Altec Lansing,* and a new company, *Acoustic Technology Laboratories,* all displayed units. It is rather difficult to predict when other manufacturers in the hi-fi industry will come out with transistorized versions of their products.

One of the major difficulties is the serious lack of engineers and technicians who are qualified designers both in audio and semiconductor technology. Our present audio engineers are mainly tube men and, although they do know basic semiconductor theory, there is still much that many of them must learn about transistors. On the other hand, semiconductor engineers are usually far from being qualified in audio work. Semiconductor manufacturers have been working with the audio industry and various basic designs have been suggested by them, but most of them to date have not added materially to the growing art of sound reproduction.

This is an unfortunate situation, since it means that those in the audio industry are not in a position to specify precisely the characteristics of the semiconductors needed, nor does the semiconductor industry know exactly what is required by the audio designers.

The problem will be solved, but it will be necessary for the audio industry to take the initiative. It is their responsibility to do the necessary development work. ▲

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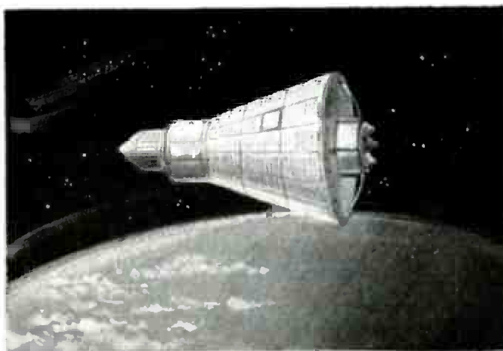

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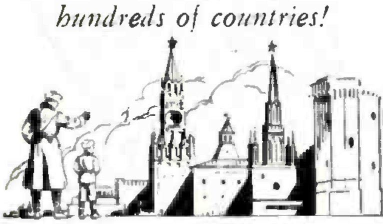

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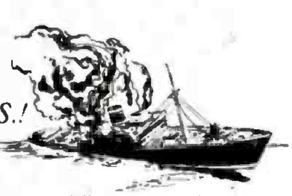

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LETTERS FROM OUR READERS

TRANSISTORIZED IGNITION SYSTEM

To the Editors:

I constructed the transistorized ignition system which appeared in the August issue of ELECTRONICS WORLD. I have been using it in my car, a 1958 *Simca*, for some time and the performance is almost unbelievable.

The most notable improvement has been in power. Top speed going up a large hill near my home with the conventional system was about 53 miles per hour. Since installing the transistorized unit, I have checked the performance on this hill three times and have never failed to do at least 68 miles per hour. Top speed on the level has increased far in excess of 10 miles per hour. I have not used the unit long enough to check out the gas mileage, but with the proven increase in efficiency, I am convinced that it can do nothing but skyrocket.

Being an electronics engineer myself, I have experimented with transistorized ignition systems for the past few months without too much success. Mr. Saatjian's circuit seems to have succeeded in giving the performance desired. After comparing this circuit with the others I have tried, I am quite sure that the main item which insures the good performance of this unit is the bias network, consisting of R_2, R_3, and SR_1, which guarantees that the transistor will turn off very rapidly. Other units which I have tried depended on the turn-off time of the transistor itself and unless this was extremely good, performance suffered.

What changes should be made in the circuit to adapt it to a 6-volt system?

Sincere compliments to your excellent magazine for publishing this article and also to Mr. Saatjian for a fine bit of engineering.

ELTON L. WOOD
Sperry-Utah
Salt Lake City, Utah

We certainly appreciate Reader Wood's comments on his experiences with the transistorized ignition system. We have heard from other readers who have been quite pleased with the circuit as well. Some of them point out a precaution that should be observed, however. The car's ignition switch should not be left on accidently overnight or for long periods of time with the engine off, since excessive d.c. current would flow through the transistor and through the coil, probably damaging them. Therefore, be certain to turn off the ignition switch after completing a drive.

For readers interested in converting the 12-volt system described in our August issue to 6 volts or to a 12-volt positive-ground ignition system, we would like to point out that Author Saatjian has worked up some additional information on the original circuit that would answer these questions. This information appears in a brief article under the title "Additional Notes on Transistorized Ignition System" in this issue.—Editors.

* * *

SEMICONDUCTOR RECTIFIERS

To the Editors:

Let me point out a fallacy in your advice on silicon-rectifier testing to Mr. Richard Shaw of Ames, Iowa in one of your recent "Letters from Our Readers" columns.

The forward and back resistance of a semiconductor rectifier, whether it be silicon, germanium, or selenium, is a complex function of the current and voltage used and are not constant values, particularly under the test conditions you describe.

Quoting from technical literature of a silicon rectifier supplier: "An ohmmeter measurement of forward and back resistance might first come to mind, but the results of such a test are not reliable and may lead to erroneous conclusions. The available current in an ohmmeter is generally one milliampere or less, and thus when measuring the forward direction of a rectifier it will not indicate the non-linear decrease in resistance for a slight increase in voltage past the threshold point. Also, in the reverse direction, an available ohmmeter voltage on the high resistance scales will not show a reduction in peak inverse voltage rating unless an almost complete short has occurred."

A tube rectifier, where used, is properly the first suspect in "B+" troubles, but with silicon rectifiers it should be the last. Silicon rectifiers are quite reliable, long-lived components and can take a surprising amount of mechanical and electrical abuse before failure, and the rare failure is usually rather complete, not a gradual weakening as with tube rectifiers. There are, however, some simple tests to detect whether or not the silicon rectifier is at fault.

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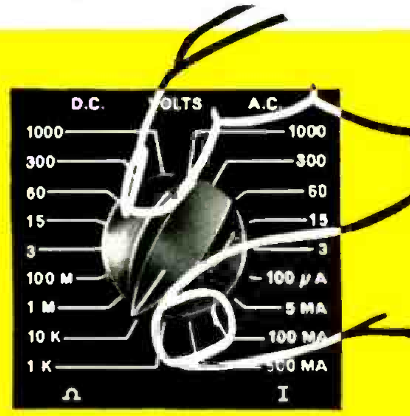

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rectifier with the fingers (protected by paper or rubber glove against shock). If the rectifier is hot (normally it should be not more than comfortably warm), it is either overloaded or defective. To check for overload measure the current between the rectifier output and the first filter section and compare with the rectifier rating. If the current is not excessive, the rectifier is very probably defective and should be replaced. If the rectifier is not hot, check the a.c. voltage to ground at the rectifier input taking care to use the lead, mounting cap, or stud of the rectifier itself as the test point. If the a.c. voltage is normal, but the d.c. voltage is not, then the rectifier has probably lost rectification efficiency and is defective. If little or no d.c. voltage is present, check for a short or semi-short under load, at the input to the first filter section and for proper a.c. input to the rectifier. If a bad short is found, the rectifier has probably been damaged beyond use.

Since selenium rectifiers, because of their lower efficiency, tend to run somewhat warm, the temperature test should be replaced by the "sniff" test. A damaged or overloaded selenium rectifier will have a distinct "garlic" odor (these fumes are poisonous in heavy concentrations).

K. C. McCartt
Senior Research Engineer
Universal-Rundle Corporation
Mahoningtown, Pa.

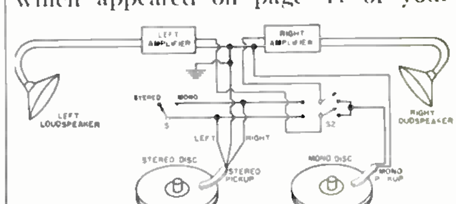
The method suggested by us was not intended to be laboratory-accurate. However, we still feel that an approximate measurement of front-to-back ratio has some validity even though it may not be done at the exact voltages and currents used in the applications.—Editors.

° ° °

NON-DIRECTIONAL STEREO

To the Editors:

I have just checked the proofs of my article "Non-directional Stereo Effects" which appeared on page 41 of your



October, 1962 issue. I find that I have made an error in the switching circuit shown in Fig. 1. I am attaching the corrected diagram with this letter.

Charles J. Hirsch
Corporate Staff for Engineering
Radio Corporation of America
Princeton, New Jersey

With the original circuit, proper operation could occur if the two discs were not played at once. The above figure shows a better arrangement.—Editors. ▲

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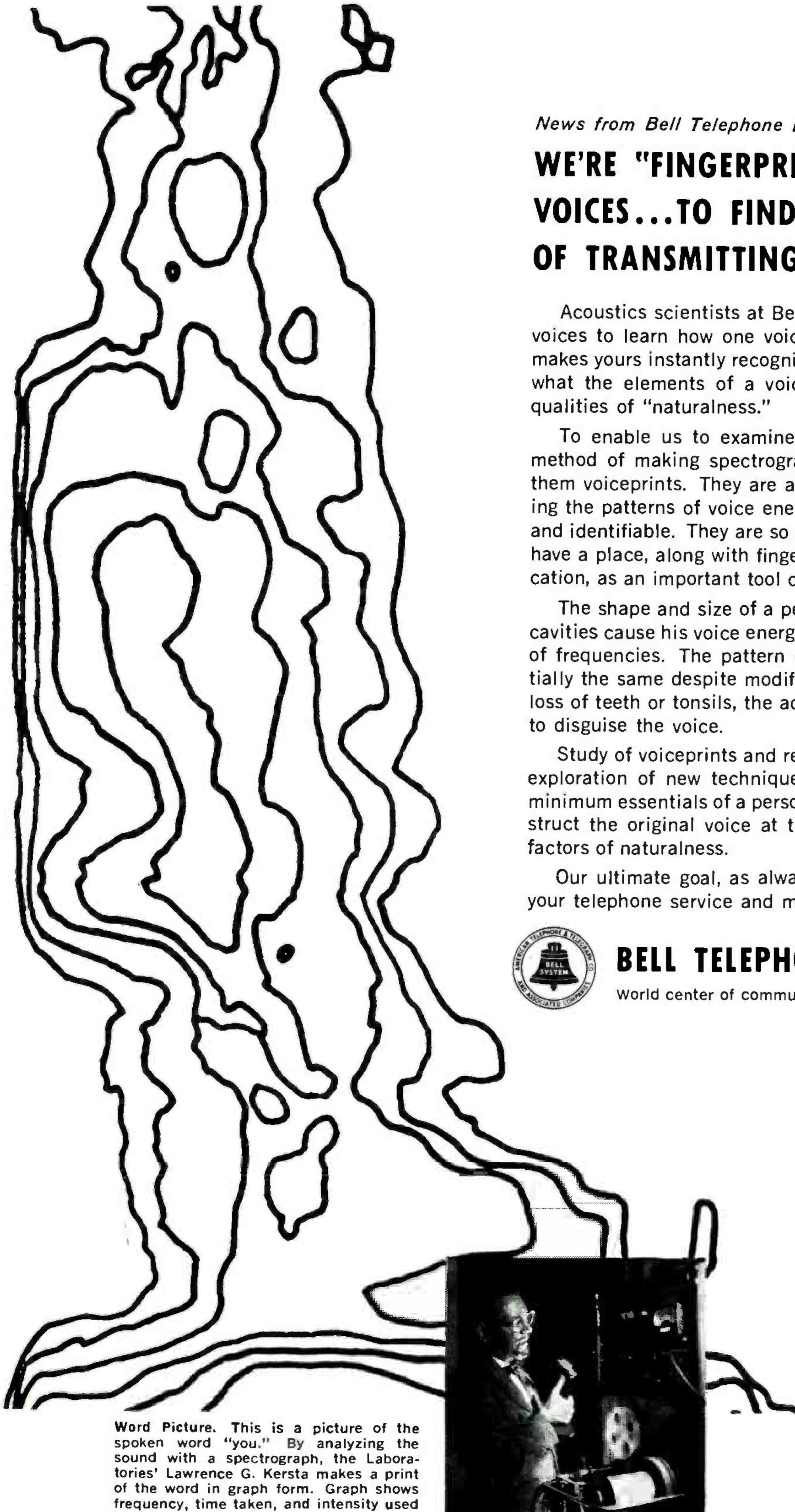

Word Picture. This is a picture of the spoken word "you." By analyzing the sound with a spectrograph, the Laboratories' Lawrence G. Kersta makes a print of the word in graph form. Graph shows frequency, time taken, and intensity used in making speech sound.

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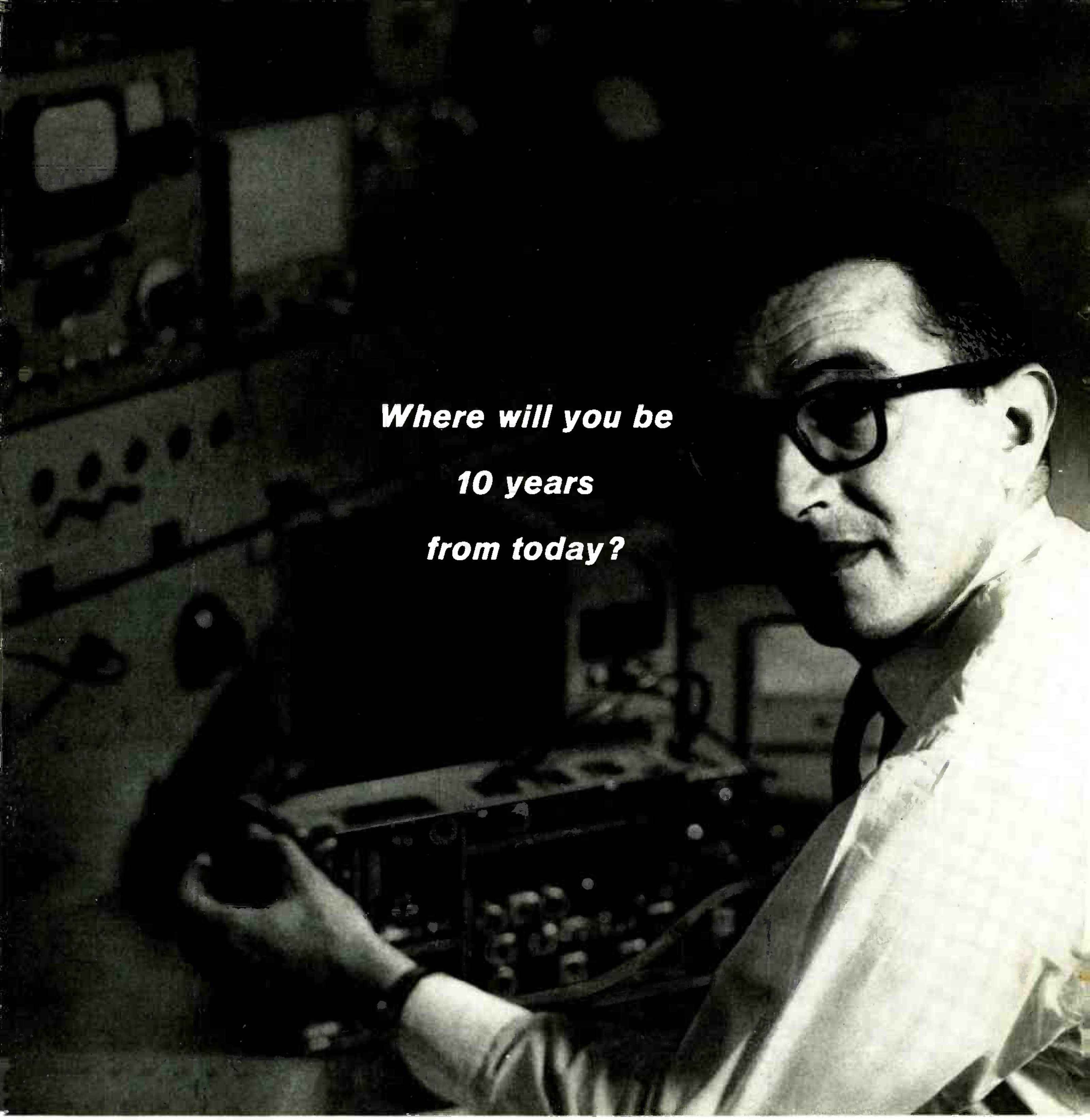

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Eico Model RP-100 Tape Recorder
Fisher KX-200 Stereo Amplifier (page 22)

Eico Model RP-100 Tape Recorder

For copy of manufacturer's brochure, circle No. 59 on coupon (page 15).

THE *Eico* RP-100 tape recorder is unique in several respects. Its technical specifications are comparable to those of the most expensive home tape recorders. Its electronic portions are fully transistorized (except for the bias oscillator). The tape transport has three motors, with push-button-operated solenoid controls. The flexibility offered by its many operating controls is exceptional. Finally, it is available in kit form, as well as factory-wired.

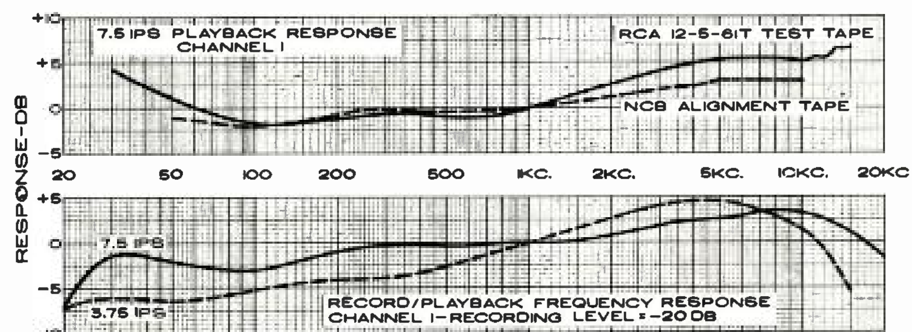
The RP-100 is a semi-kit, designed for the advanced hobbyist. In this case, the term "semi-kit" is used because only the electronics are in actual kit form; the deck mechanism is entirely factory-assembled and tested. Construction of the semi-kit is likely to require some 30 to 40 hours, even for an experienced kit builder.

A complete listing of the features would require more space than is available here. It is a two-speed (7.5 and 3.75 ips) machine, capable of recording and playing back ¼-track mono or stereo tapes, and playing back ½-track mono or stereo tapes. Having separate record and playback heads and amplifiers, it can be switched to monitor off the tape as a recording is in progress, and to make sound-on-sound recordings by copying one track on to the other, together with a second signal. This process can be repeated several times to make multiple recordings for special effects.

The push-button transport controls are positive and fool-proof. Pushing the "Stop" button turns on the amplifiers and the capstan drive motor (a hysteresis-synchronous type). The "Run," "Forward," and "Rewind" buttons operate solenoids and energize the reel motors to place the tape in motion. Before operating any of the other buttons, the "Stop" button must be pressed. The tape is brought to a rapid, smooth stop by means of d.c. braking current through the reel motors. A separate "Record" button must be pressed simultaneously with "Run" in order to make recordings. This cannot be done accidentally, so there is no danger of erasing a valuable recording. The "Record" button can be pressed together with the "Stop" button to set up recording levels before the tape is placed in motion. An "Off" button shuts off all power to the unit.

The RP-100 has a full complement of operating controls, in addition to the transport buttons. A speed-selector button changes tape speed. Separate switches control recording and playback equalization for the two speeds. There are separate inputs for line and microphone, each having a pair of concentric level controls for the two channels. Similarly, the two playback level controls are concentrically mounted. Separate mode selectors are provided for the recording and playback amplifiers. For example, one can record mono programs on either track, stereo on both tracks, or copy either track onto the other. The playback selector has positions for stereo, reversed-channel stereo, or either track played back through both amplifiers for mono playback. There are dual recording level meters, an indexing turns counter for the take-up reel, and an automatic shut-off for the take-up reel when the tape has run through.

The playback frequency response was measured at 7.5 ips with two test tapes, the *NCB* alignment tape and the *RCA* 12-5-61T test tape. Both tapes are presumably recorded to complement the NAB standard playback characteristic. There was a general similarity between the response to the two tapes, although the *RCA* tape showed a greater variation in response over the entire frequency range. With either tape, the high-frequency response was exceptionally uniform, showing no roll-off up to 15 kc.



The record/playback frequency response at 7.5 ips was also very good, being ± 3 db from 25 to 20,000 cps. At 3.75 ips the frequencies around 5 kc. were somewhat accentuated, but with suitable tone-control correction the overall response probably could be equalized to ± 2.5 db from 20 to 10,000 cps.

The signal-to-noise ratio of the RP-100 was about 53 db, referred to the normal recording level as indicated on the recorder's meters. The residual noise was virtually all hiss. The transistor amplifiers are truly hum-free, and there is apparently no hum picked up in the heads. The overload characteristics of this recorder are excellent, and recording levels up to 6 db over normal maximum can be handled with only a slight effect on distortion.

The tape speed measured slightly high, with an error of about 30 seconds in 30 minutes of playing at 7.5 ips. The fast-forward and rewind speeds are faster

than most recorders we have used, requiring about 45 seconds to handle 1200 feet of tape. The wow and flutter were slightly greater than rated, about 0.07% and 0.24% respectively at 7.5 ips and 0.14% and 0.35% at 3.75 ips. The rated wow and flutter (combined) are 0.2% at 7.5 ips and 0.25% at 3.75 ips. We have tested a second RP-100 recorder which had measured wow and flutter well within these ratings, so it may be assumed that our test sample was not representative. In fact the manufacturer states that current production standards require a combined wow and flutter measurement at 7.5 ips not exceeding 0.15% as well as a speed error not exceeding 0.3%.

In use tests, the recorder performed very well. It takes a little practice to master the proper use of the numerous controls, but the results are worth the effort. Hardly any difference could be heard between the original program and that coming off the playback heads during recording. At 3.75 ips the sound was rather bright, as the peaked response would suggest, but this could be tempered with tone controls on the associated amplifier. Playback of pre-recorded tapes did not reveal any undue emphasis of high frequencies, but were clean and nicely balanced. The sound-on-sound recording feature worked well, with the number of successive re-recordings limited largely by one's ability to coordinate the mixing of the internal and external signals.

The *Eico* RP-100 sells for $299.95 in kit form and $399.95 factory-wired. A luggage-type carrying case is available for $29.95. For rack mounting, a special panel is available for $9.95. ▲

Fisher KX-200 Stereo Amplifier

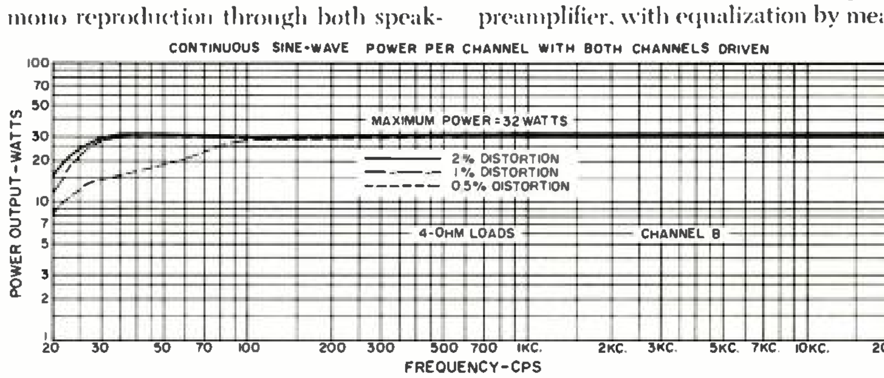
For copy of manufacturer's brochure, circle No. 60 on coupon (page 15).

THE new *Fisher* KX-200 is an integrated stereo amplifier, sold only in kit form. The "StrataKit" design is intended to make kit-building a pleasant and fool-proof process, even for a complete novice. Judging from this kit, the concept is highly successful. We'll have more to say about this later in the report.

The unit is rated at 40 watts per channel (music power) or 35 watts continuous power. It has most of the features of the factory-wired *Fisher* amplifiers, which is to say it is highly flexible. There are inputs for two magnetic cartridges (or tape heads), a tuner, and two high-level auxiliary signal sources. The mode selector offers a choice of mono reproduction through both speakers from either input, normal stereo or reversed-channel stereo, and mono with both inputs paralleled (especially desirable for playing mono records with a stereo cartridge).

The KX-200 has the usual tone controls, channel-balance control, and ganged master volume control. There are slide switches for loudness compensation, scratch filter, tape/phono equalization, and tape monitoring from a three-head recorder. Two more knobs complete the front-panel control layout —one controlling the level of a center-channel speaker (if one is used) and a stereo dimension or blend control, which mixes the two channels to form anything from pure stereo to mono reproduction.

Each channel uses a 12AX7 phono preamplifier, with equalization by means



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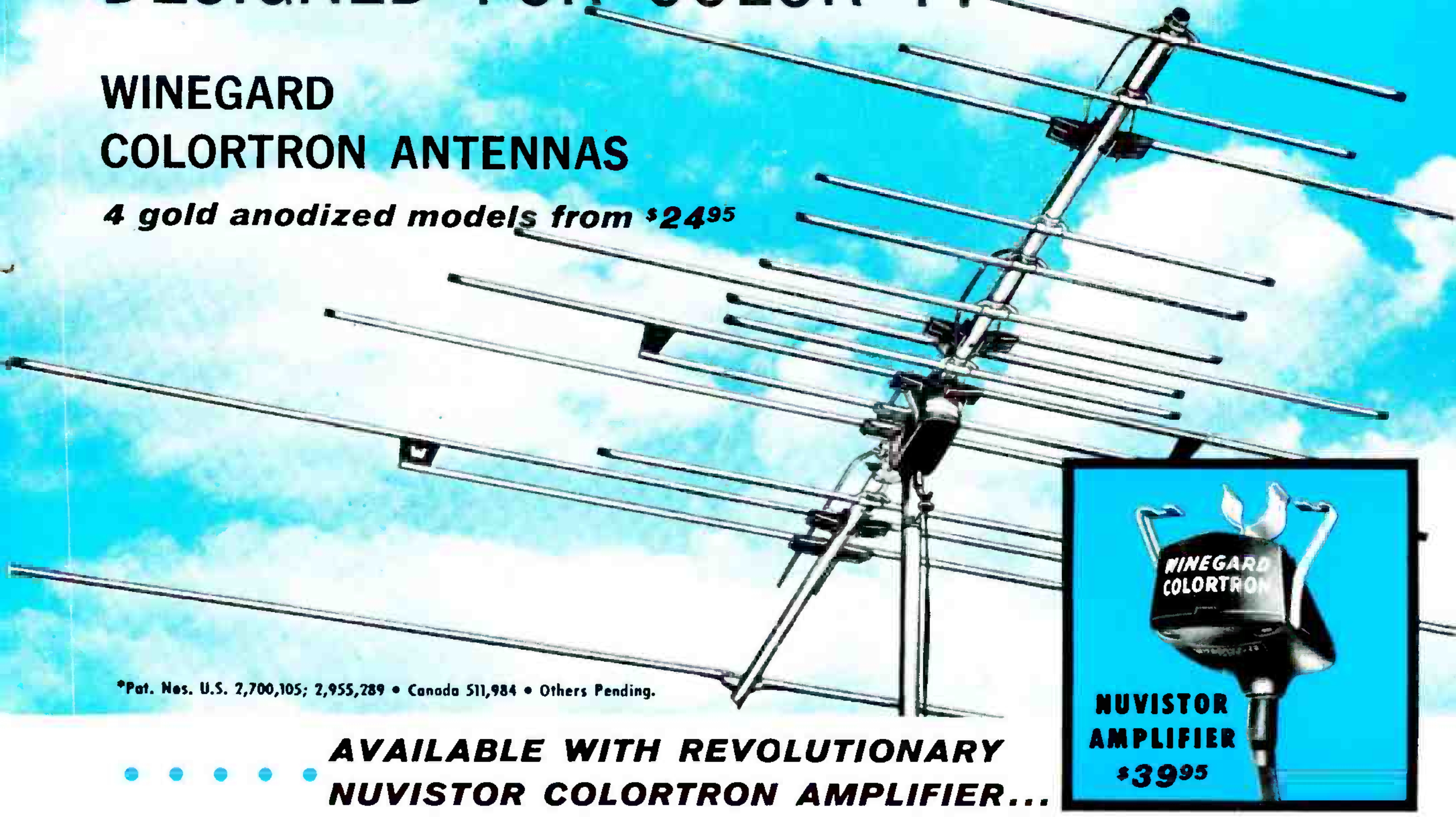

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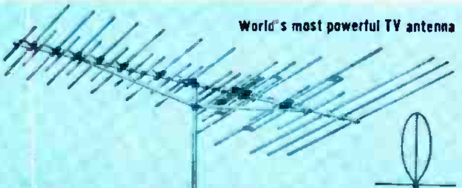

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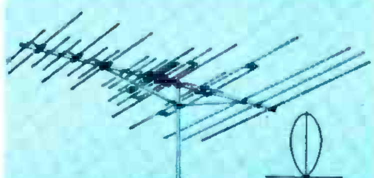

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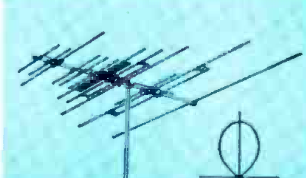

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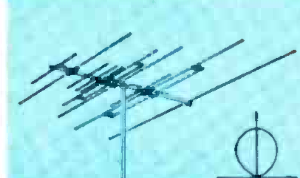

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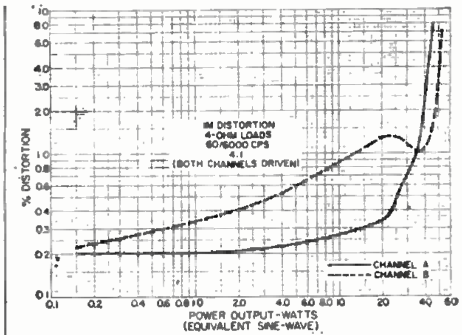

of negative feedback, followed by a scratch filter and a stage of gain using ½-12AX7. The recorder output jack and tape monitor switch are in the output of this stage so that the scratch filter affects the signals going to a tape recorder. After this come the tone controls, followed by additional gain from the second half of the 12AX7. The power amplifier section uses a 12AX7 voltage amplifier/phase inverter driving push-pull 7591's. Outputs are provided for 4-, 8-, and 16-ohm speakers. The power supply uses a voltage-doubler circuit with silicon rectifiers and a full-wave rectified d.c. supply for preamp heaters.

Alone among the integrated stereo amplifiers we have seen, the KX-200 has a built-in meter with switching facilities for adjusting bias and a.c. signal balance on each output stage. This is an important consideration in a kit designed for construction by lay hobbyists, who might not have access to test equipment.

Following are the results of our lab tests (listed first) with the corresponding manufacturer's specifications where these were available (listed second).

IHFM Music Power (per channel): Not measured by us, rated 40 watts.

Continuous Power (per channel): 32 watts @ 2% distortion at 1 kc. (both channels driven) *versus* 35 watts @ 0.4% distortion (one channel driven).

IM Distortion (at 35 watts per channel, both channels driven): 1% as against 0.8% (one channel driven).

Frequency Response (20-20,000 cps @ 2% distortion): ± 1.5 db (tone controls mechanically centered) *versus* ± 1 db.

Total Hum and Noise (referred to 10 watts): Phono: L (A) −60 db, R (B) −73 db; tuner: L (A) −79 db, R (B) −89 db *versus* −60 db for phono and −74 db for tuner (both converted to 10-watt reference level).

Input Sensitivity (for 10-watts output): Phono .002 volt, tuner .18 volt as against .0019 volt phono (converted to 10-watt reference level) and .188 volt tuner.

Channel Separation (1 kc.): Too high to measure. Manufacturer claims better than −50 db.

Bass Tone Control Range (30 cps): +17 db, −13 db *versus* 30 db total (50 cps).

(*Continued on page* 87)

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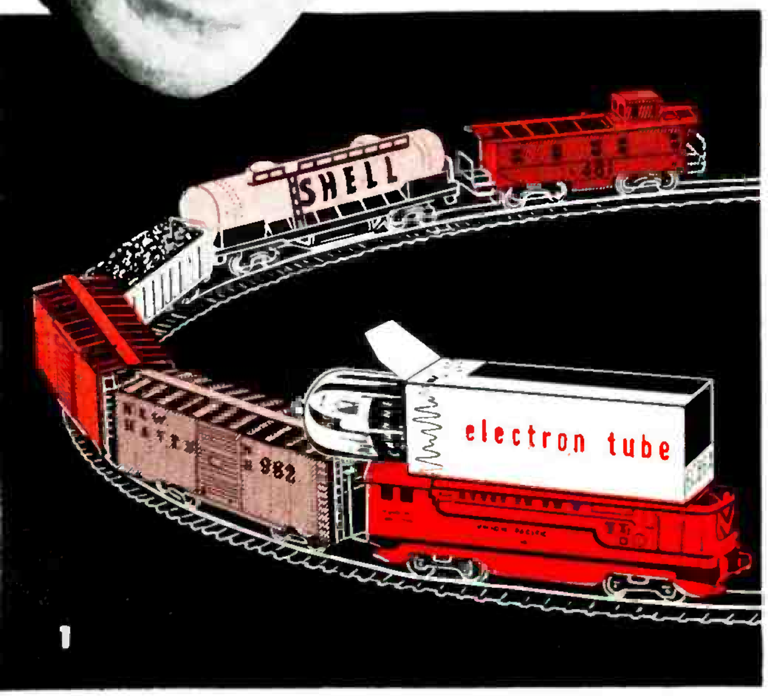

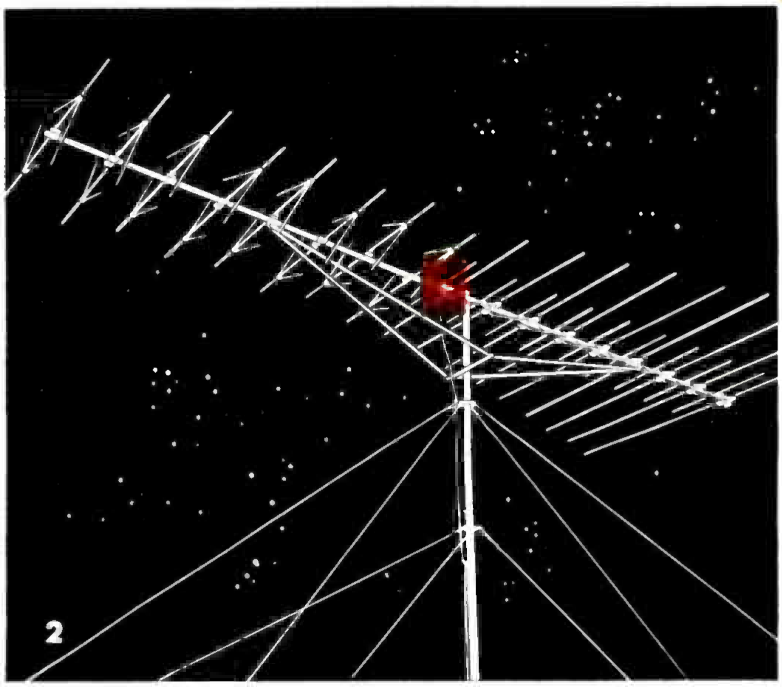

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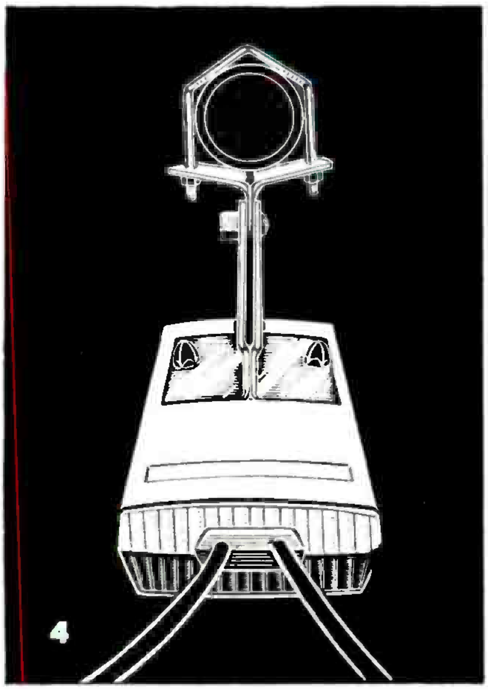
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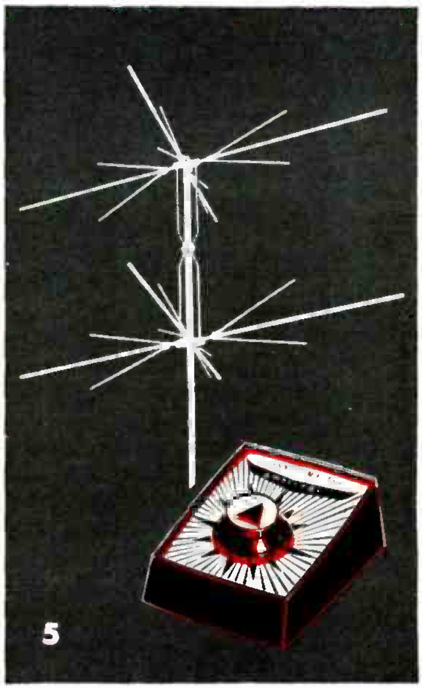
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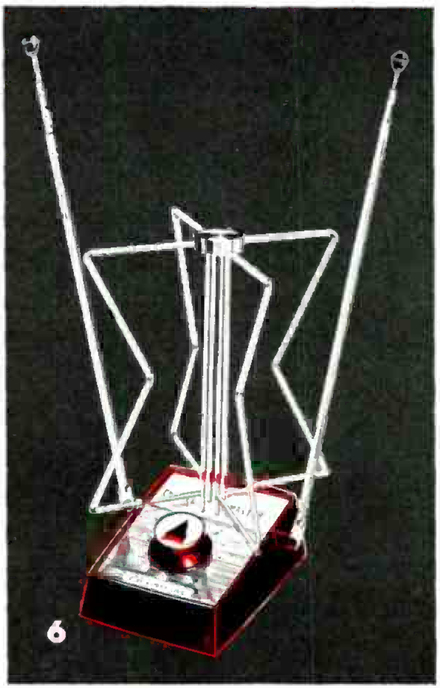
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features peak-power plus lightning-resistant circuit!

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GHOST-KILLER EXTRAORDINARY!

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1. Perfect figure-8 reception pattern, electronically rotated in 22½ degree steps.
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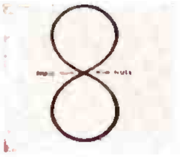

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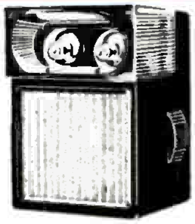

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9 New Features Now In The New EICO RP100 Transistorized Stereo/Mono 4-Track Tape Deck

A great tape recorder made greater:

1. **New** professional studio recording hysteresis-synchronous capstan motor: 24 stator slots for ultra-smooth drive, ultra-quiet and vibrationless professional bearing system.
2. Two **new** take-up and rewind reel motors, both extra-powered for effortless operation.
3. **New** cored-out steel capstan flywheel with all the mass concentrated at the rim for improved flutter filtering.
4. **New** optimally designed capstan drive belt brings wow down to negligibility.
5. **New** relay provides instantaneous extra power to the take-up reel motor at start to minimize tape bounce. Provides near-perfect stop-and-go operation and eliminates any risk of tape spillage when starting with a nearly full take-up reel.
6. **New** automatic end-of-tape stop switch cuts off take-up reel motor power. Also permits professional editing techniques, whereby tape being edited out runs off the machine while you are listening to it.
7. Playback preamps remain "on" during stop-standby mode to permit cueing.
8. Recording level adjustment during stop-standby.
9. Shock-absorbent helical spring tape lifters practically eliminate tape bounce at start of fast winding.

And All These Well-known RP-100 Features:

Separate stereo 1/4 track record and playback heads permitting off-the-tape monitor and true sound-on-sound recording; **separate** transistor stereo record and stereo playback amplifiers meeting true high fidelity standards; monaural recording on 4 tracks; digital turns counter; electrodynamic braking (no mechanical brakes to wear out or loosen); all-electric push-button transport control (separate solenoids actuate pinch-roller and tape lifters); unequalled electronic control facilities such as mixing mic and line controls, two recording level meters, sound-on-sound recording selected on panel, playback mode selector, etc. Modular plug-in construction.

Wow and flutter: under 0.15% RMS at 7½ IPS; under 0.2% RMS at 3¾ IPS. **Timing Accuracy:** ± 0.15% (±3 seconds in 30 minutes). **Frequency Response:** ± 2db 30-15,000 cps at 7½ IPS, 55db signal-to-noise ratio; ± 2db 30-10,000 cps at 3¾ IPS, 50db signal-to-noise ratio. **Line Inputs Sensitivity:** 100mv. **Mike Inputs Sensitivity:** 0.5mv.

Semikit: Tape transport assembled and tested; electronics in kit form $299.95

Factory-assembled: Handwired throughout by skilled American craftsmen $399.95

An original, exclusive EICO product designed and manufactured in the U.S.A. (Patents Pending)

Carrying Case $29.95
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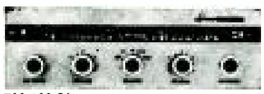
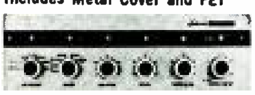


FM-AM Stereo Tuner ST96
Kit $89.95 Wired $129.95
Includes Metal Cover and FET



70-Watt Integrated Stereo Amplifier
ST70 Kit $99.95* Wired $149.95*
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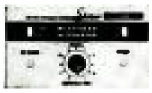

FM Multiplex Autodapter MX99 (Patent Pending)
Kit $39.95
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Cover Optional $2 95

New Stereo FM MULTIPLEX TUNER ST97
Semi-Kit $99.95 Wired $149.95
Includes Metal Cover and FET

Another brilliant example of EICO's no-compromise engineering, the new EICO ST97 combines the features of station-monitor quality and fringe-area reception capabilities with exceptional ease of assembly for the kit-builder. No test or alignment instruments are needed. The two most critical sections, the front-end and the 4-IF stage circuit board, are entirely pre-wired and pre-aligned for best performance on weak signals (fringe area reception). The front-end is drift-free even with AFC defeated. The four IF stages and 1MC-wide ratio detector achieve perfect limiting, full-spectrum flat response, very low distortion, and outstanding capture ratio. The 10-stage stereo demodulator—EICO's famous zero-phase-shift filterless detection circuit (pat. pend.)—copes successfully with all the problems of high fidelity FM stereo demodulation and delivers utterly clean stereo outputs. Excellent sensitivity, selectivity, stability, separation and clean signal add up to superb fringe-area reception. The automatic stereo indicator and station tuning indicator travel in tandem on twin slide-rule dials. **Antenna Input:** 300 ohms balanced. **IHFM Usable Sensitivity:** 3μV (30 db quieting), 1.5μV for 20db quieting. **Sensitivity for phase-locking (synchronization) in stereo:** 2.5μV. **Full Limiting Sensitivity:** 10μV. **IF Bandwidth:** 280kc at 6 db points. **Ratio Detector Bandwidth:** 1mc p-p separation. **Audio Bandwidth at FM Detector:** Flat to 53kc discounting pre-emphasis. **IHFM Signal-to-Noise Ratio:** —55db. **IHFM Harmonic Distortion:** 0.6%. **Stereo Harmonic Distortion:** less than 1.5%*. **IHFM IM Distortion:** 0.1%. **Output Audio Frequency Response:** ±1db 20cps-15kc. **IHFM Capture Ratio:** 3db. **Channel Separation:** 30db. **Audio Output:** 0.8 volt. **Output Impedance:** low impedance cathode followers. **Controls:** Power, Separation, FM Tuning, Stereo-Mono, AFC-Defeat.

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*Actual distortion meter reading of derived left or right channel output with a stereo FM signal fed to the antenna input terminals.

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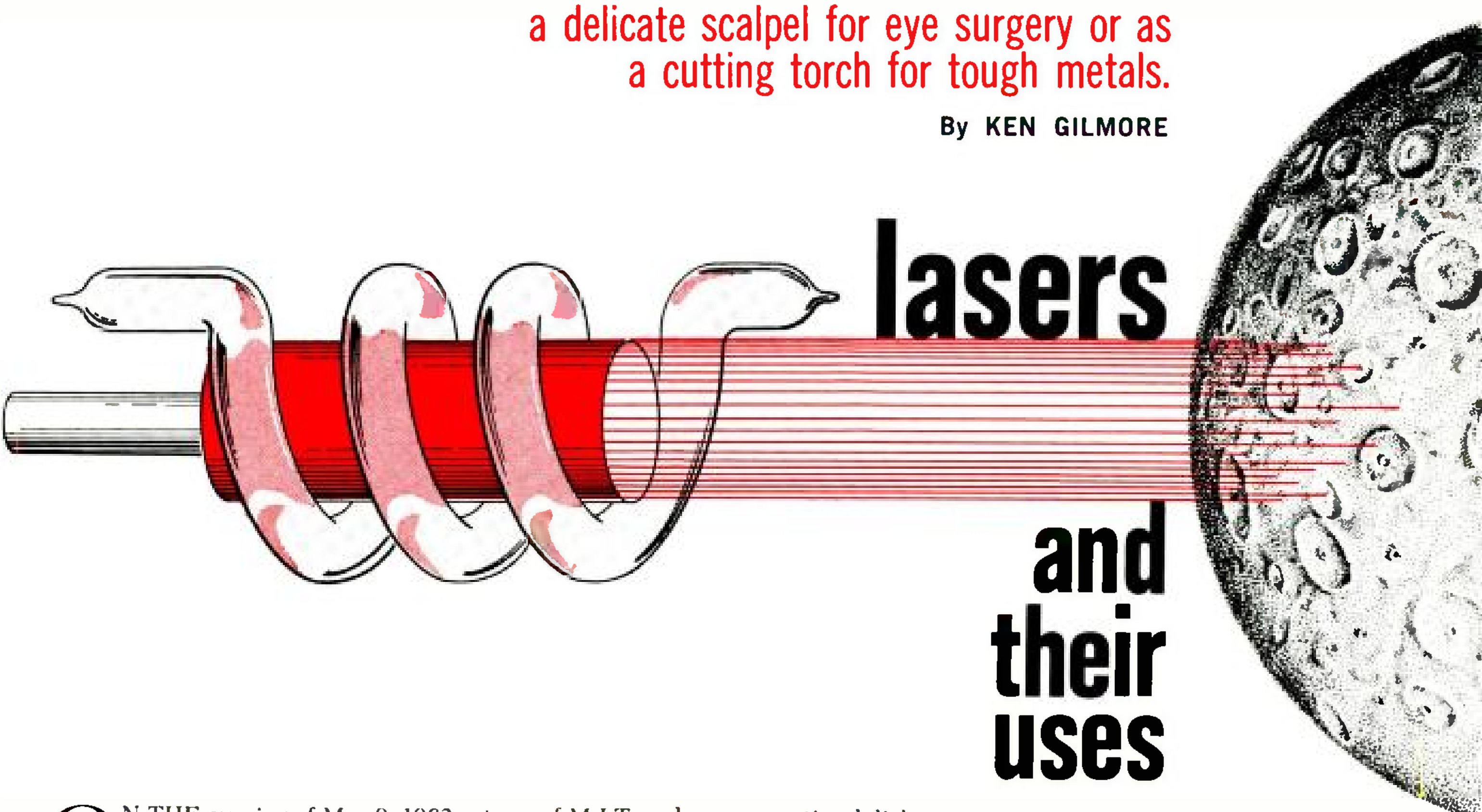
A new source of intense coherent light that can be used as a carrier for space communication systems or as the heart of an ultra-precise radar. This versatile electronic tool is also used as a delicate scalpel for eye surgery or as a cutting torch for tough metals.

By KEN GILMORE



lasers and their uses

ON THE evening of May 9, 1962, a team of M.I.T. and *Raytheon* scientists sent a bolt of brilliant red light hurtling toward the moon. It leaped the 250,000-mile void, illuminated a two-mile-wide circle of the moon's bleak surface, and bounced back to earth. The entire half-million-mile trip took just over two and a half seconds.

This startling accomplishment—the first time man has lighted another celestial body from the earth—was made possible by a super-powerful light maker called the *laser*.

Lighting the moon isn't the only job for which this strange new electronic tool is ideally suited. It also serves as the heart of a new kind of radar with a resolution far sharper than any conventional type. Surgeons have used it as a delicate scalpel for removing tiny tumors deep within the human eye. Put to work producing a carrier wave for a communications system, it may, under certain conditions, transmit more information on a single beam than 25,000 television stations all broadcasting simultaneously. It also welds tough metals, cuts through steel—literally in a flash—and may eventually power spaceships and knock attacking missiles out of the sky.

The laser can perform these and scores of other startling feats because it is the world's first source of *coherent* light; that is, all of its light waves are in step. All light until now—from the sun, from light bulbs, from flame—has been incoherent. It is generated by heat. When atoms get hot enough, they give off energy in the form of light. But atoms release their light energy in a random pattern. For this reason, all conventional light sources are, in a way, noise generators. They're similar to the old spark transmitters which were once widely used aboard ships. The spark transmitter generated many frequencies simultaneously, along with a lot of miscellaneous hash and noise. Such a signal couldn't be modulated readily. To transmit meaningful messages with a spark transmitter, you turned it on and off—sent code.

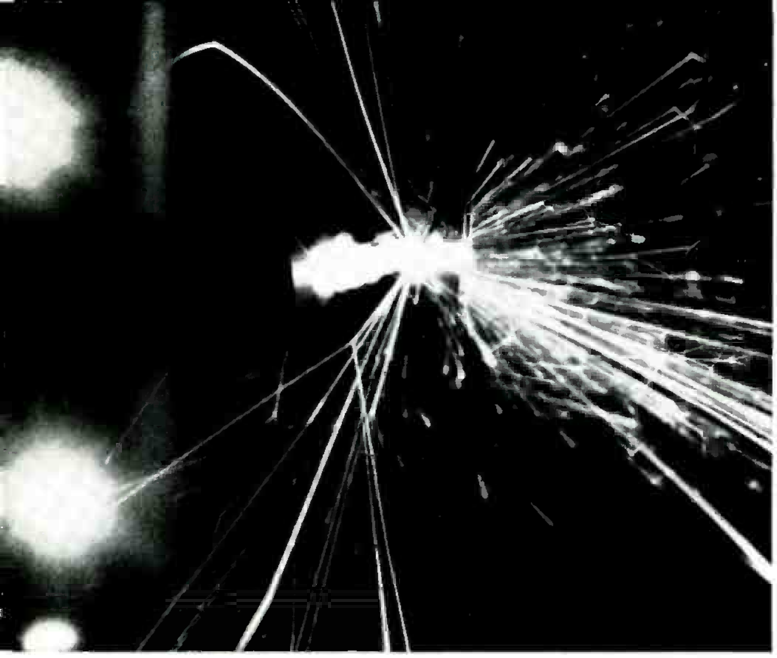
The spark generator's random signals were largely incoherent. Modern transmitters, though, generate a regular, single-frequency *coherent* signal which can carry far more information by being modulated.

The laser is now doing for light what the radio transmitter does for radio-frequency signals. It harnesses the energy of orbiting electrons, gets them to release their power in phase, rather than at random as in a light bulb, and generates a coherent beam of light.

Fluorescence

In some ways, the laser's operation is similar to that of a common fluorescent tube. All fluorescence hinges on the fact that fluorescent materials are able to absorb energy of one frequency and release it at another frequency.

All electrons can exist on a number of different energy levels. Normally, any given electron is in its so-called "ground state." But when it absorbs energy from outside it moves to a higher energy state. In the fluorescent tube, for example, the electrons in the thin fluorescent coating absorb energy in the



A laser beam blasts through a plate of hardened steel at the Bendix Corp. When the laser's tremendous energy is focused into a small spot, temperatures higher than the sun's surface over a given narrow bandwidth are produced in microseconds.

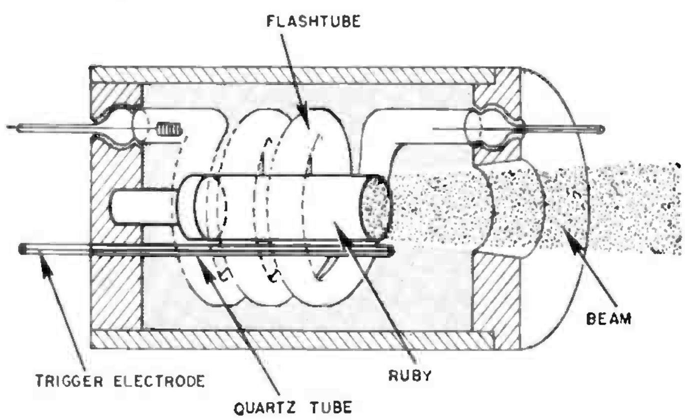


Fig. 1. Basic arrangement used in early Hughes ruby laser.

form of photons from an ultraviolet source built into the tube. In the process, they jump from one atomic orbit to another, where they contain more potential energy. In other words, they store up energy like a spring being wound.

The high-energy state, though, is an unstable one, and a few microseconds later the electrons fall back to their normal lower energy level. During this process, they must get rid of the extra energy they absorb. The electrons do this by radiating the excess energy as light. Almost always, the light radiated is of a lower frequency than that which was originally absorbed. This is true in the fluorescent light, for example, where the white light given off is considerably lower in frequency than the ultraviolet which excited the electrons in the first place.

The laser's fluorescent material is either a combination of gases or synthetic ruby made of aluminum oxide with a sprinkling of chromium atoms. The chromium absorbs green light of a certain frequency, which raises its electrons to a high level. When they fall back to the normal low-energy level, they fluoresce and give off a red light.

The light resulting from natural fluorescence, though, is as incoherent as any other light. To make the ruby into a laser, each electron must be coaxed into radiating its energy in phase with all the others.

To accomplish this trick, the ruby is machined into a cylinder some ¼-inch in diameter and from 2 to 8 inches long. The ends of the cylinder are polished, then silvered so that they become tiny mirrors. One of the ends is only partially silvered, and remains somewhat transparent. When green light of the right frequency (from a flashtube) is applied to the ruby, the chromium atoms are "pumped" to a high-energy state. As some of the electrons fall back to the normal state, the light they radiate is reflected from the end mirrors and travels back down the length of the rod. On this trip, it strikes other excited electrons, prodding them into releasing their excess energy (Fig. 1).

Fortunately, the light radiated by the triggered electrons is in phase with the beam which tripped the reaction. As the now-intensified light continues to travel through the ruby, more and more electrons are stimulated into giving up their energy, all in phase with the constantly building signal. It reaches one end, is reflected, and starts back on another trip through the tube. The light surges back and forth, and continues to build, until finally it is so powerful that a ray bursts forth from the lightly silvered end of the tube in a cascade of coherent light. The whole process, from pumping to output of the beam, takes only a few hundred microseconds.

Meanwhile, of course, other electrons have radiated their light in directions other than parallel with the tube's axis. These rays simply leave through the side of the tube and do not have an opportunity to build into a coherent beam.

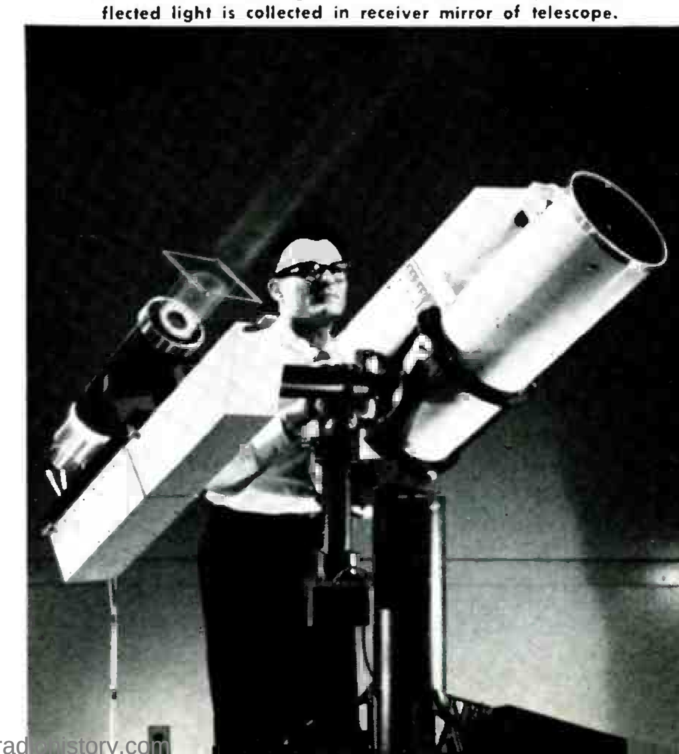
The Maser

The laser grew out of work which began back in 1954. Dr. C. W. Townes, then of Columbia University, was looking for a way to build a new kind of high-frequency amplifier. Townes confined ammonia gas in a tube and bombarded its atoms with microwave energy at a frequency designed to pump the electrons into a high-energy state. Then he piped in low-level signals to be amplified. These small signals stimulated large numbers of the unstable high-energy electrons into releasing their stored-up energy. A small input, in other words, triggered a large output.

Townes called the device a "maser"—*m*icrowave *a*mplification by *s*timulated *e*mission of *r*adiation. Other researchers soon built solid-state masers working on the same general principle. They were excellent low-noise, high-sensitivity amplifiers and made possible such feats as the M.I.T. Venus radar contact in 1958 and the cross-continent transmissions bounced from the "Echo I" satellite in 1960.

Townes, meanwhile, had predicted that a similar device could be made to operate at extremely high frequencies—actually in the visible light spectrum. Further, an active medium which would give out coherent light (it would be called an

Experimental laser radar devised by Hughes. The laser (at left) produces an intense, tightly focused light beam that is aimed toward a target a number of miles away. The reflected light is collected in receiver mirror of telescope.



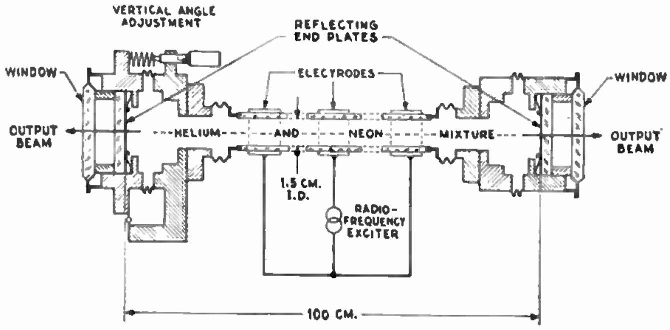


Fig. 2. One of the first gaseous optical masers built by Bell. By making one of the end plates completely reflecting and the other only partially reflecting, the output beam is made to emerge in only one direction. A horizontal angle adjustment at the right (not shown) moves the right-hand reflecting plate slightly in order to get horizontal alignment.

"optical maser" or a "laser"—*l* for light*) could be made to oscillate by enclosing it in a resonant cavity. But with the wavelength of light measured in angstrom units (the visible spectrum includes wavelengths centering around 1/2000th of a millimeter), a cavity resonant at laser frequencies would be microscopic. At this point, Townes and Dr. Arthur L. Schawlow hit upon the idea of building the active medium—still to be found in those days—into a cylinder with a mirror at each end to reflect the light energy back and forth and set up laser action.

By this time research laboratories around the country were trying to find a suitable active material which would work in this configuration. Dr. T. H. Maiman of *Hughes Aircraft Corporation* succeeded first, and displayed a working model in July, 1960. Many other experimenters succeeded with slightly different materials and configurations before the end of the year. By 1961, *Bell Labs'* scientists had built and demonstrated a different kind of laser. It used a mixture of helium and neon as the active medium (Fig. 2).

Early solid-state lasers were pulsed units. The excited electron supply was quickly depleted when laser action began. Normal output was a series of high-intensity pulses usually lasting about a millisecond. Pulse rates of one to four or five a minute were common. Recently, pulse rates of ten per second have been achieved. The gas laser operated continuously, but was inherently a much lower powered device than the solid-state version. Consequently, a great deal of research was aimed at building a continuously operating solid-state device. *Bell Labs* was first to demonstrate such a unit early last year.

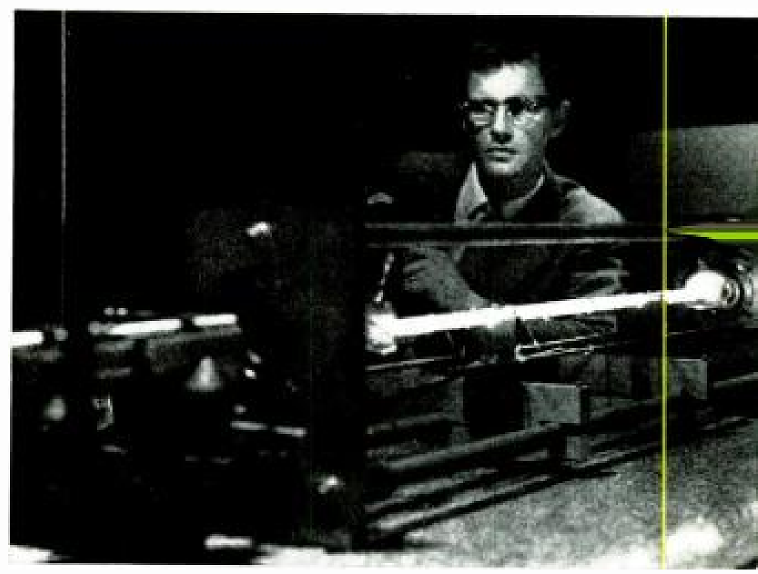
Bell Labs scientists check alignment of optical maser tubes containing the five noble gases—helium, neon, argon, krypton, and xenon. The new masers generate fourteen coherent infrared wavelengths, providing as many potential communications carriers.

*Some consider the term "optical maser" a general one to describe devices of this type operating in the visible and invisible portions of the spectrum; the term "laser" would then apply only to devices that operate in the visible portion of the spectrum.

The laser's coherent light beam is valuable in many ways. First and most obvious, it is ideally suited for communications. Unlike the incoherent light beam which can only be turned on and off to transmit intelligence—a "blinker" system used by the Navy for ship-to-shore signaling for many years—a laser beam can be modulated. Furthermore, since bandwidth—and thus information-carrying ability—is proportional to frequency, the amount of information a laser signal can carry is staggering. (This assumes a laser beam of sufficient intensity. Light is actually composed of photons. In order for a light beam to assume wave-like characteristics, large numbers of photons must be present, forming a relatively high-intensity beam.) A single laser beam under the right conditions can easily have a bandwidth of 100,000 megacycles. A single signal of this frequency can carry as much information—voice, teletypwriter, or television signals—as *all communications channels now in existence*. Obviously, a few laser relay satellites orbiting the earth could go far toward wiping out the rapidly worsening electronic traffic jam.

Some of the Problems

Of course, there are problems. The laser's beam, like other light rays, can't go through clouds, fog, snow, smoke, or other types of poor atmospheric conditions. Thus laser satellite stations will have to be located in desert regions and other similar areas which enjoy clear skies most of the time. A system of

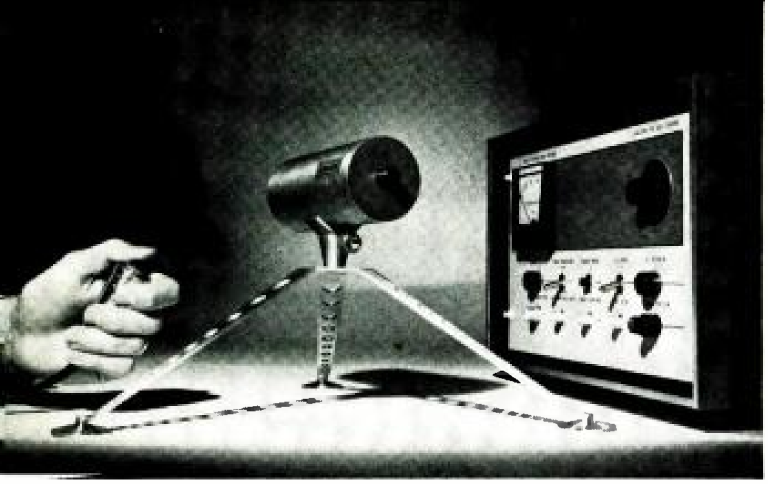


This gas laser is the heart of Sperry's moving-target radar.

alternate stations will go far toward making the over-all reliability of such a system higher, since if one is disabled by a cloud cover, another can take over.

For overland transmission of information, laser signals will probably be transmitted through waveguides. Communications experts estimate that the message load in this country doubles every ten years. A network of laser-carrying waveguides from coast-to-coast would provide enough information-carrying ability to meet the need for decades. *ITT* scientists have estimated that a 2-watt gas laser (most present ones have outputs in the milliwatt range) could transmit a wide-band signal 60 miles through such a pipe, maintaining a 20:1 signal-to-noise ratio.

One of the prime problems in putting super information-carrying systems into operation: extreme high-frequency modulation techniques have yet to be worked out. Progress in this field is being made, though. Certain electro-optical materials which change their light-transmission characteristics when subjected to an electrostatic field have been demonstrated successfully, although methods used to date are limited. Ammonium dihydrogen phosphate crystals, for example, have been used to modulate laser signals at nearly 100% up to 1000 mc. The same system yielded 5% modulation up to



One example of a commercially available laser. The head for the Hughes-built unit weighs about one pound. With the accompanying power supply (right) this model sells for about $2500. Several other manufacturers have available for laboratory and experimental use various low-power lasers, which range in selling price from around $2500 to $10,000 or more.

15,000 mc. A. E. Siegman of Stanford University recently reported attaining 100% amplitude modulation at 2800 mc. with the system illustrated in Fig. 3.

One of the big difficulties is that electro-optical crystals such as these require modulation voltages on the order of 17 kilovolts, a level difficult to handle at the necessary frequencies. The Kerr Cell, a well-known liquid electro-optical device, requires voltages on the same order of magnitude.

Sharply Focused Beams

Coherence brings with it benefits other than information-carrying ability. It also makes it possible to focus the laser's light output into an incredibly tight, sharply focused beam. As the light rays come from the end of present-day units, they spread only about 1/20th of a degree. By way of contrast, the tightest microwave beam, or the biggest spotlight, can barely squeeze its beam into a one-degree arc. Furthermore, the laser's beam can be narrowed even more by focusing it through simple lenses. The beam bounced from the moon by M.I.T. scientists, for example, was sent through a telescope backwards. Consequently, it formed a spot only 2 miles in diameter on the surface of the moon. The tightest microwave beam, on the other hand, would form a spot 25,000 miles across the moon. Besides, the antenna necessary to focus the microwaves into a 1° beam would be enormous—even for ultra-high-frequency signals.

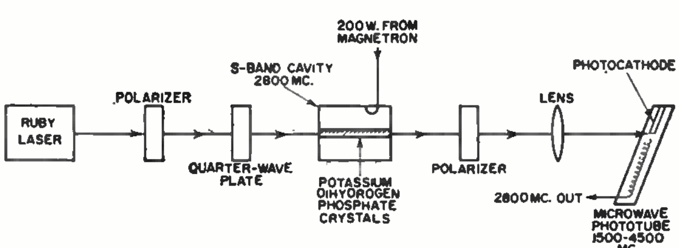
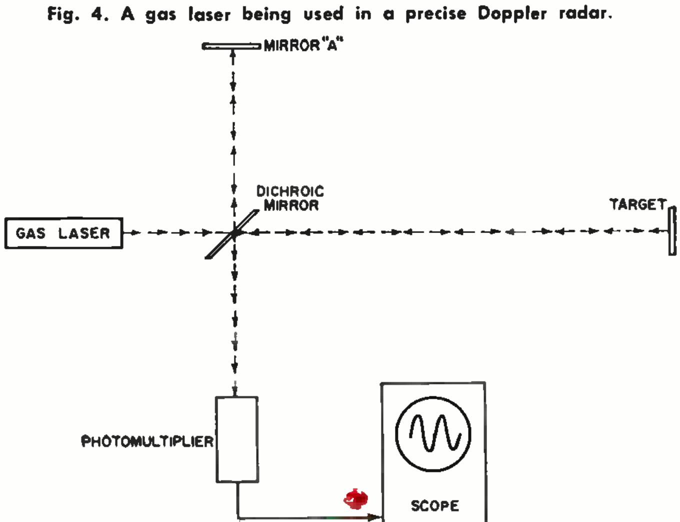


Fig. 3. System used to obtain 100% modulation at 2800 mc.

Fig. 4. A gas laser being used in a precise Doppler radar.



The laser's sharply focused beam makes it a natural for a number of applications. Radar, of course, is one of the most obvious. *Sperry Gyroscope* has built one prototype model which in early tests easily distinguished as individual targets a row of floodlights about the size of automobile headlights one foot apart at a range of 1500 feet. Engineers calculated that the actual reflecting target was a spot about four inches in diameter on each light. Future units should have even better resolution. Such radars, with their relatively tiny optical focusing devices, will be ideal for space, since they are so much smaller and lighter than microwave units of comparable resolution.

Sperry researchers have also built a prototype Doppler radar which may be extremely valuable in measuring accurately the closing rate between two rendezvousing spaceships. Fig. 4 shows the arrangement. The output of a gas laser hits the dichroic mirror, where it is split into two beams. One is deflected at right angles to reflecting mirror "A," and the other continues in a straight line to the target. The beam from mirror "A" is reflected, passes through the dichroic mirror, and strikes the photomultiplier. At the same time, the beam from the target is reflected back to the dichroic mirror where it is deflected at 90 degrees and it, too, strikes the photocell.

Now as long as the target is not moving, the two signals hitting the photocell are at the same frequency. But when the target moves in either direction, the returning echo is Doppler shifted. A beat note is generated and is detected by the photomultiplier. The faster the target moves, of course, the higher the beat-note frequency.

Doppler microwave radars working on the same principle can be built, of course, but they are accurate only for relatively high velocities. The basic frequency of the gas laser, on the other hand (in the area of 260,000,000 mc.), is so high that even a very slight movement of the target produces a large Doppler shift. A target approaching at a rate of only one inch per second, for example, produces a Doppler shift of about 60 kc., easily detectable and measurable. Signals developed by a device this precise could be applied to an automatic spaceship control system and would allow the ships to meet with hardly a bump.

With the laser's extremely tight beam, spaceships will be able to communicate in perfect secrecy. Experts estimate that a ship orbiting the earth a thousand miles up could aim a beam at its home base that would cover a forty-foot circle on the ground. No one not directly in the beam could intercept the message or jam the transmission. Laser radar, by the way, will enjoy the same virtually jam-proof quality.

A Super Heater

Coherence brings with it a third outstanding advantage: tremendous amounts of heat can be packed into the beam. Units already built produce millions of times the heat of the sun in a specific part of the frequency spectrum. The sun, for example, radiates about 7 kilowatts of energy from each square centimeter of its surface. This may seem like quite a lot of power, but it is distributed over a tremendously broad spectrum. Most of this energy is emitted in the visible spectrum, covering wavelengths from about 4000 to 7000 angstrom units. Each of these angstrom units stretches over a frequency range of about 100,000 mc. The visible spectrum, then, covers a band of over 300,000,000 mc. This compares with our present radio spectrum which is only a few thousand megacycles wide.

(*Continued on page* 72)

Useful chart for the technician that permits quick calculation of regulation by use of a straight edge.

POWER SUPPLY REGULATION NOMOGRAM

By DONALD W. MOFFAT

THE quality of a power supply is generally expressed in terms of its regulation. Ideally, the output voltage should remain the same under any load from open circuit to full rated current. However, this ideal arrangement could be achieved only if the power supply could be a voltage source with zero internal impedance, a condition that can be approached to within a fraction of an ohm with well-designed feedback regulators. Of course, we are not considering power supplies that provide a potential only, such as second-anode high voltage, where a high resistance is purposely added to limit current for safety reasons.

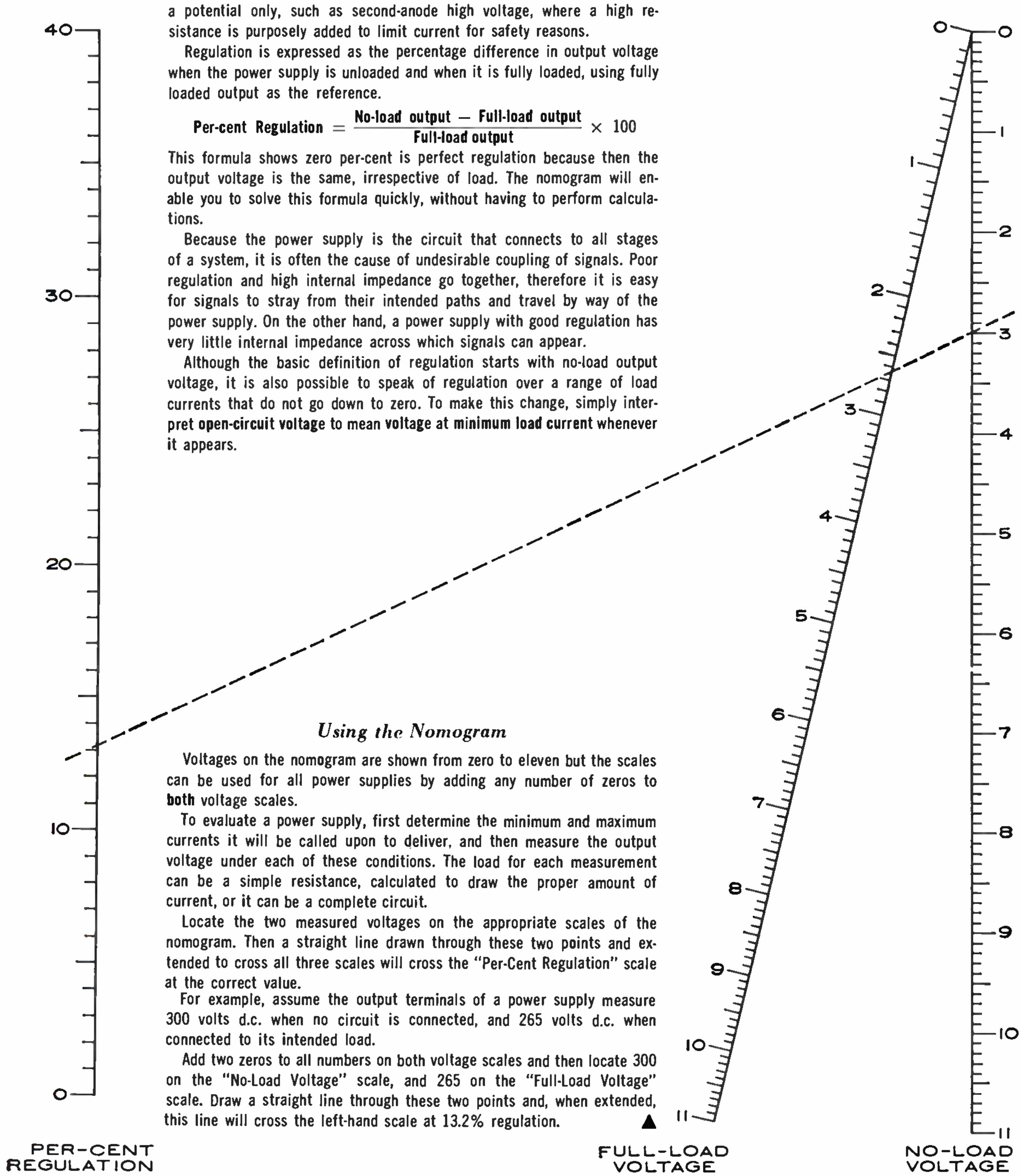
Regulation is expressed as the percentage difference in output voltage when the power supply is unloaded and when it is fully loaded, using fully loaded output as the reference.

$$\text{Per-cent Regulation} = \frac{\text{No-load output} - \text{Full-load output}}{\text{Full-load output}} \times 100$$

This formula shows zero per-cent is perfect regulation because then the output voltage is the same, irrespective of load. The nomogram will enable you to solve this formula quickly, without having to perform calculations.

Because the power supply is the circuit that connects to all stages of a system, it is often the cause of undesirable coupling of signals. Poor regulation and high internal impedance go together, therefore it is easy for signals to stray from their intended paths and travel by way of the power supply. On the other hand, a power supply with good regulation has very little internal impedance across which signals can appear.

Although the basic definition of regulation starts with no-load output voltage, it is also possible to speak of regulation over a range of load currents that do not go down to zero. To make this change, simply interpret **open-circuit voltage** to mean **voltage at minimum load current** whenever it appears.



Using the Nomogram

Voltages on the nomogram are shown from zero to eleven but the scales can be used for all power supplies by adding any number of zeros to **both** voltage scales.

To evaluate a power supply, first determine the minimum and maximum currents it will be called upon to deliver, and then measure the output voltage under each of these conditions. The load for each measurement can be a simple resistance, calculated to draw the proper amount of current, or it can be a complete circuit.

Locate the two measured voltages on the appropriate scales of the nomogram. Then a straight line drawn through these two points and extended to cross all three scales will cross the "Per-Cent Regulation" scale at the correct value.

For example, assume the output terminals of a power supply measure 300 volts d.c. when no circuit is connected, and 265 volts d.c. when connected to its intended load.

Add two zeros to all numbers on both voltage scales and then locate 300 on the "No-Load Voltage" scale, and 265 on the "Full-Load Voltage" scale. Draw a straight line through these two points and, when extended, this line will cross the left-hand scale at 13.2% regulation. ▲

the ACOUSTICAL LENS

By GEORGE L. AUGSPURGER

Operation and performance of various types of devices used professionally and in home hi-fi speaker systems to disperse and shape sound energy from horn-type driver units.

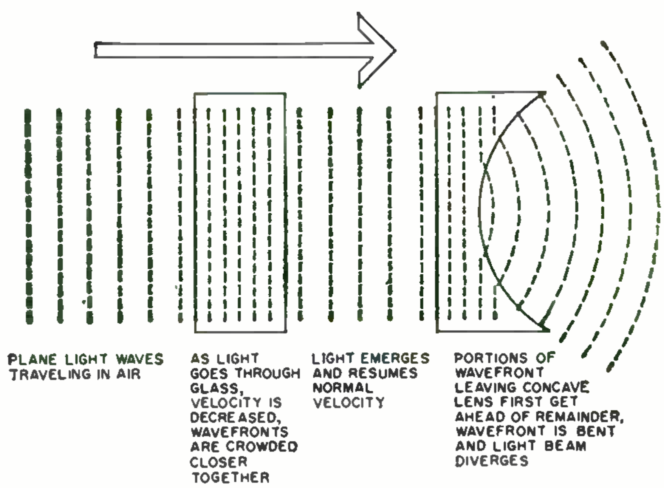


Fig. 1. Light waves passing through flat glass and concave lens.

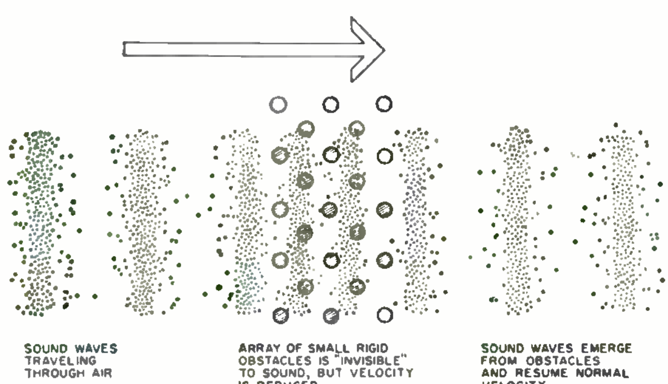
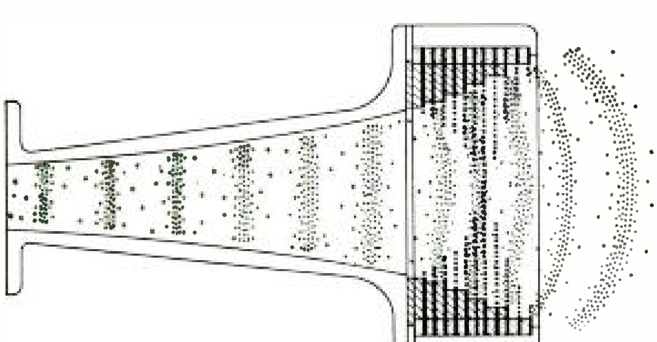


Fig. 2. Sound waves are shown passing through an obstacle array.

Fig. 3. Cross-section drawing of perforated-plate acoustical lens.



IN the last few years, more and more attention has been paid to the desirability of wide high-frequency dispersion in high-fidelity loudspeakers. This concern with a loudspeaker's distribution pattern is a good thing, but it is nothing new to the designers and users of professional equipment. In elaborate sound-reinforcement systems and theater sound installations, the problem is much more complicated than simply trying to avoid beaming of the treble frequencies. Careful control of loudspeaker directional characteristics is just as important here as are the optical properties of a spotlight to the lighting designer.

One of the most sophisticated, least understood, yet certainly most interesting methods of controlling sound directionality is the employment of an acoustical lens.

What the Lens Does

An acoustical lens is usually used in conjunction with a horn-type loudspeaker. The horn, especially in the high-frequency range, has numerous assets, but two major disadvantages: first, a good horn and driver combination tends to be more expensive than a cone-type loudspeaker and second, it is extremely directional. The first drawback is largely counterbalanced by the efficiency, dynamic range, and fidelity of the better units. The second can be overcome in a number of ways—by making the horn a special shape, by making a fan-shaped array of smaller horns, or by adding an acoustical lens. The lens introduces no tonal coloration and can be designed to give almost any desired directional pattern.

Historical Background

The possibility of making an acoustical lens, analogous in function and operation to an optical lens, first occurred to two *Bell Telephone Laboratories'* engineers who were working on refraction effects in conjunction with microwave transmission.

W. E. Kock and F. K. Harvey decided to see if certain techniques applicable to radio microwaves wouldn't also work, as theory suggested, with sound waves. In their experiments, they developed various acoustical converging and diverging lenses, as well as prisms.

The findings of Kock and Harvey were reported in the September, 1949 *Journal of the ASA* under the title "Refracting Sound Waves." The account is highly readable and remains the basis for present acoustical lens design.

How Acoustical Lenses Work

There are two basic classes of acoustical lenses: the "obstacle array" and the "path-length refractor." Both operate exactly as do optical lenses, by effectively slowing down a portion of the advancing wavefront as it passes through the lens.

When light passes through an optical lens, the effect is usually explained along the lines illustrated in Fig. 1. If we imagine a series of parallel light rays (as from the sun) this means that the wavefront is a plane surface. As this plane moves through, say, a piece of glass, it is slowed down momentarily. The refractive index, an omnipresent term in optics, is nothing more nor less than an indication of the relative velocity with which light travels through the medium in question.

So, our light wavefront slows down as it goes through the glass, then resumes its usual bustle when it gets back on the freeway. If the two surfaces of the glass are not parallel, but curved into the familiar lens shape, the part of the wavefront which has the least glass to go through resumes its normal velocity first and the wavefront is curved as it emerges.

Since the direction of travel of wave-propagated energy is at right angles to the wavefront, the light emerging from a lens tends either to diverge or converge, depending on whether the lens is concave or convex. Those who remember Huygens' principle will also probably recall the hours spent with ruler and compass laboriously plotting this effect.

To make the lens work with sound waves instead of light waves requires only that we find a substance which is transparent to sound, but which reduces the velocity of sound waves traveling through it.

The Obstacle Array

Harvey and Kock discovered that an array of small obstacles (small in comparison to any wavelength under consideration) has the same properties as a transparent homogeneous medium with a refractive index greater than one. In other words, sound will pass through such an array as if it wasn't there *except* that it comes out the other side just a little later than if it had traveled the same distance through air.

Fig. 2 shows what happens. The wavefront diffracts around individual particles, but in doing so its velocity is decreased. The obstacles, it was found, could be irregular, spherical, disc shaped, or parallel strips. Even a series of perforated plates exhibited the same refractive properties, and this configuration is obviously the easiest to use in constructing a concave, diverging lens.

Fig. 3 shows a cross-section of such a perforated-plate lens built into the mouth of an exponential horn. This basic design is used, for example, by *James B. Lansing Sound, Inc.* both in large theater assemblies and in smaller units for home high-fidelity installations.

Perforated-plate lenses are usually made of circular discs, and the resulting distribution pattern is symmetrical. The assembly shown at (B) in the photo, for example, has a smooth distribution pattern extending through a solid angle of about 90 degrees.

Path-Length Refractors

This configuration is easier to understand than the obstacle array since one can *see* why a portion of the wavefront is delayed. In this case, the delay is achieved by making a portion of the wavefront travel a greater distance to get from one side of the lens to the other. The enforced detour produces the same results as if the sound had traveled straight through at reduced velocity.

The two common varieties of path-length refractors are shown diagrammatically in Fig. 4. Sound traveling through the serpentine configuration winds back and forth until it emerges, while sound going through the slant-plate configuration travels in a straight line, *except* that the line is not its original direction of travel.

In the latter case, common sense tells us that the emerging wavefront will be heading in a different direction than when it entered. But common sense is wrong. Once through the detour, the sound continues in exactly the same direction as before! The separation between plates, remember, is small compared to a wavelength and the composite wavefront does not become tilted. If you are still suspicious, get out the ruler and compass and try Huygens' construction.

In terms of cross-section view then, a wavefront passing through either a serpentine or a slant-plate lens emerges traveling in its original direction, having only been slowed down momentarily. Where does the lens effect take place?

The answer is apparent if we look at a top view, as in Fig. 5. The design shown is equally applicable to either slant-plate or serpentine lenses, and it is easy to see that from this angle at least, the device has the characteristic of a diverging lens.

Such a path-length refractor can be compared to an astigmatic optical lens—it disperses sound waves in the horizontal plane while keeping them concentrated vertically. Such a distribution pattern is especially valuable in auditoriums and theaters where sound energy must be concentrated on the audience, and kept off reflecting surfaces to avoid excessive reverberation and echo.

Parts (A) and (C) of the photo show two *JBL* driver-horn-lens assemblies. The larger unit incorporates a slant-plate lens,

(*Continued on page* 62)

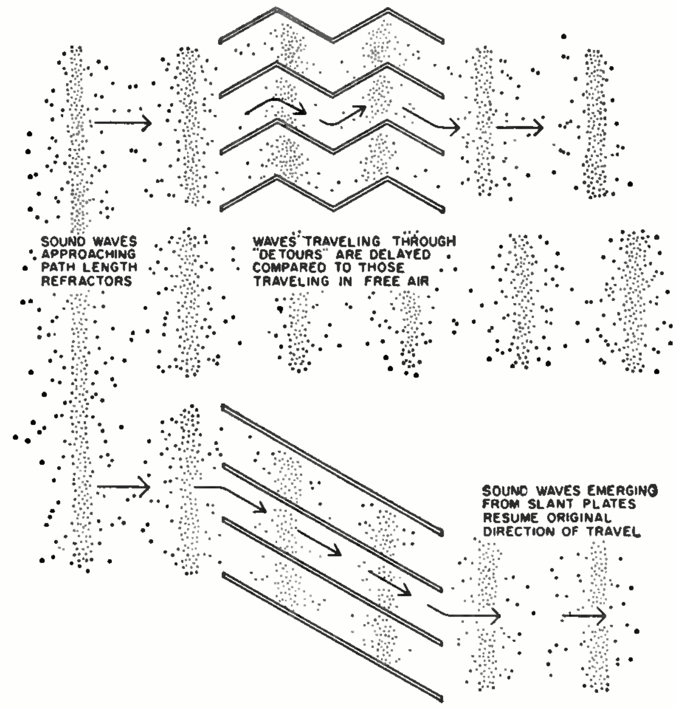


Fig. 4. Serpentine (top) and slant-plate path-length refractors.

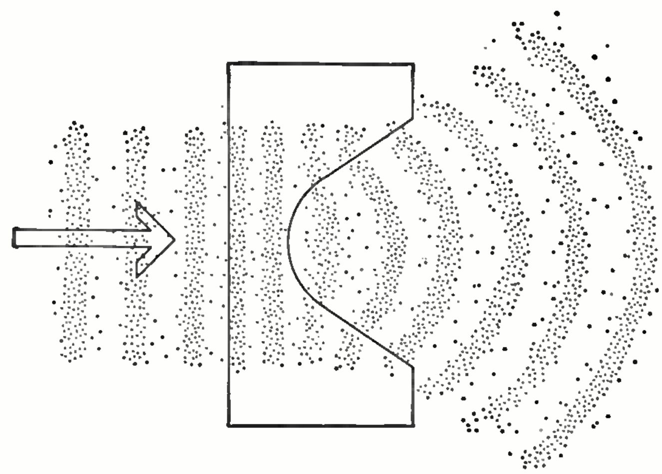
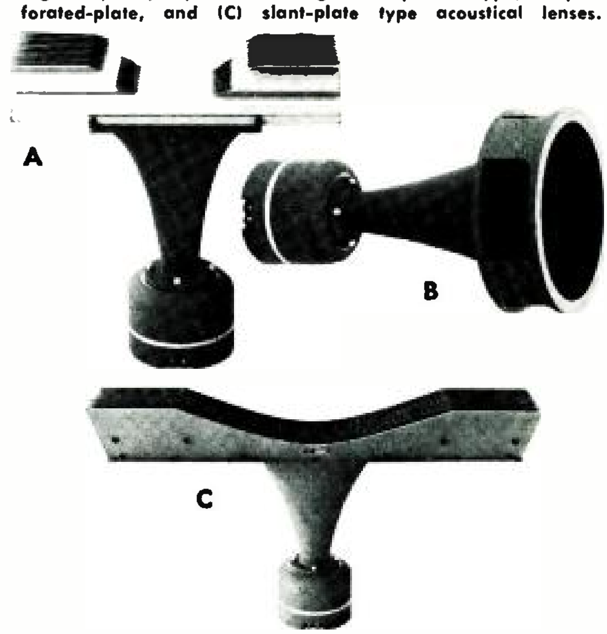
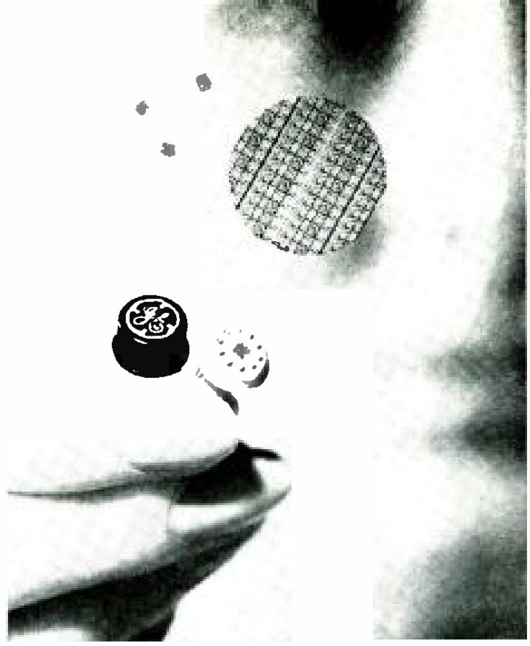


Fig. 5. Top view of slant-plate or serpentine acoustical lens.

High-frequency reproducers using (A) serpentine-type, (B) perforated-plate, and (C) slant-plate type acoustical lenses.



RECENT DEVELOPMENTS IN ELECTRONICS

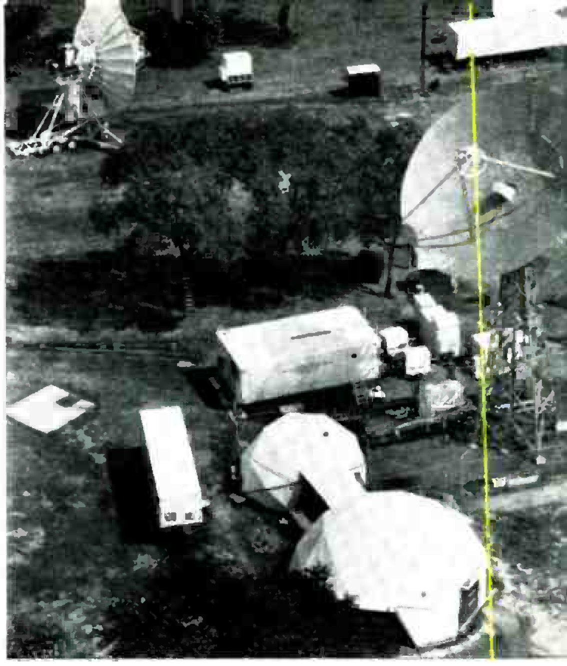


▲ New Microelectronic Circuits
A new technique for producing microelectronic circuits has been developed by G-E which cuts production time by 80% and allows a wide variety of circuits to be made. As many as 18 transistors and 66 tapped resistors are available on a single silicon chip in a TO-5 case. The various elements are then interconnected by deposited aluminum strips in a custom design as required by the user.

5-megawatt U.H.F. Antenna ▲
This 114-foot, 13½-ton television broadcasting antenna indicates a trend developing among u.h.f. stations toward improving their technical facilities. First of its type, the antenna is shown being tested by RCA at Gibbsboro, N.J. The cylindrical antenna can radiate 5-million watts of power from its oblong slots. The antenna is to be put into service by WSBT-TV, South Bend, Ind.

▲ Truck-Borne Radar
Part of the first shipment of a new tactical long-range search radar from Westinghouse to the Seymour-Johnson Air Force Base in Goldsboro, N.C. is shown in the photo during its post-loading check. The complete radar, including components, inflatable antenna and radome, can be transported in about five such trucks. Prototypes of the radar are also housed in the radomes in the background. The system can be set up and put into operation within six hours after landing anywhere on the globe.

← Plastic Antenna Lens
Plastic-impregnated Fiberglas coated with silver and formed into a cellular lens is being used to focus high-energy radar beams. Sperry Gyroscope Co. has recently been granted a patent for the manufacturing process. The company is using giant plastic radar lens, as shown in the photo, to reduce the weight and increase the efficiency of shipboard missile guidance antennas.



Project "Relay" Equipment ▲

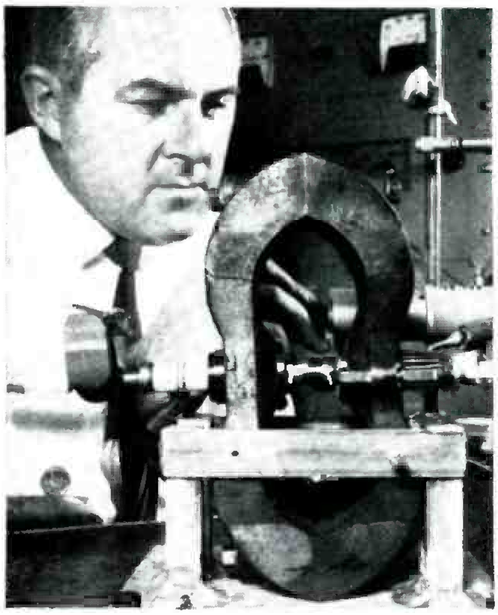
This equipment at ITT Federal Labs, Nutley, N.J. will soon take part in intercontinental communication tests via NASA's "Relay" satellite to be launched late this year. A link is to be set up between the United States and Brazil over which multichannel voice and teleprinter or high-speed data information is to be transmitted. Project "Relay" is a low-altitude, active repeater communications satellite experiment.

Electronic Phone Exchange ▲

Wiring for the first electronic community dial telephone exchange is shown being completed at Rochester, N.Y. plant of General Dynamics/Telecommunication, which designed and manufactured the system for Independent Telephone Corp. Put into commercial operation at Etna, N.Y., the exchange uses solid-state circuitry which makes connections in fraction of a second and affords improved transmissions.

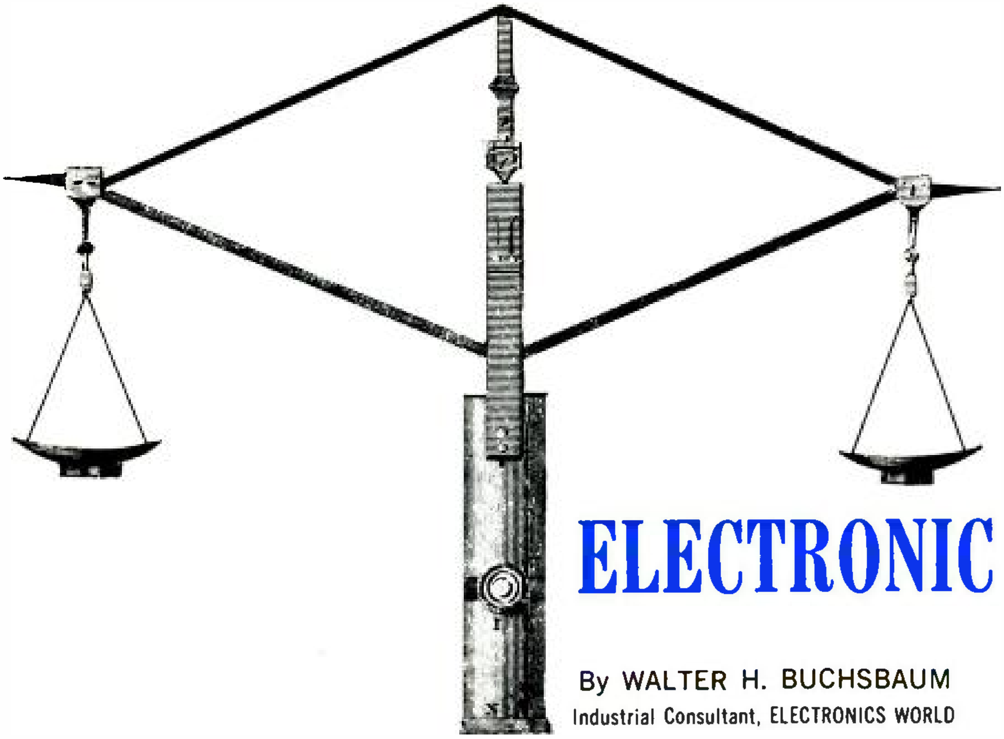
Commercial Visible-Light Laser ▼

The first visible-light continuous-wave laser designed for the commercial market is shown below. The unit uses helium and neon gases to produce a continuous bright red beam of coherent visible light at a wavelength of 6328 angstroms. The excitation chassis, mounted in the housing at the center of the tubular assembly, is a 40-watt, 41-mc. r.f. oscillator. The laser is being marketed by Perkin-Elmer Corp. at $7900.



▲ **High-Power Traveling-Wave Tube**

A new high-power traveling-wave tube, developed by Hughes Aircraft Co., could eliminate radio blackouts experienced by astronauts. Company scientists said the new tube could produce enough power to transmit through the heat-induced "ion shields" which surround spacecraft during re-entry from orbit and normally prevent communications. The tube operates in conjunction with a powerful permanent-magnet assembly as shown in the photo. The unit has been tested at a frequency of 55,000 mc. with an efficiency of 30 per-cent.



ELECTRONIC WEIGHING

By WALTER H. BUCHSBAUM
Industrial Consultant, ELECTRONICS WORLD

Electronic devices speed up automated weighing, mixing, and packaging operations and assure higher product uniformity in many industries.

NOT SO many years ago we were accustomed to go to the grocery store and have the clerk weigh out a pound of sugar by dipping the scoop into the barrel and pouring the sugar slowly on the scale. When we consider the labor that would be involved if we were to depend on hand weighing for all the things available in a modern supermarket, we realize how important automatic weighing processes are. Few of us, however, are aware of the important part that electronics plays in weighing, nor does the layman appreciate how widespread and vital automatic weighing is to all phases of our economy.

In addition to food, practically all chemicals, plastics, and other raw materials of modern industry are weighed prior to processing. Weighing is an important industrial process not only for packaging but also in mixing. Weight is further used as a measure of quality control on such diverse items as steel pipe and foundry sand. In pipe it is a measure of pipe uniformity and in foundry sand it indicates the amount of moisture present.

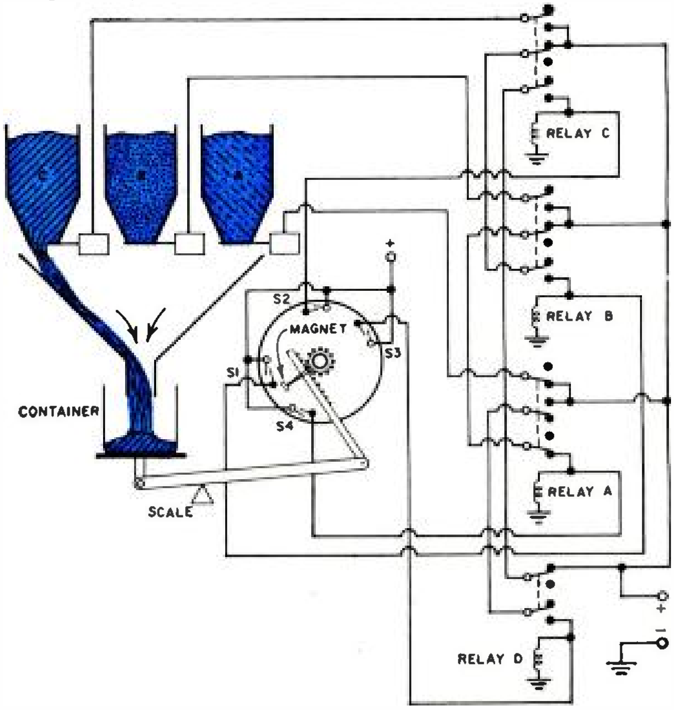
The field of weighing is large and well established but the addition of electronics is a new feature. While the electronic principles involved are well known and not very sophisticated, all-electronic weighing systems can become quite complex. The examples given here are intended to illustrate the basic configurations which are widely used where electronics and scales are combined.

The Functions of Electronics

The contribution that electronics makes to automatic weighing is in three separate areas. Electronic devices are used to detect when the scales are balanced, they also measure the weight itself, and they record the weight. In many automatic weighing systems the weighing and recording are an integrated process, almost entirely dependent on electronic circuits, but these systems usually deal with relatively large weights, not pounds or ounces. Where weighing is part of an automatic packaging process, such as filling sugar bags, the scale is usually a mechanical balance, similar to the one the druggist uses. The electronic device senses when balance is reached and actuates a shut-off gate. Because electronic devices operate almost instantaneously, the weight will be exact, without overflow or underweight.

In practically all industrial scales the counterweight is much less than the weight to be measured and balance is obtained by mechanical leverage. A very simple system of balance sensing involves a switch actuated by the scale-beam motion, as shown in Fig. 2. While industrial systems are usually more complex, this illustration contains the basic elements which make up more complex systems. As the material pours into the bag, the scale beam tilts upward until, at the correct weight, the switch is tripped. This opens the holding circuit for the solenoid which controls the flow of material. The spring working against the solenoid now pulls the shut-off gate across the loading funnel. When the full bag has been replaced by an empty one, the scale indicator will move down, closing the switch and actuating the solenoid again. The flow of material starts again. There is a moment in this cycle, when the full bag is removed and before the empty one is in place, when the solenoid gate should be closed to prevent material from spilling. This is accomplished by inserting a latching

Fig. 1. Simplified schematic of a reed-switch batching scale system.



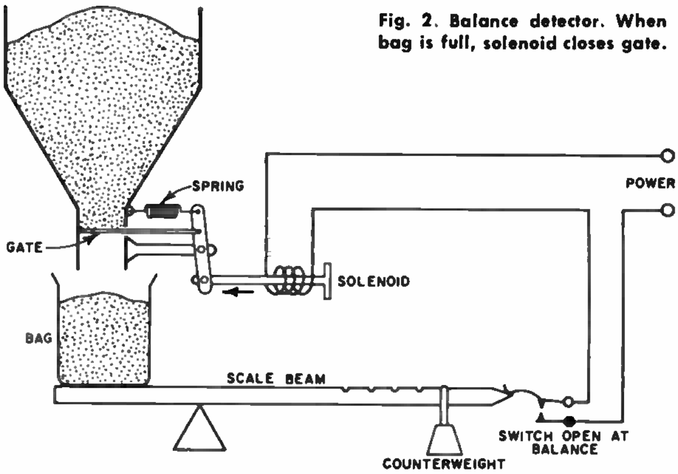


Fig. 2. Balance detector. When bag is full, solenoid closes gate.

relay between the shut-off switch and the solenoid. A second switch then resets the latching relay either after a fixed time or when the empty bag is in place. Here is room for additional electronic controls such as a photo-electric system to detect the presence of an empty bag.

Industrial scales use a variety of motion-sensing devices for balance detection. Typical of them are variable capacitors, variable inductors, photocells, magnet-operated switches, and differential transformers. In one unique system made by *The Howe Scale Company* an ordinary circular dial scale is converted to automatic balance detection by attaching a small Alnico magnet to the scale pointer. A second stationary pointer containing a miniature reed switch is then set to the desired scale reading. When the regular scale pointer comes up to the preset pointer the magnet pulls the reed switch together and the electronic circuit then actuates whatever controls are required to stop the flow of material.

Fig. 1 illustrates how a set of four such reed switches can be applied to mix three different materials into a single-batch container. As material *A* pours into the container on the scale, the pointer carrying the magnet approaches switch S_1 which closes and energizes relay *B*. When relay *B* is energized, it removes power from the holding contact on relay *A*, causing it to open, thereby closing the gate on material *A*. Relay *B*, when energized, supplies power to the solenoid in material *B*'s bin. Relay *B* is held closed by its holding contact which receives power from relay *C*, as long as relay *C* is open.

When the magnet pointer reaches the next weight level, switch S_2 closes and energizes relay *C* which shuts off material *B* and lets material *C* flow into the container. At the final weight switch S_3 is closed and *C* is shut off. Only when the pointer returns to the weight of the empty container and the magnet closes switch S_1, and through it relay *A*, is material *A* again allowed to flow. Each switch is closed only during the time that the magnet pointer is opposite it. It is therefore necessary to use holding contacts on each relay to keep it closed. Each successive relay supplies holding power when it is open to the preceding relay. The arrangement is a typical ring-relay circuit that can be replaced by a four-position stepping switch.

Probably the most widely used device for balance detecting is the differential transformer. This device is also used in motion-sensing of many industrial devices and its principles should be understood by anyone interested in industrial electronics. The circuit diagram of Fig. 3A shows that the output signal at the secondary will depend on the amount of coupling provided by the movable iron core. The motion of the core is mechanically linked to the balance beam of the scale, or to whatever motion the device is intended to report. A more complex differential transformer is shown in Fig. 3B. Here the output voltage of one secondary winding will increase as the other one decreases. When the core is exactly in the center the two secondary outputs will be equal. As the core moves, their difference is a measure of core motion. Most differential transformers use bifilar windings so that primary and secondary wires are wound together for maximum coupling.

One reason why differential transformers are so widely used is because their output signal is a sine wave, directly applicable to servo control systems. In a more sophisticated version of the basic system shown in Fig. 2, the output of a differential transformer would drive a servo system which would then control the flow of material.

Electronic Weight Measurement

All mechanical scales operate on the principle of balancing the gravitational force of the unknown weight with a known force, either as counterweight or spring tension. To determine weight by electronic means, the gravitational force is often measured directly by means of transducers. These devices convert force into an electrical signal. Probably the simplest such transducer is the strain gage in which the change in resistance of a wire grid due to elongation is proportional to

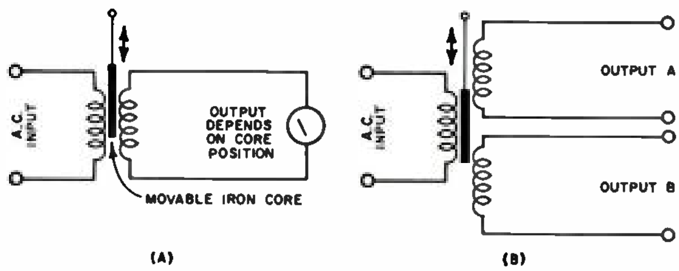


Fig. 3. Basic single (A) and dual (B) differential transformers.

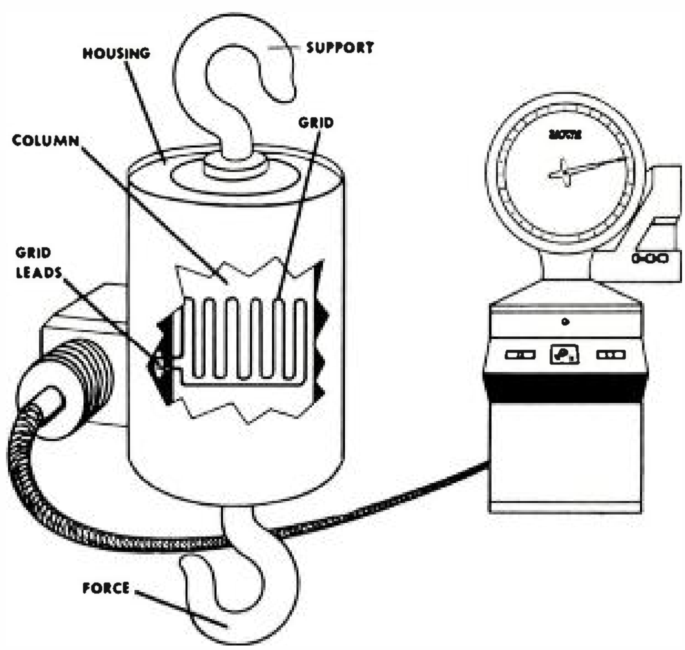
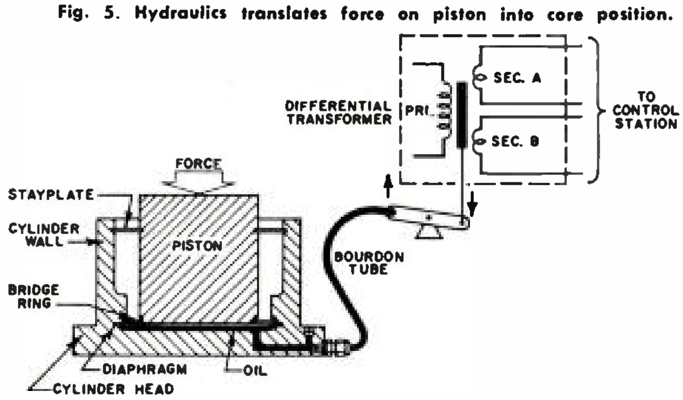


Fig. 4. In strain-gage transducer, weight changes resistance of grid.

Fig. 5. Hydraulics translates force on piston into core position.



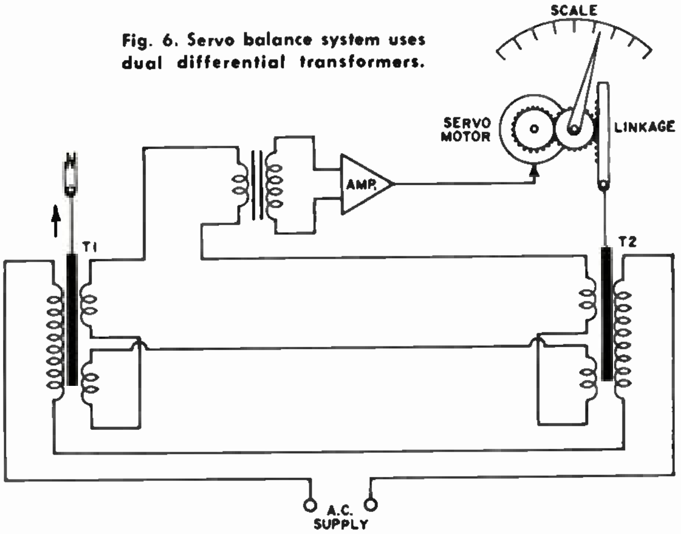


Fig. 6. Servo balance system uses dual differential transformers.

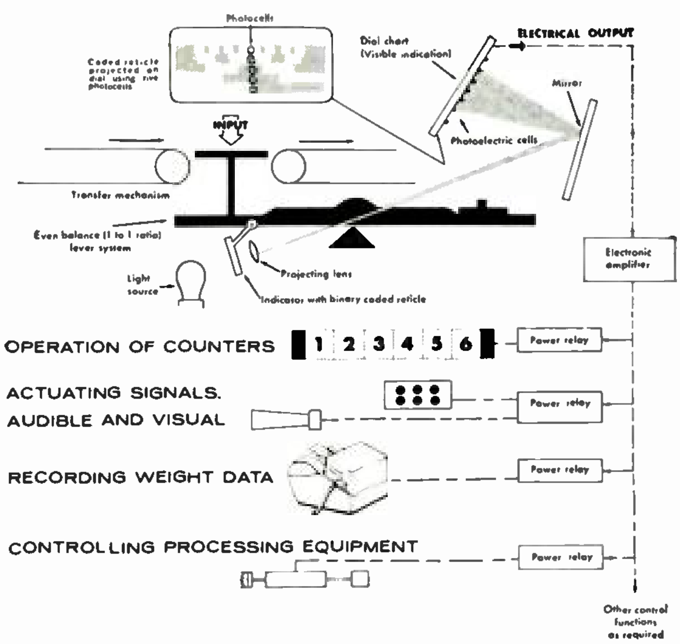


Fig. 7. Outputs of shadowgraph scale system have several functions.

the force applied. Fig. 4 shows such a resistance grid bonded to the column. When the column is stretched, the grid will stretch too. This reduces the cross-section of the vertical conductors and therefore increases their resistance. If the grid is part of a balanced Wheatstone bridge, the change in resistance will upset the balance and cause an error signal, proportional to the weight, to appear across the meter. Strain gages are widely used in industrial electronics and were described in some detail in the May, 1960 issue of this magazine.

In electronic weighing, the assembly which converts weight into a signal is usually called a load cell; the most widely used type is basically hydraulic. Electronics enters only to convert the hydraulic force into an electrical signal which can conveniently be transmitted and measured. A basic hydraulic load cell, shown in Fig. 5, consists of a large diameter piston, held concentric by the stayplate and the bridge ring, which "floats" on oil. As the piston is forced down, it exerts pressure on the oil which is passed through a very narrow tube. Although the motion of the piston may only be .005 inch maximum, the difference in diameter between the piston and the tube results in a much larger motion of oil in the tube in accordance with hydraulic principles. If the tube is curved and sealed at the end, it will be stretched as the pressure increases. This is called a bourdon tube and is used in many hydraulic systems to indicate oil pressure. In electronic weighing systems the motion of the bourdon tube is sensed by a differential transformer whose movable core is mechanically linked to the end of the tube as shown in Fig. 5.

The basic circuit for null balancing is shown in Fig. 6; it is used in practically all weighing systems which depend on differential transformers. Note that both primaries and secondaries of the transformers are connected in series although in other systems this is not always the case. A matching transformer links the difference signals to the input of the servo amplifier but in other systems a resistor network performs the same function. As long as a difference signal exists at the servo amplifier, power will be supplied to the control winding of the servo motor which will turn to pull the core of transformer T_2 to match the position of the core of T_1, the sensing device for the load cell.

Electronic Weight Indication

If we add another gear train and a counter to the linkage of the circuit of Fig. 6, the weight can be indicated directly in numbers instead of by the pointer on the scale. If the servo system were replaced by a digital voltmeter which measures the output of differential transformer T_1 we would have an indication of weight in digital form, both visually and electrically. Actually the most widely used means of reading weight electronically is with a digital shaft-position encoder. This device translates shaft position into a binary number by means of a printed-circuit pattern on a disk and a set of stationary contacts. The position of the shaft determines the electrical connections that are made. If the shaft is geared to the servo motor then the output of the encoder can be used directly to furnish binary data to a computer or automatic printer. There are also a number of all-electronic devices which convert an a.c. or d.c. voltage into pulse trains with binary codes. These so-called A/D (analog-to-digital) converters constitute a highly specialized field in themselves and while they will often be found in industrial installations, their servicing should be left to qualified specialists.

Practically all electronic weighing systems that provide a numerical display or which furnish data to a computer use some means of converting the analog output of the scale into a digital signal. One unique method of providing both a visual scale indication and a digital read-out is used in the so-called shadowgraph scale. As illustrated in Fig. 7 the scale is an even-balance type with a counterweight. The indication is by means of a light beam which is formed by a reticle mounted on the scale beam. By adding a binary coded portion to the reticle and a set of photocells adjacent to the dial chart a binary output of weight indication is obtained.

This binary signal can be used either to drive a counter, actuate certain signals, drive a data printer or some other control equipment. This type of scale is used in such special applications as coin counting as shown in Fig. 8. A carefully counted roll of coins is used as a checkweight and the shadowgraph indicator shows the amount of over- or under-weight. At the same time this information can be recorded to keep count of large amounts of coins. ▲


Fig. 8. Shadowgraph coin-counting scale is basically the same device shown in Fig. 7. Roll of coins is balanced against an exact count of coins in another roll. Over or underweight condition is indicated by projecting a line on translucent scale.

British Ground Station for Satellite Communications

By PATRICK HALLIDAY

Description of equipment installed at Goonhilly Downs now being used successfully to relay television and telephone signals from U.S. to Europe via "Telstar."

Goonhilly Downs ground station is in Cornwall at the southwest tip of England.

Steerable dish antenna is 85 feet in diameter with moving parts weighing more than 850 tons. No protective radome is used and because of exposed location and high winds, extremely solid construction is employed with considerable driving power reserves.

MANY communications experts believe that orbiting relay satellites are destined to play a vital role in world communications during the next decade. Projects "Telstar," "Relay," and "Echo" have pointed up the likely pattern of satellite techniques and equipment. But equally important for a practical world-wide service will be the establishment of a network of ground stations, with sensitive antennas that can be accurately tracked on the satellites, low-noise microwave receivers and high-power transmitters, and full facilities for patching into national television and telecommunications services.

In order to cooperate with the testing and assessment of the experimental U.S. communications satellites, the British Post Office—responsible for all telecommunications services in the United Kingdom—has erected an elaborate ground station on Goonhilly Downs, in the extreme southwest tip of England. The site is close to the spot from which the European end of the original transatlantic tests were conducted by Marconi in 1901. Although the Goonhilly station—completed by June, 1962 to meet the "Telstar" schedule—is only experimental at present, it is intended that the station will eventually become one of the first fully operational links in any future commercial service. Full provision is made for relaying from the United States of television, telephone, telegraph, and other signals.

View of the antenna dish from the antenna control console.

What will these earth-space stations of the future be like? The set-up at Goonhilly provides a key to what may be standard practice in a few years time.

The main constructional feature is the steerable dish antenna 85 feet in diameter, the moving parts of which weigh more than 850 tons. Since there is no protective radome and because of the exposed hilltop location where high winds sweeping in from the Atlantic are common, extremely solid construction and considerable power reserves have been considered essential. Two 100-horsepower driving motors are employed and provide a maximum speed of 1° per second in elevation and 2° per second in azimuth. The large parabolic dish is designed to remain fully operational in winds of 65 m.p.h. and gusts of over 90 m.p.h. In more severe gales the antenna is clamped with the axis of the dish vertical.

The antenna is steered primarily from information coming over the NASA minitrack network from the Goddard Space Flight Center. The orbital predictions are fed into a computer which processes the data to provide in each one-second interval information in punched tape form for the antenna steering equipment giving time, azimuth bearing and its rate of change, elevation and its rate of change, and the slant range to the satellite. The computer is programmed to take into account such factors as changes in atmospheric refraction. The design accuracy of tracking is better than 4 minutes of arc (0.07°) plus additional manual or automatic correction.

Receiving & Transmitting Equipment

Immediately behind the reflector dish is a cabin containing a traveling-wave maser tuned to 4170 mc. and cooled by liquid helium and liquid nitrogen. The permanent magnet for the maser weighs 250 pounds but to reduce the consumption of liquid helium, the magnet is being replaced by a superconducting magnet. Coils wound with niobium superconducting wire lose all trace of electric resistance at extremely

(*Continued on page* 73)

THE BUSINESS RADIO SERVICE

By GEORGE W. PETTENGILL

Administrator, Product Planning, Mobile Communications Equipment
Radio Corporation of America

Two-way mobile radio communications reduces costs through efficiencies in the conduct of daily business. Here are facts and figures on this fairly new radio service.

TWO-WAY mobile radio communications were first used by the safety services such as police and fire departments, but it soon became apparent that this new tool could be used to good advantage elsewhere. Business and commercial services started slowly to make installations, using licenses issued in the Citizens Radio Service. The tempo of these installations increased to the point where, on June 19, 1958, the Federal Communications Commission established a new service known as the Business Radio Service for the use of such commercial enterprises. Its growth was very rapid and at the end of the first year, there were 8800 authorizations. After two years there were 19,160 authorizations, after three years 28,400, and at the end of four years 37,450. The service continues to expand at a rapid rate. Such growth clearly indicates the usefulness of this method of communication.

Limitations of Citizens Band

The first business radio operation was licensed in the Citizens Band because there was no other category under which the necessary authorization could be obtained. However, the CB radio service was originally created by the FCC to provide personal communications for individuals and was not intended for large fleets of vehicles. It had a number of disadvantages. The frequency band, originally 460-470 mc., was good only for short-range communication, power was limited, and all stations were required to share channels with all other stations. Operation in this band left something to be desired.

Since the Business Radio Service was established, the FCC has changed the Citizens Band rules and has provided twenty-three channels in the vicinity of 27 mc. However, CB service still has some serious disadvantages for commercial use. Power is limited to 5 watts input and the service must be shared with more than 200,000 other users.

Frequencies, Eligibility, and Licenses

The FCC recognized many of the shortcomings of the Citizens Band for business operation and created the new BRS which was much better adapted to such use. It provided thirty-three base-station or mobile channels in the so-called low-frequency v.h.f. band of 30-50 mc. (actually 27-43 mc.) which could be used for stations requiring maximum range. In addition, the FCC authorized twenty-one v.h.f. channels between 150-174 mc. (actually 151-158 mc.) which provide good operation for medium range. Also, it set aside more than one hundred channels in the u.h.f. high band between 460 and 470 mc. which are excellent for city coverage and offer superior short-range communications.

Essentially, all business activities are eligible for the BRS, as well as some educational, philanthropic, and religious institutions, hospitals, and clinics. The main requirement is that it be a lawful commercial activity and that the owners, or in the case of a corporation all of the directors and officers, be U.S. citizens. Messages carried on the system should be confined to the accomplishment of business activity and must give way to any emergency communications involving immediate danger to life or property. The rules setting up the BRS do not permit point-to-point communication, but only communication to mobile units.

To comply with legal requirements, the radio station must have an FCC authorization to operate. This is obtained at no cost by filing an application which sets forth location of the station, identity of the applicant, and some technical information. The authorization is good for a five-year period. The

base-station operator must have an operator's license, or an operator's permit, and both the holder of the station license and the operators must be U.S. citizens. In addition, if an antenna tower is to be erected, permission must first be obtained from the FAA which must pass on any tall structures that could become a menace to air navigation.

The usual equipment for the BRS uses frequency modulation and 5-kc. deviation for the lower bands and 15-kc. for the high band. The FCC sets frequency stabilities of .002% for the low band and .0005% for the two higher bands. The assigned channels have various plate-power input limitations, some being restricted to 3 watts, to 30 watts, to 180 watts, to 500 watts, and others to 600 watts input. Communications over these channels is limited to voice messages and restricted to the audible frequencies between 300 and 3000 cps.

Planning the System

Planning a communications system in the BRS is normally a joint effort of the user and the supplier of the equipment. The user can be very helpful and usually can supply information on the following:

Table 1. Listing of frequencies available for Business Radio.

LOW V.H.F. BAND

FREQ.	PWR. LIMITS	FREQ.	PWR. LIMITS
27.235 mc.	30 watts (shared channel)	35.08 mc.	180 watts
27.245	" "	35.10	"
27.255	" "	35.12	"
27.265	" "	35.14	"
27.275	" "	35.18	"
27.39	500 watts	35.70	500 watts
27.41	"	35.72	"
27.43	180 watts	35.88	180 watts
27.45	"	35.90	"
27.47	"	35.92	"
27.49	"	35.94	500 watts
27.51	3 watts	35.96	"
27.53	"	35.98	"
33.14	"	42.96	180 watts
35.02	"	42.98	3 watts
35.04	180 watts	43.00	180 watts
35.06	"		

HIGH V.H.F. BAND

FREQ.	PWR. LIMITS	FREQ.	PWR. LIMITS
151.625 mc.	180 watts	151.955 mc.	600 watts
151.655	"	152.300	600 watts (shared channel)
151.685	"	152.360	" "
151.715	"	152.420	" "
151.745	"	154.540	180 watts
151.775	"	154.570	3 watts
151.805	"	154.600	"
151.835	"	157.560	600 watts (shared channel)
151.865	"	157.620	" "
151.895	"	157.680	" "
151.925	600 watts		

U.H.F. BAND

461.05 mc.-469.95 mc.

110 channels with various power limits; most channels shared with other services.

Notes: 1. Power figures refer to maximum plate-input power to final r.f. stage. 2. For other limitations and specific regulations, see FCC Rules & Regulations, Part 11.

1. Area to be covered by the radio system.
2. Number and types of vehicles in which mobile units will be installed.
3. Locations available for the base station.
4. Location of the dispatcher, or dispatchers if more than one is required.
5. Local building laws governing the erection of antenna towers.

With this information, a supplier's representative can determine the type of equipment and transmitter power required to build an adequate system. He also will be helpful in selecting the desirable frequency band and the specific channel best suited to the area. In defining the area to be covered, it is well to consider any expansion contemplated for the future as it is often less expensive to make provision for extension of the original system than to modify it at a later date. The same thinking can be applied to mobile units, as the FCC will permit an applicant to license the number of units he expects to have within the next five-year period even though he does not put them all in originally.

Antennas & Equipment

Location of the base station and antenna tower should be worked out jointly with the equipment representative as it ties in directly with the area to be covered and the amount of transmitter power which can be used. The dispatcher does not have to be located at the same place as the base station, so usually this does not create any problem. It is possible to have several dispatching locations on the transmitting equipment if there are several departments using the same radio system.

In general, the user will be more thoroughly acquainted with local building laws which ofttimes restrict the location or height of antenna towers. In many places, a building permit is required to erect such a tower. While the usual system consists of a base-station transmitter and receiver with its accompanying antenna, a number of alternate methods is available to adapt a radio system to the special requirements of the user. These take the form of directional antennas which radiate most of their energy in the desired direction. Such antennas are usually used when the base station is on the edge of the area to be covered.

If greater range is required, the base station can be located on top of a hill or a tall building and controlled over a leased telephone line or by a separate radio circuit. On the two higher bands, antennas are also available which have power gain and will extend the range by radiating signals which are equivalent to transmitters having greater power.

FCC-approved equipment to provide the radio system described here is available from several reliable manufacturers in all three frequency bands and comes in a variety of transmitter powers and types of enclosures. Mobile equipment is available for both six- and twelve-volt operation but is usually limited in power output to approximately 100 watts. This limit is imposed by the power available from the vehicle's electrical system.

Two-way mobile radio communications is a new tool which many users find helpful in reducing costs through efficiencies in the conduct of daily business. Radio transmitters must conform with certain legal and technical requirements imposed by the FCC, and stations may not be placed in operation without proper authorization. Good planning of the system before installation will pay off by better operation and more satisfactory communications. ▲

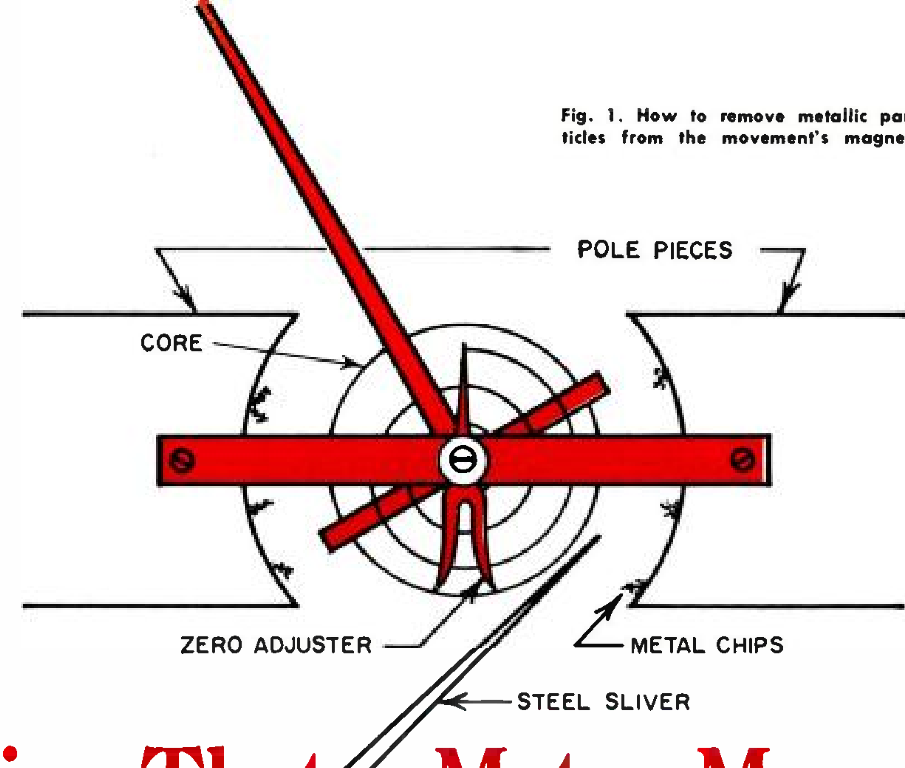


Fig. 1. How to remove metallic particles from the movement's magnet.

Service That Meter Movement

Despite the "hands off" warning for some defects, many remedies for erratic action are within the scope of the non-specialist.

By THOMAS R. HASKETT

SINCE THEY feel that such work is properly left to specialists, few technicians will attempt to work on the movements of their meters. It is true that certain jobs must be left to the meter shops and labs specializing in this field. Nevertheless, there are certain maintenance and repair measures which, although they may require some care, are within the scope of the average technician interested in saving the expense of replacement or outside repair.

If the pointer tends to stick or move erratically, or if it cannot be "zeroed" reliably by means of the external, zero-set screw, the trouble is likely to be one that can be handled without going elsewhere. This applies to the d'Arsonval movement, or basic d.c. ammeter, which is common to most instruments technicians are likely to encounter and use. It is such meters with which we deal here.

The first rule is that work should be done in a closed room; one with little air circulation. A clean, well lit table should be covered with a large sheet of white paper. Any tools to be used should first be freed of metal particles, dirt, and lint by brushing with a small, clean paint brush. The technician then rolls up his sleeves, washes his hands thoroughly, and dries them. He is now ready for "surgery." At this point, the meter can be inspected to determine whether it can be repaired or not.

Preliminary Examination

The movement is removed from its case carefully and a visual check is made of the coil and springs. If these have been burned out, no further attempts should be made; the unit is beyond repair.

If the glass or the case has been broken, it's extremely likely that dust has found its way into the coil. This would account, at least in part, for any sluggishness noted in the pointer's action. This can be remedied. However, it is also likely that the meter pivots are dull, and these can't be repaired in the field. However, if glass, case, coil, and springs are intact, cleaning and re-adjustment can be performed.

Lint and Dirt

If the pointer tends to stick at some particular spot on the dial, or if tapping the case while a static measurement is being made causes the reading to increase without an increase of coil current, the most probable cause is lint, dust, or metallic particles in the coil or on the magnet surrounding it. Such foreign particles can be removed by either or both of the techniques described here.

A thin sliver of steel is most suitable for drawing off chips of ferrous metal clinging to the magnet. This implement, which can be fabricated easily, should be filed extremely thin at its point. It should then be wiped carefully to make certain there is nothing on it that it can deposit in the movement. Then, as shown in Fig. 1, it should be inserted between the pole piece and the core in such a way as not to touch the springs or coil. This is not an easy job, particularly for someone who has not done it before, but it can be managed.

Use a magnifying glass to check for lint, since even a tiny piece can cause sticking. Relatively large pieces can be removed with fine tweezers. For others, a burning tool like the one in Fig. 2 may be needed. Wires can be taped to the outer surface of the wooden dowel for support. The working end is formed much like a small soldering tip. It may be necessary to hammer the point flat so that it can be inserted in the coil without disturbing the latter too much. Although the stepped-down voltage is intended to control the build-up of excessive heat, avoid a heavy hand or the application of the burning tool in one area for too long a time, lest the

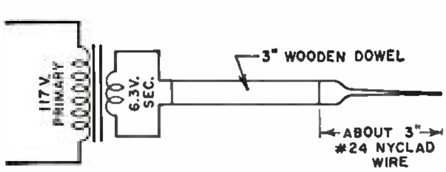
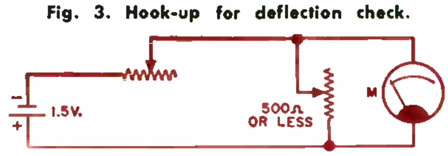


Fig. 2. A simple burning tool for removing fine particles of dust and lint.

Fig. 3. Hook-up for deflection check.



springs or the wire of the coil be subjected to damage.

Friction Problems

If the moving pointer scrapes the dial at one or more points, this friction will of course cause sticking and erratic movement; the obvious remedy is to straighten the pointer. Use tweezers and work gently. Too much force can damage the coil or springs.

If a meter has been subjected to excessively rough treatment, there is a chance that the jewels have been cracked or the pivots dulled. You can do nothing about either of these defects—but there's one other possibility that could cause similarly erratic deflection. The bearings may be too tight. The jewel screw, located in the center, should be loosened slightly to see whether friction is thereby reduced. It will probably be necessary to use a jeweler's screwdriver for this job. If one isn't handy, a thin scrap of metal can be filed down to size but, once more, be sure to brush away any filings before use.

Rebalancing

If the meter movement no longer returns accurately to zero indication when current is not applied, it is possible that misuse has disturbed its delicate balance. There is an externally available zero-set screw on the face of the case, of course, but its re-adjustment may not bring the pointer to rest at zero *regardless of the position of the meter.*

Correction of this condition involves adjustment of the balancing tail and side weights, located at the bottom end of the pointer near the pivot. Before attempting this, make sure that the pointer is straight. Then hold the meter so that the zero mark heads up at an angle of about 22 degrees from the horizontal, as in Fig. 4A. In this position, adjust the zero-set screw so that the pointer is exactly over zero.

Next rotate the meter until the zero mark and the pointer are heading horizontally, as in Fig. 4B. In this position, adjust the tail weight for exact zero. Finally, hold the meter so that the pointer and the zero mark are pointing straight up (Fig. 4C), and adjust the side weights for accurate zero indication in this position.

Screw-type adjustments may be used for these weights, but they vary with the make and model of the movement. Some ingenuity may be required in utilizing and even fabricating tools that will facilitate manipulation.

Before the movement is returned to its case, the latter should be cleaned, but never use a cloth: lint will almost certainly find its way back into the coil. Use a clean, soft-bristle brush and always stroke away from the movement itself.

Although this is largely a matter of appearance rather than performance, the dial face should be inspected for possible marks. As a rule, any that are found can be removed with an ordinary pencil eraser—but don't run the risk of having eraser particles get into the movement. Hold the meter upside-down so that debris will fall away from the coil and springs.

Checking and Calibration

It is a good idea to get the meter back in its case before final checking and calibration, and this can be done if no internal shunt is used. Where a shunt is involved, the movement is best left uncased for these final steps, since the shunt itself may require correction.

First the deflection action of the pointer with current applied should be observed. A suggested hook-up is shown in Fig. 3. The series potentiometer should be high to start out with, greater than internal resistance of the movement. The procedure can be started safely with both potentiometers at full resistance, but one of the wires to the meter terminals should be held in place by hand rather than connected securely. Thus, if rotating the arm of the series pot causes the pointer to deflect suddenly, the wire can be released before the coil has a chance to burn out.

If abrupt motion of this type is noted, a series pot of higher value should be substituted and the operation can be attempted again. By alternate re-setting of the two controls, a point is found where manipulation of one control produces a controlled deflection of the pointer. It should now be possible to adjust for deflection from one extreme of the dial scale to the other, in order to make certain that the pointer moves freely and smoothly throughout its arc of travel.

If another meter of known accuracy is on hand, it can be used to check the accuracy of the repaired unit by substitution for the latter in the arrangement of Fig. 3 or by placing the two meters in series. If such a precise standard is not available, the best thing to use is probably a simple, 20,000-ohms-per-volt v.o.m. Such an instrument generally contains a movement rated at about 50 microamperes in association with other elements that are entirely passive. Its inherent accuracy and stability are high. The v.o.m. should be switched to a current range as close as possible to the full-scale value on the dial of the repaired unit, but not lower than the latter.

If this test shows the repaired unit to be inaccurate and the latter uses an internal shunt, it may be possible to reconnect or replace the shunt to improve precision. Accuracy may have been impaired because age and the effects of other magnetic fields have weakened the magnet. Nevertheless, "re-shunting" can correct this condition. The proper resistance value is determined simply by the trial-and-error method. Make certain that voltage is not applied to the movement whenever the shunt is removed, or coil burn-out may result.

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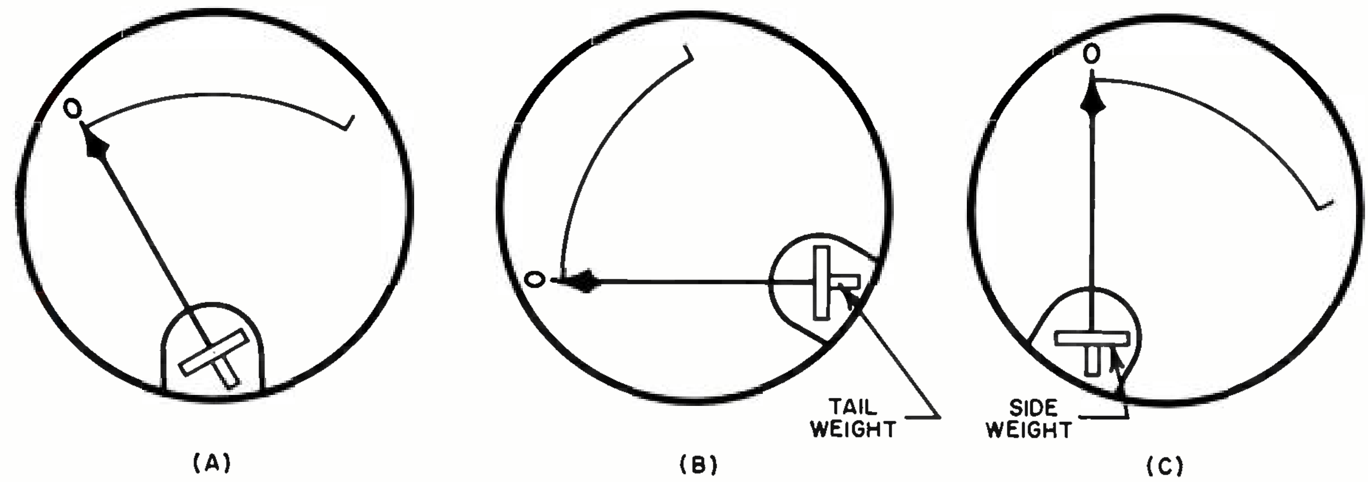
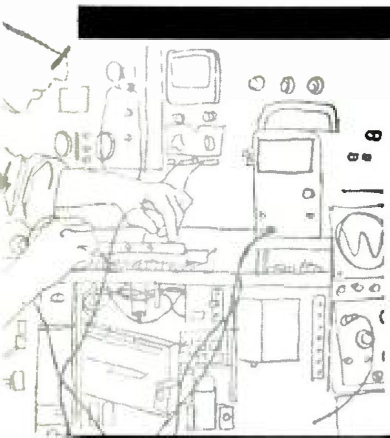


Fig. 4. Zero set holds well in any position with proper balance. Check and adjust in the three positions shown.



MAC'S ELECTRONICS SERVICE

By JOHN T. FRYE

Putting on the Pressure

BARNEY came into the service shop stamping the first wet, clinging snow of the winter off his feet under the disapproving eyes of Amanda, the office girl.

"Boy! It's really beautiful out there this morning with the snow sticking to the wires and tree branches," he said to Mac, his employer.

The latter looked up from the pamphlet he was reading and sadly pleaded, "Quit reminding me of how old I'm growing! All I thought about on the way to work was how slippery the snow made driving, the trouble it would cause the line crews, and whether or not it would break any branches off my apple tree in the back yard. When you cease just enjoying the endless panorama of the weather and start regarding a change as merely a big fat nuisance, the years are catching up with you."

"Don't take it so hard," Barney suggested with a sympathetic grin. "What are you reading?"

"An article published by a friend of mine who works in the Sonar Systems Branch, Sound Division, of the U. S. Naval Research Laboratory in Washington. His name is Chester L. Buchanan, but that "L." stands for Leroy, and I've always called him Roy. He and a fellow worker, Matthew Flato, published this paper called 'Putting Pressure on Electronic Circuit Components' in the *ISA Journal*, and Roy sent me a reprint of it.

"You see in oceanographic research various forms of electronic deep sea probes are used, and these instruments have to take tremendous pressures without failing. There are two ways of tackling the problem: (1) you can seal the equipment in a rigid, pressure-proof capsule, or (2) you can use parts inherently capable of taking the pressure without damage or change. The first method results in bulky, heavy probes. For example, a velocimeter weighing only four ounces requires a twenty-five pound housing to withstand the 10,000 psi pressures encountered four miles down in the ocean. Roy and his fellow worker decided to investigate the second method by subjecting a variety of electronic components to hydrostatic pressures up to 10,000 pounds-per-square-inch-gauge in a laboratory pressure chamber that permitted the component to be viewed and electrical connections to be made to it while the pressure was being applied."

"What did they find out?"

"Resistors made by depositing carbon film or tin oxide on glass rods did not change at all. Standard carbon composition resistors changed radically with increasing pressure, going down in resistance in an almost linear fashion. The change varied from about 14% for 100-ohm resistors to about 25% for 10-megohm resistors. It was concluded film deposit resistors would work very satisfactorily and carbon resistors might be useful as pressure transducers.

"When capacitors were tried in the pressure chamber, molded mica or glass types showed no appreciable change. Some ceramic types changed 2%. Miniature paper capacitors with the conductor deposited directly on the dielectric showed only about 1% change in capacitance. It was a different story, though, with capacitors sealed with air entrapped in them. Electrolytics, for example, collapsed at relatively low pressure; and paper capacitors made by placing them in paper tubes and sealing with wax or compound poured into the ends did little better.

"The next victims for the pressure torture chamber were magnetic materials used as coil cores. Coils wound on these materials were checked for change in inductance as pressure increased. Types tested included grain-oriented silicon steel, 75% nickel-iron, 50% nickel-iron, powdered iron of high-, low-, and medium-frequency formulation, molybdenum-nickel-iron dust core, and ferrite core. The grain-oriented silicon steel core produced about a 14% decrease in inductance at maximum pressure. The molybdenum-nickel-iron cored inductor increased about the same amount. Powdered iron core inductors all increased in inductance with pressure, with the low-frequency formulation increasing the most. The 75% nickel-iron core inductor changed only slightly as the pressure was cycled. The egregious performer, though, was the 50% nickel-iron core. Its coil nearly doubled its inductance at only a little better than 1000 psig, and most of this increase was retained after the pressure was removed. Obviously magnetic core materials have to be selected carefully in critical inductances subjected to great pressure."

"How about tubes and transistors? Did they check those?"

"Yep. A 6AL5 failed by 'catastrophic implosion' at about 2000 psig, but some subminiature types withstood 10,000 psig without any type of failure. Penlight bulbs, instrument bulbs, and small commercial neon lamps mostly came through without failure. A few imploded, and others leaked the paraffin oil used to transmit the pressure through their seals. Glass tubes were tested along the same line. Those having a wall thickness of .039" and an outside diameter as large as .355" withstood the full pressure, suggesting that some components could be sealed in glass envelopes and used in high pressures.

"Transistors did not do so well. Most of these are sealed in metal cases filled with some inert material to prevent contamination; and these cases, not being designed to withstand high pressure, simply collapsed. On the other hand, a few early transistors potted in epoxy resin withstood the pressure; and the cased ones also passed the test when their cases were pierced and the paraffin oil allowed to enter. The pressure did not affect the *elements* of the transistors; only the cases failed. Uncased passivated-surface semiconductors designed to be immersed in fluids or potted in resins without fear of contamination operated quite well under great hydrostatic pressure."

"Why not just pot any element you want to protect from pressure?"

"It's not that simple. Simply placing a resistor, for example, in resin affords it little protection because the pressure is transmitted undiminished through the epoxy. But experiment revealed that when the same resistor is first coated with a spongy type of silicon rubber and then potted in dense epoxy, it will withstand the full 10,000 psig pressure without any material change in resistance.

"Most components were subjected to high pressure for only a comparatively short period of time, but in one case a complete three-stage transistor amplifier was encapsulated in epoxy-type resin and operated without failure for several days under continuous 10,000-psig pressure. At some points, components were within 1/16" of the surface of the plastic; and the circuit contained many components that, unprotected, would have failed under the pressure."

"It looks, then, as though almost any basic electronic need

(*Continued on page* 80)

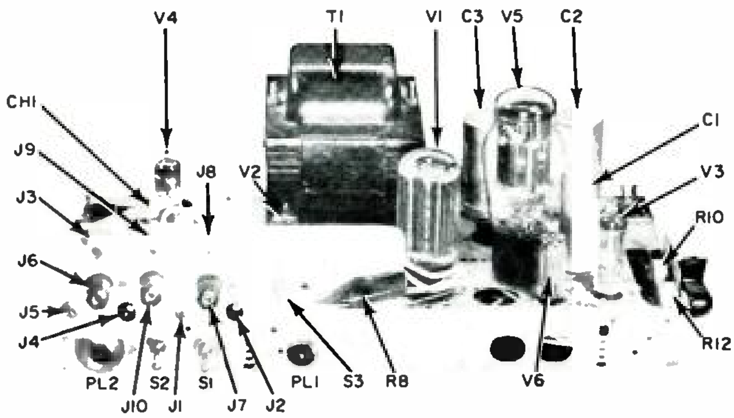


Fig. 1. Author's model was built from scrapped TV set parts.

VARIABLE-VOLTAGE, REGULATED POWER SUPPLY

By JAMES P. RODGERS

Construction of a rugged, low-cost bench power supply that can furnish up to 400 volts and will deliver 250 ma. at 250 v.

THE electronics experimenter often encounters a major problem in his laboratory: the need for well-regulated d.c. power for design and service work. This supply will meet the requirements of a variety of projects whose needs are as little as 9 v. at a few ma. to 350 v. or more at a couple of hundred ma. The output voltage is regulated within 1% for a wide range of line voltage and load current variations within the recommended current ratings.

Operation

The supply operates in this manner (refer to Fig. 2): T_1 and V_1 form a conventional full-wave rectifier. A choke was omitted for two reasons: (1) it would introduce resistance and limit the current that could be delivered by V_1, and (2) it would oppose sudden changes of current demanded by the load.

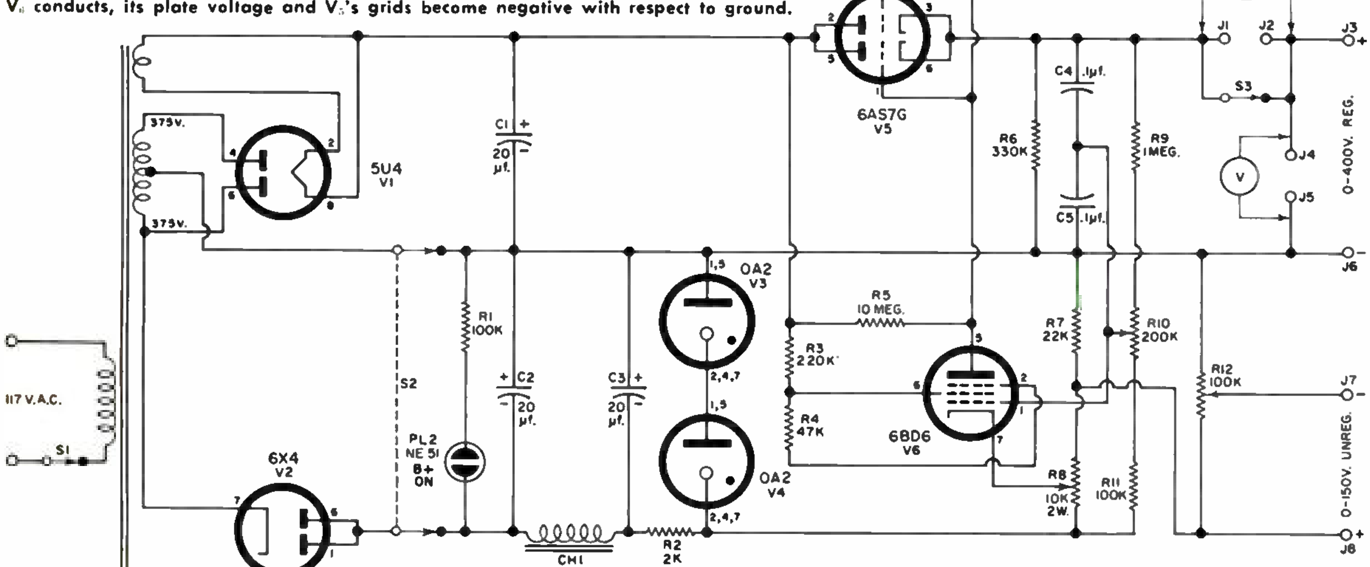
Think of V_5 as a variable resistor; by changing its bias, its plate resistance, the current through it, and consequently the output voltage of the supply will change. V_6, a d.c. amplifier samples the supply's output voltage at R_{10} and produces an error signal to change V_5's bias. As V_6 is a "starved-amplifier," its 10-megohm plate resistor is not a mistake. Voltage changes at the plate with this size resistor are much greater with small changes in grid voltage; the result is better regulation.

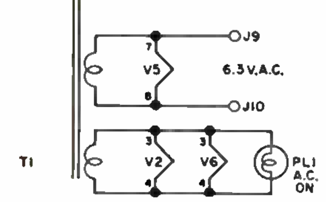
Assume that the load is decreased and the supply's output voltage rises. A proportion of the rise in output appears at R_{10} and the grid of V_6. This rise in grid voltage (the grid becomes positive with respect to the fixed, highly negative cathode voltage) causes an increase in current through V_6 and a fall in its plate voltage. (The plate voltage in approaching the negative cathode voltage becomes negative with respect to ground.) Now, as V_6's plate is connected to the grids of V_5, V_5's grid voltage becomes negative with respect to its cathode causing its plate resistance to increase and the supply's output voltage to decrease.

There are no construction problems and layout is not critical. When selecting the power transformer from an old TV receiver, make sure it will supply the necessary current. The service literature for the set will include the voltage

(*Continued on page 77*)

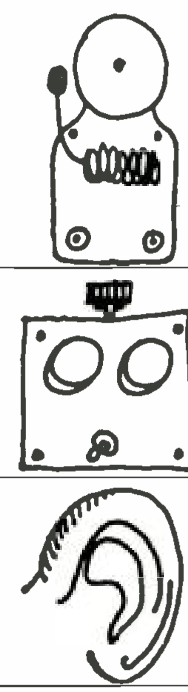
Fig. 2. R_5 applies −206 to −300 volts, from V_2, V_4, and V_3, to V_6's cathode. When V_6 conducts, its plate voltage and V_5's grids become negative with respect to ground.





R_1, R_{11}—100,000 ohm, ½ w. res.
R_2—2000 ohm, 10 w. wirewound res.
R_3—220,000 ohm, ½ w. res.
R_4—47,000 ohm, ½ w. res.
R_5—10 megohm, ½ w. res.
R_6—330,000 ohm, 1 w. res.
R_7—22,000 ohm, 1 w. res.
R_8—10,000 ohm, 2 w. pot.
R_9—1 megohm, ½ w. res.
R_{10}—200,000 ohm pot.
R_{12}—100,000 ohm pot.
C_1, C_2, C_3—20 µf., 450 v. elec. capacitor
C_4, C_5—.1 µf., 600 v. capacitor
S_1, S_3—S.p.s.t. toggle switch
S_2—D.p.s.t. toggle switch
J_1, J_2, J_4, J_5—Insulated phone-tip jack
J_3, J_6, J_7, J_8, J_9, J_{10}—Insulated five-way binding post
PL_1—6.3 v. pilot lamp
T_1—Power trans., 117 v. pri., 750 v. c.t. @ 200 ma., 5 v. @ 3 amps, 6.3 v. @ 5 amps. (see text)

DOORBELL MONITOR for the DEAF



By ERNEST S. GORDON / Armour Research Foundation of Illinois Institute of Technology

Home-built unit in which r.f. voltage superimposed on 117-volt a.c. line gives sustained visual indication when doorbell button is depressed. No special house wiring is required. Two different carrier-current frequencies differentiate the front and back doorbells.

IT is a great convenience and almost a necessity for the deaf and hard-of-hearing to know when a caller is at the front or back door. What is sometimes done is to connect a relay to the doorbell ringer and complete a circuit to a 117-volt lamp. In order to have signal lamps in various rooms of the house, long 117-volt wiring must be laid out, either along the wall surface or inside the walls. The latter must be installed during construction of the building and is very expensive; the former is an eyesore and a fire hazard.

This article will describe a carrier-current type electronic doorbell monitor. It requires no special wiring throughout the home. In the system, a low-voltage, low-frequency r.f. signal is superimposed on the 117-volt line during the time when the doorbell button is depressed. A small transmitter unit is permanently connected to the doorbell ringers and may be wall-mounted. The small receiver may be carried to any room in the house and simply plugged into the 117-volt socket for operation. Actually, the receiver may be operated equally well at the house or apartment next door, or at any home within a square block if the home is serviced by the same distribution transformer. Two bright panel lights are mounted on the receiver, one energized by the front door ringer and the other by the back door ringer. The lights remain on after the doorbell is momentarily depressed; a reset button on the receiver extinguishes the lamps.

Transmitter Circuit

The circuit diagram for the transmitter unit is shown in Fig. 1. The circuit is built around the single type 117N7 vacuum tube, the diode section of the tube acting as the rectifier for the "B+" supply and the cathode-heater being directly connected across the a.c. line. The basic oscillator (which was described in "Electronic Shortcuts for Hobbyists," *Sylvania Electric Products Inc.*, Second Edition) is of the Hartley arrangement; the beam power pentode is capable of delivering about one watt of power. The energy is coupled to the line with a small secondary winding (over the resonating inductor) in series with the 0.5-μf. capacitor. In this particular circuit two resonating capacitors are used to give two oscillating frequencies, one corresponding to the front doorbell and the other to the back doorbell. The relay coils are connected to the incoming lines of the doorbell ringers, and

Transmitter unit is 5" x 4" x 3".

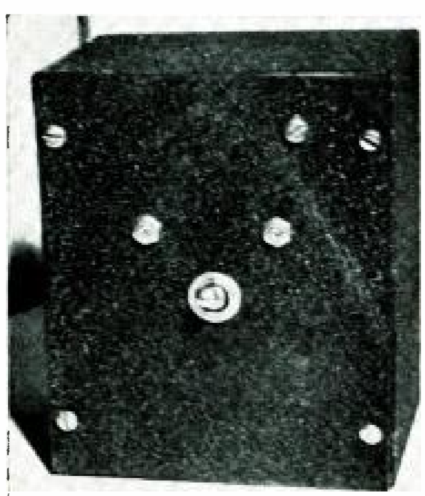
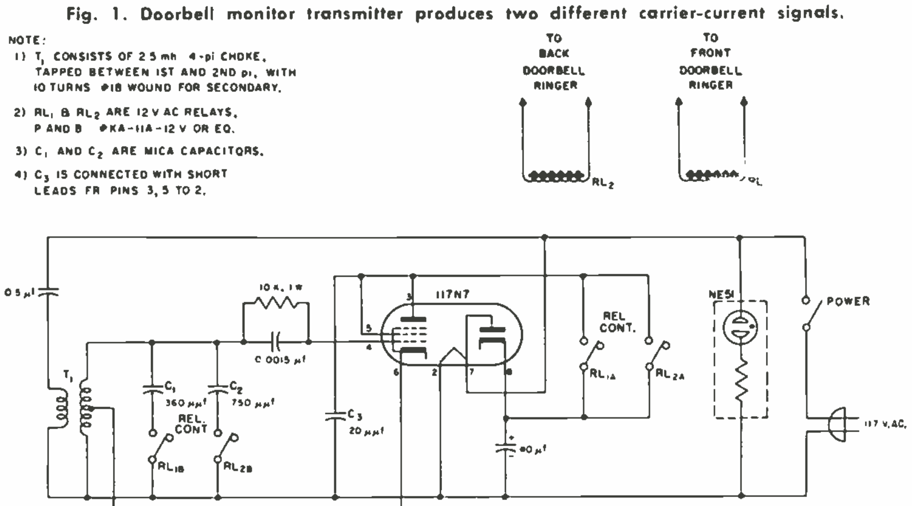


Fig. 1. Doorbell monitor transmitter produces two different carrier-current signals.



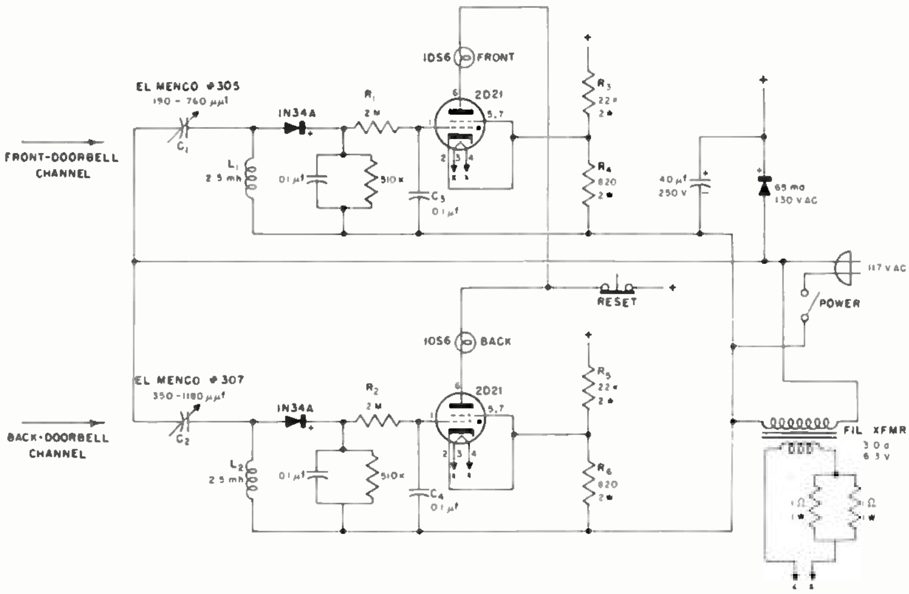
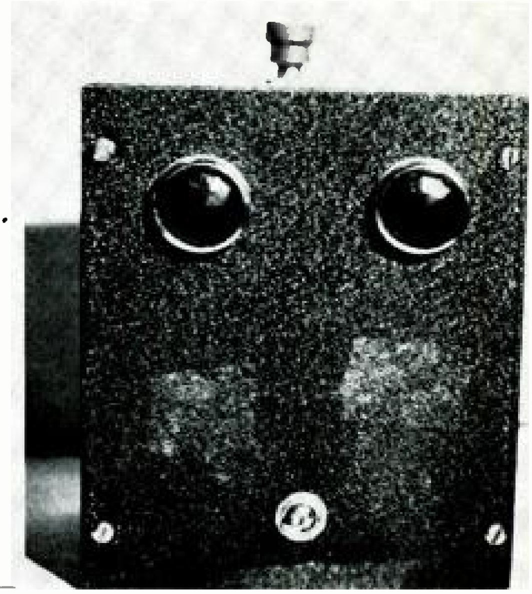


Fig. 2. Doorbell monitor receiver employs two completely separate channels.



Receiver unit is 6" x 5" x 4".

the relay contacts complete the "B+" circuit to the oscillator and to the proper resonating capacitor.

The "front" and "back" frequencies of oscillation are approximately 150 kc. and 100 kc., respectively, depending upon actual value of components used. The r.f. impressed upon the line is 4 to 7 volts peak-to-peak at the oscillator location. At other locations on the same side of the 117-230 volt line, the signal is as low as 2 or 3 volts while on the other side of the line it is as low as 0.4 or 0.5 volt.

Receiver Circuit

The circuit diagram of the two-channel receiver is shown in Fig. 2. Each channel employs a series-resonant circuit to detect its respective frequency, the variable capacitors C_1 and C_2 performing the dual function of coupling the r.f. from the line and resonating with the series inductors L_1 and L_2. Germanium diodes are used to detect the r.f. from the resonating inductors and apply the signal to the control grids of the thyratrons. The filter circuits R_1-C_3 and R_2-C_4 prevent interfering short-term line transients from firing the tubes. In the quiescent state the grids are biased negatively 3.5 or 4 volts due to the voltage dividers at the cathodes, R_3-R_4 and R_5-R_6. After firing from the positive grid signals, the tubes remain conducting, energizing their respective lamps in the anode circuits, until the anode voltage is interrupted with the reset switch. The rectifier for the "B+" supply is of the small selenium or silicon rectifier type. The series resistance in the filament transformer secondary circuit decreases the heater voltage to its rated value.

Construction and Operation

The two units were constructed by the author in *Bud* miniature sheet metal utility cabinets with attached chassis. The transmitter is 5" h. x 4" w. x 3" d. and the receiver measures 6" h. x 5" w. x 4" d. The transmitter pilot lamp, which is indicated on the circuit diagram, was not used with the original unit but was found necessary for convenience. In general, the wiring and component placement is not critical and other arrangements could be used. Note that in the circuit diagrams no connection to chassis ground is shown; such a connection is not necessary and should not be used, for safety reasons. The "B+" supplies are of the line-rectifier type (one side "hot" to ground) and all electrical components and wiring should be insulated from the chassis.

The transformer T_1 in the transmitter is constructed from a commercial 4-pi 2.5-mhy. r.f. choke. A tap is made between the first and second pi to the cathode and the secondary con-

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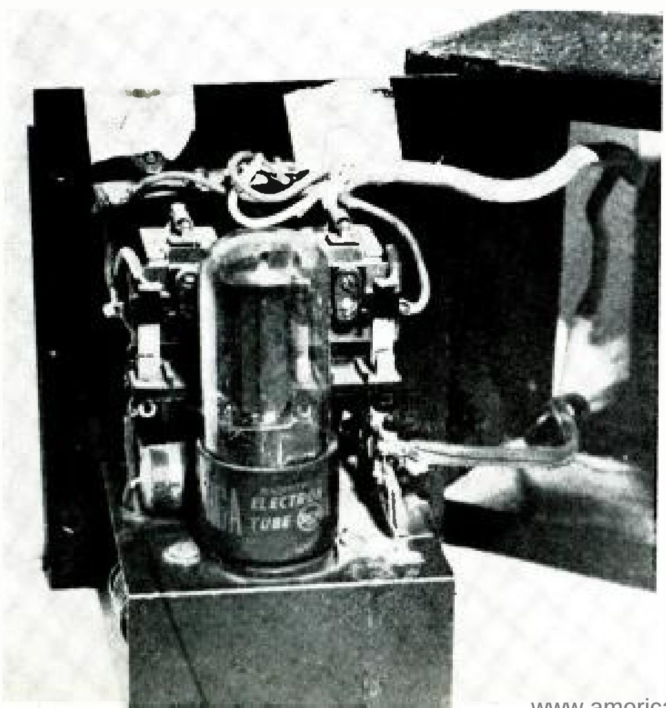
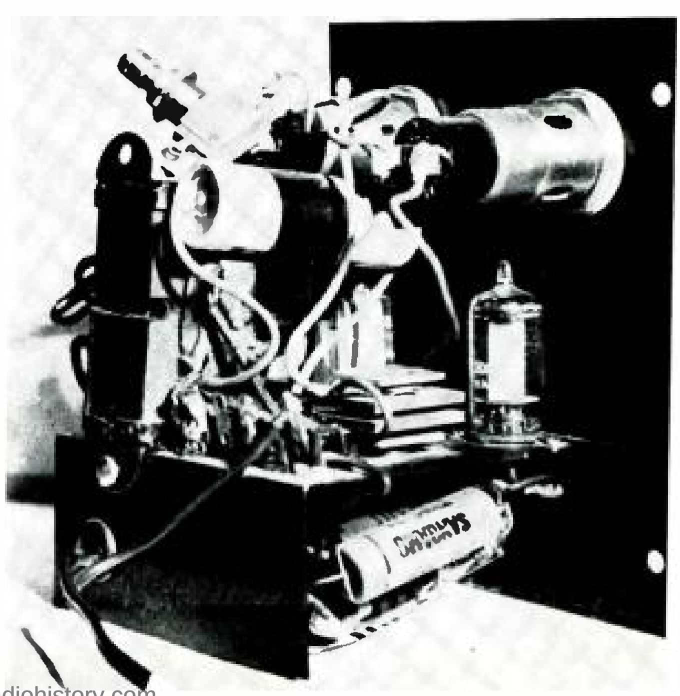
The transmitter shown out of its case. The two 12-volt a.c. relays are mounted on the front panel as shown in the photo.



The receiver shown out of its case. Two indicators are on front panel, reset switch is installed later in top of case.



TV INTERFERENCE PROBLEMS

By GEORGE P. OBERTO, K4GRY

Striking case histories illustrate various types of TVI, how obscure causes are tracked down, and their remedies.

A SERIES of unusual interference problems, largely dealing with AM broadcast, short-wave, and FM reception, were described by the author in these pages over a year ago. Although TV interference was not neglected altogether, little was said on this subject. The diversity and complex nature of TVI merit special treatment.

Television involves broader bandwidths than most other broadcast services. Also, circuits are relatively complicated, involving signals of various frequencies. These factors make the receiver inherently prone to interference from sources and frequencies far removed from regularly assigned v.h.f. and u.h.f. channels, as well as from nearby signals.

The variety of manifestations and their uncertain correlation with specific causes make systematic coverage of TVI troubleshooting difficult. The categories with which we will deal here thus are not based on symptoms. Within each group, emphasis is on individual case histories. Noting how they were resolved can perhaps suggest as much about general methods as any other approach. It may help the reader to remember that, no matter how tough a dog an interference problem may seem, the remedy—once the cause is found—is simple.

Front-End Overload

When interference originates from a strong signal below the assigned TV channels—ham, CB, commercial, or other transmission—the offending source is often quite close to the TV receiver. The r.f. section of the TV tuner tends to become overloaded by the high-level signal, thus being driven into non-linear operation. In this condition, it will develop, from the original interfering frequency, harmonics that fall within the pass-band of receiver circuits. These, of course, are passed along in the TV set along with desired signals.

If the interfering station is transmitting legally, it is not at fault here. Inadequate receiver design is more likely to be responsible. Nevertheless, the cure is usually a simple one. A high-pass filter that attenuates sharply below 50 mc. (Fig. 1), installed between the antenna line and the tuner, generally solves the problem.

The technician could fabricate one himself, winding coils to achieve the desired cut-off frequency, but good commercial filters, designed to match the 300-ohm impedance of conventional antenna systems and tuner inputs or the 72 ohms of coaxial lines, are available and preferred. Such filters should be mounted as close as is practical to the tuner. This reduces the possibility of strong-signal pickup on the length of transmission line from the filter to the tuner.

There are cases, however, where this remedy will not work when the situation seems to be exactly of the type noted here. Consider the problem encountered on one top-brand, well-designed set, which had a high-pass filter built into the tuner input, adequate shielding, and interference traps in the i.f. system and elsewhere. It worked very well until Joe Ham, located only a few doors away, fired up his new 500-watt radiotelephone transmitter in the 75-meter (4-mc.) band. An odd and irritating point was the fact that, although the TV picture was completely blanked out when the amateur went on the air, a cheap portable used as a second set by the owner of this excellent receiver was not being affected at all.

Investigation showed that, when a common, rabbit-ear antenna was substituted for the customer's good outdoor antenna, the interference disappeared! Although picture quality was acceptable, the customer had invested in a good outdoor installation to obtain the best possible reception, and he was not overjoyed at the prospect of having to abandon it.

With suspicion thrown on the antenna system, everything was carefully checked. The antenna and transmission line appeared to be in good condition. The length of 300-ohm line from antenna to set was changed on the chance that the original length may have been resonant to the ham's transmission frequency, but this improved nothing. As a last resort, the short length of twin-lead from the antenna post on the back cover to the tuner input was replaced, although it had been checked out already. The interference vanished.

Close inspection of this short line revealed an intermittent break (Fig. 2) in one conductor, which had maintained enough contact to slip by a continuity check. One side of the antenna line had been acting as a long-wire antenna that picked up the amateur's strong fundamental signal, as well as desired transmissions, indiscriminately. The tuner input was unbalanced. The filter was largely bypassed. Replacing the broken length of lead had restored the balanced input, returned the filter to full effectiveness, and re-inserted the frequency-selective, outdoor antenna into the system.

Another case: Several months ago, a customer complained of cross-hatch interference, involving channels 8 and 12, on a newly purchased set. A check revealed that the offending signal originated from a CB operator down the street, with the front end being overloaded on these two channels only.

After wasting more than an hour on applying conventional remedies without success, we decided to try new tubes in any circuit that might possibly be involved. The interference completely disappeared after a replacement was inserted for the 2nd video i.f. stage.

How could that tube be responsible? Front-end overload was clearly occurring. There was no relation between the TV receiver i.f. and the interfering frequency. We took the removed tube back to the shop and pondered the problem. In

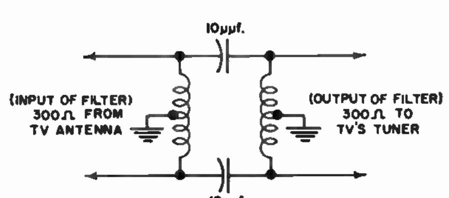


Fig. 1. Troublesome signals below the TV band are kept out of the receiver by this filter at the input of the tuner.

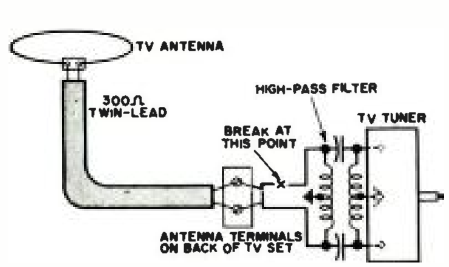


Fig. 2. A hidden break in the short lead between the antenna terminals and the tuner altered the characteristics of the input system, permitting entry of undesired signals.

fact, we inserted the tube in the 2nd i.f. stage of a set that was similar to the customer's (Fig. 3) so that we could check. After a while, it was noted that the a.g.c. voltage would change, becoming more positive.

Further investigation revealed the tube would become gassy when kept in operation for a time. Grid current developed a positive voltage at the grid itself, which was fed back into the a.g.c. line through the secondary of the i.f. transformer, bucking the negative voltage here. The a.g.c. line was also connected to the grid of the r.f. stage in the tuner. With tuner gain thus increased, non-linear operation occurred when the circuit was overloaded by such strong signals as those from the affected channels.

I.F. Pickup

In the early days of TV, when 21-mc. i.f. strips were standard, interference from hams using the popular 15-meter band by direct pickup in the i.f. strip was a common problem. A good high-pass filter often helped, and input traps tuned to the i.f. were also useful. In many cases, it was necessary to re-align the i.f. section to shift the frequency.

Because the interfering signal often enters through the front end and feeds through, rather than being picked up directly in the i.f. strip, a good high-pass filter at the tuner input will still cure a lot of present-day problems. Often a trap at this point (Fig. 4A), tuned to the intermediate frequency, is another effective measure. Where direct pickup is a factor, shielding inside the set is needed. Sometimes both measures must be used to clear up a stubborn case.

Such an instance is illustrated by complaints we had last spring from customers who were being troubled by interference from a MARS (Military Affiliate Radio System) network operating at 4.595 mc. This is very close to the 4.5-mc. intercarrier sound frequency. Interfering signals would mar TV pictures with sound bars and override TV sound with their own ear-splitting volume. In these cases, we used copper-wire and aluminum screening to shield the entire 4.5-mc. sections of the affected receivers. In addition, we installed a pair of traps tuned to 4.595 mc. at the tuner input, where necessary, with one on each side of the transmission line (Fig. 4B). This eliminated interference on most sets.

Secondary Radiation

After a long, rainy spell during the cold months of last winter, we received a number of customer complaints clustered in one area concerning severe interference from an amateur operator who lived in that vicinity. Most of the TV sets involved were good designs properly equipped with high-pass filters. Since the ham's own TV set was also being affected, there appeared to be a good case against him.

However, an interview with him indicated he had done everything possible to no avail. He was most cooperative. Several of his high- and low-power transmitters were tried, all with the same result. They were all high-quality, properly filtered, commercial units in good order. Individually switching in his various antennas for different bands also made no difference. We checked his entire system, more than once, from stem to stern. Finding nothing else, we lowered his antenna system and overhauled suspected parts, but to no good purpose.

As a last resort, and with the permission of local property owners, we decided to use a small, battery-operated TV receiver as an interference probe, to see whether some other, hidden factor was involved. Sure enough, we were on the right track. After probing most of the neighborhood with the operating portable, we noticed that the interference became most severe as we approached the clothes line on one of the properties. Replacing it cured the problem.

The line was a plastic-coated one whose core consisted of hard-drawn, stranded wire. After a period of time, and accelerated by the recent spell of unpleasant weather, the strands

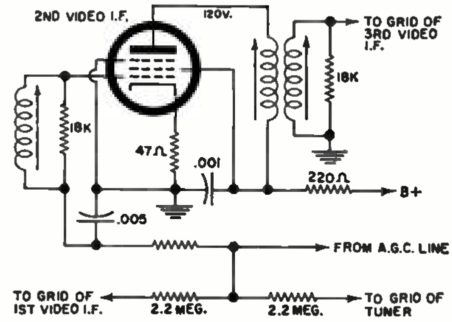


Fig. 3. A gassy i.f. tube developed positive grid voltage, which reduced the effect of a.g.c. action and permitted tuner overloading.

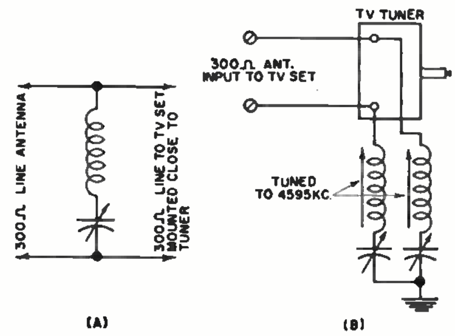


Fig. 4. Wavetrap (A) is effective for single-frequency trouble. A severe case needed two input traps (B) plus circuit shielding.

had corroded considerably. With rectification possible at points where corroded strands came into contact with each other, the line became a non-linear device. It would pick up the ham's cleanly transmitted fundamental and generate strong harmonics up into the TV band, which it would re-radiate to cause interference.

We might note that we have encountered similar problems with corroded connections in TV receiving antennas and transmitting antennas.

Rectification Puzzler

Harmonic generation through rectification or non-linear action in some element is not unheard of, although the source may not be obvious. Consider this case, however, which was encountered several years ago. The customer complained that he could hear strange voices coming out of his TV receiver even when it was turned off. In fact, he insisted the voices could still be heard when the line plug was pulled!

Whatever we may have thought when we heard the story, a trip to the scene confirmed the strange symptom. The voice was that of a ham operating in the 6-meter band, and he was talking up a storm. The set owner would often be awakened during the night, wondering what on earth was going on.

The receiver was a 1951 *Zenith*, using a turret tuner with a large drum. The sound was found to be coming from this tuner, rather than from the loudspeaker. Disconnecting the transmission line from the antenna post, however, did stop the voice. The antenna was picking up enough of the ham's signal to light a small, neon bulb connected across the open end of the 300-ohm line.

The key step in the cure was to clean the badly corroded contacts in the tuner. To be on the safe side, the outdoor antenna was also re-oriented for minimum pickup of the ham's signal and a high-pass filter was installed.

In this case, rectification at the corroded contacts was detecting the audio modulation of the amateur's transmission directly. Considering the level of his signal available from the antenna, the demodulated audio was strong enough to be reproduced by mechanical vibration in the tuner structure.

Self-Interference

In another case, we had licked a rather difficult TVI problem in a neighborhood thickly populated by amateurs and CB operators. Several months later, the customer complained that the interference had returned. Sure enough, our own

(*Continued on page* 76)

High-Accuracy Satellite Tracking System

By JAMES E. KIRCH / Program Manager, Goddard Range & Range Rate System, Motorola Inc., Military Electronics Div.

THE mixture of fact and fantasy one reads today about space and spaceships, missiles and satellites, exotic propulsion systems and spectacular methods of communication has somewhat neglected one extremely important phase of man's ventures into space.

This editorially neglected orphan of the space race is the means by which earthbound scientists can keep track of vehicles after they are launched.

Perhaps this represents the unspectacular phase of space exploration, or perhaps it is assumed, erroneously, that once the satellite or spacecraft is placed in orbit or shot out into space, its position, rate of travel, and orbit can be easily determined to any degree of accuracy.

The National Aeronautics and Space Administration (NASA) is expending considerable time and effort in developing a sophisticated new satellite tracking system, the Goddard Range and Range Rate Tracking System, which will provide an improvement in the resolution capability with which the satellite or space vehicle can be located in space and its velocity determined.

The new system was initially conceived by the Goddard Space Flight Center at Greenbelt, Maryland. Following the research and engineering of the system by Goddard engineers and scientists, fabrication of the system equipment was entrusted to the *Motorola* Military Electronics Division in Phoenix, Arizona.

Use and Accuracy

The new system, which will be suitable for tracking near-space and cis-lunar (this side of the moon) distance satellites and probes, is expected to play a major role not only in current near-space satellite tracking projects, but also to serve as a prime tool to gain data required for the advanced systems that will be required in our future deep-space probes.

Description and operation of a new system that can pinpoint spacecraft with a tracking resolution of 16 yards in distance and within a speed of as little as 4 inches per second.

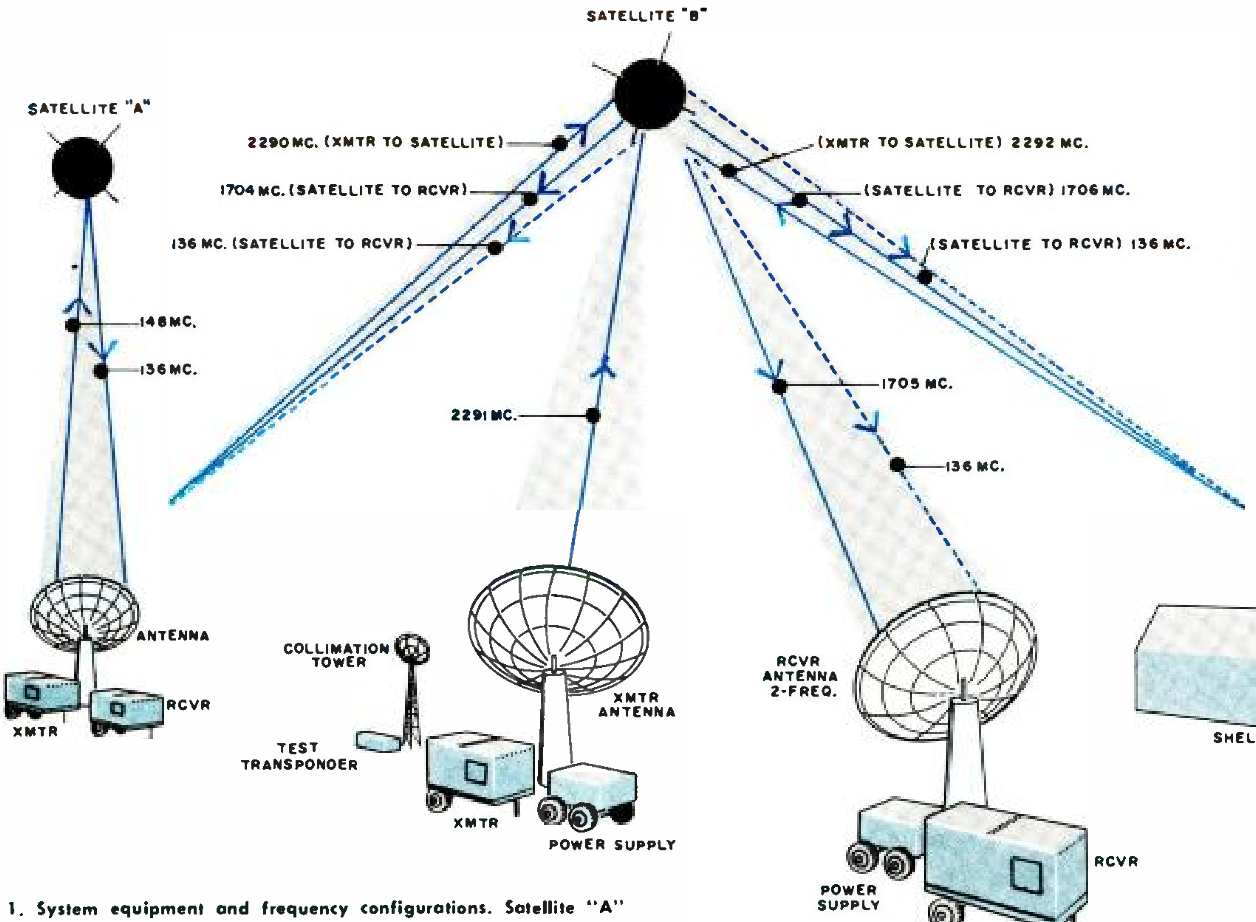


Fig. 1. System equipment and frequency configurations. Satellite "A" (left) is being acquired and ranged on by a single station using the frequencies indicated. Satellite "B" (center) is being simultaneously acquired by means of the 136-mc. beacon being received at three completely identical stations, one of which is illustrated. Then, fine tracking and ranging occurs through use of frequencies on the order of 1700 mc.

The Range and Range Rate System, when used to track satellites in near-space operations, will provide a resolution capability for determining the spacecraft position to within ± 15 meters (16 yards) in range and ± 0.1 meter (4 inches) per second in range rate. Range is described as the satellite's position in relation to the tracking station, and range rate is the velocity in relation to the tracking station.

Equipment Required

Ground-based tracking facilities will consist of tracking stations deployed around the world. Each tracking station will be equipped with a very-high-frequency (v.h.f.) antenna system, an S-band antenna system (1700-2300 mc.), and transmitter and receiver equipment installed in vans similar to the semi-trailer trucks on the nation's highways (see Fig. 1).

The ground-based equipment is just "one end" of the gear needed to communicate back and forth with a satellite to obtain the required information for precise tracking. The "other end" of the system is an electronic device in the satellite known as a "transponder."

Transponders to be used with the Range and Range Rate System—some of which will be produced by *Motorola* and others to be furnished by the government—are highly sophisticated devices which receive the signal from the earth tracking station, automatically process the signal, and return an answering signal to the ground station.

One Station or Three

The Range and Range Rate System can be used effectively with one ground station tracking a spacecraft or with three ground stations set up in a trilateration pattern.

When single stations are employed to track, the stations are positioned around the globe in the approximate path of the expected orbit. Different orbits can be accommodated by moving the stations to other global positions. The tracking station equipment, mounted in air-transportable trailer vans, can be easily moved to any desired location.

When the system is used with three tracking stations set up in a trilateration pattern, simultaneous measurement of specific regions of a satellite's orbit is obtained. The three stations employed in this mode of operation are accurately surveyed to insure that incorrect positioning of the ground equipment does not adversely affect the data obtained. Depending on the mission of the satellite being tracked, the stations can be placed at various points around the globe with either all three stations within a few hundred miles of each other or spaced thousands of miles apart on different continents.

Because the transponder in the satellite will have to function as well with single stations as with three stations in a trilateration pattern, it incorporates three channels. When used with the trilateration complex of tracking stations, the transponder will be capable of responding simultaneously to the signals sent from each of the three stations.

The system requires that a minimum of advanced information about the satellite be forwarded to each tracking station prior to the arrival of the satellite over that station. This information includes the expected time of arrival of the satellite over the particular point and the satellite's approach azimuth (elevation) angle. By furnishing this information to the tracking station in advance, the time required by the tracking station antennas to locate or "acquire" the satellite (antenna search time) is decreased.

Obtaining the Data

As the satellite passes over the tracking station, one of two different methods can be used to obtain the range and range rate data. In the first method, the S-band antenna system is used to extract the range and range rate information while using the v.h.f. antenna to locate or "acquire" the satellite. The v.h.f. antenna sweeps back and forth in a sector-scanning function until it locates and locks onto the signal being received from the 136-mc. minitrack beacon in the spacecraft. While the v.h.f. antenna is searching for the satellite, the S-band antenna is "slaved" to the v.h.f. antenna—that is—it follows exactly the same sweeping movements as the v.h.f. antenna. Thus, both antennas are always "aimed" at the same point, and when the v.h.f. antenna locks onto the satellite signal, the S-band antenna is also automatically locked onto the signal.

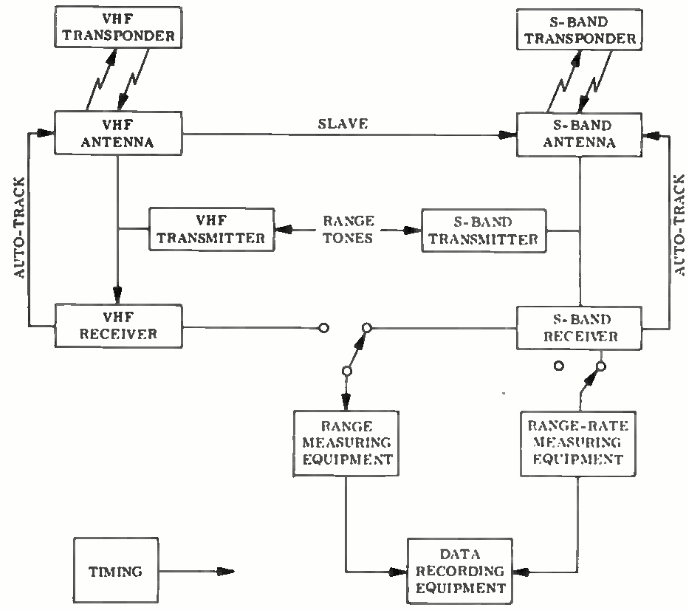


Fig. 2. Simplified block diagram of the tracking system.

At this point the function of the two antennas is separated. The S-band antenna automatically adopts an autotrack mode of operation, remains locked onto the satellite, and begins extracting range and range rate data by sending signals to the satellite for processing by the satellite's transponder and return to the tracking station. By acquiring or "finding" the satellite for the S-band antenna, the v.h.f. antenna has now completed its responsibility in this particular method of operation. See Fig. 2.

In the alternate method of operation, the v.h.f. antenna is used to both acquire the satellite and to carry out the function of extracting the range and range rate data.

Measuring Velocity & Position

Range rate or relative satellite velocity, which is the speed of the satellite in relation to the particular tracking station obtaining the data, is measured by the Doppler principle. In this method the two important considerations are the time required for a signal to be sent to the satellite and returned to the tracking stations and the strength of the signal when it is returned. By measuring the Doppler cycle shift or *character*

(*Continued on page 79*)

ON OUR COVER

A SATELLITE or space vehicle orbiting the earth or penetrating deep space accomplishes nothing for our country's space program unless we can accurately track the vehicle and gain pertinent data from it.

Lowell V. Havener, Graphic Arts Supervisor at Motorola's Systems Research Laboratory in Riverside, California, illustrates his conception of satellites being accurately pinpointed in space by means of three earthbound tracking stations. Transponders on the satellite being tracked pick up the three beams and re-transmit the signals back to the ground stations.

The accompanying article discusses the principles involved in the new tracking system which will provide the resolution capability for tracking a spacecraft with a high degree of accuracy. The system is being produced by Motorola for NASA's Goddard Space Flight Center. ▲

EVOLUTION OF THE COMMUNICATIONS RECEIVER / Part 2. Post-War Sets

By MAURICE P. JOHNSON, W3TRR

Circuit design techniques that have led up to the highly sensitive, very selective, and stable radio amateur and short-wave receivers of the present.

WHEN receiver manufacturers returned to the production of commercial products after World War II, evidences of new design efforts began to appear. The multi-purpose communications approach reached a peak of versatility with the impressive "SX-42" produced by *Hallicrafters*. This complex 15-tube package of modern styling attempted, with a large measure of success, to function as a high-fidelity AM and FM broadcast receiver, as an all-band general-coverage set tuning from broadcast to above 108 mc., and also as a bandspread ham receiver with crystal filter, noise limiter, and b.f.o. included for good measure. Despite the necessary compromises in such an encompassing design, the set performed quite well.

Several other receiver designs appeared, invariably using the standard 455-kc. i.f. with crystal filter (Fig. 5), and one or more tuned r.f. stages. Signal-to-noise ratios improved with newer high-gain r.f. tubes, so that high-frequency performance got better. The finer designs lavished attention on reduction of drift in the h.f. tunable local oscillator. Image response continued to be a problem, and was particularly bad at 30 mc.

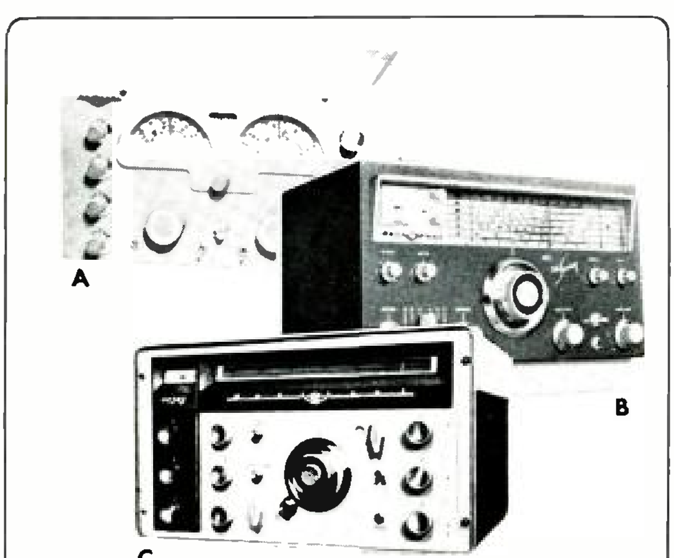
By the late 1940's, some representative receivers on the market were *Hammarlund's* "SP-400," and "HQ-129" and *National's* "HRO-7," "NC-173," and "NC-183." *Hallicrafters'* compact "S-53" hinted at things under development, with the unusually high i.f. frequency of 2.075 mc.

Dual Conversion

The image problem was never completely resolved in single-conversion receivers, even with two tuned r.f. stages. Because of the wide tuning range of most communications receivers (usually from 550 kc. to 30 mc.) and the fact that the i.f. frequency should not appear in the receiver r.f. tuning range, an i.f. near 455 kc. had become standard. Images then appeared at frequencies twice the i.f. removed from a desired signal, or only 910 kc. away. This was very close to a carrier at 30 mc. The net result was double-spot tuning, so familiar on the ten-meter band. The 455-kc. i.f. was satisfactory in terms of image response up to about 10 mc., but higher i.f. frequencies were called for at 14, 28, or 56 mc. The i.f. frequencies of 1.5 to 5 mc. would be suitable for good image rejection at these r.f. ranges, but again percentage bandwidth interferes in the form of poor i.f. skirt selectivity.

The solution to these conflicting problems is the dual-conversion i.f. strip, wherein both high- and low-frequency i.f. amplifiers are combined in cascade. The first high i.f. provides the desired image rejection, while the low i.f. gives the needed selectivity to define the passband. See Fig. 6.

National (A) NC-173, (B) NC-270, (C) NC-303.



Hallicrafters (A) SX-42, (B) SX-100, (C) SX-101A.

Hallicrafters used this design approach in its Model SX-71, a receiver of about 1950 vintage. This set gave continuous coverage from 550 kc. to 56 mc. The low-frequency i.f. with variable crystal filter operated at 455 kc., but above 7 mc. an additional converter and 2.075-mc. first i.f. were added to the string. The over-all i.f. selectivity was made quite sharp and no attempt was made to provide for wide-band high-fidelity reception. Without the crystal filter, the i.f. bandwidth was 3.5 kc. at 6-db down, and 14 kc. at 60-db down. With this narrow bandwidth, the signal-to-noise ratio was good and the set was quite sensitive. Provision was made for NBFM reception as well. Both high and low i.f. amplifiers and the second conversion oscillator were fixed-tuned, consequently the h.f. first oscillator was tunable. With the improved selectivity, plus extended coverage to the six-meter band, first oscillator stability was a very important factor.

Double conversion appeared in *Hallicrafters'* deluxe ruggedized Model "SX-73" receiver. *National* used double-conversion techniques in the "NC-183D," and up-dated the "HRO-50" to double conversion with the "HRO-60."

With the combination of high and low i.f. frequencies doing a good job of solving the image problem over tuning ranges extending to six meters, the choice of the second i.f. frequency, which had remained near 455 kc. for so long, was re-evaluated. Again the percentage-bandwidth factor—lower i.f. frequencies could be used for narrowing the over-all passband in the dual-conversion system. The increasing popularity of single-sideband signals on the air did much to spur development of increased i.f. passband control.

Hallicrafters introduced the "SX-88," which featured double conversion on all bands from 535 kc. to 33 mc. This receiver had two r.f. stages, tunable first oscillator, and selectable high i.f. channels of either 1.550 or 2.075 mc. The second conversion used crystal-controlled oscillators with a choice of either 1.500 or 2.125 mc. as beating signals. This permitted selection of either the upper or lower sideband output from the second mixer to be passed through a following 50-kc. i.f. strip. The 50-kc. i.f. featured eight tuned circuits in the three stages, with six-step variable selectivity without crystal filtering, the bandwidths ranging from 10 kc. to only 250 cycles on the "nose." An interesting aspect indicative of the selectable single-sideband approach was evident in the fact that bandwidth narrowing was not symmetrical. Instead, the carrier was located at one edge of the i.f. passband, with bandpass narrowing from one side as selectivity increased. See Fig. 7.

Previously, most i.f. strips had been designed to pass both carrier sidebands through a symmetrical passband, with carrier centrally located. Bandwidth control was by means of variable mutual inductance coupling, which served to symmetrically reduce the passband. In the "SX-88," the passband variation was obtained with more complex interstage coupling, by means of capacity and resistance rather than inductive coupling. In addition to the selectable sideband feature, the increased use of single-sideband on the air was recognized in the isolation of second detector, a.v.c. and b.f.o., variable b.f.o. injection level, and attention to the stabilization of the tunable first oscillator.

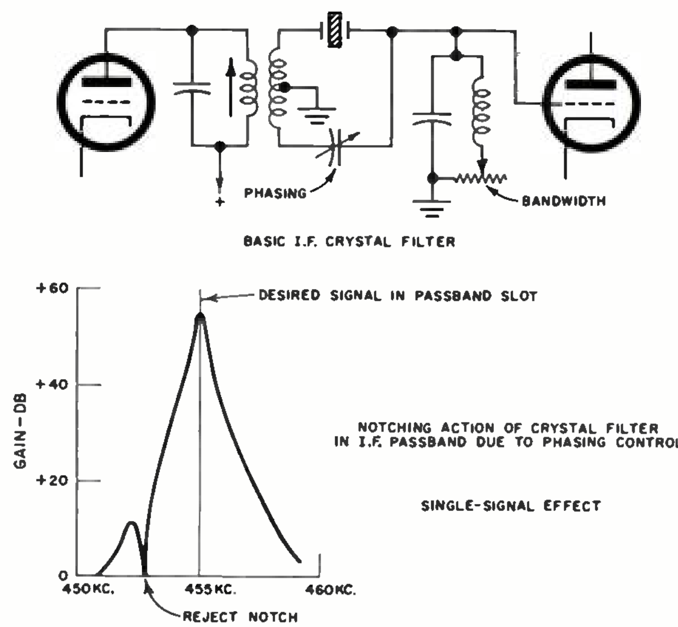
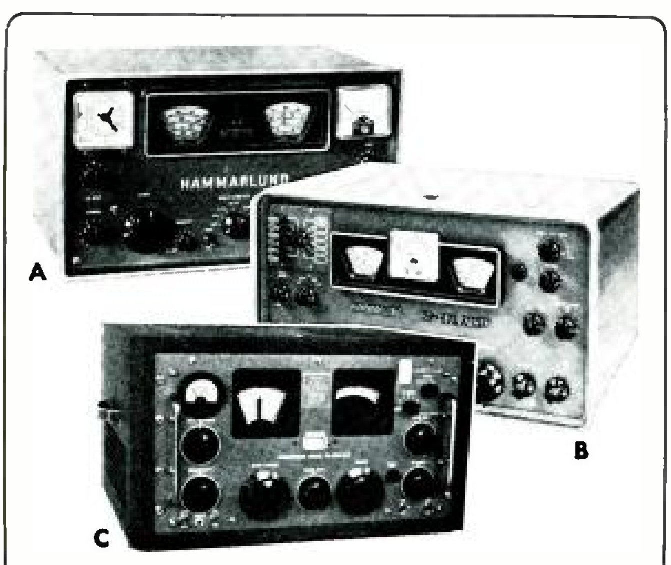


Fig. 5. Typical crystal i.f. filter and passband notching action of the phasing control. Another control is provided in the circuit in order to vary the bandwidth of the amplifier.

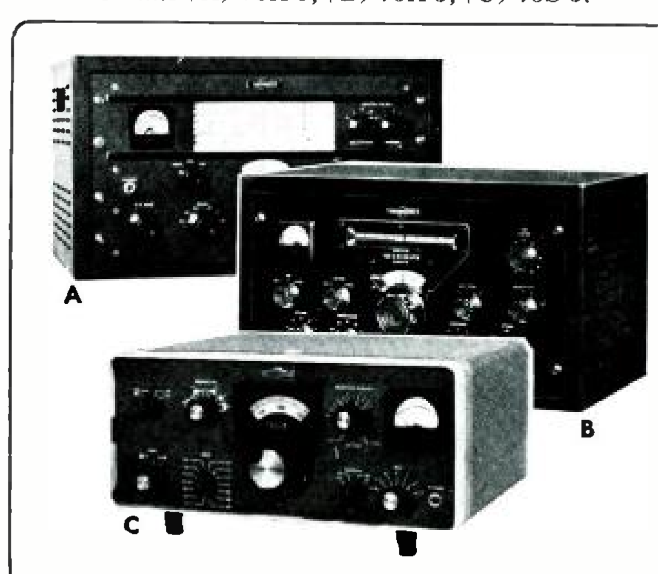
Specialized-Use Receivers

The development of special-purpose receivers continued as *National* introduced the "NC-300" intended for ham-band operation only. This was a ten-tube double-conversion design of about 1955. Besides coverage of ham bands to ten meters directly, an additional 30- to 35-mc. tuning range was included to act as a tunable i.f., giving triple conversion on the 6-, 2-, and 1¼-meter bands in conjunction with accessory converters. Thus the problem of stability on six meters and

Hammarlund (A) HQ-110A, (B) HQ-180, (C) SP-600.



Collins (A) 75A-1, (B) 75A-3, (C) 75S-3.



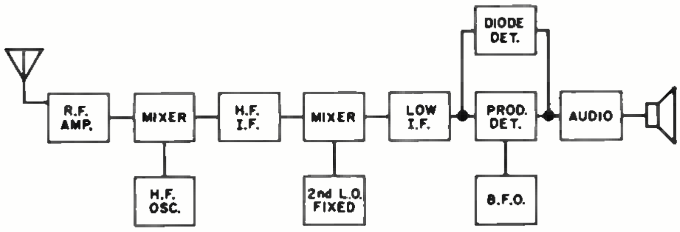


Fig. 6. Block diagram of typical present-day communications receiver employing double-conversion. Note the use of the tunable high-frequency oscillator and the fixed i.f. amplifier.

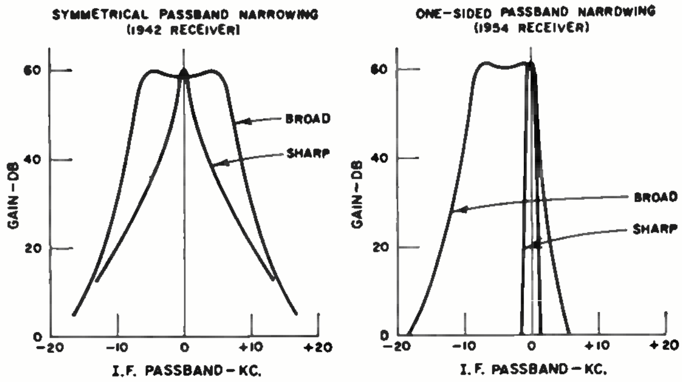


Fig. 7. Comparison between symmetrical and one-sided narrowing.

above was attacked by means of crystal-controlled converters and, effectively, a tunable i.f. amplifier.

This receiver included other features worthy of mention. The type 6BZ6 high-gain pentode, characterized by low cross-modulation or crosstalk, was used for the r.f. amplifier. A 6BA7 and 6AH6 tunable h.f. oscillator handled the first conversion. The high i.f. frequency was 2.215 mc. and here appeared a crystal filter with variable selectivity and rejection notch. The second i.f. was at 80 kc., with variable bandwidth. A choice of diode or a 6BE6 heterodyne product detector was provided, while the selection of upper or lower sideband was governed by b.f.o. frequency.

National then produced the "NC-303" receiver, a revamped and up-dated version of the "NC-300." The crystal filter was

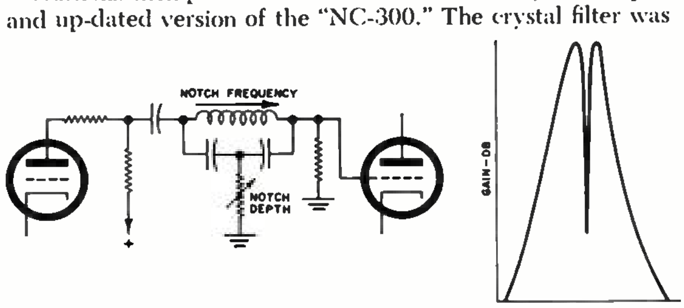


Fig. 8. Typical T-notch i.f. filter and passband notching action. The variable resistor determines the depth of the notch while tuning the coil shifts the position of the notch.

removed from the 2.215-mc. i.f. and a "Q"-multiplier added at 80 kc. Second conversion was now crystal-controlled. Both diode and product detectors were continued, with noise limiters for each.

Hallicrafters continued the development of the selectable sideband receiver with the "SX-96" and then the "SX-100." These sets continued the use of dual-conversion on all bands. A 6CB6 r.f. stage, 6AU6 mixer, and 6C4 tunable first oscillator comprised the front end. The first i.f. was 1650 kc., followed by crystal-controlled second conversion oscillators at either 1600 or 1700 kc. The second i.f. was 50 kc., with five selectivity ranges from 5.0 to 0.5 kc. A bridged-T notch filter (Fig. 8) included in the "SX-100" permitted adjustment of notch depth and frequency to help remove an objectionable signal from the passband. A series diode noise limiter was useful on both phone and c.w. signals. The a.v.c. and b.f.o. could be switched in or out individually.

Thus, it is evident in the receiver designs of the 1955 period to the present time that single-sideband reception had influenced design principles. Selectivity and stability continued as the goals of much design effort. Heterodyne product detectors for c.w. and SSB had been paired up with the more conventional diode AM detector. Bandpass shaping methods had become more sophisticated. The b.f.o. and its injection level had been given attention and a.v.c. time constants had been modified for SSB. The sideband selection feature was suited to AM as well as SSB reception. Double-conversion techniques had improved image rejection to a very marked degree. For example, the "SX-71" had an image rejection ratio of 40 db at 30 mc., with one r.f. stage, compared to only 26 db for an earlier single-conversion receiver with two tuned r.f. stages. The "SX-88," in turn, had an image rejection of 60 to 120 db over its tuning range.

Some other receivers of this period, deserving of mention, include the ruggedly built dual-conversion *Hammarlund* "Pro-310" with bandswitching coil turret, reminiscent of a deluxe TV tuner turret; the quality "GPR-90" receiver of *Technical Material Corporation;* and the *RME* "4350" with its very good noise figure of under 6 db.

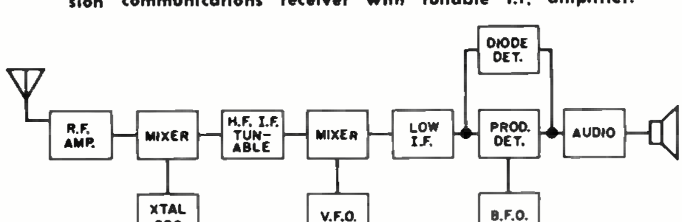
The "SX-101" which appeared in late 1956 was another *Hallicrafters* design, adapting much of the "SX-100" circuitry to a ham-band-only type receiver. With sensitivity and selectivity rather well accounted for in previous sets, this receiver is notable for its emphasis on the third important design criterion: stability. Mechanical ruggedness was apparent in the heavy chassis and solid assembly. Electrical stability was evident in the attention given to the first conversion oscillator, which included ceramic trimmers and coil forms. Crystal control was continued in the second oscillator. Voltage regulation was provided for all oscillators, plus extensive temperature-compensation methods. The use of a small eight-watt heater, connected directly to the power line to run continuously, contributed to stability by preventing buildup of humidity within the chassis confines. The newer "SX-101A" version even keeps heater voltage on the first h.f. oscillator tube by means of an independent filament transformer wired directly to the a.c. line.

Other receivers were indicative of the design efforts being directed toward increased stability. *Heath* produced the "Mohawk," a 15-tube double-conversion ham-band-only receiver in kit form. *Hammarlund* turned out the "HQ-160," which had a tuned r.f. stage, separate mixer and h.f. oscillator, and a 3.035-mc. first i.f. amplifier. This was followed by a crystal-controlled converter to generate the 455-kc. second i.f. Selectivity was controlled by a shunt-type "Q"-multiplier and a T-notch filter, replacing the crystal filter that *Hammarlund* had previously developed to a high state of perfection.

The desire for increased selectivity had resulted in new methods of bandpass narrowing. With this reduced i.f. bandwidth, however, the need for stability in the conversion oscillators had become greater than ever. Stability in the second conversion oscillator was relatively easy to obtain, because the frequency was comparatively low and usually

(*Continued on page* 69)

Fig. 9. Block diagram of typical present-day double-conversion communications receiver with tunable i.f. amplifier.



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RADIATION "FINGERPRINTING"

Pulse-height analyzers, which can identify elements by characteristic radiation levels, have many applications in medicine, agriculture, and industry.

By JOHN R. COLLINS

IN THESE times of universal concern over nuclear radiation, probably everyone knows that certain elements spontaneously give off *gamma* rays that can be detected with a geiger counter or similar instrument. Less widely known is the fact that *gamma* radiation is emitted from each different source at a characteristic energy level. Thus, *gamma* rays from cobalt 60 and cesium 137 have energy peaks of 1.33 and 0.661 mev (million electron volts), respectively.

It is also true that elements not ordinarily radioactive will emit characteristic *gamma* radiation when they are subjected to an intense x-ray beam. By measuring the energy of the *gamma* rays thus produced, it is possible to identify the elements making up a test sample. This provides a fast and accurate method of performing a chemical analysis.

While a simple geiger counter will detect the *presence* of radioactivity, it cannot discriminate between rays of different energy levels. It reflects the sum of all radioactivity present, including radiation due to cosmic rays and the scattering of *gamma* rays by surrounding objects. By itself, therefore, it is worthless for determining the nature of the radiation source.

The many peaceful uses of atomic energy developed in recent years emphasize the need for more sophisticated instrumentation, capable of distinguishing between radiation of different energy levels. Radioactive tracers, for example, are now widely used in medicine, agriculture, and industry, for such diverse tasks as locating brain tumors and diseased tissue, for determining the best methods of feeding crops, and for finding the causes and marking the progress of wear on piston rings and valves in an internal combustion engine.

By measuring their individual energy levels, it is possible to use several tracers in a single experiment. This permits the use of greatly advanced techniques since, for example, the wear on piston rings and valves can thus be measured separately in a single engine. Furthermore, the ability to distinguish between primary and background radiation provides exact, quantitative information not otherwise available.

Instruments capable of separately measuring *gamma* rays of different energy levels are called pulse-height analyzers. A typical model is shown in Fig. 1 and in block diagram in Fig. 2. It consists essentially of a radiation detector (usually not an integral part of the PHA, but necessary to its operation), a linear amplifier, a base level discriminator, an upper level discriminator, and an anti-coincidence circuit. The PHA output is to a scaler or ratemeter—also essential to the operation but usually not part of the instrument.

The detector is usually a photomultiplier tube which is optically coupled to a thallium-activated, sodium iodide, scintillation crystal. When *gamma* rays strike this crystal, their energy is completely absorbed in the crystal and is converted into photons, or flashes of light. The magnitude of these flashes is, of course, in direct proportion to the energy of the *gamma* ray. The photomultiplier tube converts the light energy into voltage and amplifies it, producing output pulses which are also proportional to the impinging *gamma* radiation.

Fig. 2 shows three *gamma* rays with energies of 200, 250, and 300 kev (thousand electron volts) striking the crystal. The resulting scintillations are converted into minute voltages which are amplified by the preamplifier to pulses of 0.04, 0.05, and 0.06 volt, respectively. They are then multiplied by a factor of 1000 by the linear amplifier, emerging as pulses of 40, 50, and 60 volts.

The pulses are next applied to a base level discriminator and an upper discriminator. The former rejects all pulses below a pre-set level and passes all pulses above that level. The upper discriminator is referenced to the base level discriminator setting and may be adjusted to a level from 0 to 10 volts above the setting of the base level discriminator. Pulses which pass through the "window" between the setting of the lower and upper discriminators are recorded by the scaler or ratemeter. However, pulses which exceed the setting of the upper discriminator are canceled by the anti-coincidence circuit and are not recorded.

The method is illustrated by Fig. 2. Here the base level is set at 45 volts and the upper level at 55 volts. The 40-volt pulse is eliminated by the base level discriminator, since it is not large enough to pass. Both the 50- and 60-volt pulses trigger the base level discriminator, producing output pulses. However, since the 60-volt pulse exceeds the setting of the window, it triggers the upper discriminator and the output pulse cancels the corresponding pulse from the base level discriminator. Hence, only the 50-volt pulse, initiated by the 250 kev *gamma* radiation, is recorded by the ratemeter. Either of the other *gamma* rays might have been selected and counted by proper adjustment of the base level discriminator and the window width.

The Amplifier

The amplifier is designed to accept input pulses up to 2 volts from the preamplifier and to provide output pulses of up to 100 volts that are linearly related to the energy of the *gamma* radiation striking the photomultiplier tube. A delay line is sometimes used in the input circuit to produce narrow, flat-topped pulses, which are best for the operation of the discriminators. Feedback circuits are employed for stability and to insure linearity over the necessary range.

Since large, positive pulses are applied to the amplifier tubes, there is danger that grid current will flow. This problem is handled by connecting the tubes as cathode followers in the critical stages. In this way, when the grid is driven positive, the cathode moves the amount necessary to prevent grid current from being drawn. Also, direct coupling is used in one stage so that, when the grid is driven positive and draws current, it will recover instantly when the pulse falls.

Except for these precautions, the amplifier design is conventional. These special features permit the amplifier to withstand heavy overloads with negligible effect.

The Discriminators

The major elements of a base line discriminator are shown in Fig. 3. The circuit is a modified Schmitt trigger, a type of multivibrator which produces a flat-topped pulse output for the period during which the input exceeds a selected value. A twin triode, such as the 6BQ7, is generally used. The two cathodes are connected together and are operated at about 100 volts above ground. The grid of V_2 is about 10 volts negative with respect to the cathode, being operated at approximately 90 volts with respect to ground. The potential of the grid of V_1 is selected by the setting of the potentiometer, and may vary from 0 to 100 volts. The potentiometer setting determines the base level in selecting pulses, since pulses below the chosen level will have no effect on the circuit.

In the quiescent state, both triodes draw current of a few milliamperes. When a pulse greater than the selected level appears at the grid of V_1, however, that tube draws substantial plate current and its plate voltage drops sharply. Since the V_1 plate is coupled to the V_2 grid, the grid voltage of V_2 falls accordingly and it is driven to cut-off. The plate current of V_2 therefore ceases and its plate voltage rises sharply, forming the leading edge of a pulse. This pulse continues for about 1 microsecond, the period during which the grid of V_1 is positive. At the end of this period, the grid of V_2 returns to its initial state, plate current flows again, the plate voltage drops, and the output pulse is complete.

The result of this operation is a sharp output pulse of about 7 volts. The pulse height is determined solely by the difference in the plate voltage of V_2 in the quiescent state and at cut-off, and is consequently independent of the size of the input to V_1. It is only necessary that the input to V_1 exceed the selected base level for V_2 to produce a 7-volt output pulse.

The output pulse is shaped through the use of diodes CR_1, and CR_2. CR_1 is a silicon junction diode which, in common with other diodes of this type, has a sharp reverse voltage characteristic. When connected in this manner, a silicon junction diode will maintain a constant voltage despite a varying load, in much the same way as a gas-discharge, voltage-regulator tube. Acting as a clamp, it keeps the plate voltage constant despite minor fluctuations in plate current. When overloaded by the sudden current surge resulting from the input pulse, however, it breaks down sharply, unclamping the plate circuit. This trigger action sharpens the leading edge of the pulse.

Diode CR_2 speeds recovery to the quiescent state at the termination of the input pulse by permitting the charge left on the coupling capacitor, C, to be discharged through its forward resistance.

The upper discriminator is almost identical to the lower. It is arranged so that its trigger level can be adjusted from 0 to 10 volts above the setting of the base level discriminator. A change in the setting of the base level does not necessitate a change in the setting of the upper discriminator. It is referenced to the base level discriminator, and the window width

Fig. 1. PHA-type radiation analyzer, by Nuclear-Chicago Corp.

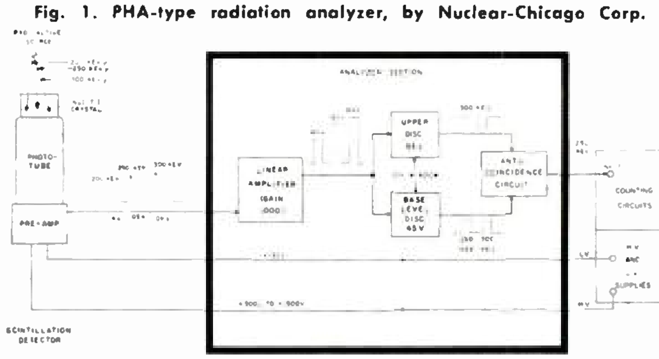
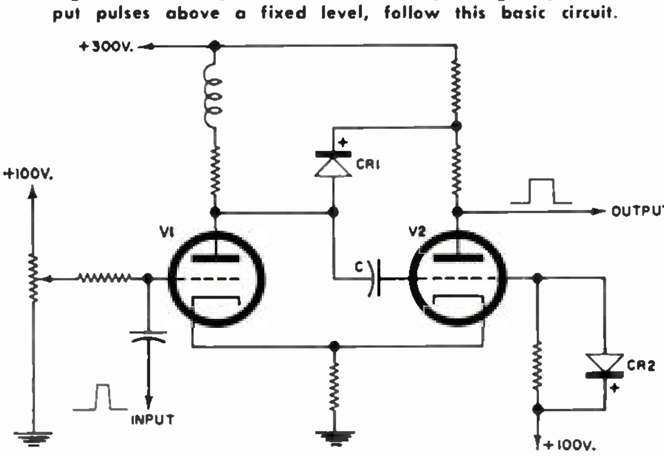


Fig. 2. Model 1810 analyzer of Fig. 1 in block-diagram form.

Fig. 3. Both analyzer discriminators, responding only to input pulses above a fixed level, follow this basic circuit.



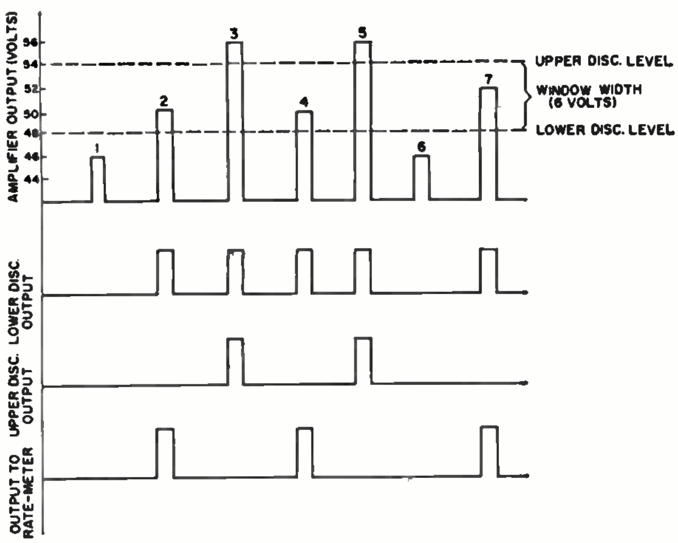


Fig. 4. Analyzer output (bottom row) consists only of pulses whose amplitudes fall in the range between both discriminators.

will remain the same unless the setting of the upper discriminator is changed.

The upper discriminator is triggered by pulses that exceed the setting of the base level discriminator by an amount equal to the window width. This situation is illustrated in Fig. 4. The lower discriminator is set to trigger on pulses whose amplitude is greater than 48 volts. With a window width of 6 volts, the upper discriminator will also operate when the amplitude exceeds 54 volts. By using a larger resistor in the plate circuit of V_2 for the upper discriminator, an output pulse of 9 volts is obtained from the latter.

Anti-Coincidence Circuit

Since the function of a pulse height analyzer is to count only those pulses of the proper height (those passing through the window), an anti-coincidence circuit, shown in simplified form in Fig. 5, is provided to cancel out those pulses which trigger both the upper and lower discriminator. Referring again to Fig. 4, it will be seen that pulses 3 and 5 trigger both discriminators, and hence do not appear in the output to the ratemeter.

To compensate for slight differences in time of arrival at the anti-coincidence tube, V_2, the output of the base level discriminator is narrowed while the pulse from the upper discriminator is stretched. To accomplish this, the 7-volt pulse from the lower discriminator is passed through a differentiating circuit made up of a capacitor C_d and resistor R_d. The output of such a circuit is normally a positive spike caused by the leading edge of the pulse, and a negative spike caused by its trailing edge. In this instance, crystal diode CR_1 is inserted in the circuit to attenuate the positive spike, so that only the negative spike remains.

The negative spike is inverted by tube V_1, producing a narrow pulse of about 2 volts. This pulse is applied to the grid of tube V_{2A}, one half of the dual triode used as the anti-coincidence tube. This tube is self-biased near cut-off, with both halves drawing approximately 2.5 milliamperes in the quiescent state. If there is no input from the upper discriminator (and hence no signal on the grid of V_{2B}), the pulse from the lower discriminator causes a negative pulse of about 8 volts to appear at the plate of V_{2A}. This pulse is fed to a ratemeter or scaler and is registered as a count.

Pulses from the upper discriminator are stretched by the resistor-capacitor network, R_s and C_s, shown in the upper left of Fig. 5. Capacitor C_s is charged through a high-back-resistance diode, CR_2. This charge decays with a 2-microsecond time constant through resistor R_s. When this voltage is applied to the grid of tube V_{2B}, a large plate current flows, causing a voltage drop of 5 to 7 volts across the cathode resistor which is common to both V_{2A} and V_{2B}. The effect is to raise the cathode potential 5 to 7 volts, so that V_{2A} is cut off and no pulse appears at the V_{2A} plate.

In this manner, pulses large enough to trigger both the base level and the upper discriminator are cancelled out and are not counted by the ratemeter. A positive pulse may occur at the plate of V_{2A} as a result of the abrupt cut-off of normal plate current, but a diode limiter in the trigger generator clips this pulse so that it does not reach the ratemeter.

Scalers are designed to record the total number of pulses, and normally have capacity to about 1,000,000 counts. Ratemeters provide information on the number of counts per minute, and are therefore useful in making rapid measurements of *changes* in radiation levels. Typical instruments have full-scale ranges of 0-100, 300, 1000, 3000, 10,000, 30,000, 100,-000, 300,000, and 1,000,000 counts per minute.

Other Considerations

Manufacturers of pulse height analyzers can supply radioactive standards which may be used for calibrating the instruments. The controls are flexible, and a particular setting of the base level control can represent any desired energy level within the range of the instrument. Thus, a setting of 66.1 volts may represent the 0.661-mev energy peak of cesium 137. When the energy scale is properly calibrated in this way, it is readily possible to identify unknown sources from their energy peaks.

The discriminator circuits are unable to function within a few volts of zero, and will oscillate at very low levels, causing a false peak. Where very low energy levels are to be measured, it is best to recalibrate the instrument using a higher amplifier gain factor. In this way, the scale can be expanded so that the required measurements do not fall near the zero level.

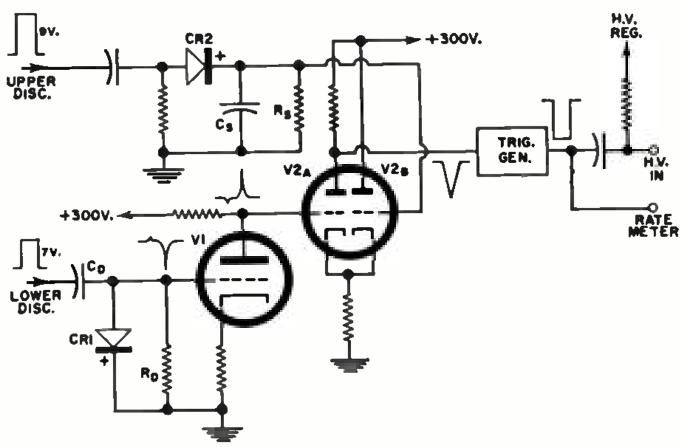


Fig. 5. The anti-coincidence circuit, which cancels analyzer output when both discriminators are triggered by large pulses.

The resolution time of a pulse height analyzer is the period required for the detector and its associated circuit to recover after a *gamma* particle has entered the system. If two particles enter the system within this period, only one pulse will be produced, since the detector system will be "paralyzed" by the pulse that entered first. The loss of counts due to this effect is called the "coincidence loss."

In a good pulse height analyzer, the resolution time is about 2 microseconds. Since pulses occur at random intervals, there is as much chance of pulses occurring during the dead time as in any other period of equal duration. It is not difficult, therefore, to compute the coincidence loss when the resolution time and the counting rate are known. Coincidence loss will obviously be greatest at the highest counting rate. At 1,000,000 counts per minute, for example, it amounts to slightly more than 3 per-cent. ▲

The new Weathers "66" weighs 96 ounces

...and every ounce is pure performance!

The Weathers "66" is the finest achievement in uncompromising design and performance. The low mass of the Weathers "66" makes it the proper turntable for today's high compliance stereo cartridges and tonearms. In appearance alone, the "66" is radically different. It is 16" long, 14" deep, but only 2" high, including the integrated base. It is the closest approach to rotating a record on air. It achieves this ideal through unique engineering design and precision manufacturing.

The Weathers "66" uses two precision hysteresis synchronous motors mounted on opposite sides of the deck. Virtually vibration-free, they directly drive two soft rubber lathe-turned wheels which in turn drive against the inside rim of the platter. This is the quietest, most accurate and dependable drive system yet designed. Its -60 db. rumble is the lowest of all turntables.

Eliminates Feedback Problem—Because the new high compliance cartridges and tonearms track at extremely light pressures, they can pick up floor vibrations which are transmitted into the music as audible distortion. The "battleship" type of turntable more easily picks up room vibrations and transmits them with greater amplitude. When a high compliance pickup system is used with the heavier turntable, acoustic feedback is apt to occur. And there is no practical, effective way to acoustically isolate these heavier units.

The Weathers "66" is suspended on 5 neoprene mounts which produce an isolation from floor vibrations of more than 500 to 1. Paul Weathers calls this system a "seismic platform" (implying that only a violent earthquake could cause any vibrations or feedback).

On Pitch—The speed constancy of the Weathers "66" is so accurate that a special test record had to be made to measure its 0.04% wow and flutter content. It reaches 33⅓ rpm immediately, and will be accurate within one revolution in 60 minutes. Most heavy turntables will usually deviate 4 or more revolutions in 60 minutes—a painfully obvious inaccuracy to anyone with perfect pitch. You hear only the music—no rumble, no wow, no flutter, no feedback, no noise of any kind.

The "66" is a strikingly beautiful turntable that you can use anywhere, without installation. And you need not buy a base—it's an integral part of the turntable! ▪ Turntable—$75.00 net. With viscous-damped arm—$99.50 net. Turntable and Arm with new Weathers LDM Pick-up—$129.50 net. At your high fidelity dealer, or write: Desk E\

WEATHERS
Division of TelePrompTer Corp.
50 W. 44th St., N.Y. 36, N.Y.

W

T-8

The Acoustical Lens
(Continued from page 35)

while the smaller has a serpentine lens.

Like the perforated-plate lens, path-length refractors can be designed to give almost any desired dispersion, but the ability to control horizontal and vertical distribution independently makes them even more versatile for professional use.

Design Considerations

Like optical lenses, acoustical lenses operate effectively only through a definite band of frequencies. The size of the horn mouth can be correlated with the characteristics of a particular lens to keep distribution uniform down to the cut-off frequency of the driver-horn combination. At the upper end of the spectrum, the smooth distribution pattern afforded by the lens begins to show irregularities as the spacing between obstacles or plates approaches a half wavelength.

This means that a lens designed for use up to 10 kc. should not have the plates separated more than a half-inch or so. Horn-lens combinations have been developed which maintain uniform dispersion characteristics from 400 to more than 15,000 cps. This is an effective bandwidth of about five octaves, obviously no mean achievement.

One might think that a substantial portion of the sound energy passing through a lens, especially an obstacle array, would be absorbed. As long as the lens is designed properly, and its elements are rigid, this is not the case. In a well-designed lens, less than 1% of the energy passing through the device is lost. Of course, in *any* type of dispersion arrangement, there is an apparent change in high-frequency intensity since all the energy which was formerly concentrated in a narrow beam is now spread through a much greater angle.

If one wants to pursue the optical analogy far enough, focal lengths and even *f* numbers can be assigned to acoustical lenses. The unit shown in part (B) of the photo, for example, is roughly equivalent to a 150 mm. *f*/0.5 optical lens. It will probably be some time before a comparable unit is available to camera enthusiasts. ▲

FM STEREO STATIONS UP

ACCORDING to Harold L. Kassens, head of the FCC's Aural Existing Facilities Branch, roughly 25 per-cent of the FM stations in the U.S. will be broadcasting in FM stereo by the end of this year.

If the present rate of conversions to stereo continues, the FCC chief said it is possible for the number of stations to go as high as 300 by January 1—50 more than the present estimate.

The FCC is undertaking revisions in its FM broadcast rules to foster this growth of FM service. ▲

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ROTATORLESS ANTENNA CAN BE AIMED

By HAROLD HARRIS, V.P. Engineering, Channel Master Corp.

A switch selects the elements for pickup or rejection in any direction, dispensing with mechanical rotation.

MOST ANTENNA design seeks higher gain for the deep fringe. Yet other problems—interference and multipath reception, or ghosts—plague millions of TV and FM fans elsewhere. Two advances, color TV and FM stereo, make these traditional difficulties more serious than ever. Effects are far more destructive to enjoyment than in monochrome TV or single-channel FM.

Heretofore, elaborate antenna-rotator combinations have met these problems. Now many viewers and listeners may find a simpler, economical solution in *Channel Master's* "Omni-Ray" design. A stacked version is shown in Fig. 2.

It is a broadband, v.h.f., TV-FM design whose reception pattern is the familiar figure-8 of the half-wave dipole (Fig. 1, Diagram 1), which features a 78° angle at the half-power points and a front-to-side ratio of 10:1. In the "Omni-Ray," however, the lobes can be turned either to pick up signal or to kill ghosts and interference *without physical rotation*.

Its basic element is adapted from the classic bat-wing: a low-band dipole broadbanded by cat-whisker stubs (Fig. 1, Diag. 2) for high-band pickup.

The simplest way to provide choice of directions is to cross a pair of dipoles (Fig. 1, Diag. 3) at right angles, then use either one dipole *or* the other. Solid lines show the north-south reception pattern of the east-west dipole; broken lines show the pattern of the north-south dipole. This gives peak coverage (or rejection) in four directions, N, E, S, and W, but not for signals arriving from intermediate directions.

In the "Omni-Ray," the principle of pattern addition provides eight positions (the top of Fig. 1), which permit maximum selection (or rejection) in 16 directions of the circle, each only 22.5° from the next. This is achieved with a 4-conductor lead-in connecting to the antenna elements at one end (Diag. 4) and terminating at the other in a switch at the control console. The latter permits the user to pick various combinations of elements, then feeds signal from the chosen arrangement to the receiver.

As to pattern or lobe addition, consider the case of the 45° angle between cardinal directions N and E (signal arriving from NE; Diag. 5). Elements N and W are joined by the switch, as are segments S and E. Both basic dipoles (N-S and W-E) receive some signal, but each at an angle where sensitivity is 70.7% of maximum gain (where solid-line lobe N and broken-line E cross). Since the two lobes are in-phase at this point, they add. Thus total NE gain is restored to about 100%, the effective pickup lobe being indicated by the shaded area in Diag. 5. Addition occurs similarly in the SW direction.

Where the S and E lobes overlap, however, instead of addition, cancellation produces a null or signal rejection. We appear to be dealing with lobes that have polarity! This can be understood if we acknowledge that arriving signal sets up a potential in a half-wave dipole, with polarity at one end opposite to polarity at the other.

Diag. 6A illustrates the same situation in another way to indicate this. Arriving signal from NE polarizes dipoles N-S and W-E as shown. These two dipoles are connected in-phase by the switch, so that half-elements N and W on one side of each dipole reinforce each other, as do half-elements S and E on the other side. However, arriving SE signal (Diag. 6B) reverses polarity of the N-S dipole only. With the same switch connection, dipoles N-S and W-E are in opposite signal phase. They cancel each other to produce an SE null. The same occurs in the NW direction. The resultant pattern is Diag. 7.

This behavior in the 45° positions between cardinal directions is obtained by feeding equal amounts of power from both dipoles to the receiver. By feeding *unequally*, the pattern can be made to fall at points between the cardinal directions and the 45° positions. The user can do this with the switch on the "Target

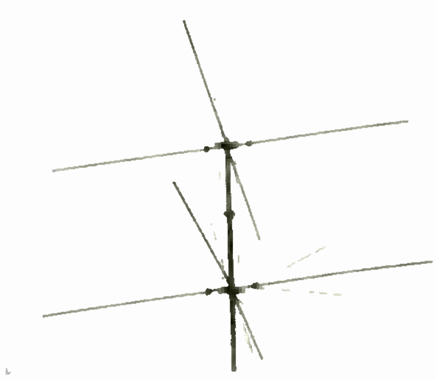


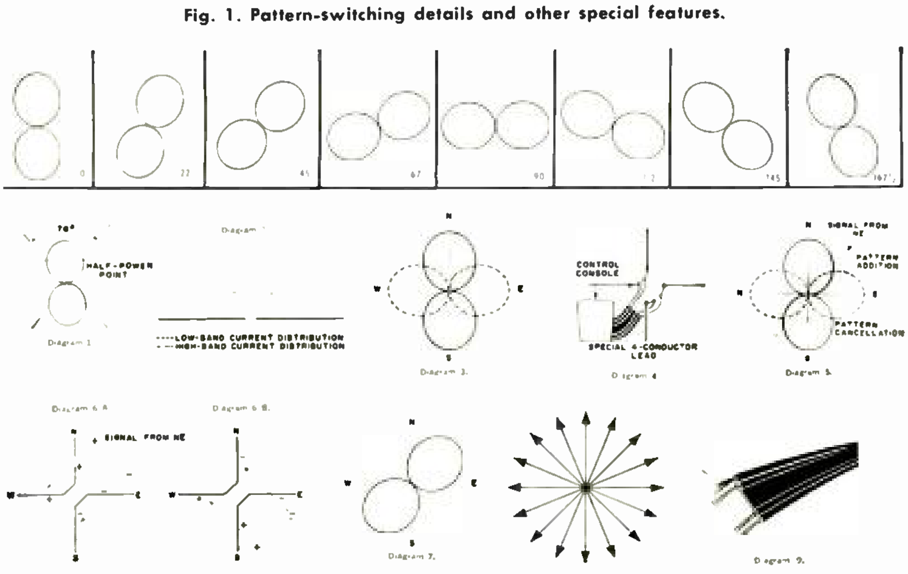
Fig. 2. "Omni-Ray" is aimed with a switch.

Timer" control console, located near his set. The 16 directions available are indicated in Diag. 8.

To maintain the desired pattern in all positions, there must be no coupling between the conductors in the transmission line from the dipoles to the phasing switch. The specially developed Duo-Twin 4-conductor line (Diag. 9) maintains this condition, simplifying installation. Using two separate lengths of standard lead-in is not likely to result in the desired performance.

To solve their reception problems, the large number of non-fringe users have heretofore had to invest in equipment designed for the smaller number of outlying viewers and listeners. This special design may provide an economical solution for many harassed people in populous cities and suburbs. ▲

Fig. 1. Pattern-switching details and other special features.



Buyer's Guide and Condensed Applications Chart—Norelco® 'CONTINENTAL' Tape Recorders

This condensed guide, prepared by the High Fidelity Products Division of North American Philips Company, Inc., offers the consumer the factual data he needs to select the tape recorder best suited to his specific requirements.

				
	Continental '100' Model EL 3585	**Continental '200'** Model EL 3541	**Continental '300'** Model EL 3542	**Continental '401'** Model EL 3534
PRIMARY USERS	The entire family—at work, at play, at home or away.	Serious music lovers with limited budgets.	Schools, churches, teachers of voice and music. Psychiatrists, speech therapists and recreation directors—and collectors of pre-recorded stereo tapes.	Professional musicians, studio recordists, serious music lovers, high fidelity enthusiasts, doctors, dentists, industrial sound installation contractors.
ESPECIALLY SUITABLE FOR	On-the-go, on-the-shoulder recording and playback — anything, anytime, everywhere.	Portable, high fidelity tape-deck applications. Portable public address.	Audio-visual and all specialized teaching applications; music program source for factory, office and home; portable P.A.	Professional-quality stereo recording, live or broadcast; space-saving hi-fi system control center and background music.
SPECIAL FEATURES	Battery-operated, 100% transistorized, feather-light. Records from any source. Tapes interchangeable with all 2-track 1⅞ ips recorders.	Stereo head output direct to external stereo preamp. Records sound-on-sound. Mixing facilities. Compact, lightweight, inexpensive.	3 speeds. Stereo head output for playback through external stereo preamp. Records sound-on-sound. Mixing facilities. Headphone monitoring.	100% transistorized. Completely self-contained for stereo recording and playback at all speeds. Dynamic stereo microphone. Multiplay permits sound-on-sound recording. 4th speed provides up to 32 hours recording time.
RECORDING CAPABILITIES	Monophonic 2-Track	Monophonic 4-Track	Monophonic 4-Track	Stereo and Mono 4-Track
PLAYBACK CAPABILITIES	Monophonic 2-Track	Monophonic and Stereo† 4-Track	Stereo† and Mono 4-Track	Stereo and Mono 4-Track
SPEEDS	1⅞ ips	7½ ips	7½, 3¾, 1⅞ ips	7½, 3¾, 1⅞, 15/16 ips
PLAYING TIME PER REEL	Up to 2 hrs. on a 4" reel	Up to 4 hrs. on a 7" reel	Up to 16 hrs. on a 7" reel	Up to 32 hours on a 7" reel.
WEIGHT	7 lbs.	18 lbs.	30 lbs.	38 lbs.
MANUFACTURER'S SUGGESTED LIST PRICE*	$129.50*	$179.50*	$269.50*	$399.50*

For complete technical data and detailed descriptions of Norelco 'Continental' Tape Recorders, write:

NORTH AMERICAN PHILIPS COMPANY, INC., High Fidelity Products Division, **230 Duffy Avenue, Hicksville, L. I., N. Y.**

†Tape head output.

*The unit prices stated above are for identification only and are not necessarily the regular or usual retail prices and are not to be represented as such.

Doorbell Monitor for the Deaf

(*Continued from page 49*)

sists of ten turns of #18 enameled wire loosely wound. The variable trimmer-type capacitors C_1 and C_2 in the receiver are adjusted with the aid of a v.t.v.m. and with the thyratron tubes removed. The d.c. input of the meter is connected across C_2 for "front-door" alignment and across C_1 for "back-door" alignment. The respective relays of the transmitter may be pulled-in manually and held with tape; the capacitors are each, in turn, adjusted for maximum reading.

The receiver indicating lamps, Type 10S6, are actually small-sized candelabra screw-base units rated at 10 watts, 230 volts and are used here for long-life performance. The 6S6 (6-watt, 120-volt) lamps may be used for greater brilliance if desired. The tubes of both units also have long life due to the absence of anode current dissipation in the quiescent state. The set which was constructed has been operating almost continuously in the home of an associate of the author for four years with the only required maintenance being the replacement of two indicator lamps. The total cost of parts purchased at a local parts distributor was approximately $35 or $40. Of course, if only one doorbell is to be monitored, the cost would be somewhat less.

The doorbell monitor may be constructed with only a knowledge of soldering and wiring and can be a great convenience and contribute peace of mind to one who is deaf or hard-of-hearing. The system requires no interconnecting wiring; the portable receiver may be operated in any room of the house or in that of a neighbor. The author is indebted to Mr. Harold Combs who provided the impetus for the development and who also supplied the operating-experience information. ▲

Servicing Meter Movements

(*Continued from page 45*)

Increasing the shunt value will increase current through the movement, producing a higher reading. If readings are too high, compensate by reducing the shunt or adding one if needed.

A final note of caution is in order. The movement may be so delicate, once it is out of its case, that air movement will affect its action. Thus, if you are working with the meter at close quarters, normal breathing may interfere with the job. If you run into this, tying a clean handkerchief or other cloth over the nose and mouth should diffuse exhaled breath sufficiently to eliminate the problem. This may lead to a ribbing if someone should happen to see you, but it is an effective measure for dealing with the problem. ▲

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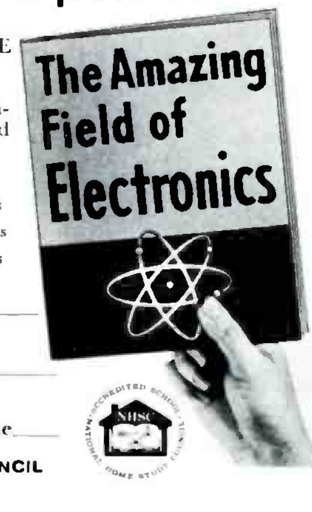

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Communications Receivers

(*Continued from page 56*)

fixed. Likewise, the b.f.o., operating at the second i.f. frequency and of narrow tuning range, could be stabilized by means of temperature compensation, voltage regulation, and mechanical rigidity. In both cases, where a very stable design was required, crystal-controlled oscillators could be called into service for these circuits.

The problems of stabilizing the high-frequency oscillator, particularly when tunable over the extremely wide frequency range needed for multi-band coverage, were not so readily solved.

Tunable I.F. Receivers

Rather than attempt to stabilize the h.f. oscillator working into a fixed-frequency i.f. strip, another design approach has become increasingly popular in some very recent receivers. Essentially, this is simply a happy marriage between a low-frequency superhet receiver and a crystal-controlled front-end converter to extend the r.f. tuning ranges. The technique had previously been used to extend the coverage of the usual communications receiver to the six- or two-meter bands. The combination might well be termed the "fixed h.f. oscillator, tunable i.f." receiver (Fig. 9). The present trend is to extend this technique down into the usual coverage range of conventional receivers.

Probably the first advocates of this approach were the designers at *Collins,* who produced the "75A" series receivers. Unusual in concept at the time was the "75A1," which had a crystal-controlled first oscillator, followed by tunable high-frequency i.f. amplifier and transmitter-type v.f.o. as tunable second oscillator. A second i.f. amplifier at 500 kc. with crystal filter was used. This receiver tuned the ham bands only.

Collins continued with the "75A2" and then introduced the mechanical i.f. filter in the "75A3." Next came the "75A4" in continuing revisions of the series. This version used a 6DC6 r.f. tube, 6BA7 mixer, and 12AT7 crystal-controlled first oscillator. The tunable i.f. ranged from 1.5 to 2.5 mc. as the v.f.o. tuned 2.955 to 1.955 mc. A mechanical i.f. filter appeared in the 455-kc. strip which followed, as did a bridged-T "Q"-multiplier. The bridged-T notched the i.f. passband somewhat like the phasing adjustment of earlier crystal filters. The b.f.o. and main tuning were ganged to produce a unique passband tuning, which served to move the signal in the receiver passband without changing the b.f.o. note.

A somewhat similar approach is used in the recent *Drake* "2A" and "2B" receivers. In these sets, crystal control is again used for the h.f. oscillator, which is bandswitched over twelve bands, but is not tunable. Instead, the high i.f. is varied over a 600-kc. increment, from 3.5 to 4.1 mc. This i.f. is mixed against a v.f.o.-type second oscillator covering 3.955 to 4.555 mc., to produce a fixed lower i.f. of 455 kc. Because the v.f.o. operates at fairly low frequency, and over a limited tuning range as well, stability is more easily obtained. A third conversion produces a final i.f. frequency of 50 kc., which then passes through an amplifier with tunable bandpass filter. The main tuning dial drives a ganged capacitor to tune the v.f.o. and tunable i.f. The r.f. stage is independently peaked in grid and plate circuits by means of another ganged capacitor. This preselector covers 3.5 to 30 mc. by bandswitching.

Other Recent Designs

Another recent receiver to use crystal-controlled h.f. oscillator design is the *Hallicrafters* "SX-115" which tunes the ham bands in nine 500-kc. steps. This set uses broadband circuits in the r.f. and mixer stages, with ganged tunable i.f. and v.f.o. The first i.f. ranges from 6.005 to 6.505 mc. as the v.f.o. covers 5 to 5.5 mc. The second i.f. is therefore 1.005 mc., which is amplified and introduced to a third mixer. Here the selectable sideband feature appears; the choice of crystal-controlled oscillator frequencies of 1.055 or 0.955 mc. is available for this conversion. The third i.f. at 50 kc. includes a selectivity control with five steps and a T-notch filter.

This improved design approach has produced receivers with less than 500 cycles drift after warmup. The tunable i.f. technique results in a constant tuning rate, irrespective of the signal frequencies being received. However, it will be noted that this stability has been achieved at the expense of limited tuning range per band, because of the reduced tuning range of the tunable i.f. The usual result is a limited-coverage receiver—ham-bands-only in most designs.

Complete coverage requires a large number of bands and a considerable outlay for first-oscillator crystals. Design is also further complicated by possible spurious problems. However, some highly stable general coverage receivers have been designed using this particular technique.

One such set is the *Eddystone* Model "880" which covers a range of 500 kc. to 30.5 mc. in thirty bands, the tunable i.f. covering one megacycle for each band. The selling price of over $1500 limits the market for this receiver, but it is an example of an extremely stable design. Other designs intended largely for military use feature crystal-controlled synthesizers as local oscillators, sometimes phase-locked, giving precision and stability for rigorous applications. ▲

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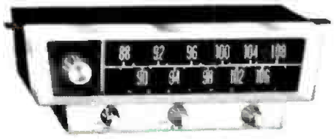

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NEW FM/FM Stereo Tuner

Stereo Indicator light; phase control for max. separation and lowest distortion; adjustable AFC for drift-free reception; bar-type tuning indicator; filtered outputs for stereo tape recording. Factory assembled tuning unit. 16 lbs.

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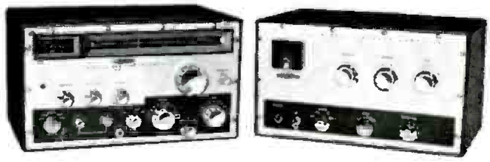

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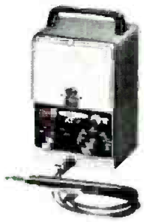

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ITEM	MODEL NO.	PRICE

Lasers and Their Uses
(*Continued from page* 32)

If a single 100,000-megacycle-wide signal in the part of the spectrum where the sun radiates its greatest energy were filtered out, it would be found that each square centimeter of the sun was producing only about 10^{-5} watt in this band.

Even our coherent radio transmitters, of course, operating over a far narrower band, can transmit hundreds of thousands of watts of power, because of their coherence. And so can lasers. Within a given bandwidth, the laser can generate up to several million times the energy radiated by the sun. Further, this energy can be focused into a very small area where desired, to produce extremely high temperatures. *Raytheon* recently demonstrated a high-powered unit which could blast holes in sheets of stainless steel in milliseconds. *G-E* researchers burned holes in diamonds.

Future Weapons

The Armed Forces are working furiously on high-powered lasers which they hope will develop into military weapons. Greatest usefulness would come, of course, if a super-high-powered laser beam could transmit enough power to burn holes in attacking missiles. Although this idea seems to hang on the fringes of science fiction, many reputable scientists are hopeful that it can be done, and the Department of Defense is spending millions of dollars on research programs designed to develop such a system.

Karl Kober, in charge of *Martin Marietta's* laser weapons program, envisions a million-watt laser orbiting in a spaceship, drawing its power from an atomic power plant aboard. He estimates that the laser would be as big as an army searchlight, and would produce a million-degree-temperature beam. Since it would be above the atmosphere, there would be practically no attenuation of the beam between ship and target.

Some scientists in the field doubt that such a weapon will ever be practical. A laser doesn't create power, they point out. It only transforms it, and rather inefficiently at that. A unit with a megawatt output would need an input of many megawatts, and that kind of energy isn't easy to come by. There would also be fantastic heating problems in a unit handling such power. The advantages of having such a weapon, though, are so overwhelming that military planners are pushing research ahead at full speed in spite of the lack of a guarantee that it will produce results.

Power Without Wires

The laser beam's power-transmitting ability may be useful in more peaceful ways, too. The old dream of wireless power transmission, for example, may come true at last. In transmitting energy—light or microwave—through a non-attenuating medium such as space, the only power loss is due to beam spread. With microwave transmission systems, the energy spreads so rapidly that a receiver even a short distance away is able to collect only a small fraction of the total.

Laser beams, on the other hand, are so sharply focused that the total energy could be easily concentrated in a spot five feet in diameter 100 miles away. A collector this size could absorb it all

An American Optical Co. laser was used recently at New York's Columbia Presbyterian hospital to burn a small tumor from the retina of a patient's eye. The operation, done with the patient awake, took about 1 millisecond and was completely painless. The doctor looks into the patient's eye through a special sighting system. When he is focused on the tumor, so is laser.

with negligible transmission loss. If any part of the transmission path is through an absorbent medium—air for example—some power will be lost. But even so, it is entirely possible that enough power could be transmitted from the ground to run the electrical and life-support systems of an orbiting spaceship. Such a system should work well from the moon.

New Surgical Tool

The laser's heat-packed beam has already been put to work in medicine. Doctors at New York's Columbia-Presbyterian Medical Center have used a carefully controlled laser beam to burn tiny tumors from the back of a patient's eye. The unfocused rays pass through the eye's lens harmlessly. But where they converge at the rear of the eye, they create enough heat to destroy the tumor instantly. Surgeons say a similar beam may also be used to "spot weld" a detached retina to the back of the eye. This has been done successfully on rabbits, but has not yet been tried on human patients.

The red beam may also serve as a superfine scalpel for other types of surgery, also for cauterization.

The Promise of Lasers

The promise of lasers in countless fields is so great that companies by the scores have hurried into research and development in the last two years. The Department of Defense estimates that more than 400 firms in this country are now doing laser work, and more are entering the field. Although the first experimental unit went into operation little more than a few years ago, this tremendous amount of research is already producing results. A number of companies already have commercial units on the market. *Standard Kollsman*, for example, markets its "PistoLaser," a 20-pound hand-held unit, for $2925. *Martin Marietta* can furnish a portable ranging unit built into a suitcase. *Sperry-Rand* is taking orders for a gas laser with an exceptionally coherent beam. *Westinghouse* has on the market a high-powered unit for experimental welding, cutting, and so on. *Raytheon, Hughes*, and others sell units of many different kinds.

Although progress to date is spectacular, many workers in the field think that the most exciting discoveries in laser technology are yet to come. Dr. Schawlow put it this way: "With the advent of the laser, man's control of light has reached an entirely new level. Indeed, one of the most exciting prospects for workers in the field is that this new order of control will open up uses for light that are as yet undreamed of." ▲

AIRBORNE TV SURVEY

AN AIRBORNE television network of 27 transmitters, of the type under consideration for educational TV, could serve the entire United States if certain conditions with respect to co-channel interference and aircraft altitude could be met, according to findings made by engineers at the National Bureau of Standards.

These conclusions are contained in a report entitled "Airborne Television Coverage in the Presence of Co-Channel Interference" (Technical Note No. 131) by M. T. Decker of the Boulder Laboratories and available from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. for $2.00 (PB-161-635).

The report notes that coverage is contingent upon altitude of the aircraft flying the transmitters and conditions of co-channel interference. Problems investigated include expected coverage, equipment requirements for specified coverage, interference from co-channel stations, and number of stations and channels required for a specified large area coverage. Graphs detail coverage in two forms: the first is the probability that at a given location a specified picture quality will be available for at least some minimum percentage of the time; and second a summation of "effective area" of a station or network of stations expressed in square kilometers. ▲

British Ground Station

(*Continued from page* 41)

low temperatures and can carry large currents without dissipating any heat. A small solenoid wound with niobium-zirconium alloy is capable of producing the intense magnetic field required by the traveling-wave maser.

The maser at Goonhilly has a gain of 25 db and a bandwidth of more than 25 mc. The maser itself has the extremely low noise temperature of about 10° K, permitting the construction of a microwave receiver with an over-all noise temperature slightly less than 100° K. The maser has been designed to allow for a movement of ±45° about its vertical axis, to accommodate the changes in reflector elevation angle. The maser handles not only the communications signals from the satellite but also the 4080-mc. beacon signals.

The initial transmitting equipment includes two high-power microwave transmitters. The first is a 10-kw. unit at 1725 mc. for Project "Relay," with the high-power stage using a multi-cavity klystron brought over from the United States. For Project "Telstar" there is a 5-kw. transmitter equipped with a British high-power traveling-wave tube. The frequency-conversion stages converting signals to and from an intermediate frequency of 70 mc. and the low-power driver stages are adapted from commercial microwave relay equipment.

For patching into the main British television networks, two-way microwave relay links have been installed connecting Goonhilly with Plymouth and Bristol from where video signals can travel all over the United Kingdom and, if required, to many other European countries through the Eurovision television network. There are also multi-channel telephony and teletypewriter facilities to London and to the United States *via* the NASA switching center in London.

In order to help assess the performance of the experimental communications satellite links there is a full range of measuring equipment as well as time and frequency standards. In order to check periodically the mechanical alignment of the antenna dish, the antenna is fitted with a boresight telescope for ranging on points of known bearing. Some 20 miles away, apparatus capable of simulating the "Relay" and "Telstar" satellite equipment has been set up.

All equipment has been made as flexible as possible to allow for expansion to meet future operational needs.

Information on the new Goonhilly Radio Station and the photographic material accompanying this article have been made available to the author courtesy of Her Britannic Majesty's Postmaster-General. ▲

A PREAMP TO INCREASE OSCILLOSCOPE SENSITIVITY

By OTIS E. VAN HOUTEN

Construction of a preamp that is suitable for general-purpose scopes, that has a voltage gain of 28 db and a response extending from 10 cps to 3 db down at 5 mc.

HOW many times have you attempted to observe an elusive waveform only to discover that the deflection obtained on your scope left much to be desired? You adjust the intensity and focus controls, flip the attenuator switch and give the gain control another twist, but the only hint of a signal is a small green wiggle. Strained eyes and a perpetual squint usually follow this experience. A possible solution would be another scope. However, after scanning the specs of other instruments, none can be found that will provide the necessary sensitivity and bandwidth at a price within the budget of the occasional user.

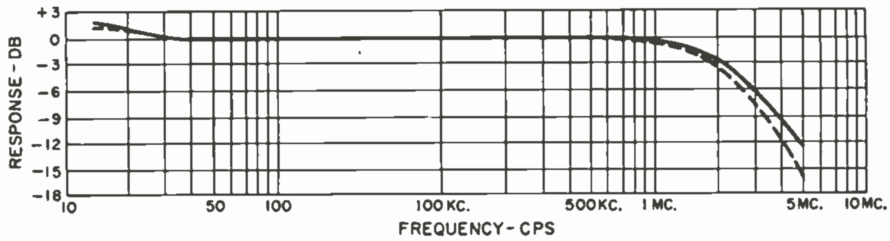


Fig. 1. Response curves. Solid line, scope; dotted line, scope through preamp. Diagrams have been superimposed at 100 cps to 100 kc. to show response more clearly.

Additional amplification for your present scope is the solution. A quick look at the trace with the gain control at maximum and the vertical input shorted will indicate if additional amplification is practicable. If the sweep is sharp with no sign of hum or noise, an additional 20 to 30 db of gain can be tolerated before they become excessive.

The quality of amplification is dependent on the quality of your present scope. A preamplifier should have a bandwidth as wide, preferably wider by one or two octaves, than your present scope. Phase distortion, hum, and noise should be low and there should be an even number of phase reversals. The preamp described here, while designed for a particular class of scope (response 3 db down at 2 mc.) can be modified so that it can also be used with higher quality scopes (response 3 db down at 4 or 5 mc.).

This preamp will provide more than one inch deflection on your present scope when viewing a signal as small as 5 mv. In addition, sync will be improved since a larger signal will be applied to the sync circuits. Also, if you use an isolation probe that introduces a 20-db signal attenuation, the preamp will offset this loss.

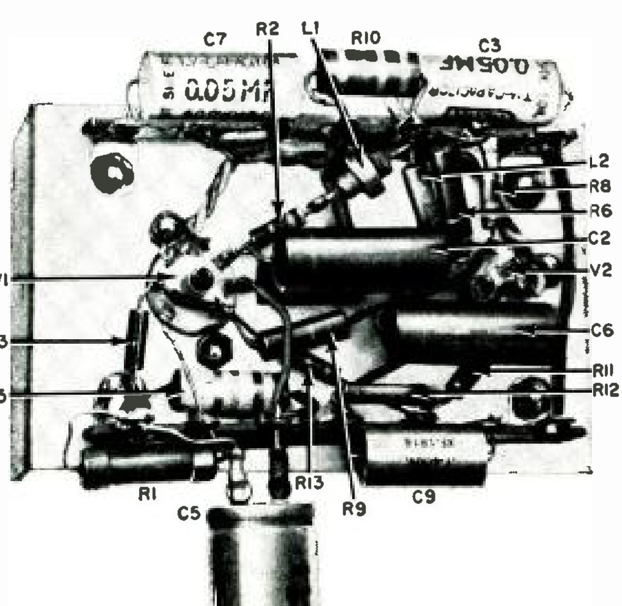
The Circuit

The circuit shown in Fig. 4 provides sufficient gain so a small amount of negative feedback can be employed to increase the bandwidth and reduce phase distortion. V_1, a shunt-compensated video amplifier, has had values selected for R_2 and L_1 that will produce the desired bandwidth. Because over-all negative feedback is provided by using R_3 as a combined cathode resistor for V_1 and V_{2B}, the over-all circuit bandwidth will be about twice what it would normally be at the -3 db points for V_1. The values given for R_2 and L_1 provide a high-frequency 3-db-down point at 2.5 mc., so the over-all bandwidth extends to 5 mc. The 3-db-down point of V_1 can be extended to 5 mc. by reducing R_2 to 1600 ohms and by reducing L_1 to 24 μhy. and the over-all bandwidth will be extended to 10 mc. at a slight gain reduction.

V_{2A} provides additional amplification. Wide bandwidth was achieved by using a low-value load resistor (R_7) alone because the input capacity of V_{2B} is very low. L_2 was not used in the author's model. However, it should be incorporated if R_2 and L_1 are changed to increase bandwidth, to extend the upper-frequency limit. A small amount of positive feedback is provided by R_9 to compensate for the loss of gain caused by not bypassing R_8.

V_{2B}, a cathode-follower, provides a low-impedance output allowing the use of a long shielded lead, if necessary, between the scope and preamp so the high-frequency response will not be affected. Adequate low-frequency response is assured by heavily bypassing (C_5) and bleeder stabilizing (combination of R_4 and R_5) the screen-grid voltage for V_1 and by using large-value grid resistors, R_1 and R_6, for both V_1 and V_{2A}. R_{11}, the grid resistor for V_{2B}, appears as a very large resistance due to the input-impedance magnification characteristic of a cathode-follower.

Fig. 2. Author's preamp. The placement of parts is critical.



Performance

The voltage gain of the author's preamp is slightly greater than 25 (28 db). The bandwidth extends from below 10 cps to 5 mc. If a different amount of gain is desired, it can be achieved by changing the value of R_{10}. Larger values increase the gain and lower values reduce the gain. Lower values also increase dissipation of V_{2B} and higher values will cause an increase in distortion and a reduction in bandwidth. The preamp will handle inputs up to 150 mv. r.m.s. without distortion with a plate supply of 180 volts. Higher or lower plate voltage will cause a corresponding change in signal-handling ability. Signals as small as 10 mv. r.m.s. will provide a full five-inch deflection and a 2 mv. signal will be clean enough for easy observation. Fig. 1 is not necessarily indicative of the response of the author's scope. It merely shows the change in response caused by the addition of the preamp. The tests were made by determining the voltage required to cause a standard deflection at each selected frequency. Front-panel controls were not changed during the tests.

Construction

Since the author's preamp was to be installed inside a scope it was constructed on a 2½" x 4" aluminum sheet as shown in Fig. 2. A 1" mounting lip was provided at the end adjacent to V_1. Parts placement, as in any high-frequency circuit, is quite critical. The layout shown in Fig. 2 should be followed closely, with all signal-carrying leads and components installed point-to-point above the chassis to prevent attenuation of the signal. Standard audio-equipment construction practices, such as tightly twisting filament leads, dressing them close to the chassis, and connecting the ground bus to the chassis at only the scope input to reduce hum and noise, should be followed.

Filter and decoupling capacitors C_4, C_8, and C_{10} may be a multiple unit installed where convenient inside the scope cabinet. The negative terminal (metal can) should be insulated from the preamp chassis and connected to the common-ground bus on the preamp chassis. R_{15} and R_{14} should be installed on a terminal strip near the filter capacitors.

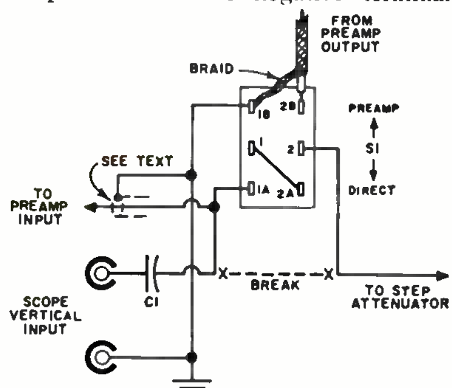
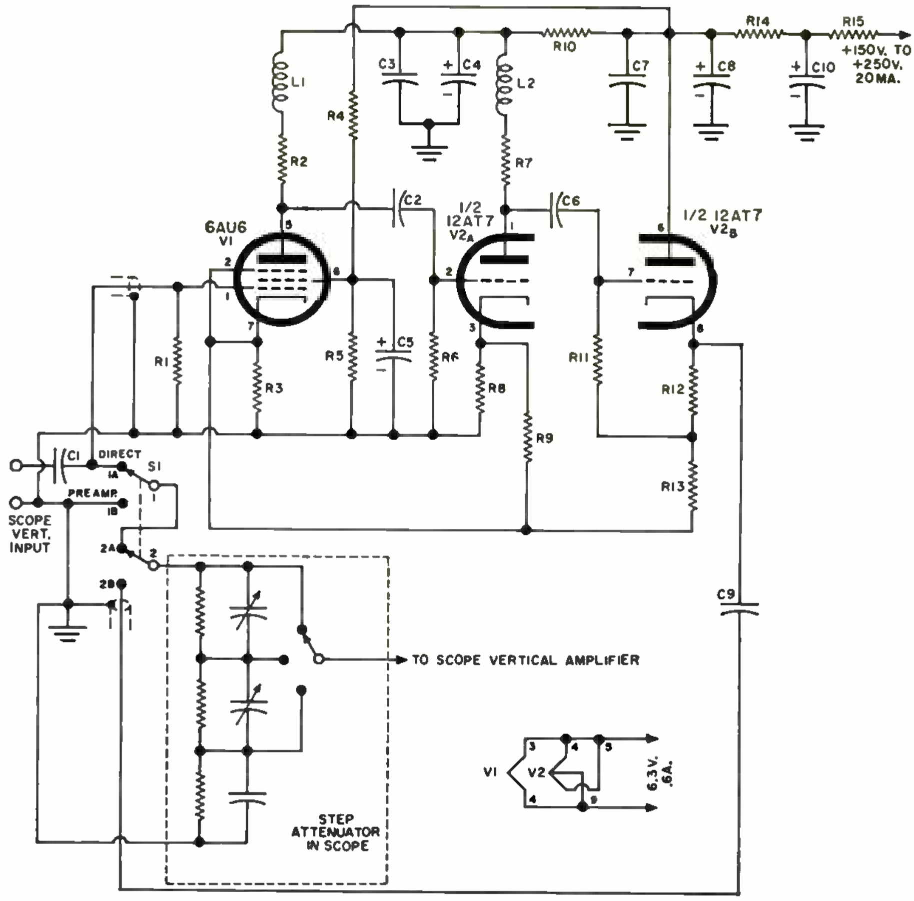


Fig. 3. S_1 and modification of scope input.



R_1, R_6—4.7 megohm, ½ w. res.
R_2, R_{13}—3300 ohm, ½ w. res. (see text)
R_3—120 ohm, ½ w. res.
R_4—10,000 ohm, 2 w. res.
R_5—20,000 ohm, 2 w. res.
R_7—3000 ohm, ½ w. res.
R_8, R_{12}—330 ohm, ½ w. res.
R_9—560 ohm, ½ w. res.
R_{10}, R_{14}—3300 ohm, 2 w. res.
R_{11}—1 megohm, ½ w. res.
R_{15}—1000 ohm, 2 w. res.
C_1—Scope input capacitor
C_2, C_6—.02 μf., 600 v. capacitor
C_3, C_7—.05 μf., 600 v. capacitor
C_4, C_8, C_{10}—20-60-100 μf., 250-250-300 v. elec. capacitor (Mallory FP335 or equiv.)
C_5—16 μf., 150 v. elec. capacitor
C_9—.1 μf., 400 v. capacitor
L_1—100 μhy. choke (J. W. Miller 4632 or equiv., see text)
L_2—55 μhy. choke (J. W. Miller 4629 or equiv., see text)
S_1—D.p.d.t. toggle switch
V_1—6AU6 tube
V_2—12AT7 tube

Fig. 4. Preamp schematic. Reducing values of R_2, L_1 increases bandwidth, lowers gain.

Installation

The preamp should be installed as close to the vertical input connections in the scope as possible; mount S_1 near the vertical-input connectors in the scope. The lead connecting S_1 to the input of the preamp (pin 1 of V_1) should not be shielded unless oscillations develop. Oscillations cause large vertical deflection without an input signal. Locate C_1 in your scope, disconnect it where it connects to the step attenuator, and connect it to terminal 1A of S_1 as shown in Fig. 3. Connect a jumper from contacts 1 to 2A on S_1 and connect the center lead of the shielded preamp output to terminal 2B. Next, run a lead from terminal 1B to the vertical input ground terminal. A wire, *unshielded* if possible, from terminal 1A to the input on the preamp and another to the chassis of the preamp from terminal 1B on S_1 finishes the wiring of S_1.

The preamp chassis should be insulated from the scope chassis. The ground connection should be made *only to the vertical-input ground* terminal in the scope.

Sources of Power

A great many scopes have a sufficient reserve of power to provide the modest requirements of the preamp. The author's scope, a *Du Mont* Model 241, has a very healthy power supply that provides regulated 180 volts with sufficient margin to power the preamp. If your scope cannot safely provide the required power, possibly you can disable a portion of its circuitry (such as the little-used intensity modulation feature) to get additional power. If there is room in the scope, a small silicon-rectifier power supply can be added. If power cannot be provided by any of the above methods, the preamp can be constructed in a small cabinet, with its own power supply, and used as an outboard unit. This method would have to be used if there is insufficient room inside your scope for mounting the preamp; several small metal cabinets are available that would be suitable. If you are going to use the preamp as an outboard accessory to your scope, a length of low-loss shielded cable should be used to make the connection between contact 1A on switch S_1 in the scope and the input of the preamp.

You may experience motorboating due to the excellent low-frequency response and high gain of the preamp. This will be apparent by the sweep jumping up and down when operating at maximum gain. Sufficient decoupling is provided by R_{15}-C_{10}, and R_{14}-C_8. However, if motorboating persists, try taking power from a different point in the scope. If a point cannot be found which eliminates motorboating, a voltage regulator (such as an 0A2) will have to be installed. ▲

TV Interference Problems

(*Continued from page 51*)

check confirmed that severe, cross-hatch interference was once more present, principally on channel 6. This looked like a real dilly, since just about every remedy known had had to be applied to arrive at a cure the first time around.

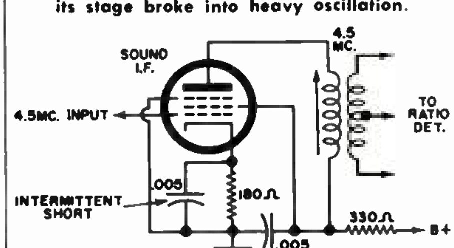
Nevertheless, a portable TV set used as a probe could not pick up a trace of interference anywhere in the vicinity. We decided to investigate the TV set itself, to see whether something had happened inside. The interfering pattern was intermittent in nature, coming on only for a few minutes at a time. Thus, after several repeat visits, we decided to bring the set into the shop despite the fact that TVI problems are best handled on the scene. Besides, we already suspected internal trouble.

A bench check disclosed that the bypass capacitor across the cathode bias resistor in the 4.5-mc. i.f. stage (Fig. 5) was intermittently shorting. Every time it shorted, it would shift bias by shunting out the resistor, and the stage would go into oscillation. After replacement of the capacitor, the cross-hatch pattern disappeared.

Similar problems, in which some circuit or section of the TV receiver itself goes into regeneration or oscillation, have been encountered from time to time. This is not always due to an outright defect. Sometimes a service technician or the do-it-yourself customer himself has decided that the set would perform better if a tube in the tuner or some other section were replaced with a similar but "hotter" tube type. In many instances, such a substitution works out well. However, it is always a good idea to check carefully whether impairment is not produced in some other respect.

The examples described here do not exhaust all possibilities to which the TVI detective should be alerted. These possibilities are not likely to be exhausted no matter how many more articles covering unusual effects subsequently appear. However, the more one becomes familiar with what can happen and why, the greater becomes the reduction in head-scratching time when these puzzlers crop up. ▲

Fig. 5. Receiver defects may cause TVI internally. When this capacitor shorted, its stage broke into heavy oscillation.



Power Supply

(*Continued from page* 47)

and current ratings in the parts list. Older sets with twenty or more tubes used 200- or 300-ma. transformers and chokes which will work well. The high-voltage winding should supply 750 volts, center-tapped, to produce a maximum no-load output of 400 volts. A five-volt winding for V_1, and a 6.3-volt winding are also necessary. On those transformers with two 6.3-volt windings, use the higher-current winding for V_5. The other 6.3-volt winding can be used for the other tubes and connected to binding posts to supply filament voltage for other circuits. The choke used by the author was a *Philco* Part No. 32-8479-2 with ratings of 150 ma., 64 ohms, and 1.5 henrys. These values are not critical, however.

After the supply is turned on (close S_2 approximately 30 sec. after S_1), turn R_9 to whichever extreme position produces the highest output voltage. R_{10} should then be adjusted to produce the highest output voltage possible, 400 to 420 volts if a 750-volt transformer is used. With R_9 and R_{10} set, V_6 is cut off and the full voltage of the supply will be delivered unregulated from J_5 and J_6. (The grid of V_6 is now negative with respect to its cathode and the plate of V_5 and V_5's grids are positive causing V_5 to conduct heavily.) Adjust R_{10} until the output voltage at J_3 and J_4 drops 20 or 30 volts. R_9 may now be varied to produce any desired output voltage. Within its rated current, the output voltage will remain stable within 1% with or without load. Below 50 volts the supply loses its ability to regulate well. R_{12} makes available 0-150 volts, unregulated, at J_7 and J_8. S_3, across J_1 and J_2, is normally closed; opening it puts a milliammeter in the circuit. S_2 prevents high-voltage d.c. from being applied to the tubes before they warm up; PL_2 lights when S_2 is closed. V_5 is rated at 250 ma., but another 6AS7G (*Tung-Sol*) connected in parallel with it and a larger power transformer will increase the current capability of the supply. ▲

Voltage/current capability of power supply.

Output Voltage	Output Current (ma.)
400	25
350	80
300	140
250	250
200	250
150	250
100	250
90	250
75	220
65	200
40	5
30	3
20	2
10	1

Radio & TV News

Events in the Service Industry

A PRELIMINARY report from Chicago touches highlights of the annual NATESA convention. The new president is Irving Toner of Buffalo, N.Y., who was eastern vice-president.

Other officers include Larry Dorst, Milwaukee, secy. gen.; H. O. Eales, Oklahoma City, treas.; A. Edward Stevens,, Miami, eastern v.p.; Paul Segars, St. Petersburg, eastern secy., Lyle Green, Oak Park (Ill.), east central v.p.; Charles LaRoche, Grand Rapids, east central secy.; Earl Steffes, Kansas City, west central v.p.; Bill Childs, St. Joseph (Mo.), west central secy.; Pat Barr, Albuquerque, western v.p.; and Les Quigley, Portland, western secy. Frank J. Moch was retained as executive director for another two-year term by unanimous vote. He renounced $24,000 in salary accumulated during the term just completed.

Other actions: The annual directors' conference in April has been discontinued. In its stead, four simultaneous divisional meetings will be held. NATESA finances were examined by the executive council acting as an auditing committee, with its approval report being accepted by the entire body. There were reports on apprenticeship, licensing, station liaison, new affiliates, and other subjects.

Convention business is reported to have moved at a brisk pace, with differences resolved quickly and activities running on or ahead of schedule. Time remained for considering new business.

Missing Groups

At least part of this smoothness is attributable to the absence of some associations no longer affiliated with NATESA. NATESA viewed the atmosphere as ". . . democracy in action. No parliamentary gobbledygook. Disagreements? Yes, but sincere and honest ones, all settled through give and take. . . . Frictions were at an all-time low." Others took a less sanguine view, feeling that disputes, however vexing, belong inside the national body rather than outside it.

Following the expulsion of ESDA of western Penna., there were expected resignations by ITTA (Indianapolis), ESA (Fort Wayne), the TV Bureau of Elkhart, and other Indiana groups. Also out is the state-wide TESA of Ohio. We have no run-down, however, on the status of individual affiliates in that state. TESA of Cincinnati, in a recently received copy of its monthly publication, continues to identify itself as "affiliated with NATESA."

The documentation on hand concerning the ESDA matter and ensuing events, from all sides, is overwhelming in quantity. There is enough to fill more than one issue of this publication. The national's viewpoint was published in a copy of "NATESA Scope." An issue of "Hoosier Test Probe" (IESA, Indiana) devotes several pages to the subject. ESDA of western Penna. has sent us a weighty collection of papers. We suggest that readers interested in detailed scrutiny of the matter address these sources directly for the information.

In general, there is little disagreement as to what happened. Differences center on the matters of why and how. Disputants deal with such questions as: Was the ESDA ouster justified or should the affiliate have been retained? Was action against one of its members justified? Was the machinery used for effecting the ouster proper? Was it a democratic procedure or was it engineered by a minority?

These are the issues on which interested associations have taken their stand, one way or another. To this point, it appears that most affiliates have rallied to the support of the national, endorsing its action and affirming continued membership.

Business Notes

A survey by the U. S. Census Bureau reports that annual receipts of the average TV service shop come to something less than $13,000. Slightly less than 30 per-cent of this gross goes into the average pay check, which comes to $75.23 a week, before taxes. Although total dollar volume had increased substantially over the amount reported in a survey taken a few years earlier, the number of service establishments had increased at an even greater rate. In other words, everybody gets a smaller cut of the pie. These figures simply confirm what we already know: consumer service in electronics does not pay very well, by and large.

Shop Size

More statistics on the service business are mulled over by Bob Ebel, writing in "The Supreme Effort" (bi-monthly of TESA of Greater Kansas City). He notes that 16 full-time service shops closed down in his city during a recent six-month span. The thousands of customers these shops used to have must have their work done some place, he reasons. With a trend to closing of smaller shops, therefore, remaining ones would have to expand.

This possibility brings the writer directly to the question of optimum shop size. Independent service has been handled on a personal basis, he reviews, with most shops being one- or two-man affairs, "able to compete with giant organizations which are generally impersonal and less flexible." He also considers the fact that stores doing heavy volume in merchandising appliances have seldom found it profitable to run their own service departments. Many, in fact, prefer to contract their service to several smaller, independent shops. He concludes that there is an "efficiency barrier" resulting from a change in the method of operation that becomes necessary once size gets to a point where more than a handful of men are needed.

Whatever the exact nature of this barrier, there is no doubt that the pattern has been that of the small shop. The history of the service industry records many attempts to set up large organizations, but few long-term successes in this direction. Yet the average small shop cannot provide decent livings for the people who depend on it, considering its limited volume—unless it takes on more people—which is not practical!

What is the answer to this dilemma? If volume per shop cannot be increased efficiently—and it would take nothing less than an unexpected revolution in the present techniques of rendering service to do that—each shop must get more money for the same amount of work done. No matter what angle one starts out with in considering the industry's paramount problem, the conclusion keeps coming out the same: more money has to be charged for service.

Publication Changes

"PacTronics," official voice of RTA of northern California (Santa Clara, Santa Cruz, San Benito, and Monterey counties), has abandoned its monthly, pamphlet-style format. It is now coming out as a weekly sheet. On the monthly basis, it often reached readers with news that was five or six weeks old. Editors, readers, and advertisers all felt that their needs were not being served on that schedule. The new format is not prettied up, but all concerned feel it will be more serviceable that way.

"ETG News," organ of the Boston chapter of the Electronic Technicians Guild of Massachusetts, is merging with "State News" to become one expanded publication serving members of all Guild chapters.

Miami "Tough Dog" Clinic

Members of TESA-Miami are spending week ends setting up a technical laboratory where service dealers will be able to bring in problem service cases for expert dissection and diagnosis. This combined facility will be available to members only. ▲

Satellite Tracking System

(Continued from page 53)

of the signal between what was transmitted from the ground station and what was received back from the satellite, tracking station personnel can accurately determine the satellite's speed.

To obtain the range or relative position of the space vehicle, the time interval principle is employed. In this procedure, tracking site personnel measure the number of very-high-frequency pulses which have occurred between the time the signal is generated at the transmitter and received back at the receiver.

Backing up the transmitting and receiving equipment are punched-tape recorders which present the data acquired in a format suitable for subsequent teletypewriter transmission, and time-labeling equipment to accurately "date" the information received. Also provided at each tracking station is a paper tape recorder for system backup data recording. The recorded tracking data must then be transmitted to the Goddard Space Flight Center at Greenbelt, Maryland for orbital calculations. As a result, there exists a need for two-way communications between the Goddard Space Flight Center and each tracking site.

When the satellite is being tracked by a three-station complex, it is important that all three stations be time synchronized so that the data obtained is time-labeled the same by all three. To accomplish this, each station's time is synchronized to the WWV national time standard signal. ▲

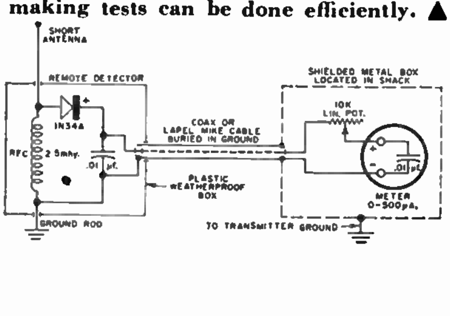
FIELD-STRENGTH METER

By GEORGE P. OBERTO, K4GRY

WITH the crowded conditions on the air we can all agree that it pays to tune our transmitters up for maximum efficiency to buck the QRM. Various types of r.f. voltmeters, antenna-current meters, and field-strength meters were tried, with the remote field-strength meter giving the most accurate indication of them all.

The 2½-mhy. r.f. choke, 1N34A diode, and .01-µf. ceramic capacitor are mounted in a small plastic box sealed against the weather and located at a remote point from the transmitter. Small coax or lapel mike cable is buried in the ground leading from the 1N34A detector output to a convenient place in the shack for the meter.

The 10,000-ohm linear pot is adjusted for good sensitivity of the meter. In case sensitivity is lacking, use a longer antenna for the detector. Now grid drive, loading of final, antenna tuning, and making tests can be done efficiently. ▲



Mac's Electronics Service

(*Continued from page* 46)

for use under high electrostatic pressure can be satisfied if components are carefully selected and properly protected."

"That's what Roy and his friend concluded, although they point out most of their tests covered only short periods of time."

"How and when did you meet this Roy?"

"That goes back to when you were wearing three-cornered pants. At the time I was fooling around with a home-brew ham station, and Roy and his chum, Langdon, were teenage Boy Scouts. Their scoutmaster suggested if they would look me up I'd show them my ham station. They did and I did, and for the next several months I couldn't get them out of my hair. They caught the ham bug but good. I was peppered with questions, requests for demonstrations, and invitations to inspect and criticize equipment they built up. Both obtained their ham tickets in jig time.

"After graduating from high school, both enrolled in Purdue University so they could pursue the interest in electricity and electronics awakened by their amateur radio experiences. Upon graduation Langdon went into the small motors division of *Westinghouse* and distinguished himself in that field. Roy worked in broadcast set engineering for a short time and then joined the Naval Research Laboratory, where he has been ever since. He never lost his interest in amateur radio, and you probably recognize his call, W3DZZ. His experimental work with the tuned-trap type of antenna now so common in multi-band doublets and tri-bander beams first focused popular attention on this approach.

"This brings up something I've thought about a lot. Every time there's a hurricane, sleet storm, or other disaster, we read how hams furnish vital emergency communication. We know how highly every branch of the armed forces regards this pool of self-trained electronic technicians that can be tapped whenever a quick need arises. But neither of these is the most important contribution amateur radio makes to our country. The really important thing is that amateur radio attracts keen young minds into the field of electronics—a field absolutely essential to our military posture, to space exploration, and to mankind's growing conquest of disease. Amateur radio is the interest-filled 'carrot' that lures youths into their fruitful scientific vocation. The story of Roy and Langdon is repeated over and over; and our country is richer, safer, wiser, and healthier because of the repetition."

"I agree, now you point it out," Barney reflected; "but getting back to how you feel about snow, maybe that's not all bad. Perhaps as we mature the accent shifts from *feeling* to *thinking*. I'm delighted by the way the snow looks, and I enjoy operating my ham station. You think about the trouble snow can cause, and you ponder the contribution amateur radio makes to our country. I'm storing up pleasurable experience—and that's an important part of life—but you're engaging in productive thought that may anticipate and so avoid trouble or discover the important significance of a hobby. I guess feeling and thinking are both part of a full man."

"Keep on like that," Mac said teasingly, "and you're going to be old and wise before your time. Maybe we both had better come down to earth and grind out some of these TV sets. What say?" ▲

EIA CHAIRMEN RENAMED

ROBERT C. SPRAGUE, chairman of the board of Sprague Electric Co., is the 1962-63 chairman of the EIA's Electronic Imports Committee, a post he has held since the inception of the committee four years ago. He has been an EIA director since 1943 and served as the president from 1950 to 1954.

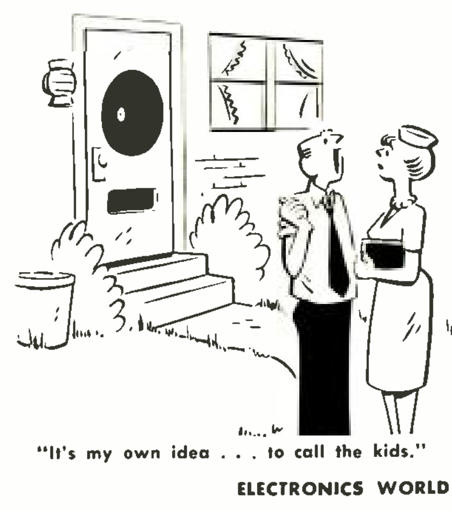
At the same time, the EIA re-appointed J. A. Milling, president of the Sams Division of Howard W. Sams & Co., Inc., as chairman of the EIA's Distributor Relations Committee. He heads a 25-man committee which works on behalf of electronic parts and tube manufacturers and distributors. ▲

CZECH DX CONTEST

THE Czechoslovak Central Radio Club, Box 69, Prague 1, has announced details of its International CW competition "OK DX Contest 1962."

The contest starts at 0000 GMT and ends at 2400 GMT on December 9th, with the following bands to be used: 3.5, 7, 14, 21, and 28 mc. Stations participating in the contest will call "Test OK." Stations will exchange code consisting of six numerals, the first three being the RST report, the latter three being the current number of the contact.

Entries may be made in one of two categories: single-operator stations and multiple-operator stations. Separate logs are to be submitted for each band. Logs are to be mailed to the Club no later than January 15, 1963. For full details on the rules governing the contest, contact the Club direct at the above address. ▲



"It's my own idea . . . to call the kids."

Additional Notes on Transistorized Ignition System

By BOGHOS N. SAATJIAN
Design Engineer, Triad Transformer Corp.

Modifications required for cars with 6-volt ignition systems and 12-volt systems that have positive grounds.

AFTER publication of our article "Transistorized Ignition System" for 12-volt, negative-ground cars in the August 1962 issue, we received so many inquiries requesting additional information on how the circuit could be adapted to cars with 6-volt and 12-volt positive-ground ignition systems that we decided to write a follow-up article to answer the numerous questions being asked.

6-Volt, Negative Ground

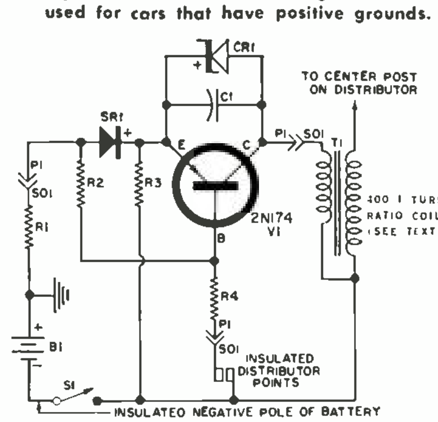
First, let's take the case of a 6-volt, negative-ground system. This requires the simplest modifications of the original circuit. All one has to do is reduce the value of R_1 from the 0.5-ohm value specified for the 12-volt negative-ground system to a value between 0.05 and 0.25 ohm, 50 watts. Start with a value of 0.25 ohm and reduce this value until a primary-coil current of 9.5 to 10 amperes is obtained, as read on a d.c. ammeter. Turn the ignition key on but do not start the engine when checking for this current. This test should be performed quickly otherwise the primary of the ignition coil and/or transistor may be damaged. This is the only modification required for a 6-volt, negative-ground system. We have also found that a coil of 400:1 turns ratio will work better in 6-volt applications. We will have more to say about this coil later.

Positive-Ground Systems

For 6-volt and 12-volt, positive-ground systems, the modifications are more complex. As there are no equivalent *n-p-n* power transistors, we must use the *p-n-p* type originally specified, for the circuit with positive ground.

For 6-volt, positive-ground systems, follow the steps given previously for 6-volt, negative-ground systems. In addition to reducing the value of R_1, you can either convert your car to a negative-ground system, which is not an easy task (but can be done with the help of a competent auto mechanic) or you can insulate the distributor points from ground. In the latter case, you will have two wires emerging from the distributor. You can use point-insulating kits available for approximately $2.50 from several auto-supply dealers, such as the *Automotive Electronics Co.*, 385 Park Ave. South, New York, N.Y. or the *W.F. Palmer Electronics Laboratories, Inc.*, Carlisle, Mass. These companies, among others, have the 400:1 turns-ratio coil, which retails for around $15.00 postpaid. Once again we would suggest that the 400:1 turns-ratio coil be used.

Fig. 1. Modified circuit diagram to be used for cars that have positive grounds.



R_1—Three Delco D-1110 1957154 ballast resistors connected in parallel or two 1-ohm, 50-watt power resistors in parallel. (For 6-volt system, see text.)
R_2—25 ohm, 5 w. wirewound res.
R_3—500 ohm, 5 w. wirewound res.
R_4—5 ohm, 25 w. wirewound res.
C_1—100 μμf., 500 v. non-inductive mica capacitor
SR_1—Silicon rectifier, 25 amps, 150 p.i.v. (International Rectifier 25HB15 or equiv.)
CR_1—Two 30-v. zener diodes in series or equiv. 60-volt, 1-watt unit (International Rectifier 1Z-30T5)
S_1—Car ignition switch
B_1—6- or 12-volt auto battery (see text)
P_1—Male plug (Jones #P-303-CCT)
SO_1—Female socket (Jones #S-303-CCT)
T_1—400:1 turns ratio coil (see text)
2 Heat sinks (Delco Radio #7270725 or equiv.)
V_1 Power transistor (2N174 or equiv.)

After the distributor points have been insulated, follow the schematic diagram in Fig. 1 for 6-volt or 12-volt, positive-ground systems.

For 12-volt, positive-ground systems, the only modification required is either a changeover to a negative-ground system through the help of a reliable garage, or distributor-point insulation. If it is decided to insulate the distributor points, then simply follow the circuit diagram shown here. No parts value changes are required.

For either 6-volt or 12-volt, positive-ground systems, be sure to test for thorough point insulation before proceeding with the connection of the ignition circuit to the distributor. Time spent on a good job here is time well spent, and will preclude non-operation or intermittent operation on the road at some later time.

Readers who have 12-volt, negative- or positive-ground systems and who want to obtain even higher ignition efficiencies than those possible with the 250:1 turns-ratio coil should also use the 400:1 turns-ratio coil suggested for 6-volt systems. This coil will deliver an output of up to 35,000 to 40,000 volts at idle.

Read our original article in the August 1962 issue first and follow all suggestions there about the heat sinks and parts values. All construction details and layout pointers in the first article apply to this one too. It is also a good idea to test and re-test the system before final installation in your car. One final precaution after installation is to make sure that the car's ignition switch is turned off at the end of a drive. ▲

WORKBENCH TOOL HOLDER

By R. A. GENAILLE

A HANDY tool holder for miscellaneous workbench tools can be conveniently fabricated from a piece of scrap "Styrofoam" left over from the holiday season. All one need do is to find a piece of sufficient width to prevent "top heaviness" and gently press the pointed or sharp ends of small hand tools into the "Styrofoam" block.

This handy tool holder will help keep your smaller hand tools from being scattered around your workbench, avoid injuries due to sharp points or cutting edges being exposed, and protect the working portions of the tools. ▲

ELECTRONIC CROSSWORDS

By N. F. LAVIGNE, JR.

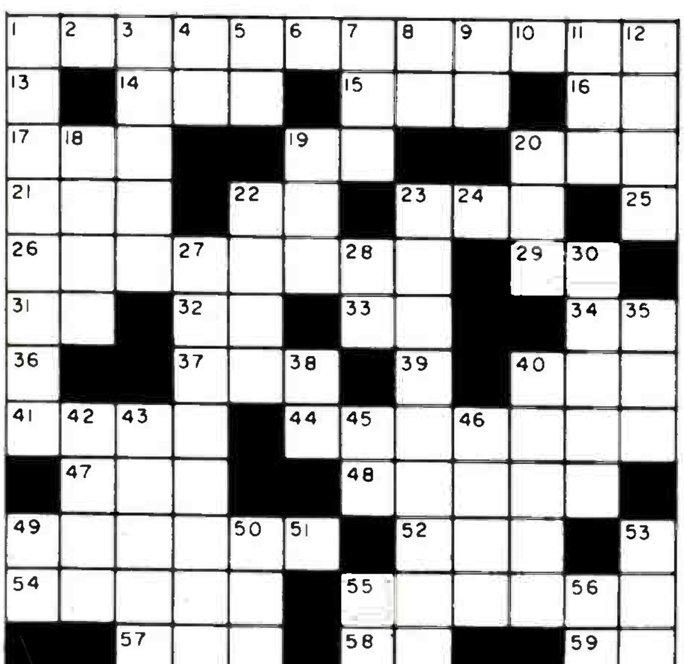
(*Answer on page* 99)

ACROSS

1. Devices for altering the impedance and potential in an electrical circuit.
13. IR = .
14. This TV transmission band has just received a "shot in the arm."
15. Radar indicator used to determine altitude and range of aircraft.
16. Amplification factor.
17. 5.5 yards.
19. Unit of length in the metric system (abbr.).
20. Device for changing rotary motion into lineal motion.
21. Three (prefix).
22. Quiet!
23. Standard used in the U.S. for steel and iron wire (abbr.).
25. Indicates the plural.
26. Type of No. 1 Across.
29. North Central State (abbr.).
31. Organization for drinkers who want to quit (abbr.).
32. Apiece (abbr.).
33. Coupling (abbr.).
34. Total E/R (schematic notation).
36. E/I = .
37. African antelope.
39. "J" scan pattern.
40. Fish eggs.
41. City in Arizona.
44. Type of tube.
47. Decay.
48. Structure of sun-dried brick.
49. No. 1 Across are always given this, usually in amps or ma.
52. Past.
53. I^2R.
54. Covering for the hand.
55. This must be known to use No. 1 Across as an impedance-matching device (two words).
57. A voltage that will not vary beyond certain given tolerances is said to be this (abbr.).
58. Suffix meaning quality of.
59. All the resistance in a circuit (schematic notation).

DOWN

1. Winding found in special types of No. 1 Across.
2. E/1 = .
3. One type of No. 1 Across.
4. Northeastern State (abbr.).
5. City in California (abbr.).
6. Reciprocal of period (abbr.).
7. Unit of E I.
8. One mode of transportation (abbr.).
9. Third tone in the scale.
10. IR = .
11. Old designation for the electronic trade association.
12. Totals.
18. Belong to the "riff-raff" (Scot.).
19. Unit of conductance.
20. Unit system of force that will move a body weighing one gram one cm. per second at the end of one sec.
22. Radar indicators have different types of this.
23. Normally, the output section of No. 1 Across.
24. I^2R = .
27. That portion of a waveshape that falls below a reference line.
28. Schematic notation.
30. Type of tube.
35. Type of r.f. coupler.
38. Not down.
40. An automaton.
42. Mountain range forming the natural boundary between Asia and Europe.
43. Device to convert electrical energy into mechanical energy.
45. Every one of any number or aggregation considered individually (abbr.).
46. Professionally characteristic garb.
49. Grid resistor (schematic notation).
50. No. 27 Down (abbr.).
51. Symbol for conductance.
53. A variable resistance.
55. Total impedance (schematic notation).
56. Voltage.



Calendar of Events

NOVEMBER 28-30

1962 Ultrasonics Symposium. Sponsored by IRE Professional Group on Ultrasonics Engineering. Columbia University, New York City. Program information from R. N. Thurston, Bell Telephone Labs, Murray Hill, N. J.

NOVEMBER 28-DECEMBER 2

First International Communications Fair. Sponsored by International Communications Fair, 310 Madison Ave., New York 17, N.Y. Open to public. Consumer and industry show covering CB, ham, SWL, and communications equipment, FM and two-way radio. New York Coliseum.

DECEMBER 4-6

Fall Joint Computer Conference. Sponsored by AFIPS (PGEC, AIEE, ACM). Sheraton Hotel, Philadelphia, Pa. Program details from E. Gary Clark, Burroughs Research Center, Box 843, Paoli, Pa.

DECEMBER 6-7

13th National Technical Conference on Vehicular Communications. Sponsored by PGVC of the IRE. Disneyland Motel, Los Angeles, California. Information from W. J. Weisz, Motorola Inc., Communications Div., 4545 W. Augusta Blvd., Chicago 51, Ill.

DECEMBER 10-11

First Annual Symposium on Unconventional Inertial Sensors. Sponsored by Republic Aviation Corp., Bureau of Naval Weapons, Air Force Systems Command Scientific and Technical Liaison Office. Meeting classified. For details contact Milton J. Minneman, Symposium Secretary, Scientific Research Staff, Republic Aviation Corp., Farmingdale, New York.

JANUARY 8-10, 1963

Millimeter and Submillimeter Conference. Sponsored by the Orlando section of IRE and PGMTT-IRE. Cherry Plaza Hotel, Orlando, Florida. Program information from J. W. Dees, Martin Co., P.O. Box 5837, MP-172, Orlando, Florida.

JANUARY 21-24

Ninth National Symposium on Reliability and Quality Control. Sponsored by PGRQC, Los Angeles Section of IRE. Program information from L. W. Ball, Boeing Co., P.O. Box 3707, Seattle 24, Washington.

JANUARY 21-31

The 1963 Engineering and Management Course. Sponsored by University of California. Los Angeles Campus. Intensified 10-day short course, 8 a.m.-5 p.m. daily (excluding Sunday). Brochure on course available from Reno R. Cole, Coordinator, Room 6288, Engineering Unit II, University of California, Los Angeles 24.

JANUARY 30-FEBRUARY 1

Fourth Winter Convention on Military Electronics. Sponsored by PGMIL and Los Angeles Section of IRE. Ambassador Hotel, Los Angeles, Calif. Program information from IRE Los Angeles Office, 1435 La Cienega Blvd.

FEBRUARY 8-10

1963 Pacific Electronic Trade Show (PETS). Sponsored by Association of Electronic Distributors. Shrine Exposition Hall, Los Angeles. Details from Association, 10480 National Blvd., Los Angeles 34. Att: Charlie Silvey, executive vice-president.

FEBRUARY 11-15

Third International Symposium on Quantum Electronics. Sponsored by IRE, SFER, ONR. Unesco Building & Parc de Exposition, Paris, France. Program details from Madame Cauchy, Secretair, 7 rue de Madrid, Paris 8eme, France.

FEBRUARY 20-22

International Solid State Circuits Conference. Sponsored by PGCT, AIEE, Philadelphia Section of IRE, University of Pennsylvania. Sheraton Hotel and University of Pennsylvania, Philadelphia. Program information from S. K. Ghandi Philco Scientific Lab, Blue Bell, Pa.

MARCH 25-27

Convention on H.F. Communication. Sponsored by the Electronics Division of the Institution of Electrical Engineers. Program information from Secretary, IEE, Savoy Place, London, W.C. 2, England.

MARCH 25-28

IRE International Convention. Sponsored by all Professional Groups of the IRE. Coliseum and Waldorf-Astoria Hotel, New York. Details from Dr. D. B. Sinclair, IRE Headquarters, 1 E. 79th St., New York 21.

APRIL 16-18

Cleveland Electronics Conference. Sponsored by IEEE, ISA, Cleveland Physics Society, Case Institute, and Western Reserve University. Hotel Sheraton, Cleveland. Details from Lapine Enterprises, 310 Hotel Manger, Clevelond 14, Ohio.

APRIL 17-19

Southwestern IRE Conference and Show. Sponsored by Region 6 of IRE. Dallas Memorial Auditorium, Dallas, Texas. Details from Prof. A. E. Salis, EE Dept., Arlington State College, Arlington, Texas.

International Conference on Nonlinear Magnetics. Sponsored by IRE and AIEE (IEEE). Shoreham Hotel, Washington, D.C. Program information from J. J. Suozzi, Bell Telephone Labs., Whippany, New Jersey.

APRIL 23-MAY 2

London International Engineering Exhibition. Sponsored by Industrial & Trade Fairs Ltd. Earls Court and Olympia, London. Details from Press Office, Commonwealth House, New Oxford Street, London, W.C. 1, England.

APRIL 24-26

Seventh Region Technical Conference. Sponsored by Region 7 of IRE. San Diego, Calif. Details from George C. Tweed, Jr., 8080 Posadena Ave., Lo Mesa, Calif.

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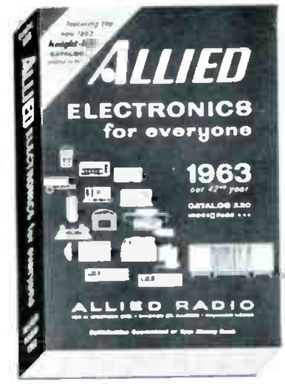

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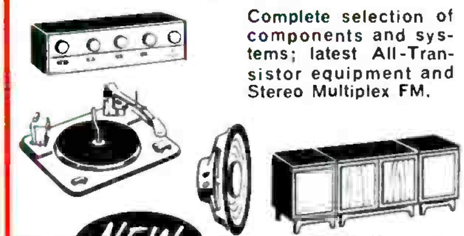

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EW Lab Tested

(*Continued from page 24*)

Treble Tone Control Range (15 kc.): +14 db, −21 db *versus* 32 db total (10 kc.).

It is evident that the KX-200 meets or exceeds practically all of its performance specifications. The principal deviation is in the power response where we use a much more stringent test method. However, the plotted power response of the KX-200 is very uniform over the entire audio spectrum. Intermodulation distortion is shown in the accompanying graph.

The construction manual for the amplifier made enjoyable reading, even though we did not construct the unit ourselves. It is written in an informal, conversational style, devoid of stuffiness. Correct soldering and lead dressing procedures are clearly explained and illustrated by photographs. Each of the 20 stages of the assembly has its own page and fold-out pictorial drawing. The parts used in each stage are separately packaged.

The assembly and wiring instructions for each stage tell the builder what portion of the circuit he is wiring, and cautions him on possible pitfalls at critical points. At intervals in the procedure there are suggestions such as "take a break" and "there are a few more hours of work remaining, so don't try to finish it tonight." The construction time for the unit we tested was 10½ hours, which is quite reasonable for an amplifier of this complexity.

In listening tests, the considerable power reserves of the KX-200 were appreciated, since it drove a variety of speaker systems at high levels without signs of strain. The exceptionally uniform power response assures that the amplifier can drive almost any speaker system throughout the audio spectrum without risking distortion or overload.

The *Fisher* KX-200 sells for $169.50. Metal or wooden cabinets are available at extra cost. ▲

"Well, for one thing, the data on this tape happens to be about 1200 feet of Frank Sinatra. . . ."

New Products and Literature

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 15.

TRANSISTORIZED SIGNAL TRACER

1 **International Representatives Corp.** is handling the U.S. distribution on a highly sensitive, rapid-testing signal tracer, the "Minitracer," made by **Unified Development Corp.**

This self-contained, transistorized unit pinpoints defective components, locates electrical

hum, mechanical vibration, and other vital functions in AM and FM radios, TV sets, communications equipment, servo-control circuits, and other industrial gear.

It is being offered in "laboratory and industrial" and in "general service" versions with the latter not including the transducer, inductor, and microphone probes.

ELECTRONIC IGNITION SYSTEM

2 **Palmer Electronics Laboratories, Inc.** is now offering a transistorized electronic ignition which has been trade named "Transfire."

The company is offering two unassembled kits of parts for the build-it-yourself group or in factory assembled versions for a variety of marine, automotive, and police applications. Depending on the model, the kits include coil, blank extruded chassis, two transistors, one or more VR diodes, ballast, resistors, leads, screws, terminals, transistor mounting kits, decal, and complete instruction details. Since various models are available for 6- and 12-volt systems, positive- or negative-ground, details should be obtained from the manufacturer before ordering.

COLOR-TV DEGAUSSING COIL

3 **Stancor Electronics, Inc.** has just introduced a new degaussing coil for color TV servicing which features rugged design for maximum convenience and usability.

The Model DGC-100 includes a 10-foot line cord with line switch at the coil end. This eliminates the need for repeated plugging and unplugging from the a.c. line.

FIBRE OPTICS CRT

4 **General Antronics Corporation** has developed a new fibre optics cathode-ray tube for use in nuclear energy studies. The 7" round-face tube, Type M1056, permits rapid recording of

information displayed against highly accurate reference lines which have been applied directly onto the rectangular fibre bundle surface.

Accuracy of the reticle is better than a tenth of the spot size, which is sufficiently small to resolve 1000 lines per inch. The tube can be customized for specific applications, including photographic recording of rapid single or repetitive events superimposed on a known accurate co-ordinate system of the user's choice.

PORTABLE TEST INSTRUMENTS

5 **The Triplett Electrical Instrument Co.** is now offering a new line of a.c. and d.c. portable instruments engineered to laboratory accuracies.

The d.c. portables feature the company's suspension movement (no pivots, no bearings, no hairsprings, thus no rolling friction). Other features are a 6-13/32" mirror scale, knife-edge pointer, and fully open meter front with top and side natural lighting. The unit measures 7⅝"x6-7/16"x3¾" with carrying handle attached.

U.H.F. CONVERTER

6 **Gavin Instruments, Inc.** is now marketing the Model G-2 u.h.f. converter which features a long-life, low-noise nuvistor circuit. The company claims that this new unit provides 50% more picture power than other single-tube con-

verters. An isolation transformer provides a cold chassis for safety and service. The built-in u.h.f.-v.h.f. coupler permits use of the existing v.h.f. antenna and transmission line.

SUBMINIATURE CAPACITOR

7 **Erie Resistor Corporation** is now offering a new line of subminiature tubular capacitors which have been specifically designed for use in industrial and military equipment.

General specifications of the Style 390 include a capacitance range of 5.6 through 1200 $\mu\mu$f.; tolerance ±10%, ±20%, or GMV depending on capacitance; working voltage of 100 at 85 degrees C or 50 at 125 degrees C; and MIL specifications meeting or exceeding MIL-C-11015.

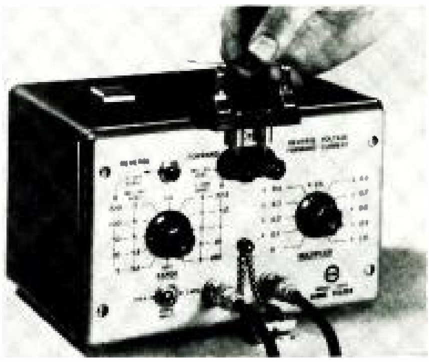
MINIATURE R.F. CHOKES

8 **Nytronics, Inc.** announces the availability of a line of r.f. chokes that meet MIL-C-15305A, Grade 1, Class B specifications.

These epoxy encapsulated inductors come in three sizes to fit most design requirements: .90" long x .31" diameter and inductance values from 1 to 10,000 μhy., .60" long x .25" diameter with inductance values from 1 to 1000 μhy., and .44" long x .188" diameter with inductance values from .1 to 100 μhy.

DIODE TESTER

9 **Disc Instruments, Inc.** is now marketing a new diode tester which provides direct connection to all standard oscilloscopes for display of E-I curves for zener, computer, power, and tunnel diodes.



Forward current and reverse voltage on the tester is continuously variable through five ranges. Push-button control allows rapid forward and reverse testing. Reverse leakage and forward current is controlled to prevent overloading by use of limiting circuitry.

The Model 1050 operates on 117 volts a.c. and measures 5¾"x8"x7½".

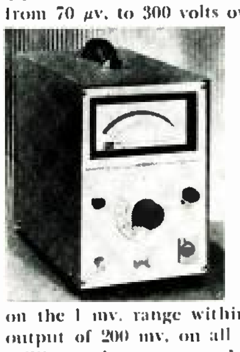
STRAIN-GAUGE LOAD CELL

10 **Braincon Corp.** has developed a new silicon semiconductor strain-gauge load cell for use in measuring and monitoring tension of equipment used in a wide variety of undersea applications.

The Type 210 load cells are available for force ranges from 0-100 and 0-100,000 pounds. The cells utilize piezo-resistive silicon semiconductor strain gauges with temperature compensation. Their design provides output levels of 250 mv. which drive indicators and recorders directly without complicated electronic amplification.

WIDE-BAND VOLTMETER

11 **Keithley Instruments** is now offering a new electronic voltmeter which measures signals from 70 μv. to 300 volts over a 10 cps to 100 mc. spectrum.



Designated the Model 120, the circuit employs u.h.f. transistors in the amplifier circuit to achieve a bandwidth 20 times greater than that of v.t.v.m.'s. The instrument provides ranges of 1 mv. to 300 v. full-scale, rise time below 6 nanoseconds, noise on the 1 mv. range within 70 μv., and full-scale output of 200 mv. on all ranges.

The unit measures 11½"x7¼"x13¾" and weighs 17 pounds. Input requirements are 105-125 volts or 210-250 volts, 50 cps-400 cps.

IN-CIRCUIT TRANSISTOR TESTER

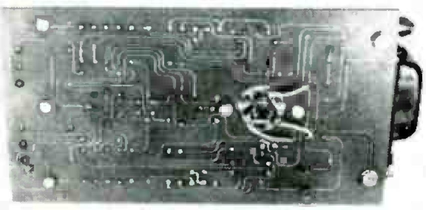
12 **American Electronic Laboratories, Inc.** is in production on an in-circuit transistor tester which incorporates automatic lead finding which eliminates the need to know lead configuration.

The instrument will test transistors both in-circuit and out-of-circuit. It checks for opens, shorts, and no gain. It will handle virtually every type of transistor including power, switching, small-signal, junction, alloy, point-contact, and military types. Results are indicated by lights. The instrument operates from a standard 117-

volt, 60-cycle a.c. line and draws approximately 30 watts.

GROOVE-GAUGE BOARD

13 **Miniature Electronic Circuits, Inc.** has developed the GG (groove-gauge) board which is said to combine the advantages of hand wiring and printed board. The board utilizes standard gauge wire conductors imbedded in milled grooves. These wire conductors terminate in soldered eyelets. Any standard phenolic or epoxy base material may be specified.



AUTOMATIC CABLER

14 **The Zippertubing Company** has developed a new automatic closing and sealing tool that reduces cable-making to a one-step operation.

With the new hand-held tool, wires are automatically wrapped in the jacketing and sealed with sealer simultaneously. The non-slip handle of the tool is designed for comfortable gripping. The sealer is contained in the handle and a button control releases it in correct amounts and offers positive cut-off. The tool itself is made of brass, tool steel, and aluminum.

NEW TYPE CONNECTOR

15 **Pylon Company, Inc.** has recently introduced a new type of electrical connector which has been tradenamed "Snail."

The unit consists of a resilient, conductive elastomer cylinder which protrudes slightly from a loose-fitting container. The elastomer cylinder is free to expand radially while compressed axially so that when connection is made, a gentle, positive true area contact is achieved.

The connectors are customed designed for each application with contact diameters ranging from 1/32" through ¼" available.

DIGITAL COMPUTER KIT

16 **Scientific Development Corporation** is now marketing a fully transistorized digital computer in kit form as the "Nordac."

Developed primarily as a teaching device, the unit uses transistorized "nor" circuitry, found in many commercial computers, to demonstrate all basic computer operations. The kit comes complete with detailed assembly instructions and a comprehensive manual listing over 100 experiments and programs covering fundamentals of computer technology. When assembled the unit measures 15"x15"x3".

INDUSTRIAL RECTIFIERS

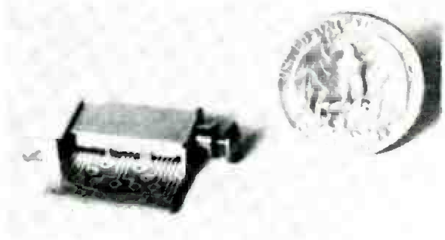
17 **International Rectifier Corporation** is now offering a new series of 1.7-amp controlled rectifiers which have been designated Types 2N1770A-2N1777A. The operating temperature range is 43 degrees higher than the originally registered 2N1770 series.

Operating temperature range for the new series is −65 to +150 degrees C. They allow operation to 105 degrees C stud temperature at full current output. The new units are designed specifically for high-temperature military and industrial applications where high environmental temperatures make it impossible to obtain full current rating from lower temperature devices.

PRINTED CIRCUIT SWITCH

18 **Chicago Switch Division** has just introduced a new male printed-circuit switch, the "Male-5."

The new switch has five s.p.d.t. switches completely packaged. The rugged new unit is



available in a variety of ratings, provided in accordance with the customer's specifications. Its integral printed-circuit board is said to save space which can be utilized for related components.

HI-FI—AUDIO PRODUCTS

STEREO TAPE RECORDER

19 **United Audio Products** has recently introduced a new stereo tape recorder as the Model TG-12-SK.

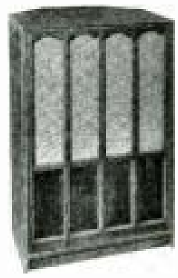
The instrument provides four-track stereo/mono record and playback and operates on three speeds (1⅞, 3.75, and 7.5 ips). All functions are

actuated by fully mechanical push-button controls. The circuit includes automatic shut-off and a 10-watt dual amplifier. There is direct output for use with hi-fi component systems. Monitoring facilities are provided on both channels while automatic locking prevents operating errors.

The two speaker systems are incorporated in easily removable top and bottom lids of the carrying case. The instrument is housed in a two-tone case measuring 13"x15"x10" and weighing 32 lbs.

HIGH-EFFICIENCY SYSTEM

20 Electro-Voice, Inc. has re-introduced its "Patrician 800" high-efficiency speaker system in a new and redesigned version.



Featuring a solid cabinet of one-inch-thick wood throughout, the system includes a 30" woofer to provide increased efficiency and extended bass response. Although designed for corner operation, the system can be placed in almost any room location without seriously hampering its over-all performance.

Frequency response is 20-35,000 cps and the system will handle 100 watts of program material. Above 100 cps a second 12" mid-bass speaker provides matched high efficiency and uncolored response. Above 800 cps a new T250 treble driver takes over with the final brilliance added by the T350 v.h.f. driver operating from 3500 cps to beyond audibility.

TRANSISTOR ORGAN KIT

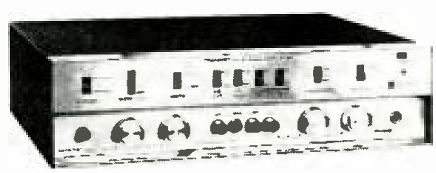
21 Heath Company is now offering a kit version of the Thomas transistor organ as the Model GD-232.

The instrument includes ten true organ voices, variable bass pedal volume control, manual balance control, variable vibrato, an expression pedal, 13-note heel and toe bass pedals, overhanging keyboards, 20-watt peak power amplifier and speaker system, all housed in a hardwood cabinet which measures 34½" high x 39¾" wide x 21½" deep.

100-WATT TRANSISTORIZED AMP

22 Allied Radio Corporation has announced the availability of its "Knight KN-450A," a fully transistorized 100-watt stereo amplifier.

Designed to drive any speaker up to 16 ohms impedance, the new unit features a cool-running 18-transistor circuit with two silicon rectifiers providing increased reliability and instant warm-up.



The circuit features military-type terminal board wiring, 15 controls, and 50 watts per channel IHFM music power (based on 4-ohm speaker impedance). Frequency response is 20-30,000 cps ± 0.5 db. Harmonic distortion is 0.5% at rated power.

The instrument measures 3¾"x13⅞"x12¾" and comes in a dark brown textured metal case with polished brass control panel.

NOISE-CANCELLING MIKE

23 Shure Brothers, Inc. has developed a new microphone which is especially designed for mobile and fixed-station use in areas of high volume background noise.

The Model 488 "Sono-Bar" provides highly intelligible speech communication while cancelling out unwanted background noise in such typical noisy installations as airplanes, helicopters, motorcycles, trucks, etc. The unit incorporates the firm's patented "controlled reluctance" cartridge. Correct placement of microphone for "close-talk" is assured by the rubber lip guard mounted on the unit's perforated grille.

Three versions are currently available: high impedance, low impedance, and transistorized for direct replacement of carbon microphones.

NEW ANTENNA FOR FM

24 JFD Electronics Corporation has added a transistorized electronic FM antenna, Model LNTFM350G-AC, to its line of "Stereo-cone" units. Developing 34 db gain, the rated operating range is said to be up to 200 miles.

The new antenna features a built-in transistorized amplifier for increased signal-to-noise ratio on all FM frequencies 88 to 108 mc. The amplifier is integrated into the twin-driven dipoles of the antenna where it amplifies FM mono and stereo signals at the point of interception. The six wide-spaced antenna elements are individually tuned and phased to pinpoint distant FM stations, eliminate interference, and provide full limiter action.

TRANSISTORIZED STEREO PREAMP

25 Harman-Kardon, Inc. is now marketing an all-transistor stereo preamp as its "Citation A."

According to the company, the new preamp has uniform frequency response from 1 to 1,000,000 cps. The unit has two individual power switches, a six-position function selector, a five-position mode selector, blend control, and separate turnover and roll-off equalization controls. Separate

front-panel tape head controls adjust equalization for any tape head, irrespective of age or tape speed.

Also included are step-type tone controls for each channel, a zero to infinity balance control, contour and channel reverse switches, low cut and high frequency filters and a switch that permits monitoring of tape while recording. There are four main preamp outputs, one center-channel output, and two tape outputs for recording.

SOUND COLUMN SPEAKERS

26 The R. T. Bozak Manufacturing Co. has announced the availability of a new series of sound column speakers expressly designed for use in auditoriums, theaters, outdoor stadia, halls, and other large-audience areas.

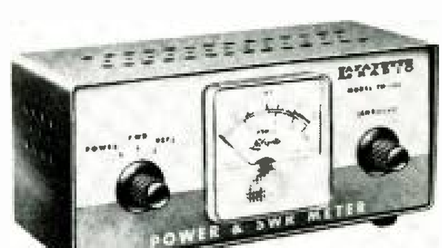
The new units feature groupings of the company's M-109 outdoor speakers arranged in vertical array and enclosed in weatherproof baffles.

CB-HAM-COMMUNICATIONS

S.W.R. BRIDGE

27 Lafayette Radio Electronics Corporation has added an s.w.r. bridge and r.f. power meter to its line of test equipment for communications and ham use.

The TM-58 provides s.w.r. and direct-power readings up to 50 mc. It may be inserted permanently in the transmission line for s.w.r. and relative power monitoring. When the 3-position selector switch is set to "Power," the meter will

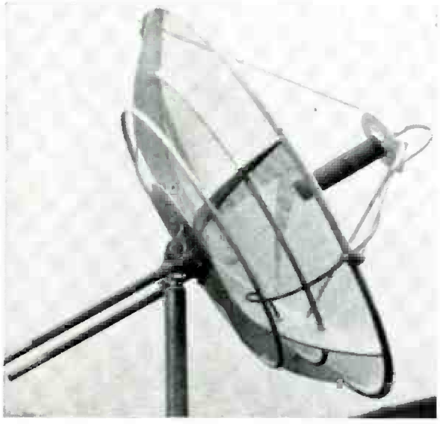


indicate r.f. power up to 15 watts, into a built-in 52-ohm dummy load. Full-scale accuracy is 10%. The meter has a 50-μa. movement, calibrated directly in watts from 0-15 and in s.w.r. from 1 to 4.

TELEMETRY ANTENNA

28 Technical Appliance Corporation is now offering circularly polarized, manually positionable parabolic antennas in 4, 6, 8, and 10 foot diameters.

Each of the antennas, which operate in a frequency range from 940-980 mc., is of all-aluminum construction and includes hydroformed ribs extending from a hub at the vertex to the outer



edge of the reflector. The tubular circumferential rings are welded to the ribs to insure rigid structure and excellent windload characteristics.

TRANSISTORIZED CB UNIT

29 Cadre Industries Corporation has added a 5-watt transistorized transceiver to its line of CB equipment. The Model 510 is adaptable for field use with its own portable power pack with rechargeable batteries. Audio power is a full 2.5 watts.

The instrument is 3⅛" high x 11⅜" wide making it suitable for installation in a car or on a

desk. There are five receiving and five transmitting channels plus full receiver coverage of the 23 CB channels.

The circuit uses 18 transistors and 8 diodes. It has a dual built-in power supply.

NEW "HANDIE-TALKIE"

30 Motorola's Communications Products Division has just released a fully transistorized portable FM two-way radio which weighs only 33 ounces.

The new "Handie-Talkie" portable radiophone features a powerful transistorized transmitter and highly sensitive receiver. The unit is especially designed for police and fire departments, railroads, construction companies, pipeline firms and utilities, governmental and industrial organizations.

The unit is powered by a single mercury cell or rechargeable nickel cadmium battery.

COMPACT TRANSCEIVER

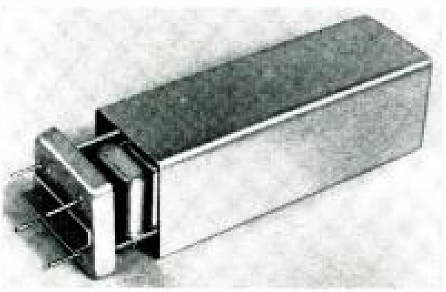
31 ITT Kellogg has announced the development of a tiny, compact radio transceiver which is no larger than a package of cigarettes.

The 9-ounce "Kel-O-Rad" unit provides hands-free two-way voice communications in a variety of severe military and industrial environments. The transceiver consists of a single package containing a crystal-controlled transmitter and receiver powered by two rechargeable batteries. The unit is attached to the user by a clip, light belt, or nylon cord. The original connection of

cable is all that is required. A voice-operated transmit switch turns on the transmitter when the user talks into the microphone. It is designed for operation in the 25-50 mc. band.

SSB CRYSTAL FILTERS

32 **Reeves-Hoffman Division** has introduced four single-sideband crystal filters designed specifically for telecommunication receivers with a carrier frequency of 250,000 kc. Carrier attenuation is 30 db minimum for F2211 and F2212 and



greater than 20 db for the models F2213 and F2214. Models F2211 and 2213 are upper sideband types while the F2212 and F2214 are lower sideband.

Case dimensions are 1-5/16" x 1-5/16" x 4" excluding terminals.

SSB TRANSCEIVER

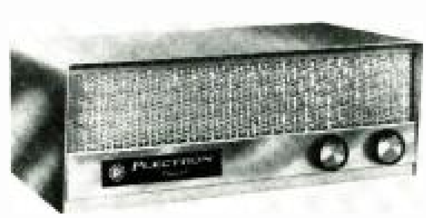
33 **Sonar Radio Corporation** has recently introduced a new one-band SSB transceiver which features a four-way meter function with "S" meter, transmitter p.a. grid, transmitter p.a. plate, and transmitter "a.m.c."

Known as the "Mono-Bander," the new unit uses a 2.1-kc. mechanical filter while the driver stages employ electronic tuning. Separate models are available for 10-, 15-, 20-, 40-, or 80-meter band with commercial frequencies available within this range.

V.H.F.-FM RECEIVER

34 **Plectron Corporation** has recently redesigned its "Patrol" model radio receiver for improved selectivity and sensitivity.

Available in black, mist green, red, blue-grey, or white, the compact unit features low operating



cost, remote speaker outlet, attached antenna, and permits continuous monitoring of any single fixed frequency. A relay-controlled squelch eliminates noise between transmissions.

MANUFACTURERS' LITERATURE

MICROWAVE COMPONENTS

35 **Microlab** is now distributing copies of its Catalogue 12 which covers over 10,500 microwave components.

This 112-page book illustrates the firm's complete line of attenuators, preselectors, directional couplers, power dividers, filters, monitor tees, d.c. shorts, d.c. blocks, signal samplers, tuners, terminations, crystal mounts, and crystal mixers. Each product line is fully described with complete specifications, both physical and electrical, plus pertinent schematics.

DIODE REPLACEMENT DATA

36 **Raytheon Company's Semiconductor Division** has issued a 4-page folder which provides replacement data for more than 250 diodes.

Comparison characteristic curves and charted ratings illustrate how specifications of several hundred devices are met or exceeded by the company's 1N3728 universal silicon diode.

TELEMETRY ANTENNA SYSTEMS

37 **Technical Appliance Corporation** has issued a 16-page catalogue which provides complete details on its line of telemetry antennas and systems.

The catalogue covers the gamut from remotely controlled multi-mode units to small special-purpose antennas. The booklet pictures and describes cross-polarized yagis, steerable parabolic antennas, manually positionable parabolic units as well as helical, tri-helical, and quad helical servo-controlled systems.

MOBILE MIKE DATA

38 **The Astatic Corporation** has released a two-color data sheet on its #511 mobile ceramic microphone which lists characteristics including output, type of ceramic element, type of response, type of switch, description of cable, repairs and service, housing material, size and weight. In addition, the sheet carries a schematic of the unit along with a variety of dimensions relating to both exterior and interior elements.

PUSH-BUTTON SWITCHES

39 **Switchcraft, Inc.** has issued a new 6-page, 2-color catalogue covering its "Tiny-Frame" push-button switch. In addition to full data on this unit, the catalogue describes the firm's "Littel Switches," "Button Switches," "Cord Switches," and others.

Designed as an industry guide for engineers, the publication lists engineering data, design features, dimensional drawings, and application ideas.

MAIL-ORDER CATALOGUE

40 **Radio Shack Corporation** is offering copies of its new 1963 consumer mail-order catalogue covering over 10,000 individual items in its 284 pages.

In addition to a complete line of audio equipment at bargain prices, the catalogue lists products of interest to hams, experimenters, service technicians, as well as photography fans and sportsmen.

DIGITAL LOGIC MODULES

41 **Solid State Electronics Corporation** has published a 28-page, two-color catalogue outlining in considerable detail its 1000 Series of digital logic modules.

In addition to listing the special features of these components, the publication includes a wealth of generalized information on the subject of modules, definitions and terminology, module color codes, electronic characteristics, interconnection methods, as well as detailed specifications on the products themselves.

15-AMP POWER TRANSISTOR

42 **Tung-Sol Electric Inc.** has issued a technical data sheet on its new high-power Type 2N2490 germanium transistor. The bulletin includes a listing of absolute maximum rating, specifications for a typical switching application, and electrical characteristics at 25 degrees C. Outline drawings of the TO-36 case are given along with four characteristic curves on collector and base voltage and current and one on temperature variations with changes in h_{FE}.

SPECTRUM ANALYZER DATA

43 **Raytheon Company's Industrial Components Division** has issued a compact 8-page handbook describing applications of spectrum analyz-

ers in telemetry, biological research, and measurement of Doppler changes, seismic vibrations, and burning stability of rocket fuel.

Illustrated with photographs, drawings, block diagrams, and charts, the handbook also describes the operation and specifications on the firm's "Rayspan" spectrum analyzers.

CRYSTAL UNITS

44 Reeves-Hoffman is now offering a two-page leaflet that gives detailed specifications on its 14 to 150-kc. N element crystal, a double-rotation cut plate that vibrates on its width-length fundamental mode.

Frequency range, holder numbers, temperature range, frequency tolerance, oven operation, frequency-temperature coefficient, maximum effective resistance, typical electrical equivalent parameters, and applicable military specifications are covered.

HI-FI COMPONENT GUIDE

45 Fisher Radio Corporation has just released its 1963 guide to custom high-fidelity stereo components, a 12-page publication which provides complete technical specifications on a wide range of multiplex receivers, tuners, amplifiers, speakers, multiplex adapters, and stereo accessories.

Each item is pictured and described in considerable detail, along with the outstanding features and circuitry of the particular unit.

RECORDING TAPE DATA

46 Eastman Kodak Company has issued a compact and concise single-page data sheet supplying complete specifications and features on its Type A301 sound recording tape. Magnetic and electromagnetic properties, physical properties, and a host of technical details are provided.

VOLTMETER-CONVERTER BROCHURE

47 Houston Instrument Corporation has issued an 8-page, two-color brochure which carries a technical description, schematic specifications, and application data on a wide-range Model HLVC-150 log-voltmeter-converter.

A new design principle is also discussed which permits accurate measurement of a.c. or d.c. voltages or voltage ratios on a true logarithmic scale over a 3160:1 or 70 db continuous range. A d.c. output is provided for recording.

U.H.F. TRANSMISSION LINE

48 Surface Conduction, Inc. is offering a four-page short-form catalogue sheet covering its line of u.h.f. transmission line, launchers, conductors, amplifiers, attenuators, antennas, and filters.

Since the "G-Line" is suitable for CB and TV service installations, details on its applications are provided.

PRESSURE-ACTUATED SWITCHES

49 The Meletron Corporation has just released an elaborate engineering manual covering pressure-actuated switches.

Included is an extensive glossary, mechanical and electrical characteristics on the firm's line, methods of measurement and measuring devices, circuit symbols, applications, and data and reference tables.

The manual is spiral wound.

CRYSTAL CATALOGUE

50 Texas Crystals has issued an 8-page catalogue which lists hundreds of crystals for CB, amateur, low-frequency, marker, and pressure applications, along with information on crystal holders, recommended circuitry, sockets, company representatives, and ordering information.

PACKAGE CUSHIONING

51 Armstrong Cork Company's Insulation Division has released a chart which facilitates the selection of corner cushions for protection against shock.

Of interest to the electronic equipment field, the chart provides information obtained in the course of a series of actual drop tests which were used to determine the shock an item can be expected to experience in shipment when protected by varying thicknesses and types of the firm's "Resilo-Pak."

PHONO NEEDLE GUIDE

52 Transcriber Company, Inc. is now offering a new catalogue and ready-reference needle guide which includes three easy-to-read sections enabling the user to locate the proper needle from any information available whether cartridge name and number, phonograph, or actual needle of any manufacture.

TRANSISTOR LINE

53 Sprague Electric Company has just issued a 6-page consolidated list of the most popular transistors in its line.

Short Form Catalogue CN-116C lists silicon transistors for chopper service and high-frequency applications, MAT germanium, MADT germanium, and ECDC germanium transistors for high-speed switching, high-frequency communication applications, and core driver use.

REGULATED POWER SUPPLIES

Kepco Inc., 131-38 Sanford Ave., Flushing 52, N.Y. has issued a 40-page reference handbook on applications of regulated power supplies for systems use.

The new publication is designed to assist engineers in making full use of the versatility of many of today's power supplies. Information ranges from basics of how to select a power supply, power supply classifications, and a glossary of power supply terms to detailed theoretical discussions on applications of a voltage-correcting system.

Copies of this publication are available only on company-letterhead request. ▲

1962 INDEX

VOLUMES 67-68

As a service to our readers we are again presenting a complete listing of all feature articles which appeared in ELECTRONICS WORLD during 1962. We suggest you keep this for reference.

AMATEUR

BUSINESS MANAGEMENT

CITIZENS BAND

COMPUTERS & COUNTERS

CONSTRUCTION PROJECTS

HIGH-FIDELITY & AUDIO

MISCELLANEOUS

PHONO

SERVICING

SPEAKERS & HOUSINGS

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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.

POWER SUPPLIES

SPACE ELECTRONICS

TELEVISION & RADIO

GENERAL

SERVICING TECHNIQUES

TEST EQUIPMENT

CONSTRUCTION

Answer to Electronic Crosswords

(Appearing on page 83)

T	R	A	N	S	F	O	R	M	E	R	S
E	■	U	H	F	■	H	R	I	■	M	U
R	O	D	■	■	M	M	■	■	C	A	M
T	R	I	■	S	H	■	S	W	G	■	S
I	R	O	N	C	O	R	E	■	S	D	■
A	A	■	E	A	■	L	C	■	■	I	T
R	■	■	G	N	U	■	O	■	R	O	E
Y	U	M	A	■	P	E	N	T	O	D	E
■	R	O	T	■	■	A	D	O	B	E	■
R	A	T	I	N	G	■	A	G	O	■	P
G	L	O	V	E	■	Z	R	A	T	I	O
■	■	R	E	G	■	T	Y	■	■	R	T

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41	H.M. Postmaster-General
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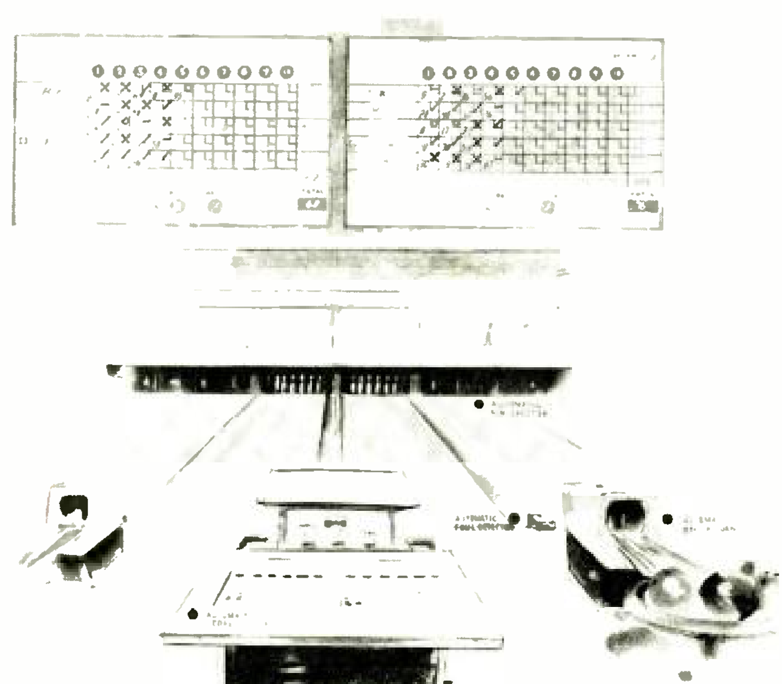
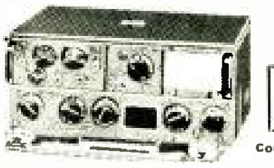
48, 49	Armour Research Foundation
52	Motorola Inc.
54 (left)	National Company
54 (right)	The Hallicrafters Co.
55 (left)	Hammerlund Mfg. Co.
55 (right)	Collins Radio Co.
59	Nuclear-Chicago Corp.
64	Channel Master Corp.
72	American Optical Co.
99	Brite-Lite Corp.

A transistorized computer that automatically records individual or team scores in bowling, provides each player with a printed record, and projects scoring to an overhead screen has been developed by Bright-Lite Corp., Phoenix, Ariz. The computer, which receives information from automatic pinsetters when pins are knocked down, is to be contained in a desk-like console. Individual score cards, automatically imprinted, will also be projected onto a 3 x 5 foot overhead screen. The equipment works in conjunction with other automatic equipment, such as foul-line detectors and ball returns. One computer serves two lanes. The system could be coin operated. It is expected that bowling alleys would rent the equipment for use.



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. PP813's modulate 813 in final up to 90%, class "B". A Real "HOT" Ham buy at our low price! Orig. cost $1800.

AN ART-13 XMTR as above. Like New .. $79.50
0-16 Low Freq Osc. Coil for ART-13 ...... 7.95
24V Dynamotor for ART-13 .... 11.95
Same as above less meter 39.50
We carry a complete line of spare parts for above.

APR-1 Navy VHF-UHF radar search Receiver, 80 Mc to 950 Mc in 2 bands. BRAND NEW $79.50
TUNING UNITS for above: TN1, TN2, TN3. BRAND NEW, each $39.50

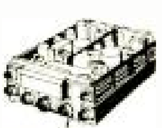
AN/APR-4 RECEIVER only, 38 to 4000 Mc in 5 tuning unit ranges. High precision lab instrument. Input 115 V60 cy. Like New $79.50
Tuning Units TN16, 17, 18 each $39.50
Tuning Unit TN19. Brand New $89.50
Tuning Unit TU54 ...... $149.50

LIMITED QUANTITY SPECIALS!

BC-312 MOBILE RECEIVER 6 bands, 1500 Kc to 18 Mc. With tubes and 12 V Dynamotor. Like New $79.50
BC-312 for AC operation $89.50
AN APT-5 AIRBORNE RADAR SET, with tubes. Like New $49.50
AN APT-5 BRAND NEW $69.50
POWER SUPPLY for AN APT-5, complete. Brand New, for 80 115 V 400 to 2600 cycles $14.95

FAMOUS BC-645 TRANSCEIVER

15 Tubes 435 to 500 MC



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.

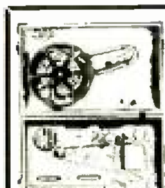
BRAND NEW

Shipping weight 25 lbs. SPECIAL! .. **$19.50**

PE-101C Dynamotor, 12/24V input $7.95
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

TG-34A CODE KEYER



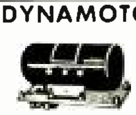
Self-contained automatic unit, reproduces code practice signals recorded on paper tape. By use of built-in speaker, provides code-practice signals to one or more persons at speeds from 5 to 25 WPM.

Like New, Tested **$26.50**

Set of 11 Reels, Army Code Practice Lessons, BRAND NEW, original packing .... P.U.R.

MOBILE-MARINE DYNAMOTOR

Model DM35



Input 12V DC. Output: 625 V DC @ 225 Ma. for press-to-talk intermittent operation. Shpg. wt. 14 lbs.
BRAND NEW **$14.95**

OTHER DYNAMOTOR VALUES:

Type	Input	Output	Excellent Used	BRAND NEW
DM-32A	28V 1.1A	250V .05A	2.45	4.45
DM-33A	28V 5A / 28V 7A	575V .16A / 540V .25A	1.95	3.75
DM-34D	12V 2A	220V .080A	4.15	5.50
DM-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 ... BRAND NEW, each $6.95
DM-37 DYNAMOTOR. Input ... BRAND NEW. Each $3.25

CARTER GENEMOTOR

INPUT: 5.9 V ... Amps.
OUTPUT: 405 V ... Amps.
BRAND NEW. special $8.95

MICROPHONES

Model	Description	EXC. USED	BRAND NEW
T-17D	Carbon Hand Mike	$4.45	$7.95
RS-38	Navy Type Carbon Hand Mike	3.95	5.75

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

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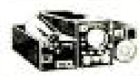
LORAN APN-4

FINE QUALITY NAVIGATIONAL EQUIPMENT



Determine 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
Shock Mount for above $2.95

INVERTER POWER SUPPLY for Loran. Made by Eclipse—Pioneer Div. INPUT: 24 V DC @ 75 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.
We carry a complete line of spare parts for above.

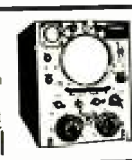
LORAN R-65/APN-9 RECEIVER & INDICATOR

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. 800 cy. 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.

LORAN APN/4 OSCILLOSCOPE



Easily converted for use on radio-TV service bench.
LIKE NEW! Less tubes, but including 5" Scope, type 5CP1 only **$14.50**

BENDIX DIRECTION FINDERS

For commercial navigation on boats.
MN-26Y 150-325 Kc. 325-695 Kc. 3.4-7.7 Mc. Complete with tubes, dynamotor. BRAND NEW $19.50
MN-28Y Receiver Control Box $4.95
MN-20E Receiver ... loop ... 18.95
... with 12 tubes and dynamotor ... 27.50
MN-20 Receiver as above ... 4.95
MN-52 Azimuth Control Box ... 2.95

SCR-274 COMMAND EQUIPMENT

ALL COMPLETE WITH TUBES

Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC	$12.95	$14.95
BC-454	Receiver 3-6 Mc	12.45	17.95
BC-455	Receiver 6-9 Mc	11.50	13.95
	1.5 to 3 Mc. Receiver Brand New		$17.95

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case, instructions $8.95
Factory wired, tested, ready to operate ... $12.50
SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. Only 49c

2.1 to 3 Mc. Transmitter, Brand New $12.95
BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal. BRAND NEW $9.75
Like New $7.95
BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal. BRAND NEW $10.95
Like New $7.95
T19 TRANSMITTER 3½ m.c. complete with all tubes and crystal. Exc. Used $9.95
BC-696 TRANSMITTER 3-4 Mc Complete with All Tubes & Crystal. Like New $11.95
BC 456 Modulator .... USED 3.45 NEW 5.95
MD7 Modulator, Like New $9.95
ALL ACCESSORIES AVAILABLE FOR ABOVE

WE Mercury Relay SPDT, 1500-ohm coil with 21 V Heater, WE #D-171581 (275-10) BRAND NEW $2.95

SCHEMATIC DIAGRAMS For most equipment on this page, each ... 65c

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JUST RECEIVED! VICTOREEN RADIATION DETECTOR (DOSIMETER)

$8.95 Model 5... BRAND NEW, actual value $45.00 SPECIAL, WHILE THEY LAST

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Like NEW $29.50
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.
Power Supply Kit for above 15.00
Factory Wired and Tested 19.95

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Companion unit for above, tunes 100 to 156 MC on any 8 pre-selected channels. 9 tubes, crystal controlled, provides tone and voice modulation. 28V DC Power input. Complete with all Tubes $18.95
Like new condition $28.50
ARC-3 PUSHBUTTON CONTROL BOX $5.95

SPECIAL! BC-603 FM RECEIVER

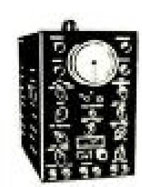
Converted for 35- to 50 Mc. Brand New, checked out
SPECIAL **$34.50**
EXTRA SET OF 10 TUBES FOR ABOVE brand new in original boxes $3.95
FT-237 MOUNTING BASE for BC-603 Rcvr and BC-604 Xmitter. Brand New $5.95
12 or 24V Dynamotor for Above. Exc. Used $4.25 .... Brand New $5.50
4-Section Antenna for BC-603, 683 Receivers. Complete with mounting base. BRAND NEW $4.95

AC POWER SUPPLY FOR BC603, 683
Interchangeable, replaces dynamotor. Has On-Off switch. NO RECEIVER CHANGE NEEDED. Provides 220 VDC @ 80 Ma. 24VAC @ 2 Amps $12.95
Complete 240-page Technical Manual for BC-603, 604 .... $3.15
BC-604 TRANSMITTER—Companion unit for BC-603 Rcvr, above. With all tubes. BRAND NEW $8.95
1-Section Antenna for BC-604, 684 Transmitters. Complete with mounting base. BRAND NEW ... $4.95
We carry a complete line of spare parts for above.

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 **$11.95**
APN-1 Exc. used, like new $8.95

TS-100AP 'SCOPE



EXC. USED (worth $750)
OUR LOW PRICE **$39.50**
Brand New $69.50
Can be used with linear sweep for general purpose test scope. Also used with circular sweep as precision range calibrator. Self-contained in metal case 8" x 12½" x 16" deep. For 110 V 50 to 1200 cycles AC. Excellent used, like new, with all tubes including crystals and CR Tube

---

LM FREQUENCY METER

Crystal calibrated modulated. Heterodyne. 125 Kc to 20,000 Kc. With Calibration book. Complete. Like New $58.50

BC-906 FREQ. METER—SPECIAL

Cavity type 145 to 235 Mc. Complete with antenna. Manual and original calibration charts included. BRAND NEW. OUR LOW PRICE ... $11.88

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
BC-221 1000 Kc Crystal Brand New $8.95

TS-16/APN TEST SET

For aligning and calibration of radio altimeters. May be used to check calibration of count or circuits and modulator-oscillator freq. and bandwidth of transmitter. Audio-oscillator range: 310 to 7250 cycles. 24 V.D.C. input. Complete with tubes, connecting cables, instruction summary. BRAND NEW $14.50

TEST SET TS-175 U. Portable crystal controlled heterodyne type unit used in field testing of CW or MCW RF Transmitters and Signal Generators. Range 85 to 1000 Mc. Power requirements: 6V DC and 135 VDC. Exc. Cond. $169.50
TEST SET TS-174 U Frequency Meter similar to above but for 20 to 250 Mc. Power input 5.5V DC and 121.5 V DC. Exc. Cond. $169.50
TS-170 ARN-5 TEST OSCILLATOR portable, battery-operated, crystal controlled, for frequencies: 332.6 Mc, 338.6 Mc, and 335 Mc. Power input 1.5 VDC and 90 VDC. Less Batteries. Exc. Cond. $22.50

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Complete portable outfit in original packing, with all accessories. Brand New **$27.50**

2 VOLT BATTERY "PACKAGE"

1—2V. 20 Amp. Hr. Willard Storage Battery. Model #20-2. 3" x 4" x 5½" high $2.79
1—2V 7 prong Synchronous Plug-in Vibrator 1.49
1—Quart Bottle Electrolyte (for 2 cells) 1.45
ALL BRAND NEW! Combination Price $5.45

WILLARD 6-VOLT MIDGET STORAGE BATTERY

3 Amp. Hour. BRAND NEW. 3⅝" x 1 13/16" x 2⅜". Uses Standard Electrolyte .... Only $2.95

CIRCLE NO. 120 ON READER SERVICE PAGE

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TV Tuners—Rebuilt or Exchanged $9.95 complete—all types—fast, guaranteed service. Send tuner with all parts to: L. A. Tuner Exchange, 4611 West Jefferson Blvd., Los Angeles 16, California.

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GOVERNMENT Surplus Receivers, Transmitters, Snooperscopes, Parabolic Reflectors, Picture Catalog 10¢. Meshna, Malden 48, Mass.

TELEVISION camera kit, easy to build step by step instructions, suitable for Ham TV, Educational, Industrial, Medical uses. Craftsmen Instrument Labs Inc., 60-30 34th Ave., Woodside L.I., N.Y.

PRECISION Resistors, carbon-deposit. Guaranteed 1% accuracy. Millions in stock. ½-watt, 8¢. 1-watt, 12¢. 2-watt, 15¢. Leading manufacturer. Rock Distributing Co., 902 Corwin Rd., Rochester 10, N.Y.

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