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JULY, 1962
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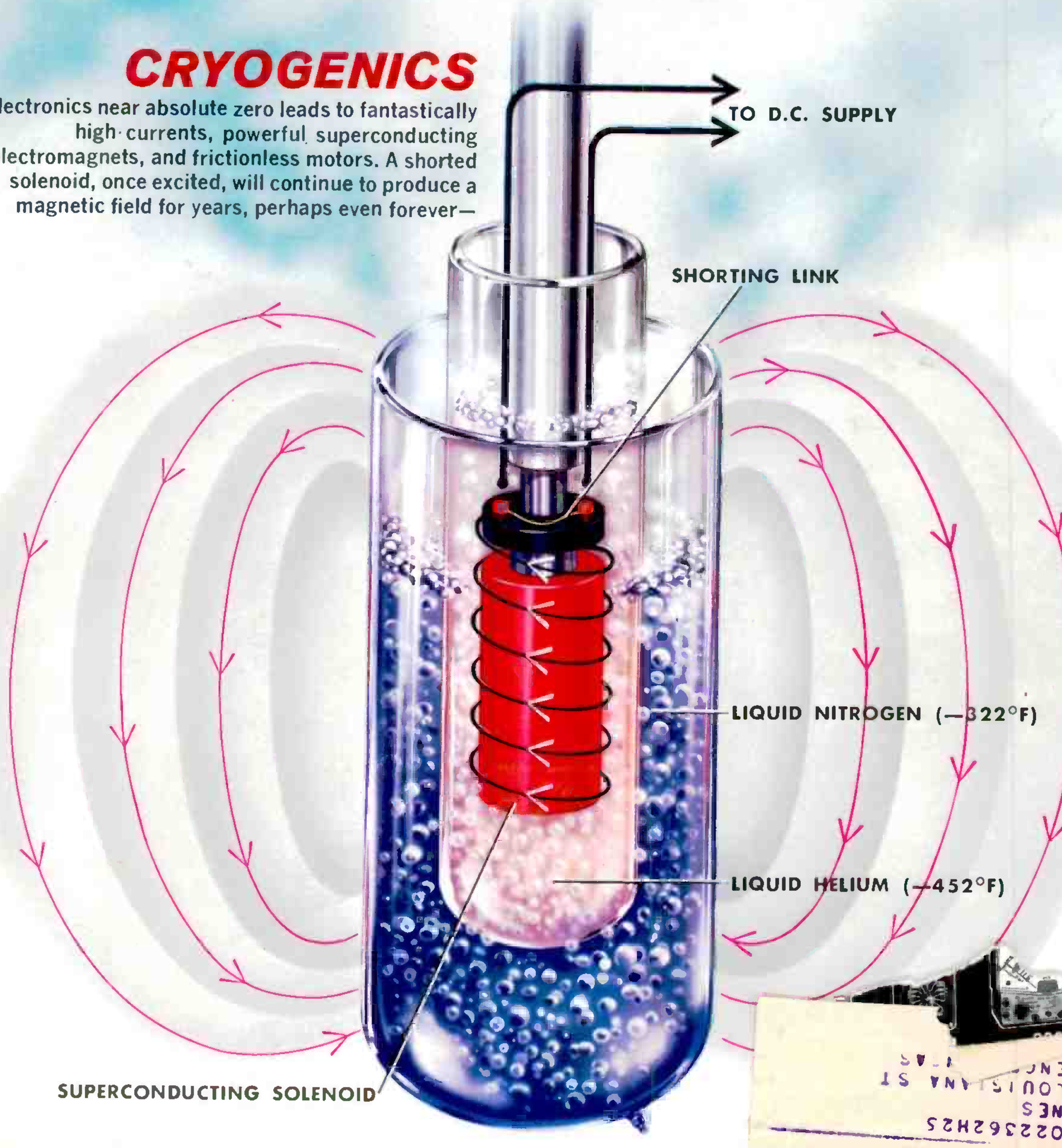

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JULY 1962 / VOL. 68 NO. 1

Electronics World

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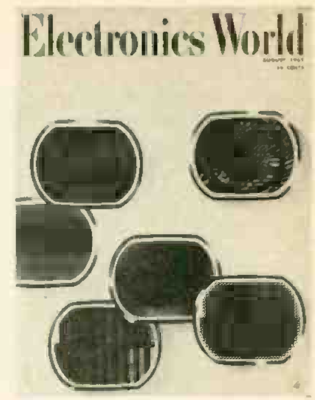

Special Feature:

COLOR TV

Analyzing Color-Set Defects—Experienced technicians recognize many faults immediately on monochrome sets by inspection of the picture. Similarly, there are many color-set defects that can be associated with specific visible symptoms, including some that appear during monochrome reception, if the technician thinks logically in terms of circuitry. This article illustrates the technique with examples. . . . **Directory of Color TV Test Pattern Generators**—Color TV servicing requires special test-pattern generators for making chroma and convergence adjustments. Here are the available units and their features . . . **Status of Color TV**—A run-down on what color sets and what TV programs will be available in color for the prospective purchaser of color TV.

Special Gatefold—Of particular interest to the audiophile, this special full-color **SOUND** chart includes graphs of frequency and volume ranges, equal loudness curves, an audible spectrum chart, a musical frequency-range chart, a graph of hearing loss with age, plus a sound-level chart showing the relative levels of a number of common sounds and noises . . . **Voltage, Power, and Decibel Nomogram**—For figuring amplifier gains and losses even when voltage measurements are across different impedances.

FACSIMILE TECHNIQUES & EQUIPMENT
A. L. Plevy, a Project Engineer for Westrex Corp., discusses the operating principles of facsimile equipment and explains some of the features to be found in modern equipment now being used to relay visual information from point to point.

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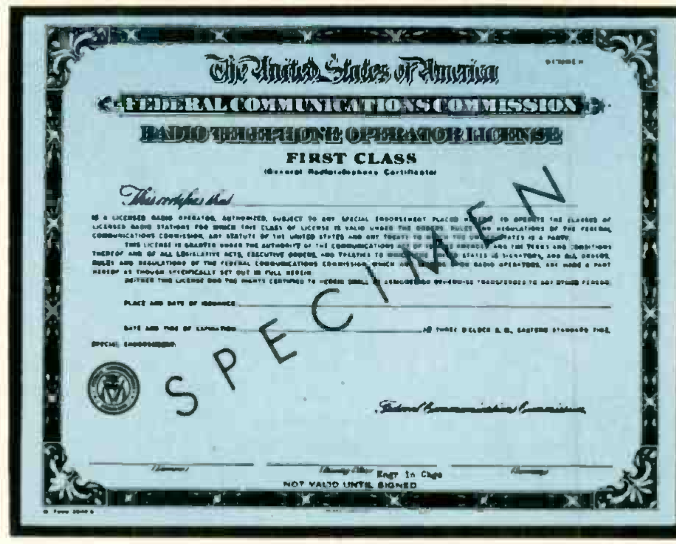

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...for the Record

By W. A. STOCKLIN
Editor

CB and the FCC

ACCORDING to word just received from Washington, some contemplated changes in the Communications Act will very shortly become law. Congress has put its stamp of approval on the new rules and, at this writing, the bill is on President Kennedy's desk awaiting his signature. There seems to be no doubt that he will sign the proposed rules.

The bill itself is quite involved, including many provisions designed solely to reduce unnecessary paper work for the FCC. The balance of the bill, however, will directly affect users of communications equipment. It involves forfeiture of licenses and fines in cases of violations of the following rules and regulations.

1. Operation by any person not holding a valid operator's license or permit.
2. Failure to identify himself at the time and in the manner prescribed.
3. Transmission of any false call contrary to regulations.
4. Operation on a frequency not authorized.
5. Transmission of unauthorized communications on any frequency designated as a distress or call frequency.
6. Interference with any distress call or distress communication.
7. Failure to attenuate spurious emissions to the extent required.
8. Operation with power in excess of that authorized.
9. Rendering a communications service not authorized.
10. Operation with a type of emission not authorized.
11. Operation with transmitting equipment other than that authorized.
12. Failure to respond to official communications from the FCC.

Once the law becomes effective, any licensee of a station violating any of the above rules will, in addition to other penalties prescribed by law, be fined a sum not to exceed $100 for each violation. A maximum penalty of $500 can be imposed irrespective of the total number of violations.

Not only is the licensee involved, but the operator of any such station can be similarly penalized for violating Clauses 2, 3, 5, and 6.

These penalties, in themselves, are certainly not too severe and we believe the FCC is not unreasonable in its demands. We all conduct ourselves according to rules and regulations, at least in our civilized society. If everyone operates within the rules, there will not be any penalties involved, but when licensees and operators flagrantly violate existing rules and regulations, they should be penalized. The penalty should be sufficiently severe so that the number of violations is reduced, if not eliminated completely.

We do not want to imply that those in communications are flagrant violators of FCC rules and regulations. In fact, we believe that most are sincere individuals who make every possible effort to use our air channels properly. Certainly no one can criticize those in commercial communications and most radio amateurs, as a whole, operate according to the rules. It is in Citizens Band communications that abuses occur daily. Although many of these operators, individually and in organizations, are making every effort to police themselves against violations, there still remain a great number who continually operate illegally.

Although we do not condone the violations, we honestly believe that much of the fault lies with the FCC and that further penalties imposed on the CB group, although legal, would not solve the problem. The FCC has set up so many misunderstood, misinterpreted regulations for Citizens Band operation that very few operators really know just what constitutes a violation. It is not the responsibility of the operators themselves to try to interpret correctly the FCC's intentions. It is the FCC's responsibility to set up simple, direct, and easy-to-understand rules and regulations that cannot be misinterpreted by anyone. In addition, the FCC has certainly been negligent in policing violations. Obviously, this is due to lack of funds, but this does not excuse them from the responsibility.

The odds in favor of being cited by the FCC for any violation are only 1 in 5000 or even more and, with this degree of leniency, it is hard to expect users of CB equipment to take the regulations as seriously as they should.

Before the FCC considers imposing *further* penalties, we would think it advisable to re-evaluate the problems and first eliminate the many deficiencies in the present Citizens Band rules and regulations. Then the FCC should organize its field offices so that sufficient personnel is available to properly monitor and enforce its directives.

We feel sure that most operators of Citizens Band equipment have a sincere desire to stay within the regulations if the regulations can be clarified for them so that they understand exactly how and for what purpose the Citizens Band is to be used. ▲

LETTERS FROM OUR READERS

U.H.F. TV EDITORIAL

To the Editors:

I was shocked when I opened the April ELECTRONICS WORLD and read your editorial "Will 50 Million TV Sets Become Obsolete?" You say the present 12 v.h.f. channels are insufficient to give proper coverage across the nation. The Television Information Office, New York, N.Y., in "Television: Dimensions" on pages 5 and 6 says: "Currently, 586 stations serve 48,000,000 U.S. television families. About 98% of these families can choose programs from two or more stations." On page 4 of the same publication, "There are over 56 million TV sets in some 48 million homes. About 9 out of 10 U.S. homes have television."

You state that u.h.f. television presents no problems that have not been solved. Please contact the first TV serviceman you encounter and ask him. For more concrete information, get first-hand data from the equipment manufacturers and their design engineers. You might also talk to someone whose picture "went to pot" when the trees leafed out in the Springtime.

In reference to the fourth paragraph of your editorial discussing the FCC New York u.h.f. test, some of us in the industry fear that this is "cut and dried"; that the FCC will find out only what it *wants* to know. Perhaps this indication is borne out by the fact that the test is a "closed" affair, with no information of the results available to the industry. Further, both the facility and set installations were made by experts, with no limit on the cost, which is certainly not what the majority of TV viewers will be able to afford in installation costs and upkeep to their installations. Common sense would indicate that any results obtained in New York City could not be even an indication of the results to be expected in the bulk of the rest of the country, with its varying terrain. Yet this "test" purportedly could determine the kind of TV that will be forced on the entire country, regardless of the present investment by citizens and TV broadcasters.

Finally, you state that television must go u.h.f. Why? You answer, "TV will be made available to more areas and be able to reach more people." Not everyone agrees with you. The Maximum Service Telecasters Fact Sheet, page 2, has this to say:

"If all existing v.h.f. stations were shifted to u.h.f. channels, very considerably more than 25% of the total land area of the United States would lose its existing television service.

"Small- and medium-sized communities and rural, farm, and other outlying areas now served by v.h.f. stations would be especially hard hit if operating stations were shifted from v.h.f. to u.h.f.

"Existing reliable technical data demonstrates: (1) v.h.f. stations usually can be expected to serve areas extending 55-65 miles and farther from the transmitter; (2) u.h.f. stations usually can be expected to serve areas extending only 30-40 miles from the transmitter."

J. E. NEWMAN
Chief Engineer
Television Station WDBJ
Roanoke, Virginia

Space does not permit us more than a brief sampling of some of the ideas expressed in Reader Newman's letter. It is obvious that there are many successful v.h.f. stations that are not anxious to switch to u.h.f. However, our own feeling, as expressed in the April editorial, is that there will be a general changeover to u.h.f. in about 10 years or so. By that time, assuming the all-channel bill goes through Congress, a good many receivers will be in the hands of the public that will allow them to receive the u.h.f. stations.—Editors.

* * *

HI-FI IN THE 30'S

To the Editors:

The writer has been fooling around with "high fidelity" since before 1930. Before the advent of the dynamic speaker—even with the old heavy field coils—the writer used more than one or two of the old magnetic speaker drivers, in which the fulcrum was attached directly to the sounding board. We even tried some of these dynamic speakers (made by *Crosley*) on the sounding boards of pianos, and got very good reproduction from the old radios and records.

In the 1930's, when the old "Cinaudagraph" speakers were made in Germany, we secured one of the largest models (an 18-incher weighing a whopping 55 lbs.) and mounted this speaker in an "infinite" speaker enclosure measuring 48 x 48 x 18 inches made with ¾-inch plyboard, and "loaded" with wool felt. Our amplifier used feedback with 6L6 tubes, and had the old *RCA* "expansion" circuit together with the *Thordarson* bass circuit.

With this combination, we got excellent reproduction from the old 78-rpm records, since we could "expand" the lows, and also had control over the highs. At one time, our setup included six other speakers in combination with the above 18-in. "Cinaudagraph" speaker. We used the old (and first) "high-fidelity" output transformer made by *Thordarson*. Incidentally, our

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amplifier had an output of less than approximately 10 watts.

Before TV came in, I built a Helmholtz resonator from data in Helmholtz's book. The enclosure was made from maple wood (cured), and the assembly weighs well over 125 lbs—without speakers! I still have the resonator, but haven't used it in years.

HORACE D. WESTBROOKS
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Reader Westbrooks' comments were prompted by an article by George Augspurger in our January issue entitled "The Importance of Speaker Efficiency." Mr. Westbrooks goes on to say in his letter that the efficiency of some of the very early enclosures that he has experimented with is far greater than that of many modern speakers.—Editors.

* * *

TRANSISTORIZED METAL LOCATORS

To the Editors:

I have received a letter from a reader of my article "Transistorized Metal Locator" which appeared in the March 1962 issue. This reader is quite emphatic in disagreeing with my claim of being able to detect a nickel three feet underground. This reader also refuses to build or service transistorized metal locators; however, his remarks on range are quite understandable as in probably 95% of the cases, faulty construction or operation will result in range of only a few inches on such a small object.

In any b.f.o. type, pulling is the key factor in range. Assuming careful shielding of both r.f. outputs right to the mixer input, the beat note should be lowered in operation to one cps or less. A good meter will then "kick" with every cycle. Range is usually reduced more than tenfold simply by an increase in beat frequency from one to thirty cps. This is where temperature stability counts.

Senior engineers, including members of the staff of *Lockheed,* Ontario, and *Autonetics Research Center* in Anaheim, have seen my unit locate a nickel in three feet of dry sand.

W. E. OSBORNE
Whittier, California

* * *

DE-STATICIZING RECORDS

To the Editors:

In your "Letters from Our Readers" column of February 1962, there was a letter from J. D. Douglass of Cleveland, Ohio, wanting some advice on the care of vinyl records.

Although liquid detergents are recommended by some to destaticize plastics, they do not do a real job. That is, they destaticize by retaining a slight amount of moisture which disappears in times of very low humidity. Also, some detergents show a slight tendency to craze certain plastics. Crazing is the appearance of tiny cracks within the plastic that eventually deteriorate it and a rough surface begins to show. Further crazing causes a break. This would not do for a recording.

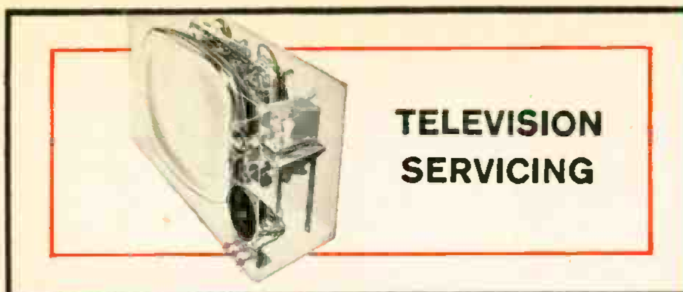
So let me recommend that a real, chemical anti-static solution be used to clean and destaticize your vinyl records.

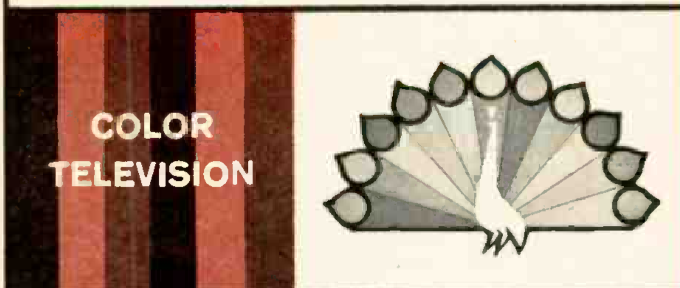
Now let me tell you how to do it. The best way (I have found) is to fill a water glass with anti-static solution and pour it over one side and then the other of a record. Stand it on end, resting so that only the top edge is supported to keep it from falling. Let it drain and dry. Wiping a record with a cloth dampened in anti-static is a sure way to get your record scratched. Recover the poured solution in another container and use over and over.

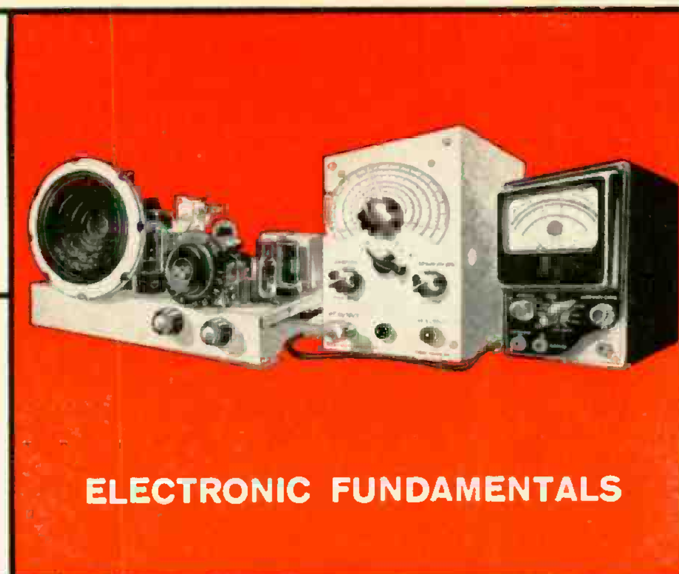
The anti-static chemical is extracted this way from the solution but it is attracted to the record surface. Such an anti-static preparation is available as "Statix PC-152-C," from the *Paint Products Laboratories,* 1018 N. Clark Street, Chicago 10, Illinois. This preparation is concentrated and is to be diluted with water. Use four parts of water to one part of the anti-static chemical.

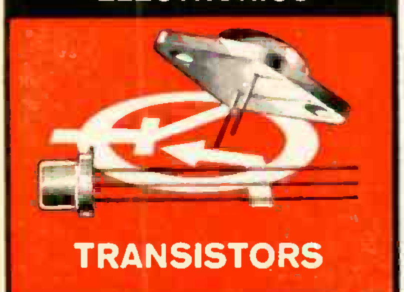
WILLIS C. WARE, JR.
Chicago, Illinois

In addition to the source of anti-static chemical mentioned above, many of the larger electronics parts dealers as well as record stores carry a number of chemicals of the type described above, and in convenient spray-cans.—Editors. ▲









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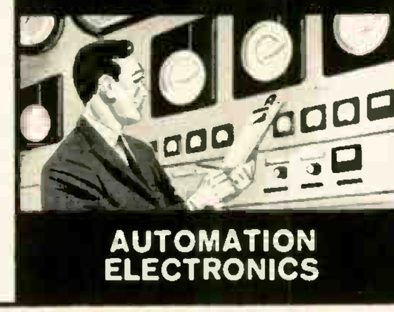

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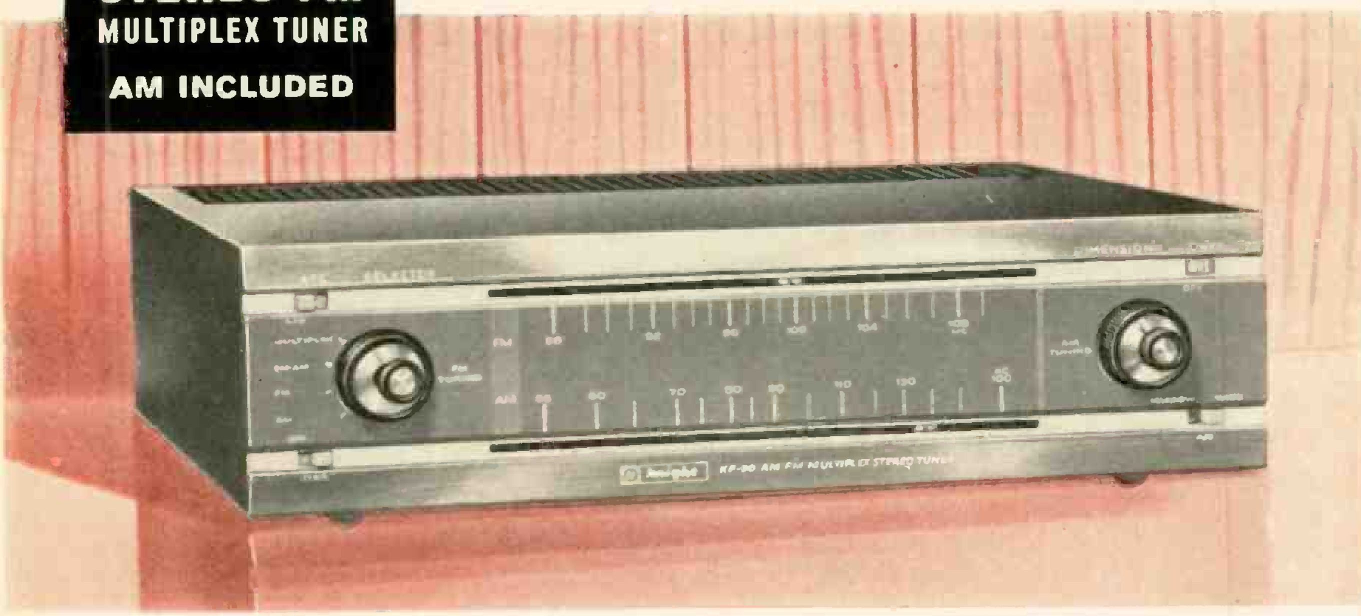

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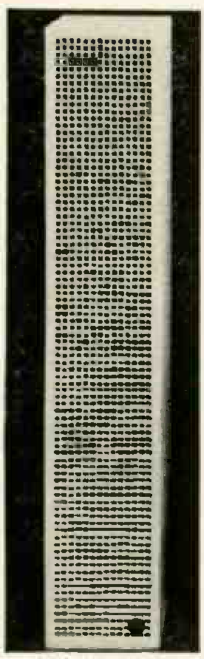
University UCS-6 "Uniline" P.A. Speaker

For copy of manufacturer's brochure, circle No. 57 on coupon (page 96).



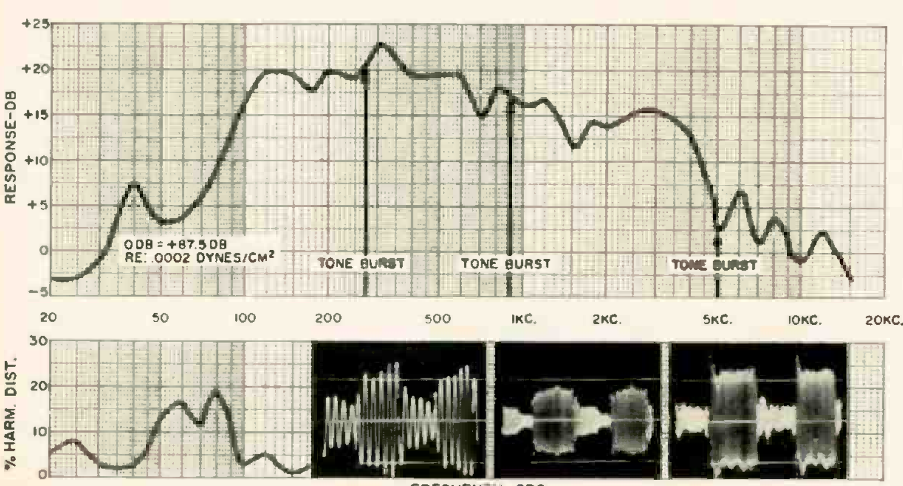
AS A rule, designers of p.a. speakers are more concerned with high efficiency than with high fidelity. A 3-db increase in speaker efficiency is equivalent to doubling amplifier power and is far less expensive. In most installations, extended frequency response is not required and most p.a. speakers are only expected to produce high levels of intelligible sound, reasonably free from distortion and with the desired directional characteristics.

A p.a. speaker should project its sound forward into the audience. If any significant portion of the acoustic output goes to the rear, or to any part of the auditorium not occupied by the audience, it represents wasted power. Worse yet, acoustic feedback is likely to result if too much sound reaches the microphone. Feedback problems are further accentuated if the speaker's response is peaked at any frequency.

The *University* "Uniline" sound-column speaker systems illustrate an interesting approach to p.a. speaker design. The Model UCS-6 is an in-line array of six 8" extended-range cone speakers. They are housed in a column enclosure, 58½" high x 10" wide x 7" deep, which is normally mounted vertically. This gives a fan-like distribution pattern, covering a 120-degree horizontal angle and a 16-degree vertical angle. The narrow vertical angle is intended to concentrate the sound in the audience instead of dissipating it above their heads.

The frequency response of the UCS-6 is rated at 55 to 17,000 cps, with a program power capacity of 150 watts for integrated program material. The system's rated impedance is 16 ohms. *University* emphasizes the high quality of its sound, which improves intelligibility and listener comfort, particularly for those seated close to the sound source.

We tested the UCS-6 in the same manner as we do high-fidelity speakers, averaging the response curves obtained at eight indoor microphone locations in a listening room. A 10-watt input level was used up to 1 kc. and 1 watt above that frequency. *(Editor's Note: Vertical and horizontal polar response measurements would have been useful to show the speaker's directivity, but this would have required a setup in an auditorium rather than in an ordinary-sized listening room.)*



The resulting response curve was very smooth from about 100 cps to 4000 cps, with no peaks or holes of more than 4 db. Above 4000 cps, the output dropped off at about 6 db/octave, the 15-kc. output being about 20 db below the mid-range level. Below 100 cps the output fell off at 12 db/octave, with a peak of about 7 db at 40 cps. The harmonic distortion was low at frequencies above 100 cps and below 40 cps. Between 50 and 80 cps, it rose appreciably to values of 10 to 20 per-cent at the 10-watt input level used in our tests. Tone-burst tests revealed ringing between bursts, about 6 to 10 db below the burst level, at most frequencies. The high efficiency of the UCS-6 was clearly shown by the sound pressure levels we measured, some 10 to 15 db higher than those generated by typical high-fidelity loudspeaker systems at the same input power.

We could not test the UCS-6 under actual auditorium conditions, but we did listen to it as part of a high-fidelity home-music system. Here it did not sound at all out of place, even when compared to the finest reference speaker systems, which is a tribute to the success of its designers. The sound was balanced, quite musical, and not at all like the usual "p.a. sound." The bass seemed much fuller than the measurements would indicate, and one was not aware of a lack of highs except by comparison with a wide-range speaker system. The physical configuration of the UCS-6 gives it a truly "big" sound, which would be very appropriate in an auditorium. Family objections prevented our operating it at high power levels, but there is no doubt that it can produce a lot of good, clean sound.

The *University* UCS-6 sells for $179.95. ▲

"Knight" KN-4000 Tape Transport

For copy of manufacturer's brochure, circle No. 58 on coupon (page 96).

THE *Allied Radio* "Knight" KN-4000 is a compact, flexible tape transport mechanism, suitable for either custom installation or for portable use. Unlike most moderate-priced recorders, it contains three four-pole motors, one to drive the capstan and one driving each reel. An obvious benefit of this type of

LK-72 80 WATT AMPLIFIER

"... no effort has been spared to make the building job simple, a lot of fun, and yet have the builder end up with a unit that looks and works like factory-built equipment . . . Whizzed through the complete construction in only about 11½ hours. A conservatively designed, versatile, integrated stereo amplifier that should be a pleasure to build and a pleasure to use."

Electronics World

LK-150 POWER AMPLIFIER

"... Checking my notebook for my feelings about the music capabilities — I find only two words, "immaculate sound" ... This unit belongs to that very small group of components which allow you to "see" past the equipment into the performance itself ..."

American Record Guide, April 1962

LC-21 PREAMPLIFIER

"Noise is totally inaudible under any listening conditions . . . Listening to music with the LC-21 proves to be as rewarding as it was with the power amplifier. It impinges nothing of itself on the performance while providing positive control ... both kits go together with no fuss at all. About a week's worth of evening work will provide a superb electronic control center ..."

American Record Guide, April, 1962

LT-110 FM MULTIPLEX TUNER

" . . . a fine stereo tuner and an unusually easy kit to build . . . "

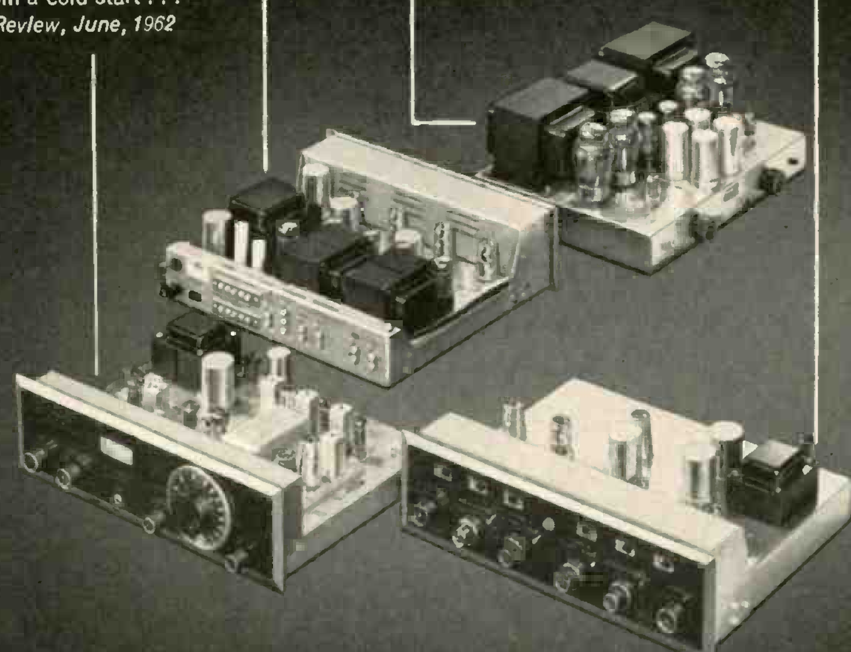
Audio, April, 1962

" . . . If you have hesitated to go into stereo FM because of imagined complexities . . . fear no more. The LT-110 shows you how to enjoy stereo FM the easy way . . . "

Electronics Illustrated, July, 1962

" ... The drift was the least I have ever measured on an FM tuner. Less than 2 or 3 kilocycles from a cold start . . . "

Hi-Fi/Stereo Review, June, 1962



Scott Kits win rave reviews from leading Hi-Fi experts

"The packaging and instruction manual for the Scott LK-72 kit help make the assembly and wiring of this amplifier painless and even pleasurable. Each stage of the work is carefully explained, with text and illustrations that leave little or no room for error, and which were obviously prepared with more than a passing sense of humor. There are no outsize "blowups" to hang on the wall, but rather meticulously detailed drawings, in color, of each stage of the work, and all contained in the manual in the normal sequence of steps used by the builder. The instructions are prefaced with helpful hints on how to unpack the kit, what tools to select, correct soldering procedures, and so on. For those who are interested, there also is a section explaining how the amplifier operates, stage by stage. All told, this is a neat, attractive, very well-designed kit, and one which gives every assurance of successful completion even in the hands of the inexperienced or first-time builder."

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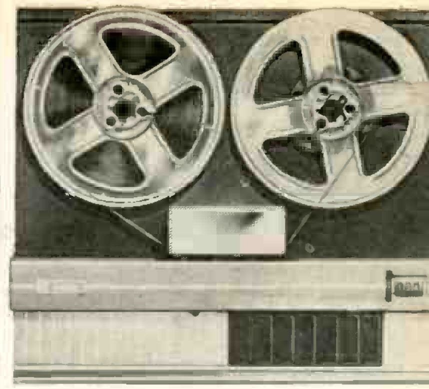

drive is the elimination of clutches and belts, with their attendant slippage problems and need for periodic adjustment. The only maintenance required in the KN-4000 is occasional lubrication. A second advantage is the ability to use d.c. dynamic braking. When the tape is brought to a stop, even from high speed, a d.c. current is passed through the reel motors. This brings them to a stop rapidly and smoothly, without danger of tape spillage or breakage.

The KN-4000 is equipped with three sets of four-track heads, for erase, recording, and playback. Depending on the associated record/playback amplifier, this allows considerable flexibility as to the mode of operation. For example, since the erase heads are of the quarter-track type, it is possible to record on one track while playing the other track. Sound-on-sound or multiple recordings are made in this manner.

All operations of the transport are controlled by a row of seven "piano-key" push-buttons. Two of them select the tape speed, either 3.75 ips or 7.5 ips. An "off" button shuts off all power to the deck and releases the pressure pads holding the tape against the heads. A "Standby" button turns on the capstan drive motor and applies the d.c. braking current to the reel motors. This control is also used to stop the tape, either from normal or fast speed. The "Run" button places the tape in motion at the selected speed, either for recording or playback. The last two buttons control the "Fast Forward" or "Rewind" operation.

There is little that can be tested on a tape mechanism without some electronic circuitry, so we tested the KN-4000 with a "Knight" KN-4001B stereo record/playback preamplifier. It is difficult to separate the contributions of the amplifier and the heads to the over-all frequency response. Since the KN-4001B is being covered in a separate report next month, we will merely say that the measured record/plaback response of both units was 30 to 13,500 cps ± 3 db at 7.5 ips and 30 to 9000 cps ± 3 db at 3.75 ips.

The tape speeds were slightly fast, the error amounting to about 45 seconds in 30 minutes playing time. The fast forward and rewind operations each required 60 seconds for a 1200-foot reel. The wow was 0.05% at 7.5 ips and 0.14% at 3.75 ips. The flutter varied, within a period of several seconds, from 0.08% to 0.24% at 7.5 ips and from 0.11% to 0.15% at 3.75-ips tape speed. These fig-

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- Plays back: ¼ & ½ Track Stereo; ½ Track & Full Track Monaural

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The KT-220 Multiplex adaptor is supplied complete with shielded cable for input and output connections; metal case and all parts plus the famous Lafayette detailed kit instruction manual. Front panel is finished in beige and ivory trim with contrasting beige and brown cabinet. Size 8½Wx4⅜Dx 4³⁄₁₆"H. For 110-125 volts, 60 cycle AC. Shpg. wt., 4 lbs.

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City ____________ Zone ______ State ______ ures are within the equipment specification of 0.25% combined flutter and wow, although the flutter could be heard on certain sustained tones.

The transport is constructed on a heavy sheet-metal panel, which is quite rigid when it is firmly screwed to a larger surface, although it seems a trifle light when considered by itself. The head cover and trim are thin metal stampings, which sometimes buzzed when the tape was in motion.

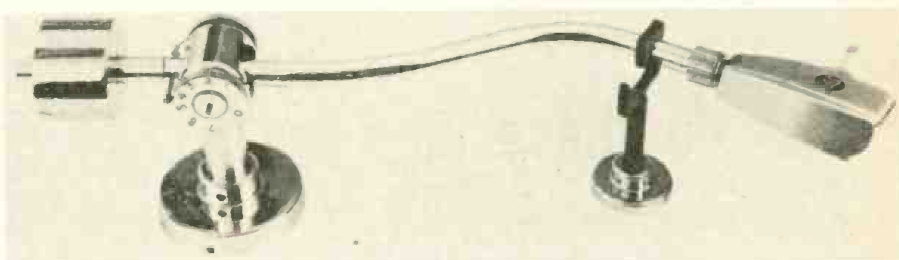
In operation, the transport was smooth and easy to use. There was never any tendency to spill tape, and stops from a fast tape speed were gentle if not particularly rapid. The reel motors shut off automatically when the tape has finished playing, but not on fast forward or rewind. There is an index counter for logging portions of a recording and afterwards locating them.

The full utilization of the transport's facilities, as we have stated, requires separate recording and playback amplifiers, with a bias oscillator operating at 65 to 70 kc. The transport can be used by itself to play monophonic, half-track stereo, or quarter-track stereo tapes, by connecting the playback-head outputs to a preamplifier equipped for NAB tape equalization.

The "Knight" KN-4000 tape transport sells for $134.50. A portable carrying case, capable of holding it and the KN-4001B preamplifier, costs $24.95. ▲

ESL S-2000 "Super Gyro/Balance" Tonearm

For copy of manufacturer's brochure, circle No. 59 on coupon (page 96).



ALTHOUGH many tonearms feature a greater or lesser degree of balance in their design, it is doubtful if any can be more thoroughly balanced than the new *ESL* S-2000. This is an improved version of the well-known Model S-1000, one of the earliest arms which could be played at any angle (even upside down).

The S-2000 can be balanced along three different axes, with a spring supplying the necessary tracking force. Most installations, where the turntable is level, require only a simple balancing of the cartridge mass by the sliding counterweight. This takes only a few moments. On the other hand, if the turntable is not levelled, if several different cartridges are to be used in the arm, or if maximum immunity to shock and jarring is desired, the complete balancing procedure must be followed.

This is best done before mounting the arm on the motorboard. With the cartridge installed, the stylus force adjustments are set to zero and the counterweight is adjusted for balance in the horizontal plane. Next, the arm is tilted up 90 degrees, so that the shell is straight up. The counterweight, which has an asymmetrical mass distribution, is rotated so that the arm balances in the upright position. Finally, while lying on its side, the arm is shifted along the axis of the vertical pivot by a spring-loaded adjustment to balance it in this plane.

This procedure is difficult to visualize without the actual arm or the illustrated instruction booklet. It is not a simple business, since the various adjustments interact to some extent and must be repeated until perfect balance is achieved. Once the arm is balanced, it is mounted on the motorboard and the desired tracking force is set by the two calibrated dials controlling the spring tensions.

Mounting the S-2000 arm is very simple, using no screws. An aluminum tube, detachable from the arm base, fits into a 1" diameter hole in the motorboard and is fastened by a *Tinnerman* fixture. This is a gripping device which is slid up the tube to clamp it to the motorboard. It cannot be removed without breaking it, but an extra fastener is included with each arm in case it must be re-installed on another turntable. The arm (which comes complete with two shielded cables and phono plugs) slips over the tube and is fastened by an *Allen* setscrew.

The extreme flexibility of the *ESL* S-2000 arm is further illustrated by the stylus overhang adjustment. The arm base is eccentric with the mounting tube, so that it may be shifted with respect to the turntable center by rotating the base before tightening the setscrew. A calibrated scale under the base provides reference points for re-setting the stylus overhang if different cartridges are used.

We found that the almost total flexibility of the S-2000 made its installation and balancing a rather lengthy and tedious process. It is advisable to have an assistant hold the arm while the various balancing adjustments are being made. Since the cartridge must be in place during balancing, great care must be exercised to avoid damage to the unprotected stylus. Once it is set up, the S-2000 performs very well, being completely immune to playing angle and relatively unaffected by jarring or vibration. It has a good "feel" and is convenient to handle. The open front of

(*Continued on page* 75)

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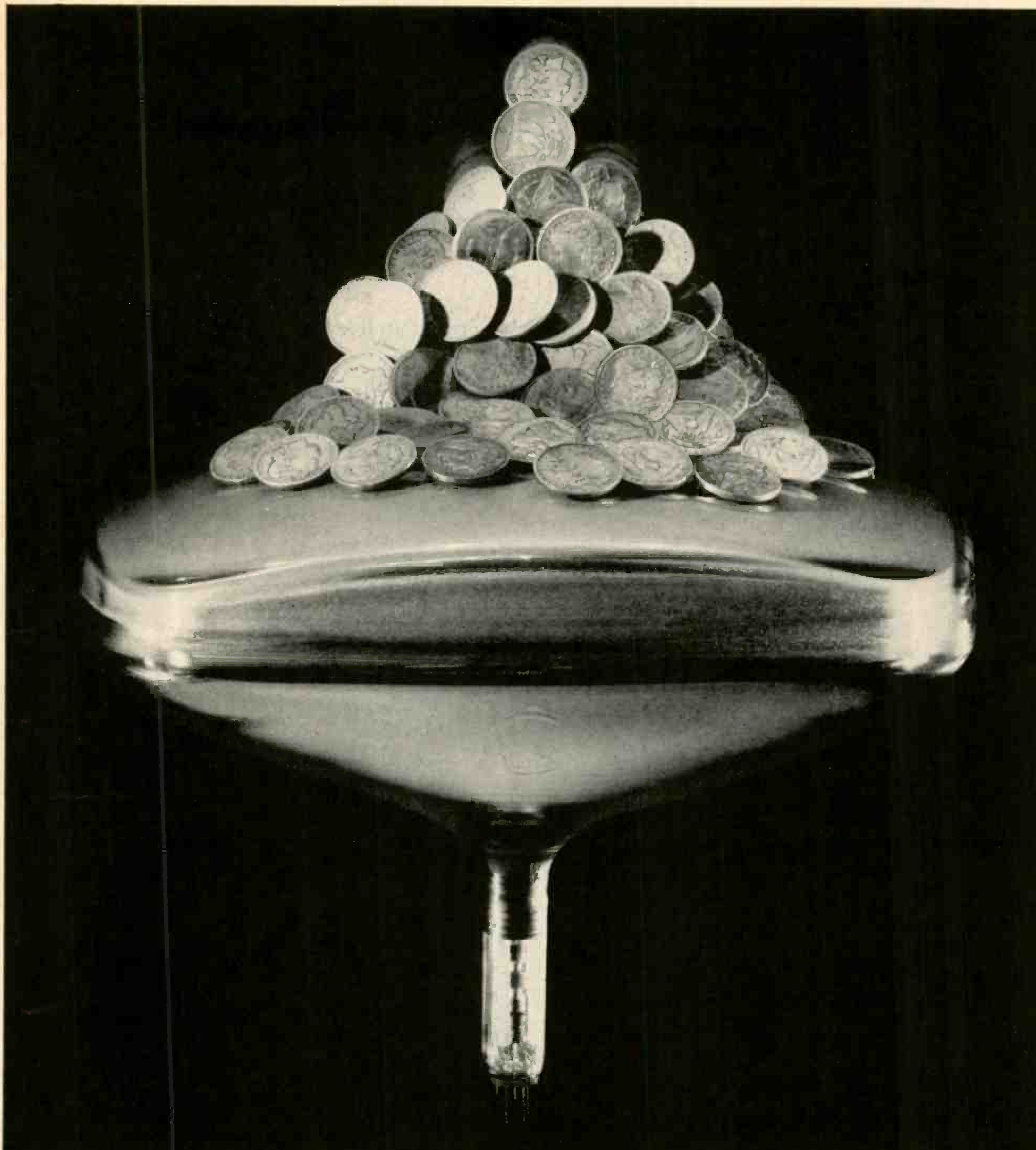

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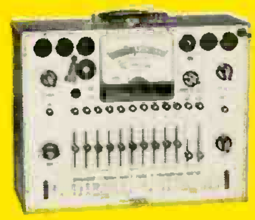

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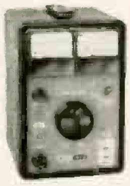

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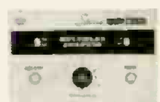

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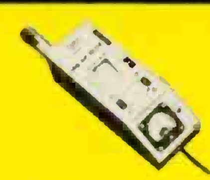

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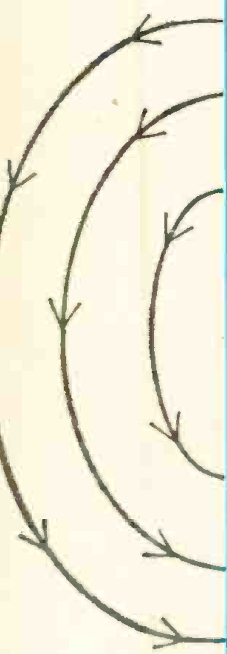
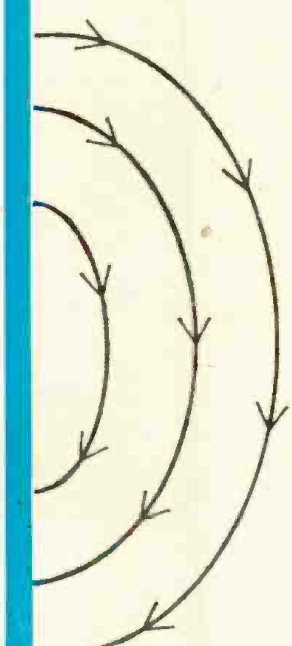
CRYOGENICS

ELECTRONICS AT ULTRA-LOW TEMPERATURES

By KEN GILMORE

Powerful superconducting electromagnets, shoebox-sized computers able to do the work of today's giants, frictionless motors, zero-loss power transmission systems—these diverse benefits and scores of others are now or soon will be flowing from cryogenic research labs.





CRYOGENICS—the science of producing and using extremely low temperatures—comes from the Greek word "*kryos*" meaning "icy cold." While the Greeks may have had a word for it, they didn't really know what "cold" was. The temperatures which occur in nature—even winter's sub-zero blasts—are red hot compared to the unbelievably frigid realm now produced routinely in hundreds of laboratories around the world.

Cryogenic temperatures — frequently defined as those below −297°F, the boiling point of liquid oxygen—interest scientists because ordinary substances whose temperature is reduced to this region take on many weird—and frequently useful—new properties. A bar of lead which usually clinks dully when tapped rings like a piece of fine crystal at cryogenic temperatures. A rubber ball will shatter like a Christmas tree ornament when dropped and you can drive nails with a cryogenically cooled banana. Steel becomes five times as strong, but so brittle it will splinter if struck.

Near absolute zero (about −460°F or −273°C) some metals lose all electrical resistance and become *superconductive*. A current circulating in a superconductive ring will whirl around forever, even though connected to no power source, as long as the temperature is kept low enough. Furthermore, superconductive metals become diamagnetic—magnetically opaque. Set a lead ball above the ring with the circulating current and if its temperature is low enough to maintain it in a superconductive state, magnetic lines of force cannot enter the lead, so the ball is repelled. It will float in mid-air on the cushion of magnetic force created by the revolving current.

Startling new cryogenic techniques are coming into use in many diverse fields. Scientists of the *Linde Division* of *Union Carbide* working with the Naval Research Laboratory, for example, have devised a system for deep-freezing whole human blood for an indefinite period. Live cells and bacteria cultures can also be frozen and stored for years. Artificial insemination of dairy cattle, using cryogenically stored semen, has become routine.

Another promising area is in the storing and shipping of food. A shipload of food was superfrozen and sent from New York to Venezuela a few

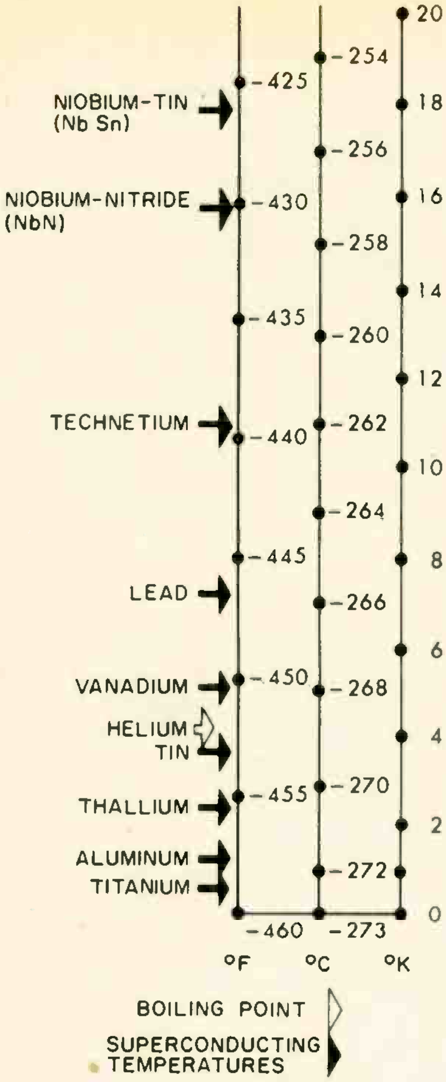


Fig. 1. Various materials become superconducting at different temperatures as shown.

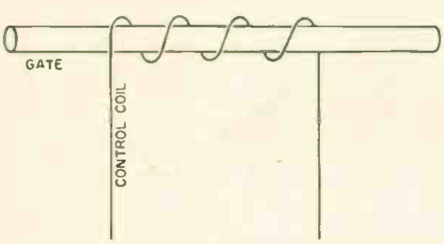


Fig. 2. Current flowing through the control coil creates a magnetic field and switches the superconductive gate to resistive state.

years ago. There, the cargo was broken into smaller shipments—still solidly frozen—and transshipped to points around the country. Experts estimate bulk shipments lowered to several hundred degrees below zero and well insulated will remain frozen for weeks or months without further refrigeration.

One of the strangest cryogenic products is "Helium II," simple helium gas cooled to within about one degree of absolute zero. Helium II refuses to obey the natural laws of liquids. It becomes what scientists call "superfluid." For example, it flows easily between two sheets of optically flat glass pressed together, a joint which is normally completely fluid-tight. Even stranger, dip a test tube half way down into a Helium II bath and this odd super-viscous liquid will flow up over the lip of the tube in apparent defiance of the laws of gravity and continue to flow until the level inside of the tube is even with that outside. Then lift the tube a little and it flows back in the other direction.

A Promising Cryogenic Frontier

The Dutch physicist, Kamerlingh Onnes, who first liquefied helium in 1908 and thus opened the door to ultra-low-temperature research, made many discoveries which are just now beginning to be understood and applied in the field of electronics. He made one of his most important discoveries in 1911 while studying the resistivity of metals at low temperatures. Under classical theory, electrical resistance of most conductors should slowly decrease as temperature drops, finally reaching some residual level near absolute zero.

Onnes tested the theory by measuring the resistance of a block of mercury, found that it varied just as predicted. But, as the temperature approached absolute zero, *all resistance suddenly disappeared*. Onnes named this strange phenomenon superconductivity, and went on to find that some—but not all—metals also became superconductive near absolute zero, each at its own characteristic temperature (Fig. 1).

A few years after his original discovery, Onnes uncovered another strange fact. When a magnetic field of sufficient strength is applied to a superconductive circuit, the superconductivity disappears and the circuit reverts to its normal resistivity.

Although superconductivity fascinated and baffled scientists for years (it wasn't until 1957 that three University of Illinois scientists came up with the first plausible theory as to what causes it) nobody thought of anything to do with it until 1935. In that year, two Dutch scientists applied Onnes' basic discoveries and they came up with a superconducting switching element.

This Month's Cover

The illustration on our cover symbolizes the operation of a superconducting solenoid which is shown producing an intense magnetic field even though completely disconnected from its power supply. The solenoid consists of many turns of niobium-tin or niobium-zirconium wire, submerged in a bath of liquid helium. A shorting link, made of the same wire, has comparatively high resistance at normal room temperature but at the extremely low temperature of the liquid helium the link is a dead short.

The coil, initially at room temperature, is connected to a high-current d.c. supply. Then it is plunged into the liquid helium and the power supply is disconnected. Because of the superconductivity of the wire forming the solenoid and the shorting link, a very large amount of current continues to flow. Hence, the intense magnetic field set up about the coil persists as long as the current continues. The current keeps flowing as long as the ultra-low temperature is maintained.

In order to keep the solenoid superconducting as long as possible a double Dewar flask is used. Each of the two glass jackets is double-walled, silvered, and evacuated in order to prevent heat transmission. The use of liquid nitrogen in the outer container also helps to keep the liquid helium from boiling away.

(Illustration by George Kelvin)

The two—J. M. Casmir-Jonken and W. J. DeHass—twisted a hair-like niobium wire around a slightly larger conductor of tantalum (Fig. 2). Normally, with the temperature near absolute zero, the tantalum (the gate) was superconductive. When current flowed through the niobium (the control) though, it created a magnetic field and switched the gate from a superconducting to a resistive state.

Superconductors Go to Work

No one thought of any practical use for this device until Dudley Buck, an MIT graduate student, demonstrated on Christmas Day 1954, that large numbers of these superconductive switches—which he named cryotrons—could be hooked together to form computer logic and memory circuits.

Buck died a few months later before he had a chance to begin refining his ideas. But scientists from MIT, *Arthur D. Little*, and *IBM* — among others — launched stepped up research and de-

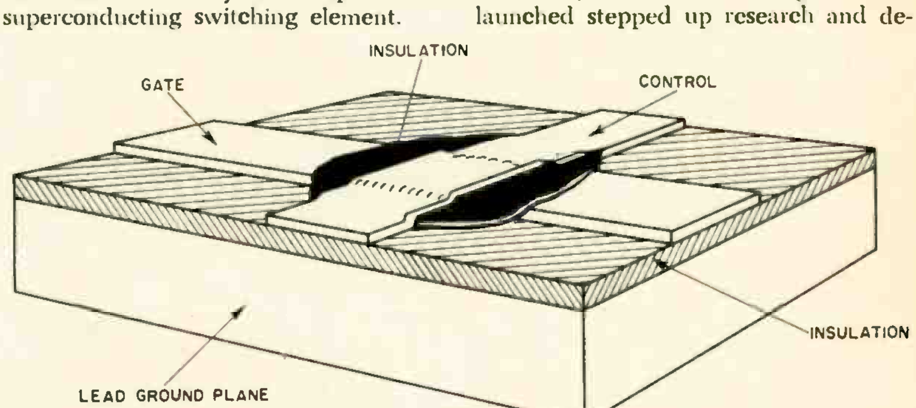


Fig. 3. A small current through the control conductor creates a magnetic field sufficiently large to switch the gate conductor from superconductive to resistive state.

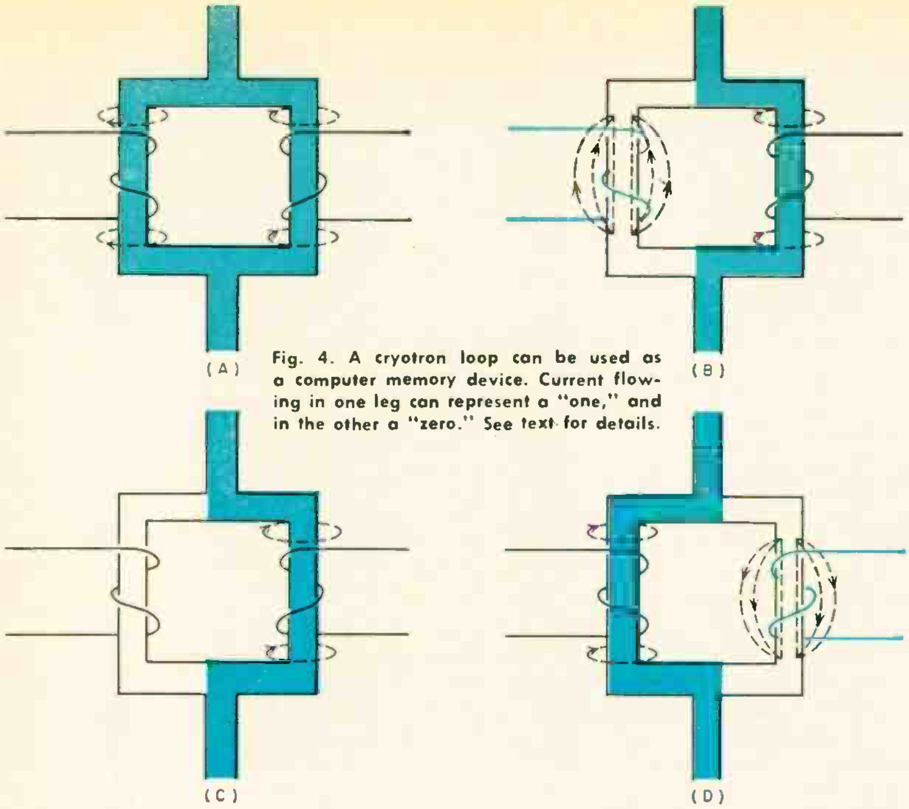


Fig. 4. A cryotron loop can be used as a computer memory device. Current flowing in one leg can represent a "one," and in the other a "zero." See text for details.

velopment programs. Wirewound cryotrons, they found, had two shortcomings. They were too slow—they take several hundred microseconds to switch and they were too expensive to manufacture. Researchers have now solved both problems by building thin-film cryotrons (Fig. 3).

Buck timed his discovery just right. Through the late 1940's, there were only about ten research laboratories in the country capable of producing super-cold temperatures within a few degrees of absolute zero. Then in 1949, Professor Samuel Collins of MIT invented the Collins Cryostat. It was the world's first small, highly efficient machine capable of liquefying helium. Its cost—as laboratory equipment goes—was modest: about $30,000. Cryogenic research in hundreds of laboratories around the world soon went into high gear.

At the same time, work on Dewars—Thermos-bottle-like storage tanks for ultra-cold gases—advanced rapidly too. One company developed an insulating material so astonishing in its heat retaining properties that it could be used to build liquid fuel missiles which could be loaded with liquid oxygen and hydrogen and kept permanently ready for firing at a moment's notice. (Today's birds are fueled immediately before firing, since the evaporation rate is extremely high.) With the new insulation, the fuel tanks would only have to be topped off occasionally; the insulation would keep the super-cold liquid from warming up and evaporating.

Modern electronics research has benefited tremendously from advances in cryogenic technology. Even small laboratories which don't want their own cryostats buy cryogenic liquids from companies such as the *Linde Division* of *Union Carbide* and *Air Reduction*. These firms make regular deliveries, leaving Dewars of highly volatile liquids as routinely as the morning milk.

While working on research projects, scientists usually get a liter or two of needed liquid gas from a central supply, dump it in a Dewar, then dip electrical circuits to be tested into the liquid to lower them to operating temperature. With present Dewars, a single loading of gas can last for hours, sometimes days. Operating equipment such as maser radio telescopes, on the other hand, usually have built-in cryostats,

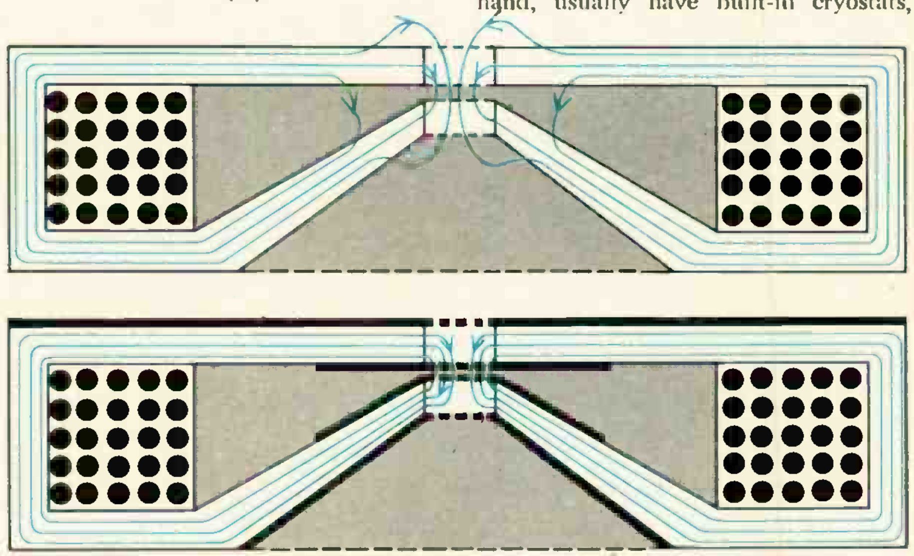


Fig. 5. In an ordinary electron microscope, magnetic flux lines from the focus coil are difficult to control and spread out as shown in the upper drawing. With magnetically opaque superconductivity shields in place (shown solid black in lower drawing) the lines are shaped more precisely, giving substantially better resolution.

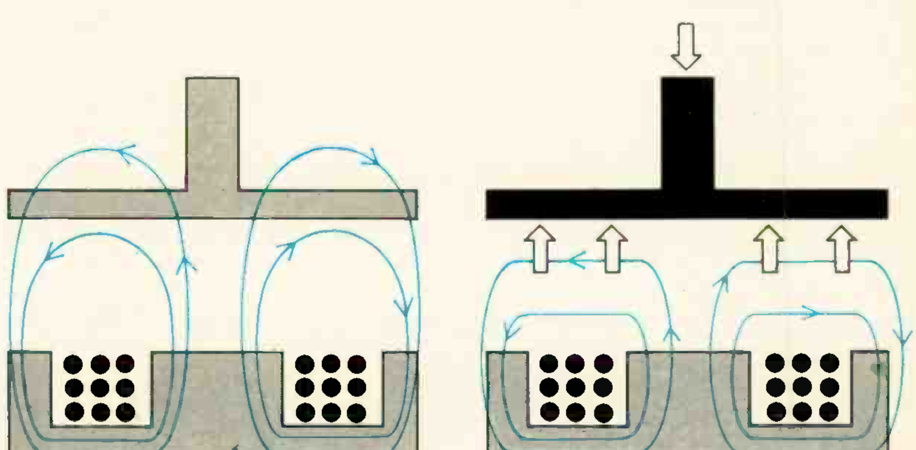
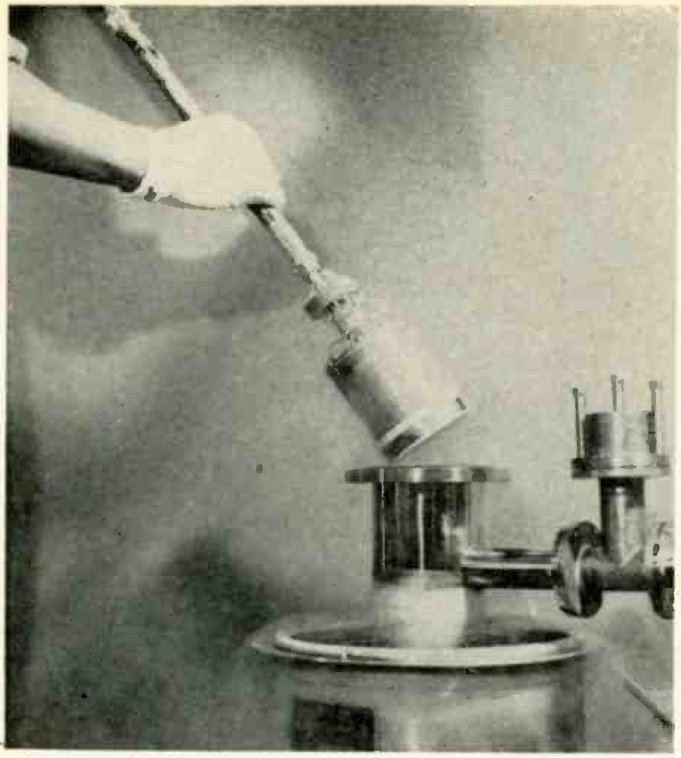
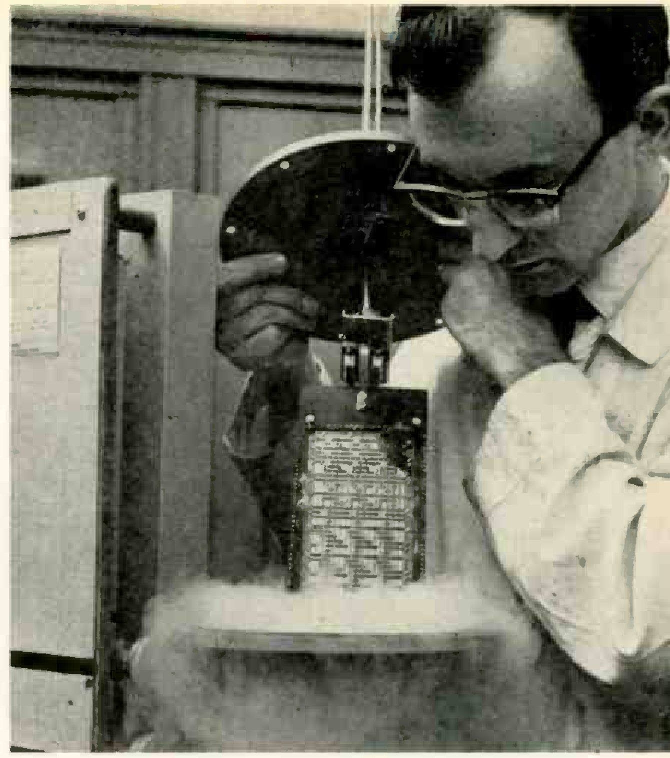


Fig. 6. Cross-section illustration of current-carrying coil above which a disk is placed. At the left, the magnetic lines of flux go right through the disk. But when a superconductive disk is used at the right, the lines are distorted as shown. Now any force exerted downward on the disk is strongly opposed by an upward force produced by the magnetic field. The disk can actually float on the magnetic "cushion" thus created. Frictionless magnetic bearings have been built using this principle.



A niobium-tin supermagnet is shown being taken out of its Dewar at Bell Telephone Laboratories. The solenoid electromagnet is only 4" long and 3½" in diameter but it has generated an intense magnetic field of 70,000 gauss while in a superconducting state.



Enshrouded in vapor, G-E's new cryogenic memory circuit is lowered into a Dewar flask to maintain its low temperature. The new logic circuit is composed of five thin-film layers and contains 81 cryotrons. Experimental unit has storage capacity of three 3-bit words.

capable of keeping the critical parts at ultra-low temperatures indefinitely. But they, too, can be and sometimes are operated with liquid replenished from a central supply.

With spectacular advances in cryogenic technology in the early 1950's, cryotron research advanced rapidly. With the necessary low temperatures easily available in labs across the country, researchers solved the major problems of cryotron design and are now busy adapting these minute switches to computer circuitry.

Cryotrons for Digital Computers

Modern computers are, for the most part, binary devices, that is, all information is reduced to and handled as a series of "yeses" and "noes" or, more usually, "one's" and "zero's." The cryotron, with its two states of operation, fits the system beautifully. In one state, say superconducting, it may represent a *zero*; in the resistive state, a *one*. Using this simple principle, cryotrons can be connected in a variety of useful ways. Fig. 4, for example, shows a simple cryotron loop. When current is first applied to the loop, half of it flows through each leg as shown in Fig. 4A. When current is applied to one of the control coils, say the one on the left, resistivity is restored in that branch and all of the current shifts to the right side, setting up the lines of magnet flux as shown in Fig. 4B.

When the control current is removed from the left side, a strange thing happens. The magnetic flux is trapped on the right side, and it and the current in the loop, will remain on that side despite the fact that the entire loop is again superconductive (Fig. 4C). Now if a signal is sent through the control winding on the right side, this leg will become resistive and the current will switch to the left side (Fig. 4D). Even when the control current is removed, the current will remain in the left leg. In a computer, a current through one side of such a circuit can represent "one," through the other, "zero."

Cryotron networks can be infinitely complex, since cryotrons can be built with gain, that is, a small current in the control winding switches a large current through the gate. Thus any number of cryotrons can be wired into a circuit without intermediate amplifiers.

Quantum-Jump in Computers

Cryotrons will make possible a whole new generation of computers. First, they'll be small. As an indication of how small, *IBM* recently built one unit about 1" x 2" and approximately as thick as three playing cards which contains 135 cryotrons. Twenty-five such units stacked together would contain more than 3000 cryotrons in a package little larger than a matchbox. A cubic foot at the same packing density could hold about 2.5-million units.

Second, power consumption is practically microscopic. A cryotron loop in a steady-state condition with either side conducting consumes no power at all, since the current flows through zero resistance. The only current consumption is during switching. *IBM* scientists say the power required for switching is so small that a network of a million loops, each being switched 10-million times a second, will use only one watt of power. Even the power required to run the refrigeration equipment and keep the cryotrons in a superconducting state will be only a fraction of that used by a conventional computer of the same capacity.

Small size will bring another important advantage. As computers reach the stage where they can do billions of computations per second, the time required to send the signals from one section of the computer to another begins to take longer than the time spent performing calculations (an electrical impulse takes about one-billionth of a second to travel one foot along a wire), therefore it becomes important to have the various circuits as physically close together as possible. Cryotronic computers will advance this goal tremendously, since they will be only a fraction of the size of conventional units of the same capacity.

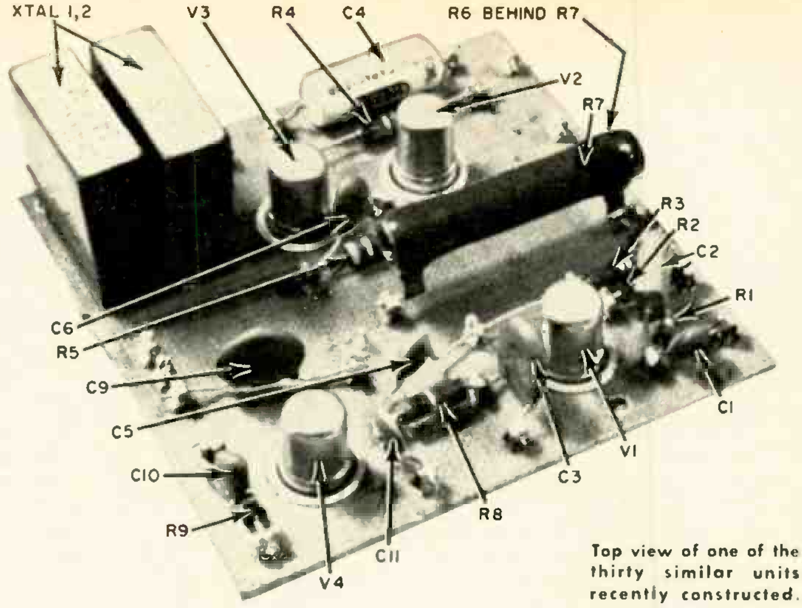
Superconducting Super-Magnets

Cryotrons, while undoubtedly one of the more important electronic cryogenic developments, are by no means the only ones of importance. Ever since superconductivity was discovered, the dream of a superconducting magnet has intrigued physicists. Since the solenoid of a superconducting electromagnet would

(*Continued on page* 84)

COMPACT NUVISTOR PRODUCT DETECTOR

By **R. M. MENDELSON,** W2OKO
Electron Tube Div., RCA



Top view of one of the thirty similar units recently constructed.

Construction of a circuit small enough to add to any communications receiver that will provide improved single-sideband, c.w., and radioteletype reception.

NUVISTORS have been described in r.f. converter[1] and preamplifier[2] circuits, but little has been published about other uses in amateur radio, especially where small size is paramount.

An excellent application for the *RCA* 6CW4 is in a miniature product detector that can be made small enough to be added to any communications receiver—commercial, home-built, or surplus. The size of conventional tubes has often made it difficult to construct an adapter small enough to fit into the compact chassis.

The value of the miniature product dectector to be described was shown last winter when the Livingston, New Jersey Amateur Radio Club chose it as a winter project and built more than 30 units. The merits of the product detector are well known, but will be reviewed here.

Product-Detector Advantages

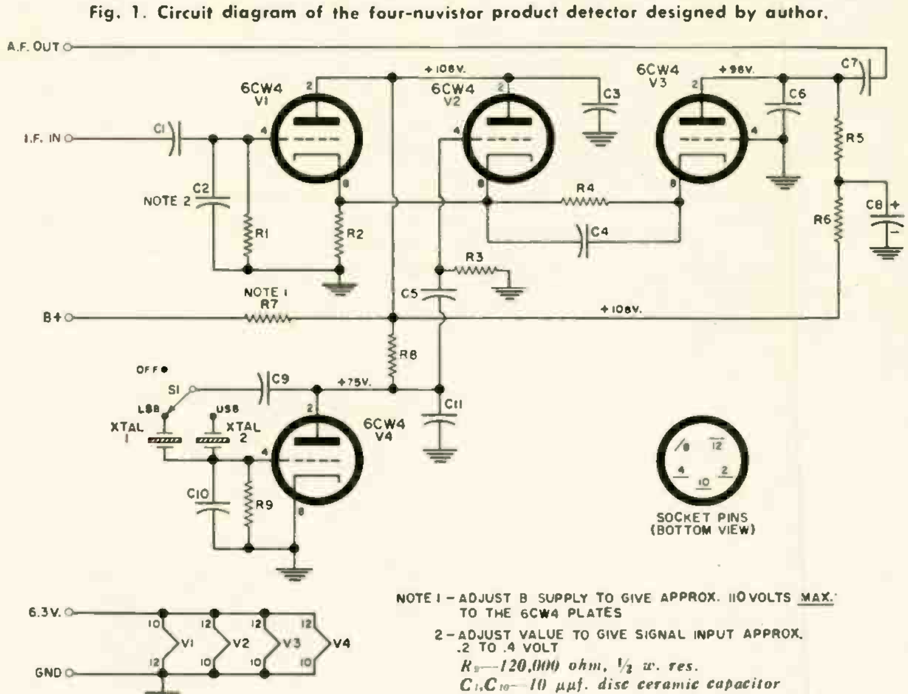
When a conventional diode detector is used for single-sideband reception, the beat-frequency oscillator must also be used to supply the carrier. Under these conditions distortion usually results. It is necessary to reduce the r.f. signal input to the detector and raise the audio gain all the way to help reduce this distortion. The beat-frequency-oscillator injection voltage must also be changed from that used for continuous-wave reception. In lower-priced receivers, running the audio at full gain often introduces hum. The receiver a.v.c. cannot be used, but rather the r.f. gain must be continuously adjusted manually according to the strength of each signal received. In a multi-station round table, this adjustment is quite a chore. Many of the weaker signals may be lost altogether.

The best solution to the problem of good single-sideband reception is the use of the product detector, so named because the output voltage equals the algebraic product of the input signal and the local oscillator voltages. Its use allows for operation of the r.f. control at full gain with use of receiver a.v.c., distortion-free reception, and a low value of beat-frequency-oscillator insertion voltage for good reception. The product detector will also greatly improve the conventional code reception.

The circuit itself consists of three triodes V_1, V_2, and V_3, as shown in Fig. 1. V_1 is a cathode-follower for coupling the signal from the i.f. stage of the receiver to V_3, which serves as a mixer stage. V_2 is a cathode coupler between the local oscillator (V_4) and the mixer tube V_3. In the mixer, the received sig-

(*Continued on page* 64)

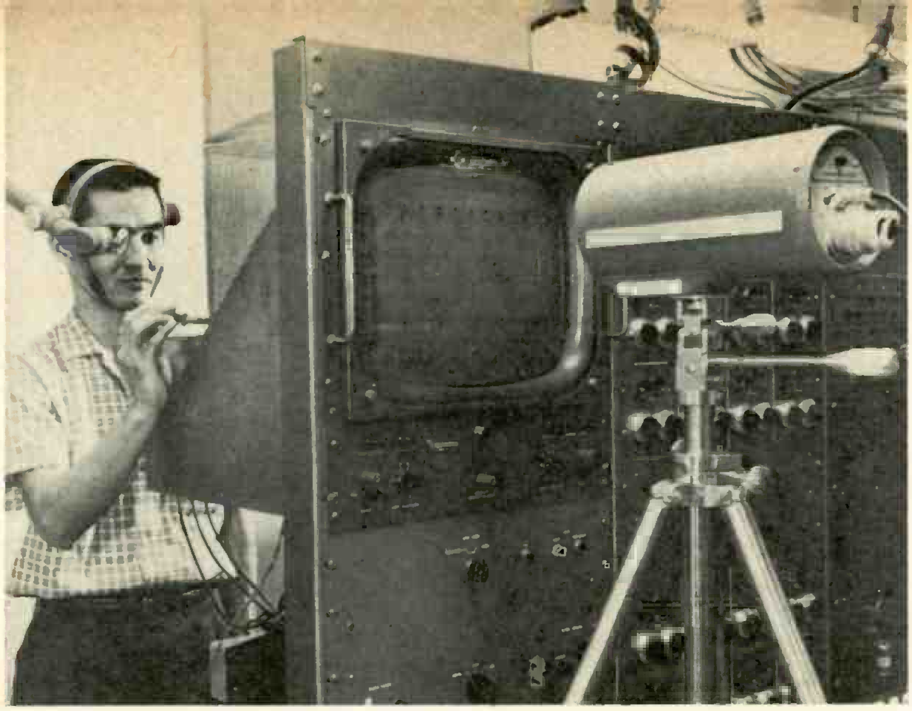
Fig. 1. Circuit diagram of the four-nuvistor product detector designed by author.



NOTE 1 – ADJUST B SUPPLY TO GIVE APPROX. 110 VOLTS MAX. TO THE 6CW4 PLATES

2 – ADJUST VALUE TO GIVE SIGNAL INPUT APPROX. .2 TO .4 VOLT

R_1—500,000 ohm, ½ w. res.
R_2—820 ohm, ½ w. res.
R_3—82,000 ohm, ½ w. res.
R_4—680 ohm, ½ w. res.
R_5—47,000 ohm, ½ w. res.
R_6—1000 ohm, ½ w. res.
R_7—10,000 ohm, 10 w. wirewound res.
R_8—10,000 ohm, ½ w. res.
R_9—120,000 ohm, ½ w. res.
C_1,C_{10}—10 μμf. disc ceramic capacitor
C_2—82 μμf. disc ceramic capacitor
C_3,C_9—.01 μf. disc ceramic capacitor
C_4,C_7—.02 μf. plastic tubular capacitor
C_5—100 μμf. disc ceramic capacitor
C_6—1000 μμf. disc ceramic capacitor
C_8—20 μf., 250 v. elec. capacitor
C_{11}—250 μμf. disc ceramic capacitor
Xtal.$_1$, Xtal.$_2$—See Table 1
S_1—3-pos. selector switch (see text)
V_1,V_2,V_3,V_4—6CW4 nuvistor triode (RCA)



◀ Head-Mounted TV Viewer

An Electrocular TV device, used to speed work in industry is demonstrated by Hughes Aircraft Co. engineer. Adjustments are being made on rear of digital-analog panel, while viewing results furnished to head-mounted TV unit by closed-circuit TV camera trained on screen on front of panel. The camera may be located in any desired remote area to give the wearer information necessary to accomplish his task. The headset itself resembles an L-shaped flashlight with a monocle attached to one end and positioned in front of the eye. A miniaturized cathode-ray receiving tube is in the long leg of the "L". The image on the screen of this CRT is reflected by a 45-degree mirror onto the monocle, which is actually a dichroic filter that the user can look right through or at the reflected CRT picture. The entire headset, to which a mike and earphone may be added for audio communication, weighs only 30 ounces.

RECENT DEVELOPMENTS IN ELECTRONICS

Televised Radar

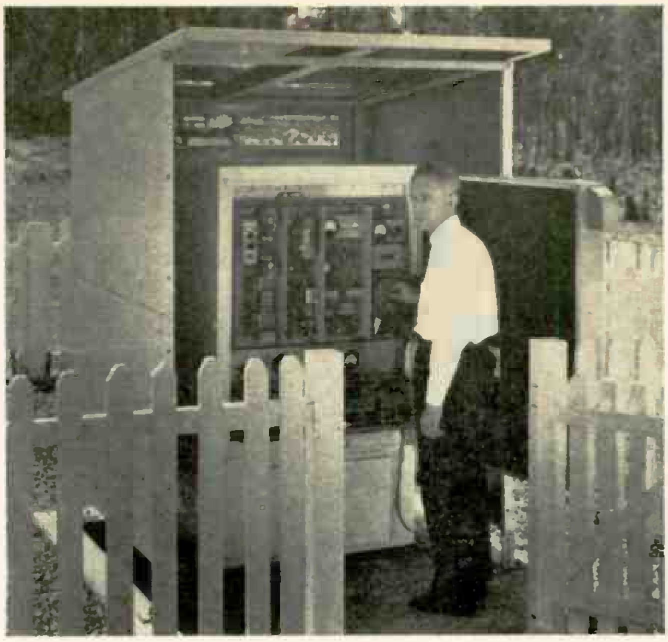
The lieutenant shown below is referring to his Ratan television presentation as he steers his patrol boat through busy Ambrose Channel entering New York Harbor. The televised radar picture is clearly visible even in bright sunlight. Unlike ordinary shipboard radar, it is free of "sea return" (extraneous echoes caused by wind-whipped seas around his own vessel) because the radar that scans the harbor is shore-based. The experimental system was developed by Raytheon Co. for the U.S. Coast Guard. Heart of the system is a special storage tube that converts the radar image to a television picture for transmission to vessels in the harbor. Signals are now being transmitted on u.h.f. TV channel 47 so that all that is needed to pick them up is an ordinary TV receiver that is equipped to pick up u.h.f. ▼

▲ New Thermoelectric Material

Scientist at Bell Telephone Laboratories is shown using a powerful electromagnet in the study of bismuth-antimony alloy, a thermoelectric material which has shown the highest figure of merit ever measured. Semi-metals, such as this, are particularly sensitive to magnetic fields because they contain equal numbers of highly mobile electrons and holes. The increased figure of merit makes possible the design of equipment for refrigeration that will produce lower temperatures than have been previously possible by electronic means. Experimental devices using thermoelectric materials have been built to cool individual components in electronic circuits such as the varactor diode in a parametric amplifier.

▲ Thermoelectric Generator

This experimental thermoelectric generator, which produces electricity from high-temperature heat, is the first device of its kind to employ thermocouples containing a new germanium-silicon alloy. The generator, developed by RCA scientists, will undergo extensive laboratory testing. Thermoelectric modules made from the new alloy are being fabricated for the SNAP-10A auxiliary power system under development for the Atomic Energy Commission. The germanium-silicon alloy is said to combine the advantages of high melting point, good mechanical strength, light weight, and efficient energy conversion. Tests indicate that the material also has the desirable qualities of long life and reliability.

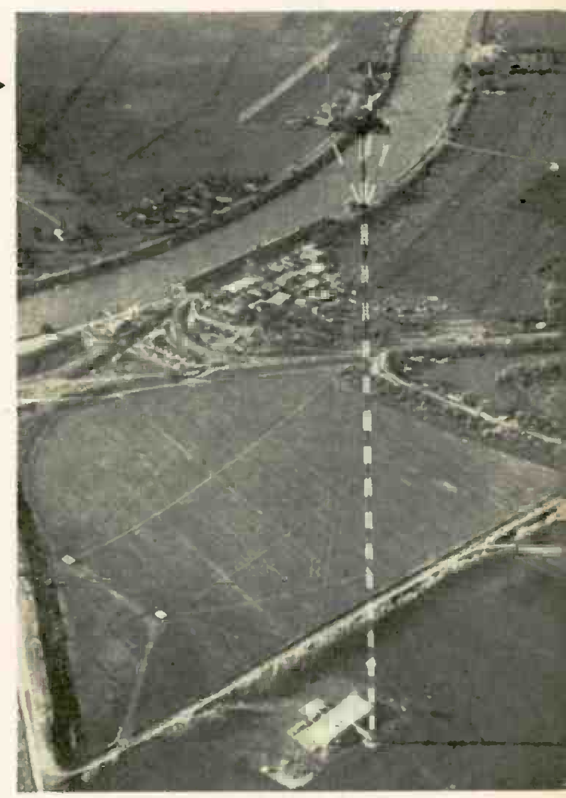


Transistorized Radio Beacon

The world's first completely transistorized radio navigational beacon has been developed by an Australian associate company of ITT. The equipment is now undergoing field trials at the holding area for jet aircraft using Mascot airport at Sydney. In Australia, transistorized beacons are expected to have an important function at many small, infrequently used airports that presently lack navigational aids due to the high cost. The newly developed beacon needs no special building and can operate from its own built-in power supply; it functions for long periods without maintenance or adjustment. The beacon is used with an omni-directional antenna system and operates between 200 and 415 kc. The signal can be picked up by aircraft using standard direction-finding receivers or radio compasses; each beacon is identified by two or three letters in code sent by automatic keyer. Although of somewhat lower power than the usual tube-equipped beacons, the transistor beacons give adequate coverage and, since power consumption is low, operation from self-contained batteries charged by a wind-driven generator is possible.

Candelabra TV Tower

Recently completed 1548-foot TV tower near Walnut Grove, Calif. which supports broadcasting antennas of three TV stations at its peak. RCA was prime contractor for the $1,340,000 project which uses candelabra-type tower of record height for antennas of stations KCRA-TV and KXTV, Sacramento, and KOVR, Stockton. Tower is supported by guy wires anchored as far as a quarter-mile from its base.



X-Ray for Aircraft

A special x-ray unit for aircraft inspection purposes has been introduced by Picker X-Ray Corp. The unit is small enough to fit through 8-inch openings, has a 5-ma. output at 150 kv., and weighs only 55 pounds. It yields high-quality radiographs of 4½-inch aluminum or 0.6-inch steel in four minutes at 24 inches.

Transistorized TV Camera

A lightweight camera designed primarily for field use but which also can be used within a studio is shown at the left. The unit is the Toshiba transistorized TV camera. It provides composite or non-composite video signals conforming to the 525-line, 30-frame U.S. scanning standards. The camera uses a variable zoom lens and has one-knob control for zooming and optical focusing. The entire image orthicon assembly is mounted on a ball-bearing slide mechanism and swings out sideways for easy tube change. An 8-inch view finder is employed. The unit can be operated from a.c. current or from batteries.

MARINE RADIO SERVICE INSTRUMENTS

By ELBERT ROBBERSON

An old hand at marine radio maintenance and service tells you what equipment you need to handle this field and how it fits into the operation.

THE AUTHOR broke into commercial marine radio work in the 30's, in a large manufacturer's shop in a major seaport. We installed and maintained long- and short-wave telegraph transmitters, receivers, automatic S.O.S. alarms, and direction finders on steam schooners, freighters, tankers, and transoceanic passenger liners. Our main instruments were a hydrometer for checking the emergency batteries, a frequency meter for keeping the radio inspector happy, a neon bulb for detecting r.f., and a v.o.m. for solving all other problems. Actually, what we needed most of all were strong backs (equipment was heavy and bulky), long slim hands (for getting to almost inaccessible adjustments), and extensile eyes (for seeing where to put the long slim hands).

The field has become more complex. While a very smart technician might still struggle along in marine electronics servicing with just these accouterments, it pays to be set up for efficiency. Fortunately, the bill for shop instrumentation in this field is not prohibitive. What makes the cost even more reasonable is that some of the necessary gear is available in kit form, or can be home-brewed. It should be possible to instrument a shop or lab for the installation and service of the major electronic items used in today's small-boat fleets for about $1000. Less, if you are handy at rigging up your own equipment; more, if everything is ready-made; and figure on a multiplying factor of a husky whole number if you get laboratory-precision instruments.

Power Source

Whether a shop is already established for another activity and is going to diversify its work to take in the growing waterfront, or is starting out from scratch, the first requirement is a dependable source of high-current, low-voltage d.c. power. Marine gear cannot be plugged into the light socket; its natural diet is d.c.

The power consumption of a marine radiotelephone jumps between wild extremes, depending upon whether it is receiving or transmitting. A "battery eliminator" type of a.c.-operated power supply that will have good enough regulation will cost as much as all of the other equipment you will need. The simple and realistic solution to the problem is a bank of batteries, kept in shape by a battery charger (Fig. 1).

For small-boat service, 6 and 12 volts will be needed the most. Larger yachts and work boats often have 32-volt equipment. To be able to fire up 32-volt gear in the shop you need five 6-volt batteries. Inexpensive auto batteries are perfectly adequate. An auto-shop charger that will accommodate a string of five or six batteries in series will keep them in condition. The batteries should be wired to a heavy terminal board (¼" studs) and all connections should be with No. 6 cable or heavier.

It is a good idea to keep the batteries in an asphaltum or lead-lined tray, and be sure ventilation is adequate to carry off fumes and gas. Remember that hydrogen boiled off in charging is explosive. Rig the power supply with a low-range panel voltmeter, a d.c. ammeter good for 50 amperes, and a 100-amp. safety switch. Wire a shunting switch across the ammeter to protect the movement from high surge and short-circuit current. A hydrometer, syringe, and a distilled-water bottle are also needed.

In the very rare case of an establishment serving a great number of large vessels, it might be necessary to increase the voltage of the battery bank to 120 (20 6-volt batteries). However, most vessels equipped with 120-volt d.c. equipment are large enough (and have enough power available) to permit complete servicing aboard. For such work, you can use a portable inverter to provide 117 volts a.c. for any instruments you might need to use.

Frequency Measuring

Marine radiotelephone transmitters are required to be kept on their assigned frequencies within .02% for channels between 1600 and 3500 kc., and to within .005% of frequencies between 4000 and 25,000 kc. (used on rivers, lakes, and the high seas). The electronics shop must be able to measure transmitter frequency when equipment is first placed in service, any time it is moved, and any time work is done on it which might affect frequency.

A convenient foundation for a frequency-measuring system is a "general coverage" receiver for the reception of standard frequency broadcasts. The most useful receiver to have is one covering both low and high frequencies. *Hammarlund* is one of the manufacturers who makes them, and there are a number of surplus receivers that will serve. The low-frequency range is useful for listening to marine and aircraft beacon stations, and this band can also be used in receiver servicing as a "signal tracer" at i.f. frequencies.

Next best is a receiver that covers from the standard broadcast frequencies up into v.h.f. While the better receivers offer superior selectivity and stability, it is not necessary to "go overboard," because practically any of the present-day "all-wave" receivers (even kit jobs) will do a good job of picking up WWV and marine channels.

A military-surplus frequency meter of the BC-221 type, in good condition, is capable of measuring frequency within the FCC-required tolerance. Many marine service shops employ these instruments. Advantages are modest cost plus the fact that they can be operated from self-contained batteries and, hence, can easily be used aboard boats.

The *Lampkin* Type 103-B Micrometer Frequency Meter (Fig. 3) is well suited for shop use. It relies upon the WWV signal from the communications receiver for calibration. The Type 105-B has a self-contained crystal calibrator. Either unit requires 117 volts of a.c. power, which can be obtained on a boat from a portable inverter if the vessel is not already provided with an a.c. source. These instruments are furnished with charts that show directly the percentage of error of the transmitter frequency being measured.

Power Measuring

Boat radiotelephone transmitters range in power from 15 to 150 watts on inland waters. Ocean-going vessels go up to 400 watts on the high-seas ship-to-shore channels between 2000 and 4000 kc., and up to 1000 watts for high-seas operation between 4000 and 25,000 kc. The higher-powered stations are in a decided minority. Fifteen to about 50-watt transmitters are most common.

The FCC requires that transmitters conform to the power authorization in the station license. This value is given in d.c. power input to the anode of the tube or tubes supplying r.f. to the antenna, in the absence of modulation. There is generally a tolerance of plus or minus 20%. Plate-input power can be measured most conveniently by conventional d.c. voltage and current meters. The values (and the tolerances) are within the range of a service-type v.o.m. It is also convenient to have separate voltage and milliampere meters on a bench panel, to measure voltage and current simultaneously.

It must also be possible to measure transmitter r.f. power output. This requires a dummy antenna of known resistance and an r.f. ammeter. For low-power transmitters, non-inductive power resistors can be used in the dummy antenna; however, unless their performance at radio frequencies is known, readings may be only approximate. *Heath* manufactures a transmitter dummy load rated at up to 1 kw., with an impedance of 50 ohms.

The impedance of a typical marine antenna system is complex, composed of a resistance that may range from about 10 to 50 ohms (most of them in the lower portion) and a capacitive reactance of from 200 to 1500 ohms. The dummy antenna should be able to approximate values within this range. Thus, in addition to the non-inductive power resistor and the r.f. ammeter, a variable capacitor is needed. They are connected in series. With the dummy antenna at resonance and the transmitter-loading adjustments set for optimum output-stage plate current, output power equals I^2R.

The capacitor should be double-spaced, and of at least 200 $\mu\mu$f. For low-power transmitters, the meter should read 1.5 amperes full scale, while 2.5- and 10-ampere meters should be used with medium- and high-power transmitters. The complete dummy-antenna assembly can be mounted on a panel or in a utility cabinet. A transmitting lead-in insulator makes a good antenna terminal for the unit. The author's home-made dummy antenna (Fig. 5) incorporates both a coil and a capacitor to simulate antennas with various properties.

Modulation Measurements

Regulations require that transmitter modulation be within 75% and 100% and that overmodulation be prevented. Total bandwidth is 8000 cps.

A rough idea of modulation percentage can be obtained by observing the antenna current while the transmitter is operating normally or into a dummy load. The percentage of modulation = $141\sqrt{(I_2/I_1)^2-1}$, when I_1 = unmodulated antenna current, and I_2 = antenna current with full sinusoidal modulation. A rise of antenna current of about 22½% is obtained with 100% modulation, while a rise of about 13% indicates 75% modulation.

More accurate measurements are obtained with an oscilloscope. Observation of the modulated carrier (applied directly to the vertical plates of the CR tube by a pickup coil near the transmitter antenna circuit) will show overmodulation by the bright and heavy lines indicative of flat-topping and bottoming of the modulation envelope. The percentage can be obtained by measuring the heights of the trough and the peak of the envelope. A trapezoidal pattern is obtained by applying a.f. voltage from the transmitter modulator to the horizontal input, together with the r.f. on the vertical plates. Modulation percentage is obtained by measuring the heights of the base and apex of this trapezoid.

In either oscilloscope method, this formula: Modulation Percentage =

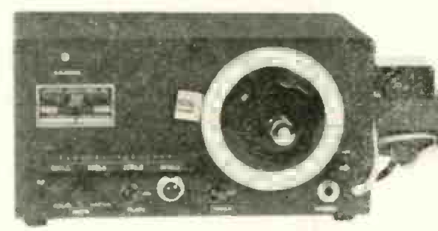


Fig. 3. Frequency meters (like this one by Lampkin) are available with enough precision to meet FCC standards on all bands.

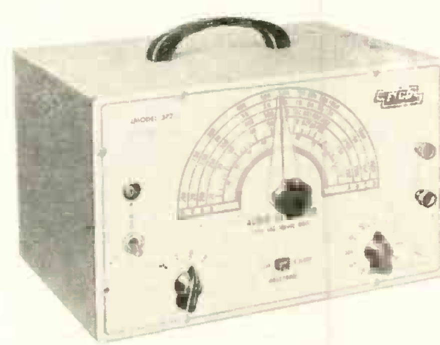
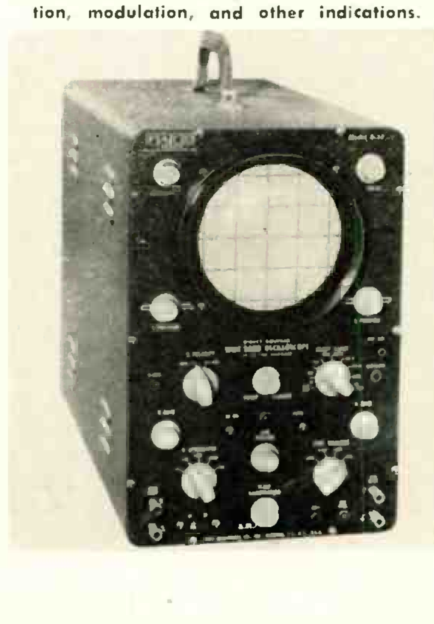


Fig. 4. An audio generator that produces both sine and square waves (Eico 377 is shown), facilitates distortion checking.

Fig. 1. Float a conventional battery eliminator, like the Eico 1064, across a battery pack for a regulated power source.

Fig. 2. A scope, like this Paco S-55, is useful for measuring a.f., r.f., distortion, modulation, and other indications.



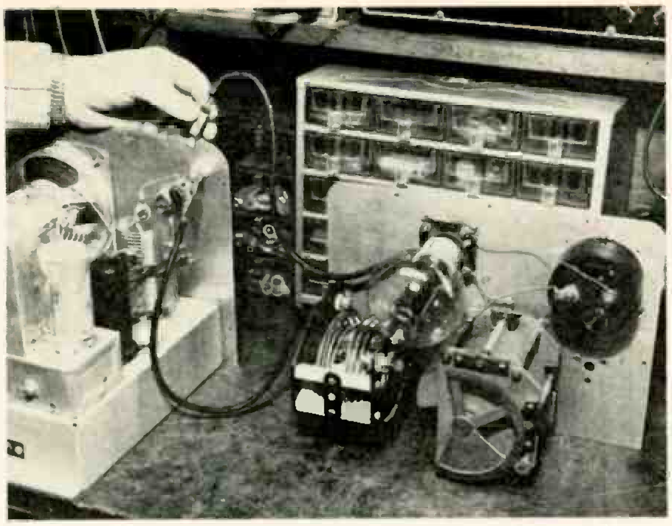


Fig. 5. Rear view of a home-made dummy antenna in use. This one has a coil and a capacitor to simulate antenna constants.

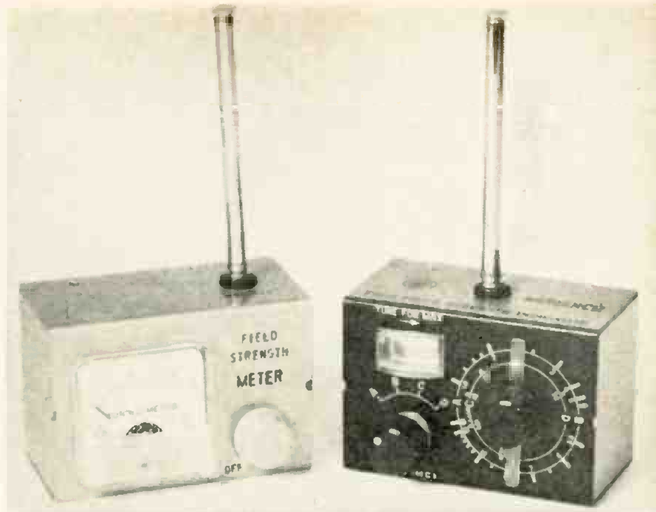


Fig. 6. Field-strength indicators (2 by Monarch Electrical) monitor xmitters, show relative output, and simplify tuning.

$100(A-B)/(A+B)$, with A standing for the maximum height and B for the minimum height of the pattern, measured in convenient units, can be used.

A good oscilloscope is useful for a number of purposes, in addition to transmitter adjustment. A portable type could be taken aboard boats, but this should not be necessary very often. The unit chosen need not be the most elaborate or expensive. A kit job (Fig. 2) will perform very creditably.

Bandwidth can be estimated with an audio generator. The modulation percentage of the signal output should drop off markedly at audio input frequencies of 4000 cps and above. Because microphone characteristics are sometimes a part of the frequency-limiting means in the transmitter, tone from the audio signal generator should be coupled in acoustically, by means of a loudspeaker placed close to the microphone.

An oscillator that produces both sine and square waves (Fig. 4) is adaptable to a number of audio measurements. However, an ordinary sine-wave oscillator is sufficient for this work. Important features are constant output over the entire frequency range and a good attenuator. For radiotelephone work, a frequency range of from about 30 to 30,000 cps is adequate. However, if the frequency range extends to a few hundred kilocycles, the instrument will also be useful in working on echo depth sounders, some of which operate on frequencies as high as 400 kc.

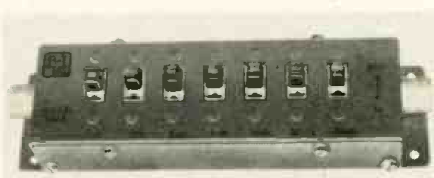


Fig. 7. An r.f. attenuator, like the Blonder-Tongue SA-7, is useful for measuring receiver r.f. gain and attenuation of harmonics in the transmitter.

For modulation measurements of laboratory caliber, a commercial modulation meter and a spectrum analyzer are needed. However, the instruments and methods just discussed will fill normal service-shop requirements.

Harmonic Radiation

The second harmonic frequencies of certain marine radiotelephone channels are coincident with aircraft communication channels. The FCC therefore requires that second-harmonic radiation from operation on 2738 and 2830 kc. be kept at least 40 db below the level of the unmodulated carrier for transmitters to 150 watts, 50 db for transmitters from 150 to 600 watts, and 60 db below for transmitters over 600 watts in power. Present type-accepted marine radiotelephones are certified by the manufacturer to satisfy these requirements; however, a transmitter defect or mistuning could cause a serious increase in harmonic output.

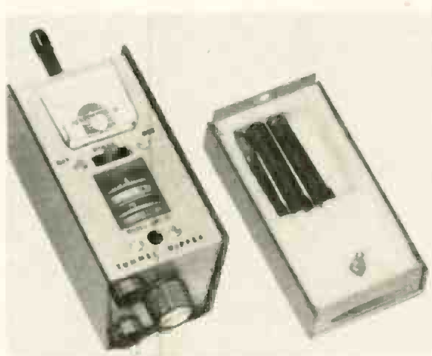


Fig. 8. Heath g.d.o. with tunnel-diode circuitry is suitable for jobs afloat.

If the shop's communications receiver has an "S" meter calibrated at 6 db per "S" unit, it can be used to determine if a transmitter's second-harmonic emission is sufficiently below the requirement. A shunt resistor on the receiver's antenna terminal can be used to reduce the fundamental-frequency signal to a convenient level, such as S9. Signal on the 2nd-harmonic frequency should be about seven or more "S" points lower.

An r.f. attenuator (*Jerrold, Blonder-Tongue,* and others make them like the one in Fig. 7, and a careful workman can make his own) in the receiver input circuit can be used in conjunction with an "S" meter of unknown calibration to find the difference in level between fundamental and harmonic frequencies. A calibrated signal source, such as a laboratory-type signal generator can also be used for making comparisons, as can some of the field-strength meters (Fig. 6). However, the relatively inexpensive means of a receiver check is sufficient to determine if something is radically in need of correction in a transmitter. Practically speaking, reception of any second-harmonic signal when the fundamental input is adjusted to an S9 level indicates something needs to be looked into.

Transmitter Work

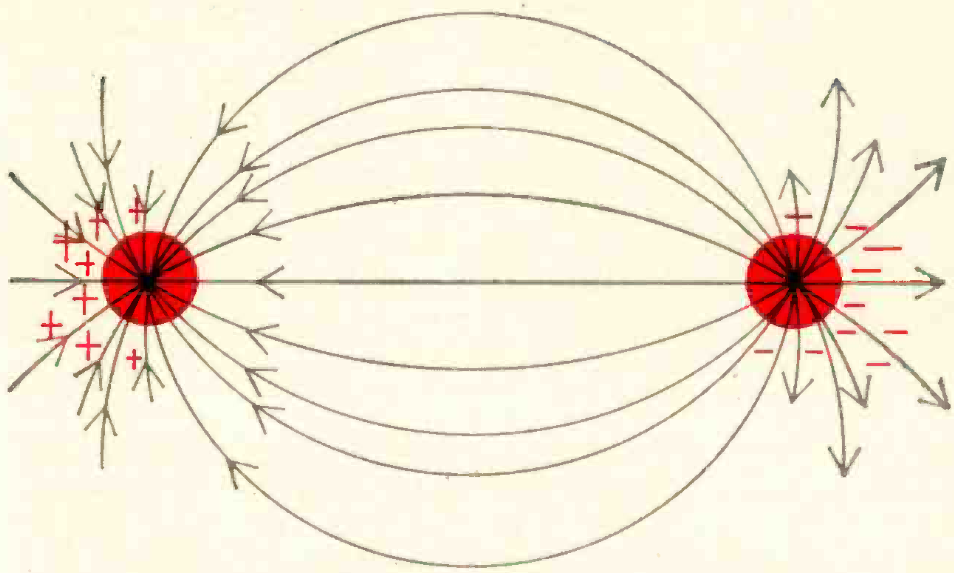
In addition to the instruments needed to insure that transmitter operation conforms to FCC requirements, there

(*Continued on page* 72)

Fig. 9. A g.d.o. (Paco G-15 shown) aids alignment, checks crystals, acts as crystal-controlled oscillator, monitors modulation with headset.

THE ELECTROMETER

By JOHN R. COLLINS



Where It's Used/How It Works

High-voltage static charges and current as low as 0.001 micromicroampere can be measured with this instrument whose input impedance is on the order of 10^{14} ohms.

ANYONE who has tried to measure voltage in a high-resistance circuit with a low-resistance voltmeter knows that the meter circuit can act as a shunt and cause an error in the reading. To minimize this effect, known as *loading*, it is necessary to use a high-resistance meter for such measurements. Vacuum-tube voltmeters, with input resistance ranging from 11 megohms and up, are popular for radio and television work.

The resistance of a conventional v.t.v.m. is inadequate, however, for many of the measurements needed in industrial electronics—as, for example, determining the charge on small capacitors, the voltage output of quartz crystals, the contact potential of dissimilar metals and semiconductor diodes, the static charge on plastics, and the potential of pH electrodes. Furthermore, ordinary instruments cannot measure tiny currents found in radiation work and mass spectrometry.

Special instruments, called *electrometers*, have been developed to permit the measurement of voltage and current without loading the test circuit. Characteristically they have an extremely high input resistance on the order of 10^{14} ohms (*i.e.*, 100,000,000 megohms). They can measure both large and small voltages and are sensitive to currents of 0.001 micromicroampere or less.

Electrometer Voltmeters

Electrometer tubes, specially designed to have high input resistance, are used in the front-end of certain electrometer voltmeters. Their grid current may be less than 0.02 micromicroampere, compared with about 0.01 microampere for a good conventional vacuum tube, even when it is biased negatively.

Grid current in a negatively biased tube is accounted for by gas ions formed in the tube when it is operated at high voltage, by photoelectric emission from the grid, and by leakage current across the insulating surfaces of the tube. These effects are overcome in the electrometer tube in several ways. The formation of gas ions is prevented by thorough evacuation of the tube envelope and by operating the tube at a voltage below the ionization potential of any gas that might remain. A filamentary-type (directly heated) cathode is employed and it is operated at low temperature so as to give off almost no light to excite photoelectric emission. The tube is shielded from external light. Finally, the glass is specially treated inside and out to minimize surface leakage.

The method of connecting an electrometer tube is shown in Fig. 2. The grid nearest the cathode, called the accelerator grid, is operated at a low positive potential to repel any positive ions given off by the cathode and to prevent them from reaching the control grid. The second grid is the control grid; it is operated at a negative potential. A small positive voltage, typically about 4.5 volts, is placed on the plate.

The grid-leak resistor R_G is a special high-megohm resistor which may have a value from 10^7 to 10^{14} ohms, depending on the circuit requirements. Such resistors consist of carbon-coated glass rods encased in vacuum-sealed glass envelopes which have been treated with a special silicone varnish to resist the effects of moisture. Since even finger oils will reduce their effective resistance, care must be exercised when handling them.

The primary function of an electrometer tube is to match the impedance of the signal source, which may be extremely high, to that of the indicating instrument. While voltage amplification is normally about unity, the current amplification is very great. Amplification is a secondary consideration, however, since several amplifier stages employing conventional tubes may be used to achieve any desired output level.

A vacuum-tube electrometer is shown in Fig. 1. When its detecting head is 3/8 inch away from a charged surface, the ranges are 10 and 30 kv. When 6 inches away, the highest range is 100 kv.

Noise and Drift

The factors limiting the useful range of an electrometer are noise and drift. The signal-to-noise ratio is much better for an electrometer than for a conventional v.t.v.m. This is because the signal increases directly with resistance,

Fig. 1. Electrometer voltmeter equipped with head for measuring static charges.

whereas noise increases in proportion to the square root of the resistance. Consequently, the signal-to-noise ratio is improved as the input resistance is increased.

Because electrometers have very high input resistance, a very small current will produce a sizable voltage drop. Thus, with a resistance of 10^{12} ohms, a 1 micromicroampere current will produce a 1-volt signal, and the resulting signal-to-noise ratio will be about 6600 to 1.

Like all d.c. amplifiers, electrometer voltmeters are subject to drift. Drift is detected by the movement of the meter needle from the zero position when the input is shorted, and it is cumulative. Since it is caused by small changes within the tube itself, drift cannot be corrected through feedback.

Drift in a carefully designed instrument may amount to no more than 2 millivolts per hour, but this may prove troublesome when measuring small voltages. The difficulty is overcome by re-zeroing the instrument before making a measurement, or at intervals if continuous measurements are being made.

In an a.c. instrument, drift is non-cumulative. An obvious solution to the drift problem, therefore, is to employ a mechanical chopper, not unlike the vibrator used in an automobile radio, to convert the d.c. input signal voltage into a square wave. The square wave is then amplified by means of a step-up transformer and applied to the input of an a.c. amplifier. While the chopper method is excellent for measuring small voltages, the input resistance is relatively low, and this limits its usefulness where high-resistance test circuits are involved.

Vibrating-Reed Electrometer

The problem of converting a d.c. signal to a.c. while maintaining extremely high input resistance is solved by the vibrating-reed electrometer (Fig. 5). The instrument is named after a special capacitor consisting of one stationary and one vibrating plate. The latter, called the reed, is moved through a fixed distance by an electromagnet at a constant frequency, producing a cyclical change in the capacitance. The relationship existing between the charge Q, the capacity C and the test voltage E is expressed by the equation: $Q = CE$.

If the charge on the capacitor is constant, then a variation in capacity must be accompanied by a voltage change. Voltage will increase as capacitance decreases, and *vice versa*. The result is an a.c. signal having a voltage proportional to the d.c. test voltage and a frequency equal to the vibration rate of the reed.

A vibrating-reed electrometer circuit is shown in the diagram of Fig. 6. The test voltage is applied at I, producing a d.c. voltage across the vibrating reed capacitor C_r. An electromagnet and oscillator cause the reed to vibrate at 450 cps, producing an a.c. voltage of that frequency across C_r. This a.c. voltage passes through a special capacitor (which serves as the principal input impedance of the electrometer) to a preamplifier, then to the main amplifier and rectifier.

A portion of the rectified output is applied as negative feedback to the preamplifier, increasing the stability. A shorting switch permits the capacitor to be discharged before the instrument is used. A high-megohm resistor can be connected across the terminals marked R_i to provide resistance across which the test voltage is dropped. When very small currents are to be measured, however, an input resistor is not used and the current will then be applied directly to vibrating-reed capacitor C_r.

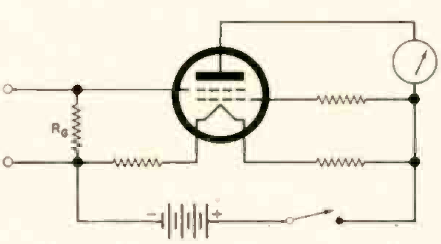


Fig. 2. Electrometer-tube circuit. Positive accelerator grid is near cathode.

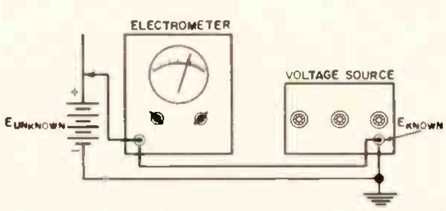


Fig. 3. Buck-out method of voltage measurement. Electrometer indicates null.

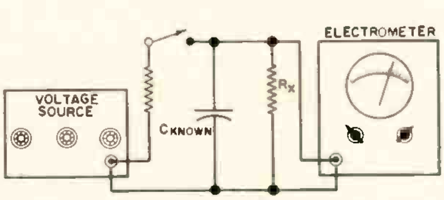


Fig. 4. Typical set-up for measuring a high resistance with an electrometer.

Unlike the chopper circuit, the vibrating-reed electrometer has very high input resistance—as high as 10^{15} ohms. Since there is no grid current, there is no problem of grid leakage. The stability is very high and while bandwidth is quite narrow—about 1 to 10 cps—this is not a disadvantage for many purposes.

Electrometer Applications

An electrometer will perform all the functions of a conventional v.t.v.m. and will, in addition, do many things not possible with a less sensitive instrument. Voltages within the range of the electrometer can be read directly as with an ordinary meter. To avoid excessive current flow through the test voltage source, the buck-out method shown in Fig. 3 can be used. Here an accurately known voltage source is connected in such a way as to oppose the unknown voltage and is adjusted until there is no current flow. The electrometer serves as a sensitive null detector.

Electrometers are extremely sensitive to static electricity, and measurements can be made simply by fitting a short electrode to the input terminal, zeroing the instrument, and then exposing it to the static field. The electrometer will then read the charge induced on the input capacitance. A specially constructed head, shown in Fig. 1, has a well-defined geometry which permits the observed reading to be correlated with the potential and the charge density of the static field.

Small currents can be measured not only on the basis of the voltage drop they produce across the input resistor but, as mentioned above, by the charge they cause on a capacitor of known value. This is called the *rate of charge* method and is based on the relationship: $I = (CE/t)$, where t is time in seconds.

Fig. 7 shows a vibrating-reed electrometer connected to measure the current from an ionization chamber by the rate-of-charge method. The chamber is a gas-filled metallic shell with an insulated collecting electrode in the center. A voltage is applied between the center electrode and the shell to create an electrostatic field within the chamber. When the gas inside the chamber is subjected to radiation, either by exposure to external penetrating radiation or through the insertion of a radioactive sample in the chamber, ions are produced. These ions migrate to the electrode and generate an output current that is directly proportional to the radioactivity.

The output of the ion chamber charges the input capacitor, and the rate of input voltage change is plotted on a chart recorder, as shown. The high-megohm input resistor is disconnected during this operation, since the measurement involves the charge on the capacitor rather than the voltage drop across the resistor.

Resistance can be measured with a Wheatstone bridge, using the electrometer as an extremely sensitive null detector. Where especially high values of

Fig. 5. This vibrating-reed electrometer measures current as low as 10^{-17} amp. Shielded box at left contains preamplifier.

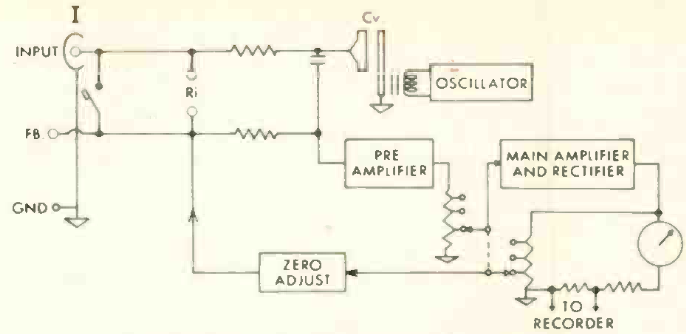


Fig. 6. Vibrating-reed electrometer. Circuit converts d.c. input to a.c. by moving charge through electrostatic field.

resistance are to be measured, the arrangement shown in Fig. 4 is useful. Here the unknown resistance is placed in parallel with a good capacitor of known value, and a voltage source is connected as shown.

When the capacitor is charged, the voltage source is disconnected by means of a switch. The voltage E_o is recorded at the instant the switch is opened. After a period of seconds, during which the voltage falls because of leakage through the resistance, the voltage again is recorded. The second reading is called E_t.

The unknown resistance can then be calculated with the equation:

$$R_x = \frac{t}{C \log_e (E_o/E_t)}$$

where t is the period between the two voltage measurements in seconds (timed with a stop watch), R_x is in ohms, and C is in farads.

If a standard resistor of known value is used, the same circuit can be employed to measure an unknown capacitance. In this instance, the formula is re-arranged thus:

$$C_x = \frac{t}{R \log_e (E_o/E_t)}$$

Where great accuracy is needed, it is useful to plot the voltage decay against time on semi-log paper, voltage being plotted on the logarithmic scale and time on the linear scale. A departure from a straight line indicates the presence of factors other than R and C. A capacitor which does not discharge in a regular manner should not be used for critical work, especially over long time intervals.

Special Considerations

Attention must be paid to the insulation used in the electrometer itself and in the test fixtures, leads, switches, etc. Unless the insulation resistance is several orders of magnitude greater than the resistance of the test voltage source, the test voltage will be partially short-circuited and the reading obtained will not be the same as the open-circuit voltage. Current measurements will also be inaccurate, since part of the current will flow through the insulation and shunt the measuring instrument.

Teflon is one of the most satisfactory insulating materials. It has excellent resistivity and is not impaired by humid air or by finger oils acquired in normal use. Spurious charges may appear internally when Teflon is deformed, but this is not a serious problem if ordinary care is exercised.

Polystyrene has greater resistivity than Teflon, but is more affected by humidity and is harder to clean. Sapphire, one of the best insulators, is often used for switches and connectors. It is difficult to machine, however, and is quite expensive. Quartz has similar insulating properties, but its high piezoelectric output may cause spurious voltages to appear.

Shielding is also of the utmost importance, since electrometers are quite sensitive to electrostatic fields. If a short wire is connected to the input of an electrometer, the meter can be deflected to full-scale simply by rubbing a comb on a wool suit and bringing it to within several feet of the wire. Pick-up of either stray 60-cycle fields or r.f. may also affect the accuracy of electrometer readings.

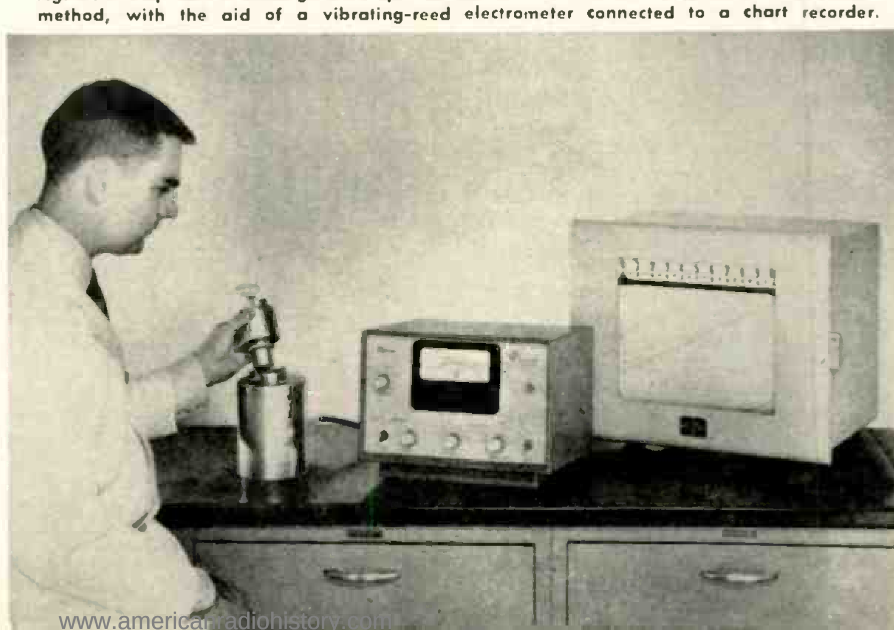
While a screened room is probably most effective, it is usually sufficient to enclose the test set-up in a simple metal box and to connect the assembly to the electrometer with a short piece of shielded cable.

All capacitances are kept to a minimum, since large time-constants may result from the combination of various sources of stray capacitance with the high input resistance. Normal input capacitance, for example, may range from 10 to 30 $\mu\mu$f., made up of the capacitance of the input connector, the wiring inside the electrometer, and of the control grid of the electrometer tube to the other tube elements. If this capacitance shunts a resistance of 10^{12} ohms, a time-constant of 10 to 30 seconds will result. Since accurate measurements can be made only after the lapse of 4 or 5 time-constants, it is imperative that stray capacitance be kept to a minimum to avoid sluggishness.

Reducing the input resistance would reduce the time-constant, but since this would affect the sensitivity of the electrometer it would defeat the purpose. Input leads should be as short as possible. If remote measurements must be made, it is best to place the electrometer close to the test circuit and to relay the output, rather than to use a long input lead. The shielding of the input lead should be spaced as far as practical from the lead itself so as to add the least possible capacitance.

If the grid of an electrometer tube is driven too far from its operating point by a voltage overload, the tube elements may produce gas and form positive ions. When this happens, the instrument should be allowed to sit with the power on until the tube getter has had a chance to clean up the gas and restore the tube to normal operating condition. However, if the grid current does not drop below 10^{-13} ampere (0.1 micromicroampere) after 4 to 8 hours, the electrometer tube should be replaced. ▲

Fig. 7. Set-up for measuring the output of an ionization chamber by the rate-of-charge method, with the aid of a vibrating-reed electrometer connected to a chart recorder.



new motorola tv design

Can the cost of television be brought down without a corresponding quality cut? Here is one approach to the problem of letting viewers eat their cake and have it.

THE HISTORY of the low-priced TV receiver, spurred by the existence of many manufacturers competing for the buyer's preference, is rich in unhappy memories. With cost the dominant consideration, product quality faltered often. More than once, we have gone through a wave of "stripped" sets with reduced tube complements, inferior sensitivity, impaired picture quality, unreliable operation, excessive frequency-of-repair records, and, finally, a lack of amenability to service that has become the bane of technician and owner alike.

Set the task of re-appraising the cost problem, *Motorola* engineers were given this starting point: high standards with respect to performance, reliability, serviceability, and safety would somehow have to be maintained. With no "cheating" allowed, the only remaining approach was to devise less costly ways of achieving the same objectives. Their answer is the 23T17, which uses the TS-578 chassis and a 23-inch, rectangular picture tube but sells no higher than the going price for a 19-inch set of good quality.

Did the engineers succeed? Final judgment will not be in for some time. Acceptance by viewer and technician, along with influence on future design, will be the criteria. Some acceptance is foreshadowed: the circuit is tailored after a pilot 19-inch version successfully introduced at the end of last year. Schematically the circuit shows nothing unfamiliar but for several tube-type numbers. The use of only two tubes in the video i.f. strip (Fig. 2) and a transformerless power supply that features series filaments and relatively low "B+" from a single, half-wave rectifier catch the eye quickly. Aside from the CRT, there are only 14 tubes. Does this sound suspiciously like the pattern of past failures? Perhaps, but it is only one part of the story.

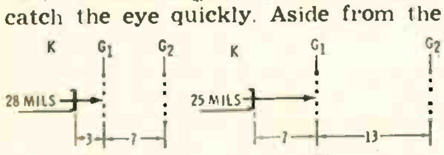


Fig. 1. Spacing of electrodes (A) in gun of the low-drive CRT as compared to spacing (B) in a conventional CRT gun.

The physical appearance of the chassis is somewhat more reassuring. Although it is compact, access is good. It can come out of the cabinet conveniently, but removal should not be required very often. Seated horizontally at the rear of the cabinet (Fig. 3), it provides good access to all rear controls, tubes, and top-mounted adjustments as soon as the back cover is taken off. A quick removal of the fiberboard bottom exposes all under-chassis wiring (Fig. 4) and components. Also, the chassis can be bolted to the back edge of the cabinet in a vertical position, leaving top and bottom accessible and permitting wires to such chassis-mounted components as the picture tube to remain connected.

On the chassis, the eye begins to pick up points of interest. A couple of plug-in circuit modules, one each for the horizontal and vertical sweep circuits, indicate possible cost streamlining although there has been no skimping on circuit operation. Also topside is a small, vertically mounted printed board with half a dozen coils, some capacitors, and a few resistors on it, inside a shield. This is the entire input circuit to the i.f. strip (from L_{101} to the first i.f. grid in Fig. 2), which is integrally manufactured at a cut in cost compared to the several, normally separate components it replaces. Automatic coil-winding techniques, used here and elsewhere, account for another saving.

Bottomside, there is something novel in the appearance of the tube sockets on the wired chassis. Socket lugs have been so designed that considerable time is saved in wiring. Simple insertion of the end of a lead in one of the wire-grip lugs automatically makes a good mechanical connection. The tube sockets themselves and all terminal strips have, as a matter of fact, been inserted automatically in a single operation. Although wiring is by hand, dip soldering is then used to bond all connections.

So far, we have considered the contribution of mechanical ingenuity and production planning. Before this, however, came the choice of components. The manufacturer sought everywhere, in this country and abroad, for the lowest prices at which reliability would be maintained. As a result, there has been actual improvement over conventional standards for some parts—including tubes. But mention of tubes puts us ahead of the story. It also brings us closer to the heart of the matter: How well does the streamlined circuit work? How well ought it to work?

Performance Criteria

The high usable sensitivity made possible by today's low-noise front ends was not to be sacrificed, the designers concluded. Furthermore the receiver should be able to drive the picture tube through an adequate range with the minimum usable signal. To maintain picture quality, bandwidth could not be sacrificed. From the i.f. strip through the video amplifier, response should exceed 3 mc. To assure a crisp, bright picture, corners could not be cut in the high-voltage circuit. Good stability without the inconvenience of excessive adjustment depends on the a.g.c. circuit. Gated a.g.c. would thus be preferable to a less expensive, simplified circuit. Skimping on traps and filters was out of the question: immunity to interference is important. Noise immunity in the sync circuits should also be retained. A means of controlling raster width, one of the first conveniences to go when economy becomes the by-word, is worthwhile.

Many of these goals appear to be obstructed by the power supply, based on a single, half-wave rectifier without a transformer. To wring the highest possible "B+" out of this configuration (140 to 150 volts), supply impedance has been kept very low by using a silicon rectifier across which there is a minimal drop and by cutting series resistance to the bone: the limiting resistor is only 5 ohms and the filter choke has low resistance. For safety's sake, the "on-off" switch is in the hot lead and a polarized power plug is used. A re-settable circuit breaker protects the set. Each of the two series-heater strings has its own dropping re-

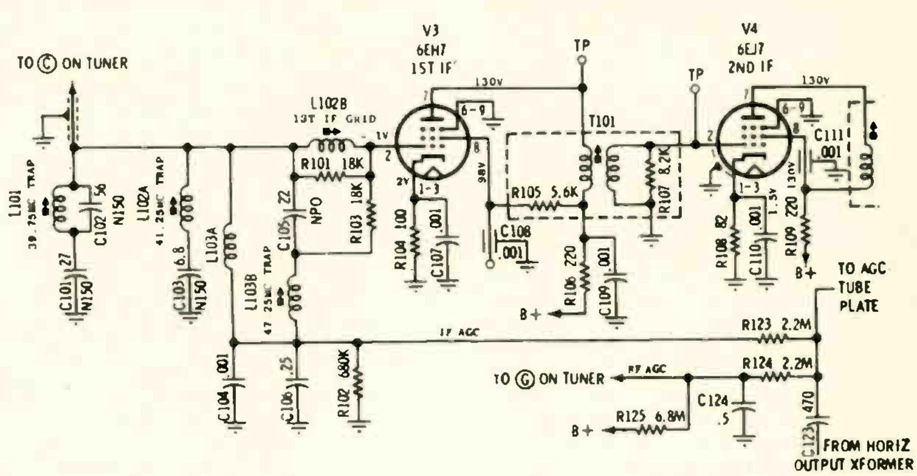


Fig. 2. The 2-stage i.f. strip retains features of conventional, 3-stage section.

sistor. Thus, if a severed heater should open up one string, the drop across the resistor in the other string cushions heater shock. In addition, the horizontal oscillator and output-tube filaments are in the same string. The latter tube is thus protected when heater failure occurs in the former.

Despite the desirable features, one still wonders how adequate operation can be obtained with the maximum available "B+." This is entirely adequate for most circuits, but a few important ones, using conventional tubes, ordinarily require at least twice as much to do the best possible job. In such stages as the horizontal and vertical outputs, the high power that must be developed is generally obtained with elevated plate and screen voltages. Normal output current of this receiver's d.c. supply provides a clue to the solution that was found: it is close to 400 ma.

Increasing tube current, however, will not solve the problem at one important point. The CRT, a voltage-driven device, normally needs about 90 volts of peak-to-peak signal to reproduce the full contrast range. This amplitude is so close to the maximum d.c. voltage available for the video amplifier that such a level cannot be developed. Also, increasing tube current will not make a 2-stage i.f. strip perform like one with three tubes. Other techniques had to be employed here.

The Circuits

Most problems were overcome with the tubes used, and here we may include the CRT itself. Previously unused types include some frame-grid designs used to obtain high gain and some high-current types for developing power with low operating voltages. Developed abroad, these devices have been assigned EIA type numbers and are being or will be manufactured domestically. In any case, replacements are available here now.

The r.f. amplifier, a 4GK5, is very similar to the 6FY5 neutralized triode that has earned widespread tuner use by virtue of its good gain combined with low noise figure. Although the former incorporates no significant design departure, it offers a gain improvement over the latter of about 2 or 3 db and a noise figure that is 1 db better. These were achieved through improved quality control.

Another frame-grid type is the 7HG8 triode-pentode used as oscillator-mixer. With a G_m of 11,000 (as compared, say, to 4500 for a 6U8), mixer gain is commendably high. Coupling to the i.f. strip through a common impedance is used, in addition, since it transfers somewhat more signal than link coupling.

In addition to overcoupled i.f. transformers, the latter section uses a full array of response-shaping coils and traps, including an adjacent video (L_{101}) and an adjacent sound (L_{103B}) trap, an audio "shelf" coil, and others. As a result, it provides good shaping of the response curve with a video bandwidth of 3.5 mc. While such measures reduce gain, there is more here than would be expected from two tubes. The 6EH7, with a G_m of 9000, and the 6EJ7, with a G_m of 16,000, compare impressively with the 6BZ6 commonly used in this circuit (G_m of 7000). The two used here are both frame-grid types.

Nevertheless, over-all gain of the section falls short of that obtained with a conventional 3-tube line-up. A good part of this shortage is made up by the fact that the entire strip gets more signal to work with. This is obtained from the improved tuner gain and coupling efficiency from the mixer, which have been mentioned. After detection by a crystal diode, signal passes through a video-amplifier pentode (15HB6) and is applied to the cathode of the picture tube.

With only 100 volts d.c. at its screen grid, the video amplifier cannot be relied upon to provide the drive-signal amplitude required by a conventional picture tube. But the 23DAP4 is not a conventional CRT. Newly introduced in this receiver, the type is a low-drive device. The 3-mil spacing between its cathode and first grid (Fig. 1A) is less than half that used in conventional guns (Fig. 1B). Spacing between G_1 and G_2 is also sharply reduced. In addition, the G_1 aperture is increased to 28 mils. The combination of these changes reduces the drive requirement to 45 volts, peak-to-peak, not much more than half the signal normally needed. That amplitude is well within the capability of the video amplifier. Considering the video chain as a whole, from tuner input to picture tube, only 10 microvolts of signal are needed for full driving amplitude.

The CRT has noteworthy features other than low-drive design, which cannot be detected by visual inspection. What does meet the eye (Fig. 4) is the tube's shape. It is obviously not a wide-angle tube of the type so prevalent today; yet a sharp look suggests that it does have the relatively short neck with narrow width characteristic of the wide-angle CRT. The actual deflection angle is 95 degrees. This reduces deflection-power requirements substantially.

Nevertheless, other developments that grew out of the introduction of 114-degree tubes are employed to advantage. More efficient flyback transformers and circuits were designed. Reducing diameter of the CRT neck to bring the yoke's deflecting fields closer to the electron beam prevented deflection-power

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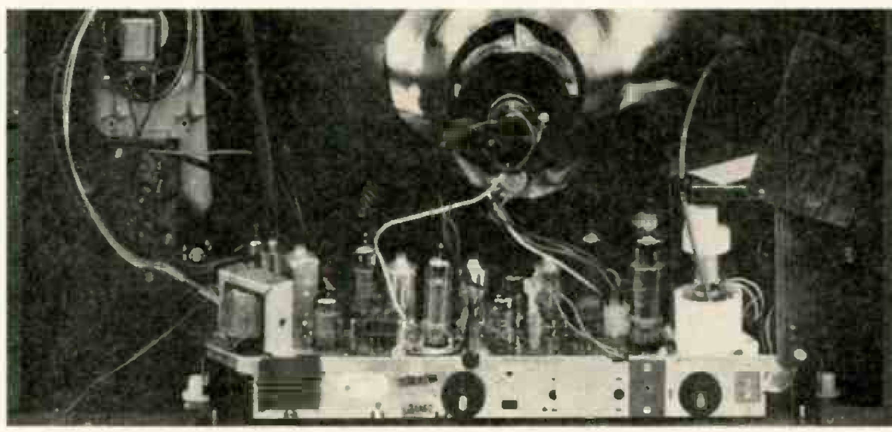


Fig. 3. Access to tubes and top-mounted components is good on the horizontal chassis.

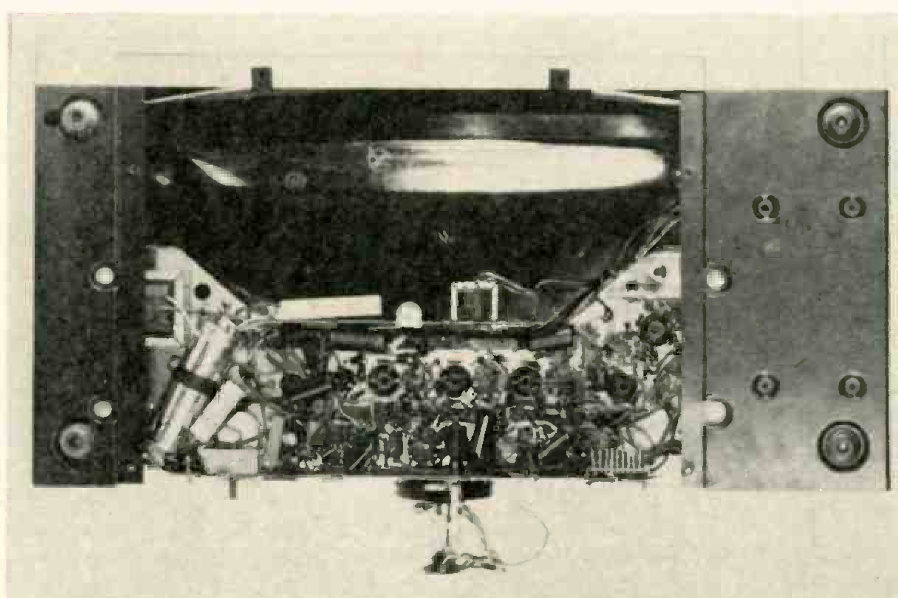
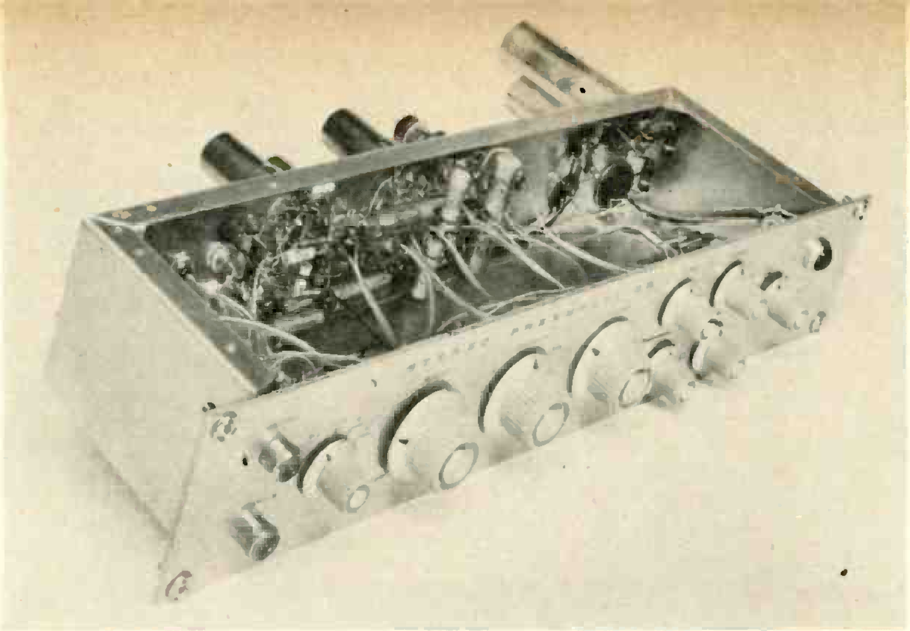


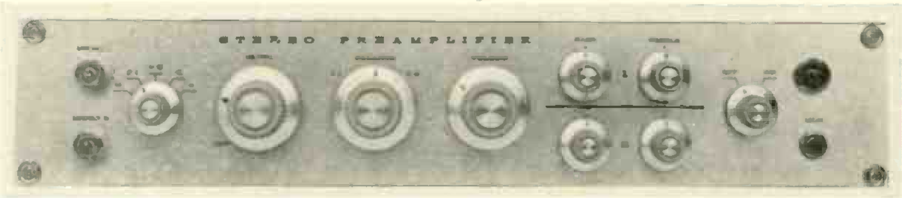
Fig. 4. All under-chassis wiring is available after easy removal of the bottom board.



Top cover has been removed on completed amplifier to expose the wiring.

ANODE-FOLLOWER STEREO PREAMP

By CHARLES P. BOEGLI / Acting Dir. of Engineering, Bendix Corp.-Cincinnati Div.



Front panel view of the author's stereo preamp showing the operating controls.

Construction of a well-designed versatile hi-fi preamp with feedback volume, tone controls, and low distortion.

PREAMPLIFIER design is far from being the controversial subject it was ten or twelve years ago. In 1950 there were arguments over whether passive filters or feedback networks were preferable for equalization of recording characteristics. Determining the recording curves used by different record companies took a lot of detective work, and by the time enough equalizers were incorporated to take care of the numerous curves then in use, the preamplifier had become a truly formidable device.

Passage of time has benefited this aspect of high-fidelity reproduction. First, recording companies realized that publication of their curves helped listeners attain better sound from their records; later, the massed prayers of thousands of audio enthusiasts evidently were heard, and most of the industry standardized on a playback curve. Picking the proper equalizer was no longer a problem, except to those who retained their collections of 78-rpm records or who had acquired great numbers of early LP discs. The needs of even these people, who are often found to value musical performance over fidelity of reproduction, have gradually been met through the years, the growth of their LP collections usually reflecting a corresponding decrease in the number of 78-rpm albums.

Nowadays, although a few preamplifiers still boast a great number of equalizers, the benefit of this feature rests more in some advertisers' minds than in most users' needs; the RIAA equalizer suffices for all but the most unusual records. At the same time, the continuing development of listeners' critical faculties and the improvement of sound sources have dictated continual reduction of acceptable distortion limits; the outstanding preamplifier of ten years ago is substandard merchandise today. Feedback has become the standard tool for distortion reduction.

Introducing Feedback

If any controversy still remains, it is in the method of introducing feedback.

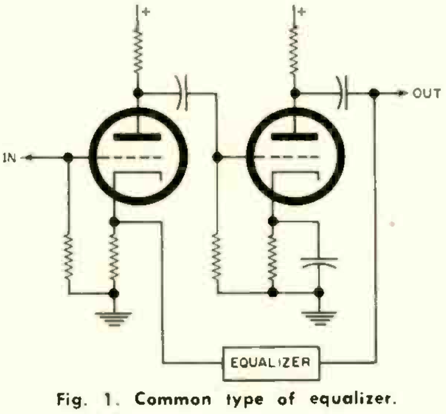
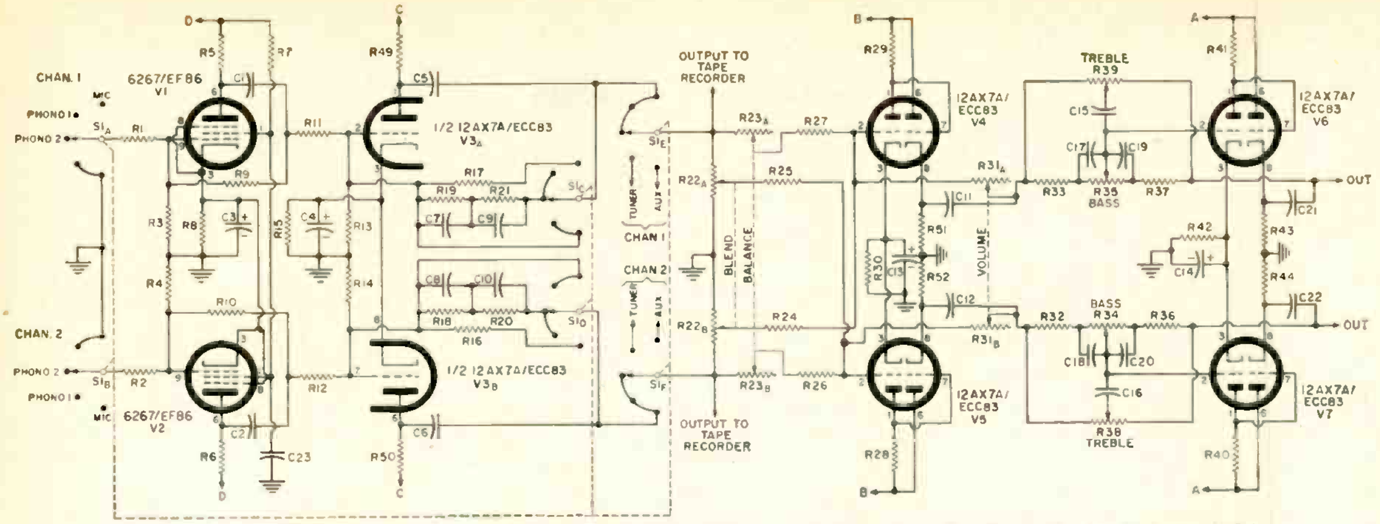
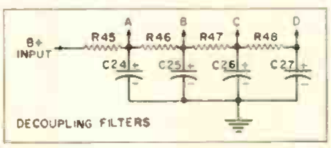


Fig. 1. Common type of equalizer.

Most preamplifiers are designed to work with magnetic cartridges (or crystal units loaded to be velocity responsive and interchangeable with magnetic cartridges) having outputs on the order of 10 mv. The signal from such a cartridge is often raised to tuner level by two cascaded stages, feedback from the second plate being brought back to the first cathode. Volume controls are generally of the passive type and the anode-follower tone control developed by Baxandall has been accepted for most high-quality preamplifiers.

Because these schemes are widely accepted, however, does not mean that they are the best. The temper of the present-day market demands that the designer spend more time concocting gimmicks than in improving his circuitry. The equalization scheme in which the output from the second-stage plate is fed back to the first cathode (Fig. 1) has some serious shortcomings. First, the unbypassed cathode resistor reduces the gain of the first stage. This resistor is thus usually kept as small as possible. If it is too small, the impedance of the feedback equalizer also becomes small, placing a heavy load on the second stage and reducing its signal-handling capability. A second shortcoming is that this type of feedback is not capable of reducing the amplifier gain below 1.0; playback equalization is consequently apt to show an





R_1, R_2—68,000 ohm, ½ w. res. ± 5%
R_3, R_4—270,000 ohm, ½ w. res. ± 5%
R_5, R_6—100,000 ohm, 1 w. low-noise res. ± 5%
R_7—220,000 ohm, 1 w. res. ± 5%
R_8—470 ohm, ½ w. res. ± 5%
R_9, R_{10}—1.5 megohm, ½ w. res. ± 5%
R_{11}, R_{12}, R_{24}, R_{25}—220,000 ohm, ½ w. res. ± 5%
R_{13}, R_{14}—1 megohm, ½ w. res. ± 5%
R_{15}, R_{30}, R_{42}—680 ohm, ½ w. res. ± 5%
R_{16}, R_{17}—2.2 megohm, ½ w. res. ± 5%
R_{18}, R_{19}—330,000 ohm, ½ w. res. ± 5%
R_{20}, R_{21}—3.3 megohm, ½ w. res. ± 5%
R_{22}—2.5 megohm dual linear-taper pot ("Blend Control")
R_{23}—250,000 ohm dual audio-taper pot ("Balance Control")
R_{26}, R_{27}, R_{28}, R_{29}, R_{32}, R_{33}, R_{36}, R_{37}, R_{40}, R_{41}, R_{43}, R_{44}, R_{49}, R_{50}, R_{51}, R_{52}—100,000 ohm, ½ w. res. ± 5%
R_{31}—2.5 megohm dual audio-taper pot ("Volume Control")
R_{34}, R_{35}—1 megohm linear-taper pot ("Bass Control")
R_{38}, R_{39}—500,000 ohm linear-taper ("Treble Control")
R_{45}, R_{46}—1000 ohm, 2 w. res. ± 5%
R_{47}, R_{48}—2200 ohm, 1 w. res. ± 5%
C_1, C_2—.022 µf., 400 v. Mylar capacitor
C_3, C_4—100/100 µf., 50 v. elec. capacitor
C_5, C_6—.1 µf., 400 v. Mylar capacitor
C_7, C_8—220 µµf. silver mica capacitor ± 5%
C_9, C_{10}—.001 µf., 200 v. capacitor
C_{11}, C_{12}—.047 µf., 400 v. Mylar capacitor
C_{13}, C_{14}—50/50 µf., 50 v. elec. capacitor
C_{15}, C_{16}—470 µµf., 400 v. Mylar capacitor
C_{17}, C_{18}, C_{19}, C_{20}—.0022 µf., 400 v. Mylar capacitor
C_{21}, C_{22}—.1 µf., 400 v. Mylar capacitor
C_{23}—.33 µf., 200 v. Mylar capacitor
C_{24}, C_{25}, C_{26}, C_{27}—40/40/40/40 µf., 450 v. elec. capacitor
S_1—6 pole, 5 pos. rotary switch
V_1, V_2—6267/EF86 tube
V_3, V_4, V_5, V_6, V_7—12AX7A/ECC83 tube

Fig. 2. Complete circuit of the preamp, which requires 6.3 v. @ 2 amp. and a "B+" voltage of about 250 v. @ 13 ma.

undesirable high-frequency rise or low-frequency droop unless careful design has provided more open-loop gain than usual. The third disadvantage of this equalization scheme is that hum is apt to be developed across the unbypassed first-stage cathode resistor unless a d.c. heater supply is used. This hum is not reduced by feedback. Direct-current heater supplies may cause more trouble than they eliminate unless filtering is very thorough, which is an uneconomical proposition.

Finally, there seems to be no good reason for retention of the passive volume control when a feedback control requires only one more resistor and has many advantages in reduction of distortion.

The problem of minimizing hum arising from a.c. heater supplies has been alleviated by introduction of newer tube types utilizing helically wound heaters. The 12AY7 was the first such tube widely commercialized, but it has become almost obsolete in the wake of newer additions like the 12AX7A, the ECC83, and the 7025, which are high-*mu* dual-triodes, and the 6267 and 7543 pentodes. In a properly designed circuit using the 12AX7A, the average equivalent a.c. hum at the grid is around 1.8 microvolts; with the 6267, the level never exceeds 5 microvolts. Since the higher of these figures is 66 db below the 10-mv. output of the average cartridge, the advantages of d.c. heater supplies have become academic except where they are needed to forestall generation of hum across an unbypassed cathode resistor.

This article will describe a stereo preamplifier in which an a.c. heater supply is employed and in which the necessity of unbypassed cathode resistors in low-level stages is eliminated by the employment of anode-follower feedback.

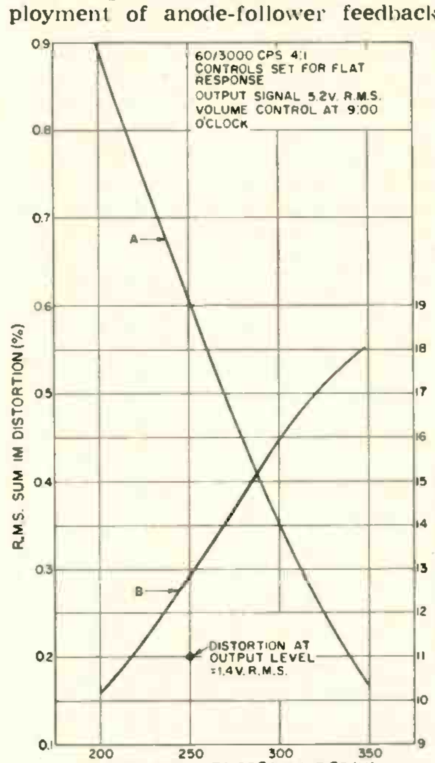


Fig. 3. (A) IM distortion of preamp high-level stages at various values of "B+" voltage. (B) "B+" supply current that is drawn by the preamplifier at various "B+" voltages.

Volume control is of the feedback type, and a simplified and highly satisfactory version of the Baxandall anode-follower tone control is also used. Because of the inherently low hum level, the preamplifier can be powered from a remote supply like the power-amplifier power supply; hence, the circuit to be described does not contain its own power supply.

The circuit of the stereo preamplifier, Fig. 2, permits not only the common functions of volume and tone control, but also those peculiar to stereo needs, like balance and blend control. Microphones, phonograph, and tuner sources can be accommodated.

High-level Stages

The last two stages comprise the high-level portion in which volume and tone are controlled. Each of the two stages is an anode-follower; they differ only in the type of feedback network. Each uses a 12AX7A as a single-function tube; the first section, an ordinary voltage amplifier, is directly coupled to the second cathode-follower section. The low output resistance of the cathode-follower is further reduced by the feedback returned around the combination; when the voltage gain has been reduced to 1.0 by the feedback, the output resistance is on the order of 17 ohms. The low output resistance of the volume-control stage permits realization of maximum bass and treble boosts from the subsequent tone control while that of the tone-control stage allows connection of the preamplifier to the power amplifier with extremely long cables, without diminution of high-frequency response.

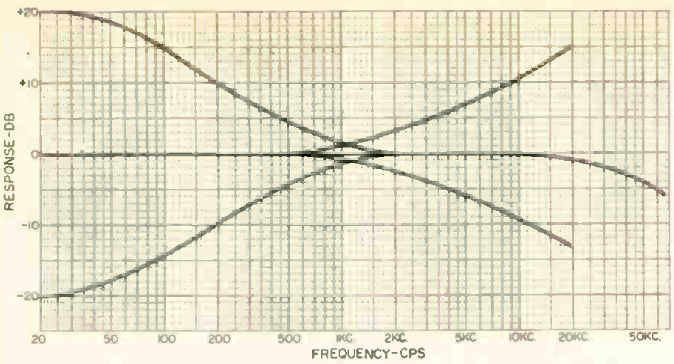


Fig. 4. Frequency response of preamp to high-level inputs.

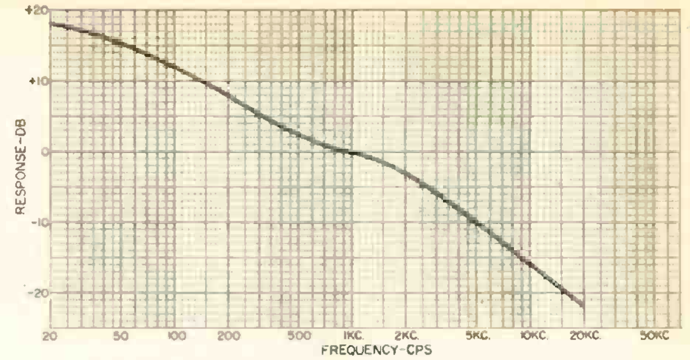


Fig. 5. Frequency response of the preamp on the phono input.

The volume control employs a fixed input resistor and a variable feedback resistor. The gain of this stage may be varied from 0 to about 15, although it is not anticipated that the maximum gain will be necessary save in exceptional cases. Reducing the feedback resistance (by counterclockwise rotation of the volume control) lowers the gain of the stage. Up to the point where the control resistance becomes less than the tube load resistor, reduction of volume is accompanied by the reduction in distortion. When the feedback resistor becomes smaller than the tube load resistor, the distortion of the tube begins to increase, tending to offset further reduction of distortion by increase in feedback.

The balance control is a dual 250,000-ohm potentiometer in series with the stage input resistor. This control is wired so that rotation of the shaft increases the resistance in one channel while decreasing the resistance in the other. The gain of the volume-control stages may be unbalanced to the point where one side has a gain about 3.5 that of the other. The gain ratio established between the two channels by the balance control will be maintained over almost the entire rotation of the volume control, the exception being where the two sides are severely unbalanced and the volume control is opened up completely. Under these circumstances, the feedback around the high-gain side is reduced to the point where the stage gain is limited by tube parameters rather than feedback.

The "blend" control introduces a controlled amount of crosstalk into the preamplifier. Presumably, when the "blend" control is rotated to maximum, the sound resembles monophonic reproduction, even though stereo sources are used. A passive attenuator is employed to permit reduction of crosstalk to zero and to avoid interference with the feedback controls that already exist.

The tone-control network is essentially similar to that devised by Baxandall[1] except that (*a*) the 1000-ohm series grid resistor, which apparently served no purpose, is eliminated, (*b*) the treble feedback capacitor is increased in size to allow elimination of the associated 470,000-ohm resistor in Baxandall's circuit, and (*c*) the grounded center tap has been removed from the treble control. The last change, apparently made feasible by the second one, permits selection of any of a wide variety of commercially available controls, instead of restricting the choice to one or two, as has previously been the case.

The high-level stages are used for all input signals, while the equalizer stages are employed only for those from pickup and microphone. The response and distortion curves for the last two stages are shown in Figs. 3 and 4. To realize minimum distortion, the amplifier to which the preamplifier is connected should have an input resistance that is greater than a value of around 100,000 ohms.

Low-level Stages

Cascaded anode-followers make up the two low-level stages. The first stage is an amplifier of flat response, the necessary equalization for phonograph input being accomplished in the second stage. The object of doing things in this order is to avoid attenuating the signal until it is well out of the noise and hum.

The preamplifier uses a 6267 pentode in the first stage and half of a 12AX7A for the second. The pentode permits closed-loop gain of about 22. When the microphone input is being used, the second-stage equalizer is replaced by a resistor, which gives the second stage flat response and controlled gain. The microphone input can be used with high-impedance microphones of about 0.5-mv. output.

The response curve for the entire preamplifier, including the phono-equalizer stages, is shown in Fig. 5. The IM distortion on the microphone channel was the same as that for the last two stages only, Fig. 3. With the volume control wide open, a 4-mv. input signal to the phono terminal produces 1.0-volt output at 1000 cps.

Conclusion

Many stereo preamplifiers have a "phase" switch that permits inverting the phase of one of the channels. Examination of the circuits usually shows that this choice of phase is provided by a split-load phase inverter, the switch merely selecting either the plate or cathode output for transmission to the power amplifier. The cathode output is usually considered "normal" and the plate output, "reverse" phase, is recommended only for occasional use. The same inversion of phase can be done by a double-pole, double-throw switch on one of the speaker lines, which simplifies the preamplifier.

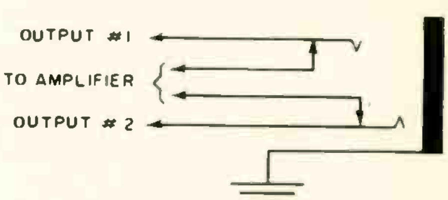


Fig. 6. Monitor-jack connections.

The preamplifier shown in the photographs is equipped with a monitor jack, the intent of which is to permit listening with earphones. The circuit for this jack (Fig. 6) shows that when the phone plug is inserted, the preamplifier outputs are disconnected from the power amplifier. If the power amplifier has a high input impedance, this disconnection may result in hum or squealing, and in such cases additional provision should be made to short-circuit the power am-

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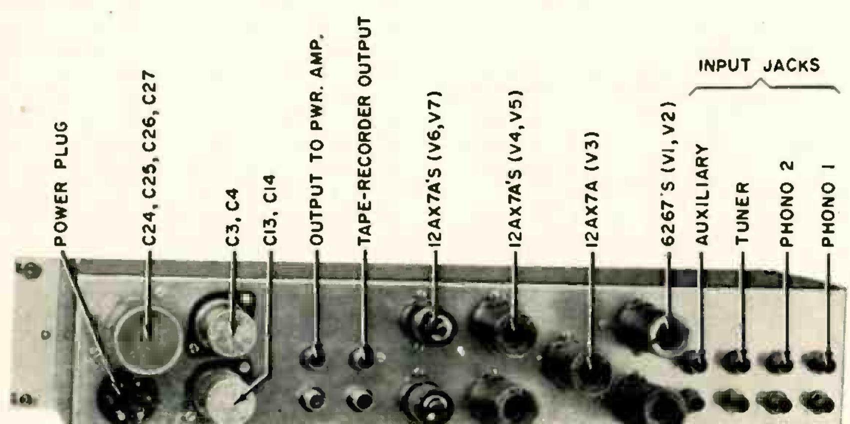

Rear view of the chassis showing the various input and output jacks that are used.

a day in the shop with the scope

How important should the scope be in TV service? A pair of experienced technicians, whose views on the instrument are at opposite poles, put their theories to the test.

By **DENIS A. GENTRY**

ARE YOU ONE of the many TV service technicians who "gets along very well" without an oscilloscope? Perhaps even the owner of a scope that is seldom or never used? You may want to know why anyone still bothers trying to sell you on the instrument. The fact is that, among your successful colleagues, there are large numbers who claim they couldn't manage without one. Once the habit is caught, many will tell you, the scope becomes the most widely used, single tool. You might be missing something after all.

However, you are not interested in a bystander's prejudice. We know good technicians who will argue the issue firmly on either side. Why not throw the argument into their laps, as we did in an experiment with Bill and Dick? Those aren't their real names, but they are a couple of shop owners who know each other, know their business, were willing to cooperate, and hold opposite views on the scope. Dick practically has his scope probe strapped to his hand. Bill owns a scope too, but it gathers dust.

The experiment was scheduled for Bill's shop. The scope we brought along was the ES-550B, made by *Precision Apparatus Co.* Designed for TV service, it was the model that Dick owned; but it was agreed that this didn't give him an unfair advantage. He was entitled to be sure of having the features and facilities he normally used in an instrument he was accustomed to handling. By the same token, Bill would be using his regular shop equipment.

While Dick was setting up, Bill was puzzling over a TV chassis whose picture was being wrecked by what looked like curving lines of interference all over the CRT screen. "Having trouble?" asked Dick. "I've gone quite a way already," said Bill. "It looks like a classic case of i.f. regeneration and it almost has to be right here in the third i.f., but somehow I haven't nailed it yet. I've made a fistful of hot and cold meter checks, and everything seems okay. I checked out all bypasses too."

"Seeing" What's Wrong

By this time, Dick was ready to go. With his demodulator probe plugged into the scope's input cable, he began to poke around the third video i.f. stage. In no time at all, he was poking his finger at the CRO screen (Fig. 1) and saying, "There you are." "And where is there?" Bill wanted to know. "That's a fairly normal waveform for this stage." "Not where I have my probe touching," Dick insisted. Sure enough, the probe was at the *ground* end of the cathode resistor, where there should have been no signal at all. The trouble was some cold solder at the connection. After a little heat from the soldering gun, the set was working as good as new.

"I don't get it," Bill said. "I got a normal resistance reading from cathode to ground. I also got a normal d.c. voltage reading at the cathode. Are you using hidden strings or mirrors?" "The only magic is what's in this wand," Dick said, pointing to the probe. "Apparently high resistance isn't the only trouble you get out of a cold joint. There is evidently some kind of a.c. impedance that won't necessarily show up on a d.c. test. I won't guarantee that guess, but the exact reason doesn't make any difference. What counts is that the proof is in the pudding—this isn't the first time I've run into a case like this. The scope is the only thing that lets me see what's going on in the circuit during operation. Without it I'd probably nail the trouble anyhow, I admit—eventually. But I can't afford the time for tough dogs."

Bill yielded grudgingly, but he was obviously impressed. "How often do you run into that sort of problem?" he wanted to know. "Probably not often enough to make a big difference. Let's see what we can do with this lemon, for example. There's no raster here because high voltage is way down. I started with the grid of the horizontal-output tube as my key check-point. The peak-to-peak scale on my v.t.v.m. tells me that drive is normal. So I let the oscillator alone and went ahead into the deflection and flyback circuits. I can't find a tube, other component, or reading that's out of line. It might still be a bad flyback, but I'm not anxious to run out and get a replacement I might not need. What would you do?"

"I wouldn't go after a new flyback

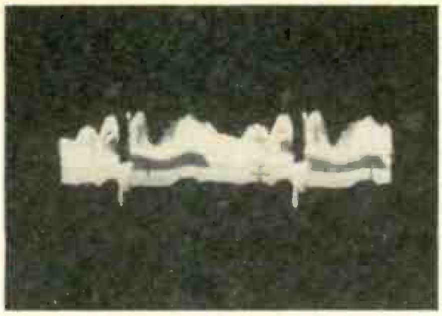

Fig. 1. Normally observable in an i.f. stage with a detector probe, this video waveform occurred at an unexpected point.

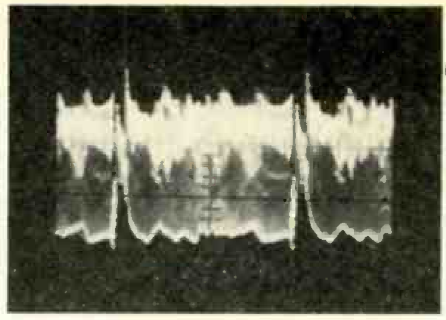

Fig. 3. Improperly separated sync output, shown at the vertical rate, is irregularly marred by video information.

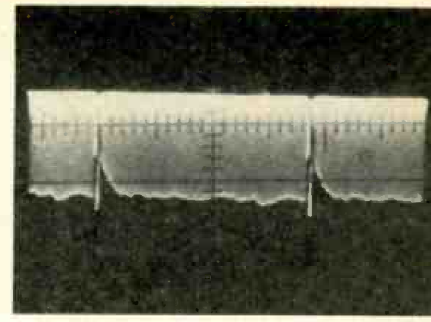

Fig. 5. Properly separated sync pulses, displayed at the vertical rate, are reasonably uniform and stripped of video.

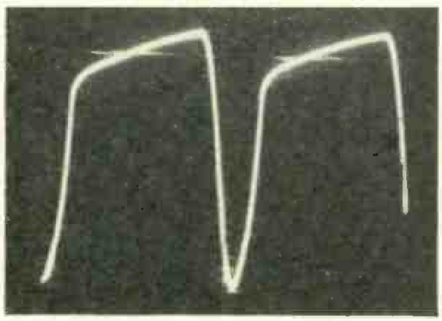

Fig. 2. Waveshape of this modified saw-tooth at the grid of the horizontal-output tube was normal for the circuit used.

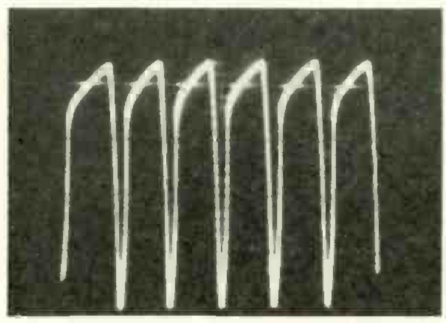

Fig. 4. Although output amplitude and waveshape were normal, the horizontal oscillator was too high in frequency.

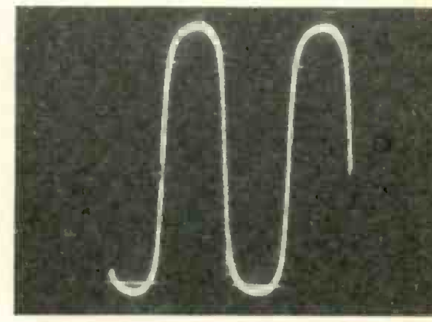

Fig. 6. Amplitude of this semi-squared sine wave, used for calibrated a.c. measurements, is regulated for accuracy.

either, without more confirmation," Dick sympathized. "Your check-point is fine. Why not start all over again, this time with the scope? And take a crack at it yourself." He handed the scope's isolating probe to Bill, who immediately made his connection to the output-tube grid, then adjusted his coarse and fine sweep frequency and other controls until he got the display of Fig. 2. The saw-tooth looked a little out of shape, but it's perfectly normal in some sets. In fact, on comparison, it closely resembled the waveform shown in the service manual for this older receiver. There was no mistaking Bill's sarcasm when he muttered, "A big help, so far."

"Hold on a minute," Dick countered, "we're not through." Bill had used one of the normal positions of the "Sweep Selector" switch to get his display. However, the last two clockwise positions on the switch (Fig. 9A) are specifically for viewing two-cycle displays at the vertical and horizontal sync rates used in TV, being set near 30 and 7875 cps respectively. Dick simply rotated this coarse frequency selector to the latter position, since we were looking at the horizontal saw-tooth, and then adjusted the "Sweep Vernier" control to lock in six cycles (Fig. 4) instead of two.

A Check of Frequency

Bill felt the change meant nothing, because the number of cycles simply depended on the frequency setting; but Dick disagreed. The special "TV Hor." position on the switch is set so close to desired frequency that the vernier control doesn't permit much range for changing the number of cycles. According to him, this meant the saw-tooth frequency had gone way up, even though shape and amplitude were acceptable.

Sure enough, going back to the horizontal oscillator, the boys found an open capacitor. With the defect the flyback, which is most efficient when excited at its resonant frequency in the circuit, couldn't develop enough high voltage to produce a raster. After the oscillator was repaired, Dick proved his point. In the special horizontal position on the "Sweep Selector" switch, a two-cycle display like that of Fig. 2 was the only one that could be locked in at any vernier setting. He had used the scope to check operating frequency!

Fair Means or Foul?

Bill had an objection to the method: There was no such special control position on his unused scope and on a lot of others, he knew. Wasn't the "trick" a little unfair, then? Dick took the occasion to make an important point. "No, it's not unfair. I used a scope specifically designed for service work. That's the only kind I want. In fact, one of the big reasons that a lot of fellows who own scopes are not using them, in my opinion, is the fact that their instruments were not designed for their type of work. There are a lot of things to consider. Bandpass and sensitivity are just two more, for example. A man sometimes goes out to buy a piece of equipment without stopping to think what he wants it to do. With many standardized instruments, there isn't much to think about or much difference from one to another. That's not true of oscilloscopes. If you end up with the wrong one, of course you won't be using it much. It won't do your job."

Later on, we came across a set with unstable horizontal and vertical sync. Bill used his v.t.v.m. to check d.c. voltages and resistances in the sync amplifier-clipper. He also took a peak-to-peak voltage reading at the clipper plate. Everything seemed in tolerance. Dick then moved the scope probe to the plate and adjusted for the vertical rate. "Look what we have here," he said (Fig. 3). "See this junk along with the sync pulses? This stage isn't operating at the right point. It's letting some video creep into your sync oscillators, so they don't always trigger reliably. Sometimes that results from the accumulated effect of several small changes, none of which is enough to give you an off-tolerance reading at one point. But we can *see* it happening here."

A slight change in the value of the clipper's plate-load resistor and replacement of a capacitor at the grid restored the set to rock-steady sync. Just for comparison, Bill used the scope himself to check the waveform after the repair (Fig. 5) The cleaned-up display impressed him. His inclination to talk down the scope was waning. "Without argument," he said, "this is one case where the instrument does the job. Of course, I could find that one without the scope, eventually; but I would have to guess—and take plenty of time."

A.C. Voltage Checks

On another, later job, the two technicians got into a discussion on taking voltage amplitude readings. Bill was entirely content with the peak-to-peak scale on his v.t.v.m. Dick said it might give you a slightly lowered false reading on narrow pulses, but he admitted that, if the v.t.v.m. rectifier were properly designed, this wouldn't happen often or be off much. He noted, however, that you might make a "bonus" discovery with the scope. He used the unstable-sync case that had come up

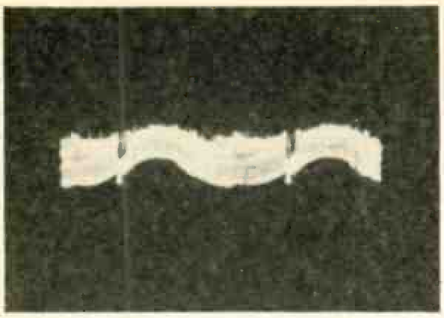

Fig. 7. Video riding on sinusoidal 60-cps signal instead of normally straight baseline pinpoints obscure hum problem.

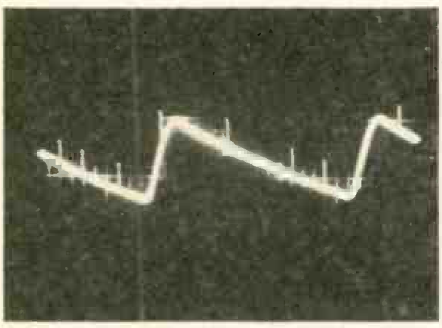

Fig. 8. Ripple output of "B+" filter, showing random spikes fed back to d.c. supply when a decoupling network failed.

earlier as an example (Figs. 3 and 5). Both waveforms had the same amplitude. The meter would show no difference, but the scope did. "That's true," Bill yielded, "but is it worth the trouble in practice? You have to go through quite a mess, with a calibrator and all that, to read amplitude on the scope. In the long run, you might lose more time than you save."

"There's nothing to that myth." Dick said emphatically, "and I'm talking from experience. A lot of the trouble that seems to be involved with some procedures is simply a matter of lack of practice: try it a couple of times and it becomes a snap. I guess there is also some difference that depends on the set-up used for reading voltage amplitudes. Some scopes use built-in calibrators with direct-reading scales. Take the one we have here, for example (Fig. 9B).

"Suppose you are already looking at a waveform whose amplitude you want to measure. Simply adjust it to some convenient height, say one that comes out to a convenient number of vertical markings on the transparent grid built over the CRO face. Then you just press this button down here ("P-P Cal." in Fig. 9B) for the calibrating voltage. It cuts out the regular input signal and substitutes the internally generated semi-square wave (Fig 6), which has a controlled, fixed amplitude.

"Now you just adjust this display's height to be that of the original waveform, using the grid markings as a guide —but *not* with the vertical-gain control. You leave that control untouched. Instead you use these two special controls, marked in red ("P-P Cal. Voltage," "P-P Range"). One chooses the voltage range (.05, .5, or 5 volts) and the other, a vernier adjustment, has fine calibrations from zero to 5. Now just read.

"You have manipulated no more controls than you would have to adjust on a v.t.v.m. And reading is just as simple. Let's say your range switch is on .5 volt and the fine control is on 2. You are reading .2 volt, peak-to-peak, if your coarse vertical attenuator switch is in its X1 position. If it isn't, there is just one more mental calculation. Multiply the reading by 10 or 100 if the gain multiplier ("V. Attenuator") switch is in the X10 or X100 position. That is no more difficult than reading from a composite scale on a meter and adjusting your reading to the position of the meter's range switch.

"As an aside, you might turn down horizontal gain altogether before you take a reading, so that the waveform you're measuring—you don't care about shape here—becomes a straight, vertical line, as does the calibrating voltage. It makes height adjustment more obvious.

"Now there's another lesson to be learned here. You may have to make two more quick adjustments than you would with a v.t.v.m., at most, but you've saved that time because you're *already using the scope.* You don't have to set up the meter from scratch and make additional connections. And that's one of the great satisfactions you get from the scope. Because it's so versatile, it can do many jobs for which you ordinarily have to set up separate instruments."

Where Did the Hum Enter?

There were other interesting cases before Bill and Dick called it a day. One set had an obscure hum problem. The top of the raster was somewhat darker than the bottom and vertical sync sometimes slipped. The hum first showed up at the plate of the first video amplifier (Fig. 7), with video riding on it; but the cause wasn't obvious. Leakage from the tube heater, quickly suspected, was almost as quickly eliminated by substitution. It took a while to discover that the leakage was in the tube socket, which had to be replaced. Nevertheless, the day could have been spent poking all over the video circuits, with no other clear indications, if the scope hadn't singled out the right stage.

In another case, some other, unstable signal mixed with the video, degrading the picture somewhat and making sync slightly touchy. The clue was not clear-cut. There was some guess about incipient oscillation somewhere. While checking filter ripple at the "B+" output, Dick got an acceptably low level of a.c., but found many unstable, slender spikes dancing all over the filter waveform (Fig. 8). To him this meant that unbypassed horizontal pulses were feeding back to the power supply, from which they were contaminating other circuits. Tracing back, he found an open bypass capacitor in the horizontal "B+" line.

No-Sweep Bandwidth Check

A smeared, fuzzy picture on another set, in spite of good focus, caused some head-scratching. With no sweep generator in the shop to check alignment and bandpass, Dick decided to press an ordinary r.f. generator into service. First he connected its output directly to the scope. Then, without changing settings of the scope's gain controls or the generator's output control, he tuned from below 1 mc. to above 5 mc. He didn't try to sync the display, but simply observed amplitude, which did not change significantly.

"Well, now we can assume that the scope and generator are flat in this range—although I knew the scope was already — so let's try something," he said. Bill was puzzled until Dick then

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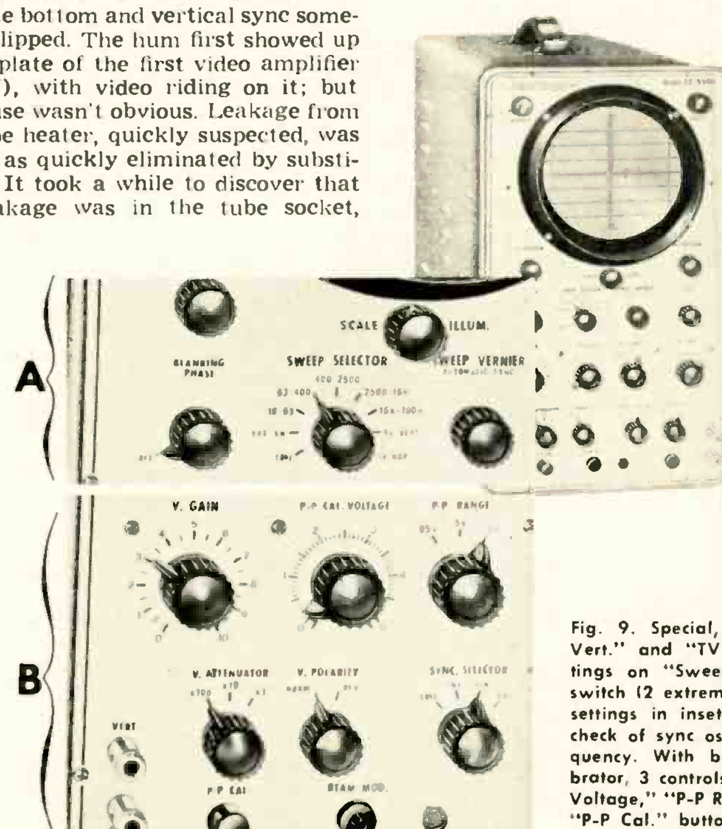
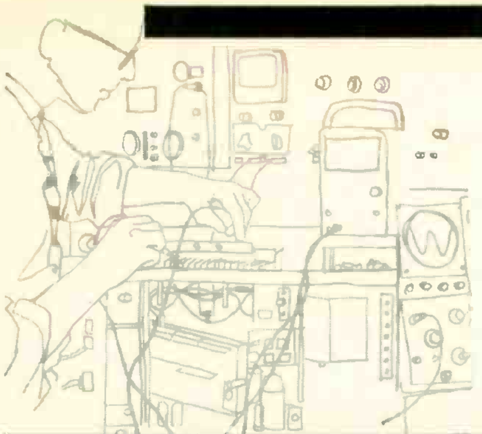


Fig. 9. Special, fixed "TV Vert." and "TV Hor." settings on "Sweep Selector" switch (2 extreme clockwise settings in inset A) enable check of sync oscillator frequency. With built-in calibrator, 3 controls ("P-P Cal. Voltage," "P-P Range," and "P-P Cal." button, inset B), make scope an a.c. voltmeter.



MAC'S ELECTRONICS SERVICE

By JOHN T. FRYE

Gently, Brother!

BARNEY was scowling at a little transistor radio lying on the bench in front of him.

"What's the matter, Flash; has the little job got you talking to yourself?" Mac, his employer, asked.

"Aw the oscillator is dead on this thing. The i.f. signal feeds straight on through from the base of the converter transistor, but you can't pick up any stations. I'm trying to decide whether to replace the oscillator coil or the converter transistor first. I've checked everything else around the oscillator circuit. Both the transistor and the coil are soldered to the printed circuit board; so one is as hard to remove as the other. Which do you think is most likely to be the villain?"

Without replying, Mac reached over and picked up the little chassis. He took a jeweler's loupe from a drawer and examined the chassis carefully. Next he picked up a miniature soldering aid and carefully moved a hair-like wire. The sound of the local broadcast station burst from the speaker. When the wire was moved again, the radio went dead.

"Hey! What did you move?" Barney demanded.

"One of the flexible leads from the ferrite loop antenna is broken loose from its soldered connection on the printed-circuit board. It happens often. The leads get pushed around a good bit changing batteries, etc. You should have checked that."

"Why? Disconnecting the loop antenna from a radio doesn't kill the oscillator."

"It does when the oscillator circuit is contained in a transistorized autodyne converter and energy from the oscillator tank circuit is transferred to the base of the converter through the secondary of the ferrite loop antenna, as it is in this set," Mac explained. "Mind you this is not true of all transistorized autodyne converters. It depends on whether the signal from the collector is eventually fed back through the oscillator tank to the emitter or the base. The latter is true in this case; so a broken antenna lead kills the oscillator."

"Okay," Barney said with a sigh as he plugged in the pencil-type soldering iron and picked up a pressurized can of contact cleaner; "but while the iron is hotting up I may as well spray a little of this gunk into the volume control. I noticed it was erratic and noisy."

"Ah, ah, ah!" Mac remonstrated, taking the can out of his assistant's hands. "Let's check first to see what the cleaner does to the case and the knobs."

He squirted a little of the cleaner into an empty plastic resistor box lying on the bench and dipped the end of a pipe cleaner into the fluid and touched it to an inconspicuous spot on the inside of the back cover of the receiver. After a few seconds, he tried to wipe off the little drop of cleaner with a cloth. The cloth stuck to the case; and when it came away it left a smudged, lint-covered spot on the smooth surface of the plastic.

"I was afraid of that," Mac grunted. "Most of these plastic cases and knobs are partially dissolved by chemicals in the contact cleaner. Never use the spray can when there is any doubt. Surplus cleaner is likely to drip down on the volume control knob and render it sticky or fog the transparent window in front of that knob. Use a hypo needle to put a very small amount of the cleaner inside the volume control where you really want it. See how the cleaner has etched the plastic of the resistor box?"

"Yeah, I see. This just isn't my day. First I muff a troubleshooting job, and then I come close to ruining a customer's receiver case."

"You don't seem to be thinking your best," Mac murmured; "but I'll admit to being a bit of a nut on this business of being gentle and careful with sets we are servicing. In my book, a really good technician is never impatient or rough with either his own equipment or that of his customers. He locates the trouble and repairs it with a minimum of mechanical mayhem or circuit cruelty."

"I take it you don't go for the quick-and-dirty way of doing things."

"You take it right—and that goes for other lines of work as well. Every trade has its ham-handed practitioners. There is the hammer-and-cold-chisel mechanic who uses these tools to loosen a tight nut rather than hunt the proper wrench. Carpentry has its wood-butchers; electronic labs, their meter-wreckers; and chemistry labs, their glass-breakers, but the derisive names tagged to these people reveal the contempt in which they are held by their fellow workers.

"What are some examples of 'unnecessary roughness' you would cite in radio and TV servicing?"

"Just remember you asked for it. The slob technician never uses a knob-puller. If a knob comes off hard, he pries on it with a screwdriver or grips it with pliers until he breaks it. He can't be bothered to spread a soft, clean cloth on the bench before he turns a receiver upside down to get at the bottom chassis screws. As a result, bits of solder and wire imbedded in any bench that has been in use for long scratch and gouge the smooth plastic or varnished surface of the cabinet—right on top where it's sure to be seen. He doesn't even own a tube-puller. To keep from burning his fingers, he yanks tubes vigorously from side to side to get them out quickly, doing a fair job of wrecking the sockets in the process; and then he throws the hot tube down on the bench. As long as the bulb doesn't fracture, this doesn't hurt the tube a bit—or so he says!"

"Yeah," Barney chimed in, warming to the spirit of the verbal tar-and-feathering, "and he doesn't use a solder aid, either, in loosening wires from tube sockets, i.f. transformers, volume control lugs, etc. He simply yanks on the wires as hard as he can while the iron heats the joints and hopes the wrapped connections will uncurl before the lugs break off. His careless use of the solder gun or iron turns it into more of a torture weapon than a tool. When he is trying to solder a connection in a tight place, he manages to burn the insulation off wires, melt gullies in capacitor cases, and soften the wax on coils for inches all around. This is true in spite of the fact he roughly yanks capacitors and resistors out of the way before he starts—usually managing to break at least one resistor in two or pull a capacitor lead loose from its foil in the process."

"Our boy," Mac continued, "thinks brute strength and awkwardness are substitutes for skill and neatness. In aligning slug-tuned coils, he never takes the time to select the alignment tool that fits the tuning slot or hole in the slug. He simply grabs up any screwdriver that will go through the hole in the coil shield and 'makes do' with this. The result, of course, is a fine useless collection of cracked and broken coil slugs. He never quite savvies the fact that lead-dress is very important in a high-frequency TV i.f. section or in the high-frequency tuning sections of FM or all-wave receivers; so he recklessly pushes the leads about every which way in these and then wonders why they are out of alignment. Punching a hole in a speaker cone with some object on his cluttered workbench worries him not at all. A gob of speaker cement will fix that as good as new—well, almost as good as new."

"I don't suppose any one service tech-

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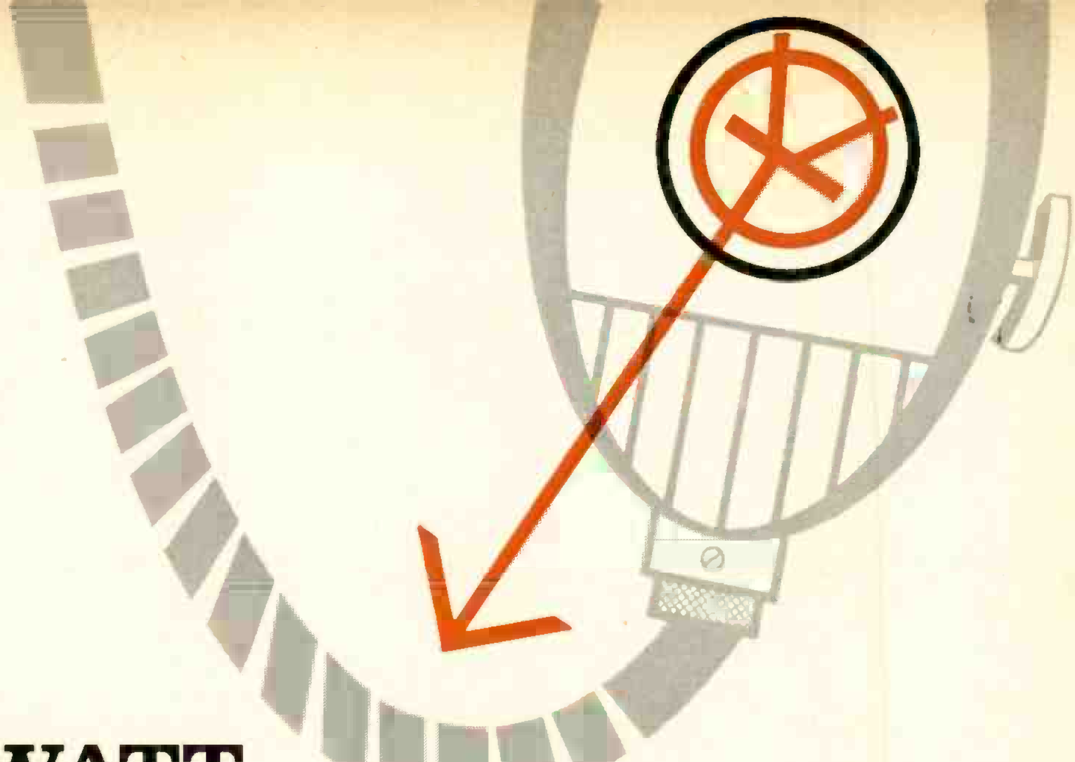


MULTI-WATT TRANSISTORIZED CB TRANSCEIVERS

By DONALD L. STONER, 11W1507

Circuit details on fully transistorized Citizens Radio units that are able to deliver several watts of r.f. output.

AT PRESENT, several manufacturers are preparing a so-called "second generation" of Citizens Band equipment—completely transistorized 5-watt transceivers. The advantages of these units will be immediately obvious. They are extremely compact, draw only a fraction of an ampere on receive," and are instant-heating. In mobile service these are particularly important considerations. A not-so-obvious advantage is the fact that no high voltage is required for the transistorized transmitter, thereby eliminating the noisy and inefficient vibrator or heat-producing a.c. power supply.

The receiving section represents no great design problem. Transistorized receivers have been available for some time. The problems associated with generating 3 watts of r.f. output (with less than the maximum 5 watts input permitted by law) seemed almost insurmountable until recently.

Obviously, something has happened to change this situation. For some time semiconductor manufacturers have been producing rather amazing silicon switching transistors, but their primary market has been in the computer and military fields because of the high production costs. Because of stringent switching specifications, many of these transistors were not acceptable for their intended applications. Switching transistors have tight specifications on the delay, rise, storage, and fall times. The ability of the transistor to pass these tests depends on many things, among them junction capacity and resistance. Until recently the transistors which would not meet switching specs were considered "rejects" and therefore unusable.

"Grade-Outs"

A transistor which is not usable for its primary application and yet is acceptable for secondary service is called a "grade-out." Radio-frequency operation, particularly in class B and C, closely resembles the switching application since the transistor serves to turn the flow of current in the tank circuit off and on. It can be correctly assumed that a high-speed switching device would be quite useful in r.f. applications.

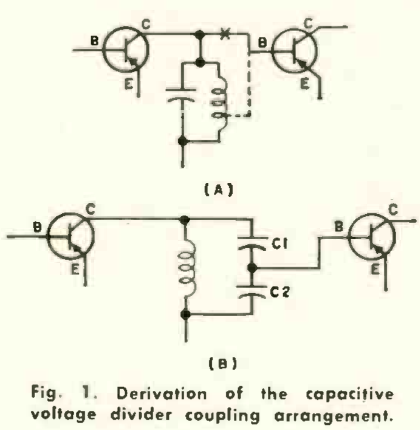


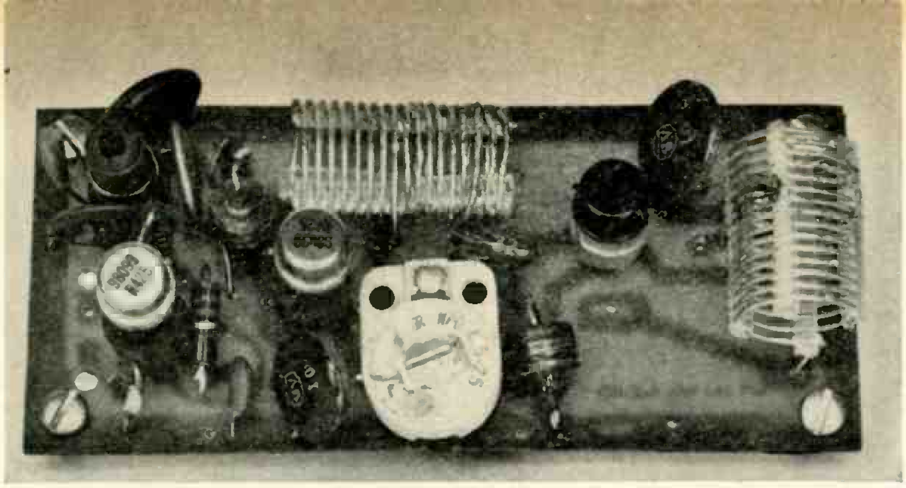
Fig. 1. Derivation of the capacitive voltage divider coupling arrangement.

In r.f. service the requirements on the transistor are less severe. For example, switching at high speeds requires that the transistor operate in low-capacity circuits. In r.f. service, however, the junction capacities can be made part of the tuned circuits that are employed in the equipment.

One of the most popular transistors for r.f. power amplifiers is graded out of the 2N696 family. The 2N696 is a silicon mesa switch which is capable of 2 watts dissipation at 25 degrees C, has a 60-volt collector breakdown rating, and can switch from one state to the other in less than 100 nanoseconds (a nanosecond is 1/1000th of a microsecond). In r.f. applications the 2N696, which has an output capacity of 20 $\mu\mu$f. and a maximum frequency of 200 mc., is capable of delivering more than one watt to a load at 27 mc. with a 12-volt supply. The 2N696, in fact, provides the basis for many of the "high-power" CB transmitters.

Capacitive Voltage Dividers

The capacitive voltage divider is a very popular technique for impedance



Experimental unit constructed by author to produce one-watt r.f. output power at 27 mc. Two germanium transistors are used to drive silicon power-amplifier stage.

matching and is almost universally used in the new high-power transistorized transmitters.

Fig. 1 shows the theory behind this matching network. With the collector and base connected to the top end of the tuned circuit, the parallel impedance of the collector and base determines the circuit impedance. Since the output impedance of the driving transistor is usually higher than the base input impedance of the following transistor, some method of impedance matching must be employed to bring about the greatest transfer of power. This is usually accomplished (see Fig. 1A) by breaking the connection at "X" and placing a tap on the coil (shown dashed). If the tap is at the center, the tap-point impedance will be one-fourth that at the top end. From a production standpoint, coils of this type are uneconomical because of the extra labor required in winding and wiring them. Further, production changes might require that the tap be moved.

Since a capacitor is required to block d.c. (not shown in Fig. 1 for simplicity), we can make the coupling capacitor serve a dual purpose. Fig. 1B shows a simple capacity divider. If the value of the two capacitors is equal, it is the same as placing a tap at the center of the coil. The impedance at the junction of the capacitors will be one-fourth that of the top impedance. If the ratio is two-to-one (C_2 twice the value of C_1) the impedance at the junction would be one-eighth the top impedance, and so on.

In practical circuits C_2 may be the base-emitter capacity of the driven transistor making it possible to eliminate a separate capacitor for C_2. Thus the value of C_1 can be adjusted to match the base impedance of the driven stage. In addition, this series capacity (C_1 plus C_2) can be used to resonate the coil at the signal frequency. In cases where there are large differences in impedance, which result in poor LC ratio, it may be necessary to use both the coil tap and the capacitive divider.

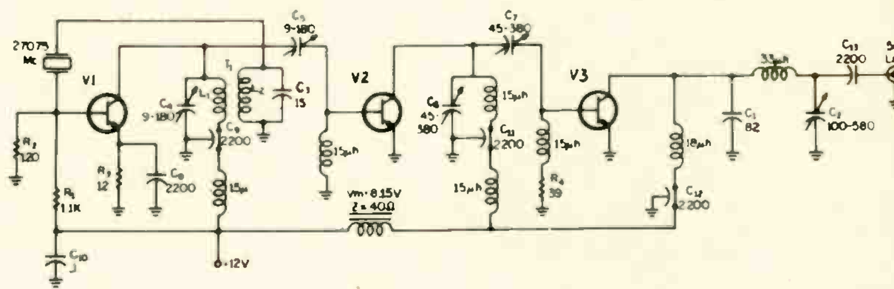


Fig. 3. All-silicon-transistor, 1-watt transmitter designed by Texas Instruments.

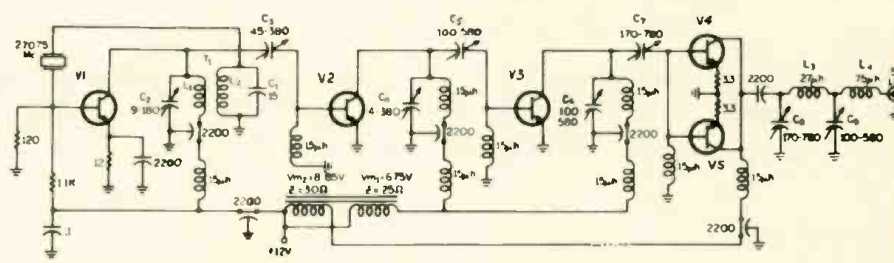


Fig. 4. Two-watt output CB transmitter circuit also developed by Texas Instruments.

Modulation

Generally speaking, it is more difficult to 100% modulate a transistorized transmitter than its vacuum-tube equivalent. On high modulation peaks the transistor may tend to saturate and lose h_{fe}, or gain, producing a flat-topping of the r.f. envelope. Further, during 100% modulation (sine-wave conditions) the collector voltage may reach four times the supply voltage. With speech waveforms it may exceed this value. Thus the transistor must have a V_{ce} rating in excess of 50 volts when operated on a 12-volt supply.

To 100% modulate a transistorized transmitter, it is usually necessary to modulate both the driver and the final amplifier. Some of the new transistorized CB rigs even go so far as to modulate the oscillator.

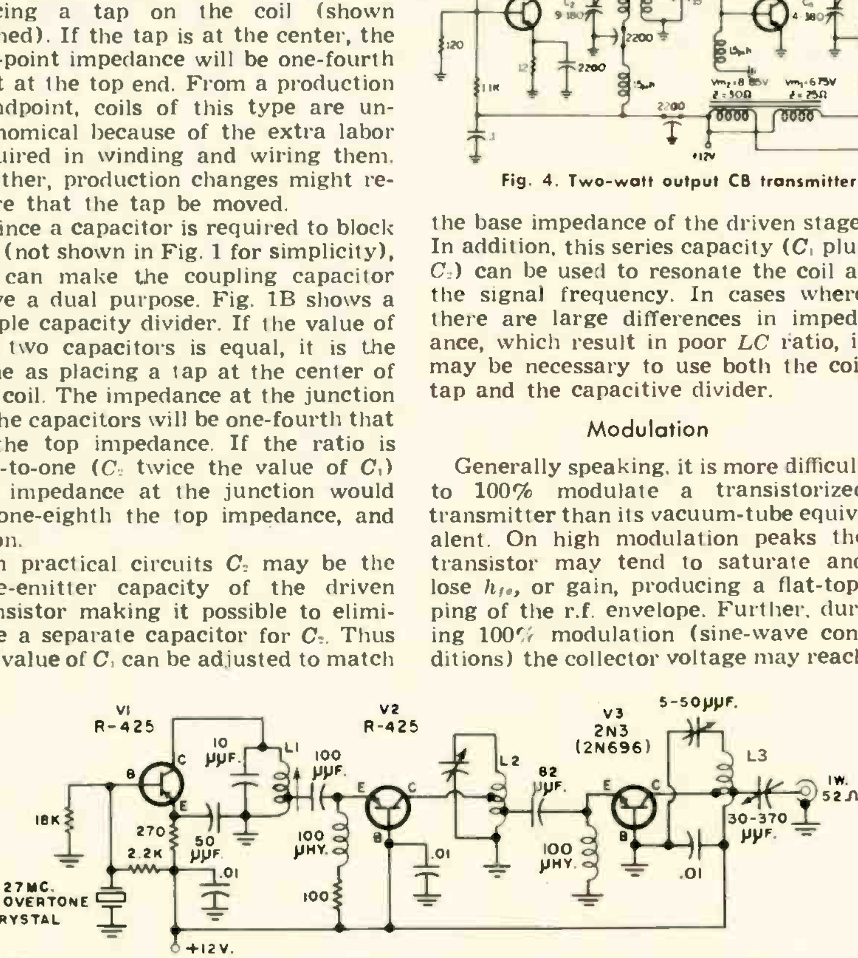
For simplification, no modulators are shown for the CB transmitter circuits to follow. In most cases the required modulation transformer impedance can be determined by dividing the collector potential by the collector current of the modulated stage, or stages. The amplifier gain is then adjusted for the required voltage to produce 100% modulation. As a rule of thumb, the driver stage (s) will require one-half the modulation voltage of the final amplifier.

Experimental Circuit

Fig. 2 is the circuit for a transistorized, 1-watt-*output* 27-mc. CB transmitter. The design should not be considered optimum and is not presented here as a construction project. But it was constructed by the author to determine what the 2N696 would deliver in a practical application. The fact that the transistor operating temperature never exceeds 45 degrees C (it is rated to 175 degrees C) indicates that maximum was not reached and far more output could be obtained with additional drive from the buffer/amplifier.

The oscillator uses an early *Texas Instruments* R-425 *p-n-p* germanium transistor as a common-base oscillator. Feedback takes place between the collector and emitter through the "built-in" capacity. The 50-$\mu\mu$f. capacitor shifts the feedback phase angle. The r.f. energy at 27 mc. appears across L_1 and is coupled to the buffer from a low-impedance point on the coil.

The buffer/amplifier operates common base and a 100-ohm resistor in the emitter path stabilizes the stage. The 100-μhy. choke prevents this resistor



L_1—15¾ t. #24 en. closewound on 5/16" p.c. slug-tuned form, emitter tap at 3¼ turns
L_2—17 t. #24 en. spaced dia. of wire, ½" i.d. (Air Dux #416), collector 8½ t. from cold end, emitter 2½ t. from cold end
L_3—14½ t. #24 en. spaced dia. of wire, ½" i.d. (Air Dux #416), collector-antenna tap 3 t. from cold end

Fig. 2. Schematic diagram of 3-transistor, 1-watt-output Citizens Band transmitter.

from loading the circuit. The buffer stage runs approximately 120 mw. input (10 ma. at 12 volts) and therefore the collector is tapped down the coil to provide a satisfactory loaded "Q."

The final amplifier is a silicon mesa *n-p-n* transistor derived from the 2N696 family which operates in the common-base configuration. No emitter stabilization is required because of the silicon characteristics and the high dissipation of the 2N696. The collector current of the final is approximately 100 ma. at one-watt r.f. output, indicating a rather good efficiency. The high efficiency is due, in part, to the fact that a considerable amount of the driving power appears in the output circuit.

The output impedance of the final is approximately 100 ohms and is close enough to 52 ohms to permit a capacitive matching system. The collector tap point is a compromise between harmonic suppression and tuned-circuit losses.

As mentioned earlier, both the driver and final must be modulated. This complicates matters somewhat since both *p-n-p* and *n-p-n* transistors are used. The modulation transformer must have two windings, one 1200-ohm impedance for the driver and the other 120 ohms for the final. Naturally the audio must be phased correctly so that the output of both stages increases at the same time.

Silicon One-Watt Transmitter

The circuit shown in Fig. 3 was developed by the Silicon Applications Group at *Texas Instruments* for commercial applications. The circuit will deliver more than one watt to the load at 27 mc. It differs from the preceding circuit in that silicon mesa *n-p-n* transistors are used throughout the entire unit.

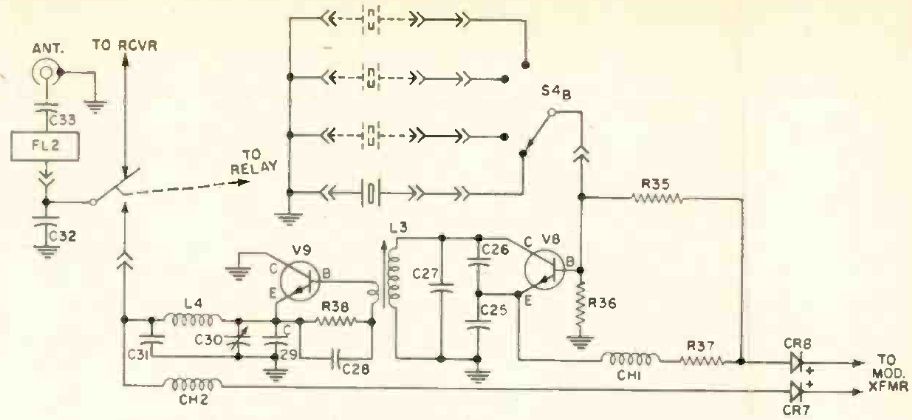


Fig. 5. Schematic of r.f. portion of Osborne transmitter, which uses two silicon transistors and develops 3.2 watts of peak envelope power output.

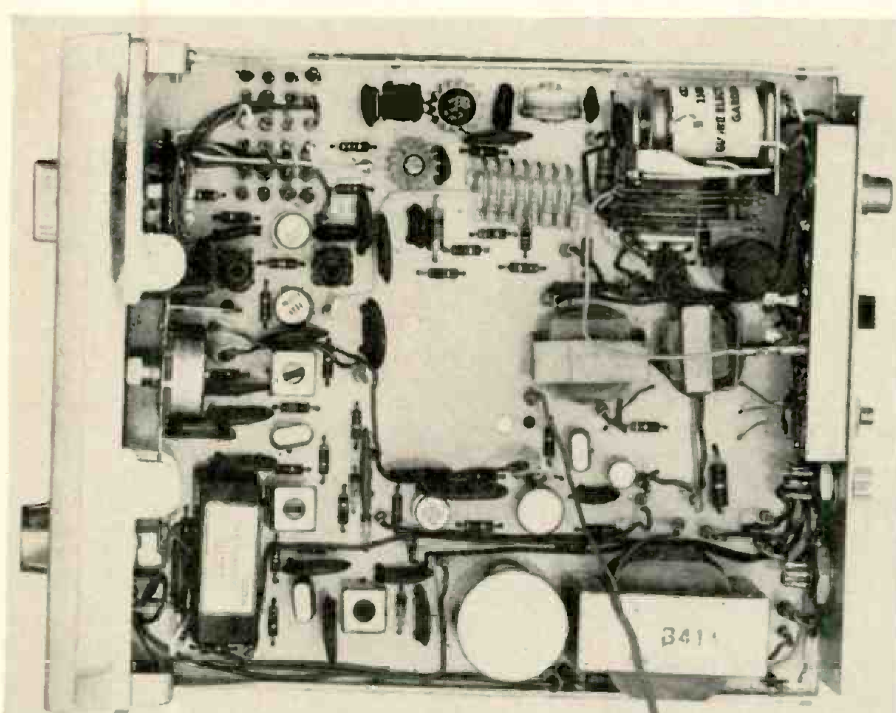
The crystal oscillator operates at a higher power level than in Fig. 2. This results in a lower circuit impedance and reduced feedback voltage. The oscillator coil is connected to produce an impedance and voltage step-up between the collector of V_1 and the crystal. The r.f. output is obtained at the low-impedance collector and coupled to the driver through matching capacitor C_5. The driver transistor V_2 operates in common-emitter configuration and requires no stabilization.

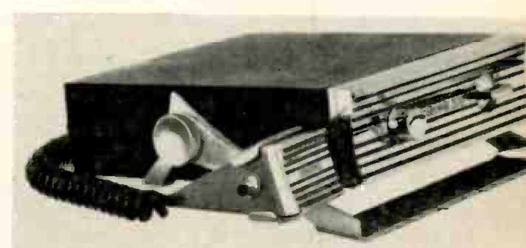
A second divider couples this stage to the power amplifier. Note that no forward bias is applied to the driver or final. The positive cycles of r.f. drive cause the transistors to conduct during a portion of the cycle. Self-bias is developed across R_4 due to base current flow which drives the transistor deep into the class C region.

The final also differs from the driver in that a *pi*-network is employed to match the final collector to varying antenna impedances. The required modulating voltage is also shown in Fig. 3.

Two-Watt Transmitter

Fig. 4 is the schematic diagram of a five-silicon-transistor, two-watt CB transmitter which was also designed by *Texas Instruments Inc.* The driving section is identical to that of the transmitter of Fig. 3, however two parallel amplifiers are used to increase the power output to the two-watt level. A 15-μhy. choke provides a d.c. return for the base current. The stage is driven into deep class C due to the voltage developed across the base emitter junction resistance. A 3.3-ohm resistor is used in each emitter lead to provide stabilization and a means of balancing unmatched transistors. Also, unlike the previous circuit, the low collector impedance requires that a double pi-coupling system be used between the transistors and feedline. If this is not done, the loaded "Q" of the tuned circuit will be too low to offer sufficient harmonic suppression.


Chassis view of the completely transistorized transceiver. A low-pass filter in the antenna circuit (on the chassis rear flange, at the right in the photo) prevents TV interference. Also, a special fixed-tuned Clevite ceramic i.f. filter (at the lower left-hand side of the photograph) produces good i.f. selectivity.

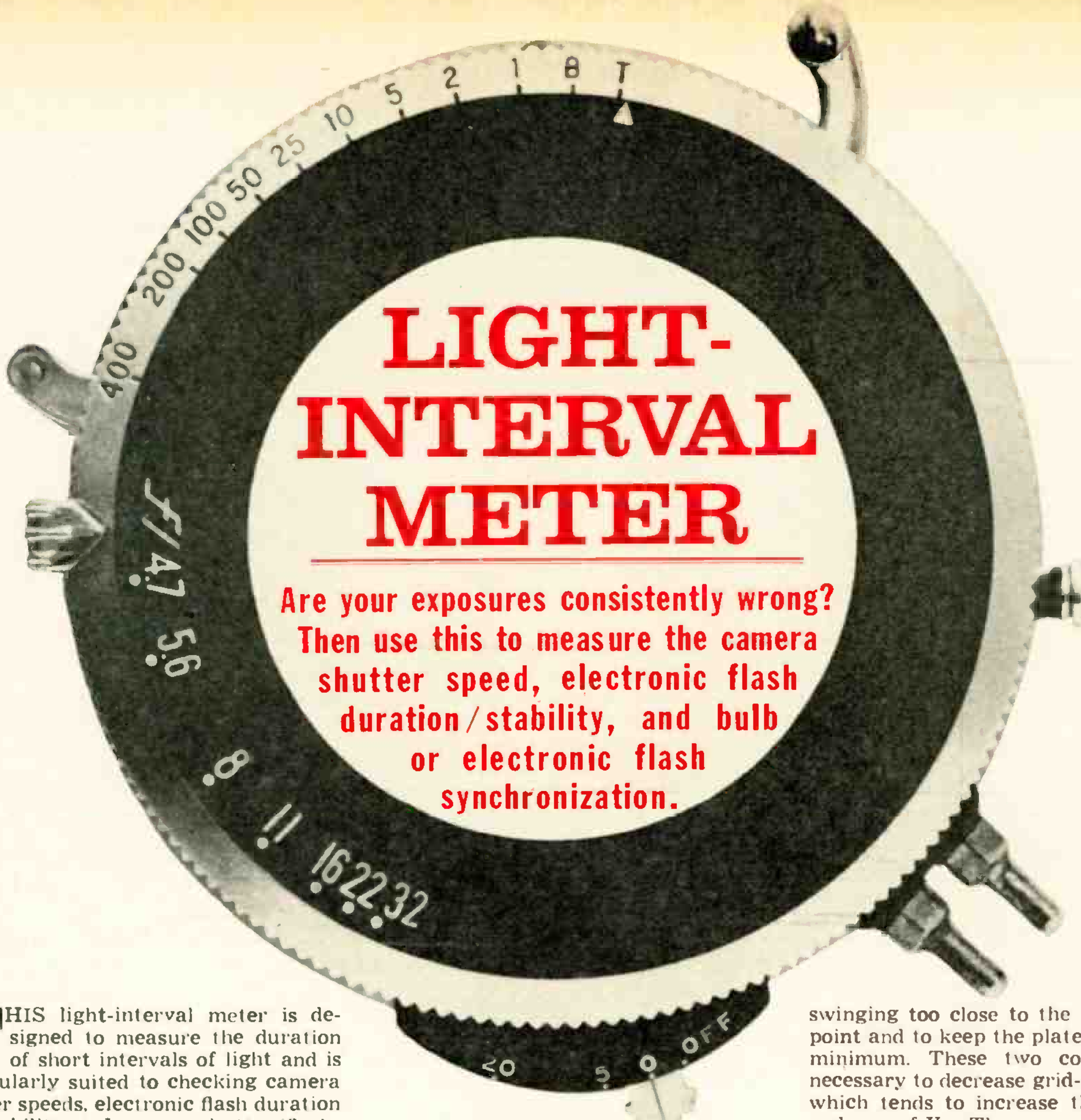

Example of an all-transistor transceiver.

To provide adequate depth of modulation, the audio waveform is applied to both driver stages. Source V_{m1} provides 6.75 volts r.m.s. at 25 ohms impedance. The final is driven from a 30-ohm source delivering 8.85 volts r.m.s. of audio signal.

The Osborne "300"

The *Osborne* Model 300 is worthy of special mention since it represents the first commercial unit to be offered in the high-power CB transistorized equipment market—at least as far as the author is aware. The circuit for the transmitter portion of the Model 300 is shown in Fig. 5.

Transistor V_8 is a silicon *n-p-n* type (*Continued on page* 77)



LIGHT-INTERVAL METER

Are your exposures consistently wrong? Then use this to measure the camera shutter speed, electronic flash duration/stability, and bulb or electronic flash synchronization.

By JOSEPH GIANNELLI

THIS light-interval meter is designed to measure the duration of short intervals of light and is particularly suited to checking camera shutter speeds, electronic flash duration and stability, and camera-shutter/flash-synchronization. The meter has a test range of 1 second to 1/10,000 sec. and an accuracy of ± 4.5% if the specified tolerances are adhered to for R_2-R_5 and C_2.

If you have ever had reason to suspect that your camera is not stopping action the way it should at fast shutter speeds, or if your exposures are consistently incorrect, a quick check with this meter will pin down the source of the trouble. If the camera's shutter is not opening just before and closing immediately after the peak light output of a flash bulb (see Fig. 1), the film will be only partly exposed. Again, this meter will reveal the trouble.

Circuit Description

The circuit (see Fig. 2) consists of a photocell (PC_1), an RC charging circuit (R_2-R_5, C_2), and a storage circuit which drives a linear meter circuit (an external v.t.v.m.). PC_1 is a vacuum-tube photocell, chosen for its rapid response. Its response is limited only by the electron transit time (10^{-9} sec.) and the total capacitance in parallel with it. PC_1's anode voltage is kept low (50 volts) to increase its reliability and to minimize ionization of residual gas. Excessive light levels will ionize gases thereby lengthening the duration of short light pulses because of the time required for the gas to de-ionize. To avoid this, light levels should be kept to approximately 0.12 lumen which will limit the anode current to 5 microamperes. This light level will produce a drop of 10 volts across R_1—the voltage level upon which the unit's calibration is based.

V_{1A} is a cathode-follower, required to match the high output impedance (approximately 8 megohms) of PC_1. Cathode-load resistor R_6 was chosen not for the best output impedance, but as a compromise to produce a load line that will prevent the input signal from swinging too close to the −1-volt bias point and to keep the plate current at a minimum. These two conditions are necessary to decrease grid-current flow, which tends to increase the input impedance of V_{1A}. The same applies to V_{1B} except that here these undesirable effects can be tolerated even less. Since a low input impedance at V_{1B} would discharge C_2, cathode-load resistor R_8 is a larger (30,000 ohms) value.

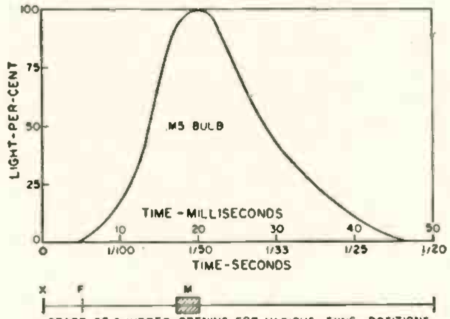


Fig. 1. Light output vs time. Peak output for a No. 5 bulb is at 1/50 second.

The output of V_{1A} is applied to the R_2-R_5 (only one, selected by S_2) C_2 network to provide a time-constant, (for example with R_2, C_2) of 1.5 sec. Three other resistors can be selected by S_2. If 10 volts is applied for 1.5 sec. to the R_2-C_2 combination, the voltage across C_2 will reach 6.3 volts exponentially in that time. A 10-volt pulse of shorter duration will result in a lower voltage across C_2. Since the RC charging circuit (R_2-R_5, C_2) causes C_2 to charge exponentially, the following formula can be used to determine the voltage across C_2 for other time intervals:

$$E_{C2} = E_B\ (1 - \epsilon^{-t/RC})$$

E_{C2} = the voltage across C_2, E_B = the applied voltage, ϵ = the base of natural logarithms (2.718), t = the time in seconds after the application of voltage, R = resistance (R_2 − R_5) in ohms, and C = capacitance (C_2) in farads.

In this meter's design, the 63% point of the exponential charging curve is never reached. C_2's charging time and voltage are limited to the 50% point of the curve to assure linear operation.

Diode V_2 provides a one-way charging path for C_2, thereby allowing C_2 to hold its charge even after the charging voltage has been removed. V_2 is operated at reduced filament voltage (approximately 4.5 volts) to minimize the effects of contact potential and gas ionization, both of which would discharge C_2.

If the recommended capacitor (C_2) is used, the meter indication will drop only about 2% one minute after the application of a light pulse. This is adequate time to make a reading.

"Reset" push-button S_1 discharges C_2 making it ready for another shutter-speed check. C_2's quiescent voltage will always be 4 volts since it is connected to V_{1B}'s cathode when S_1 is depressed. If C_2 were discharged to ground, there would be a time lag as it charged to 4 volts after S_1's release.

The meter drive circuit is a cathode-follower modified with feedback to oppose the reduction in cathode bias because of the applied signal. Neon lamps PL_1 and PL_2 drop the 150-volt "B+" supply to 30 volts for the meter-balancing circuit. Since neon lamps also act as voltage regulators, changes in the plate voltage of V_{1B} will also appear at the top of R_9. Neon lamps are superior to a resistive network in this feedback application as the latter would reduce the change at R_9, requiring changes in resistor values to produce the same amount of feedback.

The meter-drive circuit was designed for a v.t.v.m. with an 11-megohm input resistance. If the 10-volt scale of a 20,000 ohms-per-volt v.o.m. is used, increase the meter readings by 5%.

Construction

The author's unit was constructed on a flat metal chassis (Fig. 3); the photocell was housed in a cardboard box. The photocell plugs into an octal socket that is mounted on an "L" bracket and then cemented to the bottom half of the box. A shielded wire should be used to connect it to the timer. The top half of the box has a 1" diameter hole directly above the photocell. Other wiring is not critical.

Measuring Shutter Speed

When your unit is completed and the wiring checked out, open or remove the back of the camera whose shutter speed you wish to check and put it over the photocell opening as shown in Fig. 3. Connect the v.t.v.m., set to 10-volts d.c., to J_1 and J_2. A flashlight is used as the light source since an a.c. light source would produce a 60-cycle modulation error.

This is the procedure for checking compur shutters:

1. Depress and release "Reset" push-button S_1.

2. Adjust R_{10} ("Zero Set") to zero the v.t.v.m.

3. Set the camera diaphragm to about $f/5.6$.

4. Set the camera shutter speed to "Time."

5. Open the camera shutter and adjust the diaphragm opening until the v.t.v.m. indicates 10 volts.

6. Set S_2 and the camera shutter speed correspondingly.

7. Depress and release S_1.

8. Snap the shutter with a cable release so as not to move the camera.

9. Note the voltage on the v.t.v.m. and refer to the chart (Fig. 4) to determine the true shutter speed.

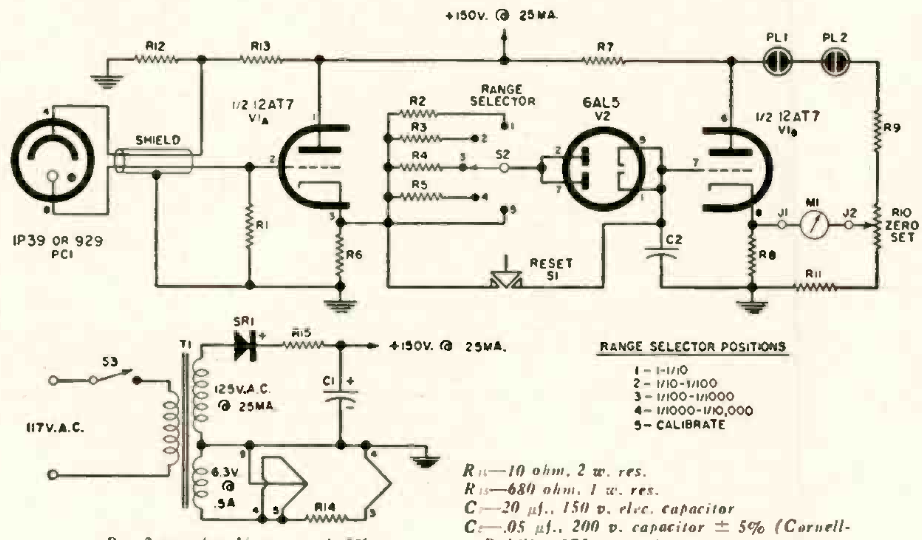
To check speeds of focal-plane shutters, it is necessary to cut a slot that is the same width as the slot in the shutter curtain. The slot is then taped with the opening across PC_1. The 10-volt calibration is then made with the curtain held directly over the slot across the cell.

Checking Speed and Stability

To check the speed and stability of an electronic flash, this test should be performed in subdued light with the photocell facing the flash unit on a table. A light attenuator made of a stack of file cards placed in front of PC_1 must be used to control the amount of light reaching the cell.

It is now only necessary to calibrate the output of the photocell to 10 volts. This is accomplished by resetting and zeroing the metering circuit and then setting S_2 to the "Calibrate" position. Fire the flash unit without disturbing its position on the table and note the meter reading. If the reading is above 10 volts, add a few file cards; if below 10 volts, remove file cards. Reset and

(*Continued on page 58*)



R_1—2 megohm, ½ w. res. ± 5%
R_2—30 megohm, ½ w. res. ± 1%
R_3—3 megohm, ½ w. res. ± 1%
R_4—300,000 ohm, ½ w. res. ± 1%
R_5—30,000 ohm, ½ w. res. ± 1%
R_6,R_7—5100 ohm, ½ w. res. ± 5%
R_8—30,000 ohm, ½ w. res. ± 5%
R_9—33,000 ohm, ½ w. res.
R_{10}—2500 ohm linear-taper carbon pot
R_{11}—8200 ohm, ½ w. res.
R_{12}—10,000 ohm, ½ w. res.
R_{13}—20,000 ohm, ½ w. res. ± 5%
R_{14}—10 ohm, 2 w. res.
R_{15}—680 ohm, 1 w. res.
C_1—20 µf., 150 v. elec. capacitor
C_2—.05 µf., 200 v. capacitor ± 5% (Cornell-Dubilier 2S5 or equiv.)
T_1—Power trans. pri: 117 v.; sec: 6.3 v. @ 1 a., 125 v. @ 25 ma. (Stancor PS-8416 or equiv.)
S_1—S.p.s.t. normally open push-button switch
S_2—S.p. 5-pos. rotary switch
S_3—S.p.s.t. toggle switch
SR_1—Silicon diode, 50 ma., 400 p.i.v.
PL_1,PL_2—NE-2E neon lamp
PC_1—1P39 or 929 photocell
V_1—12AT7 tube
V_2—6AL5 tube

Fig. 2. M_1 is an externally connected v.t.v.m. C_2 is available in 5% tolerance on special order. If C_2 is 10% and R_2-R_5 are 5%, the instrument's accuracy becomes ±10%.

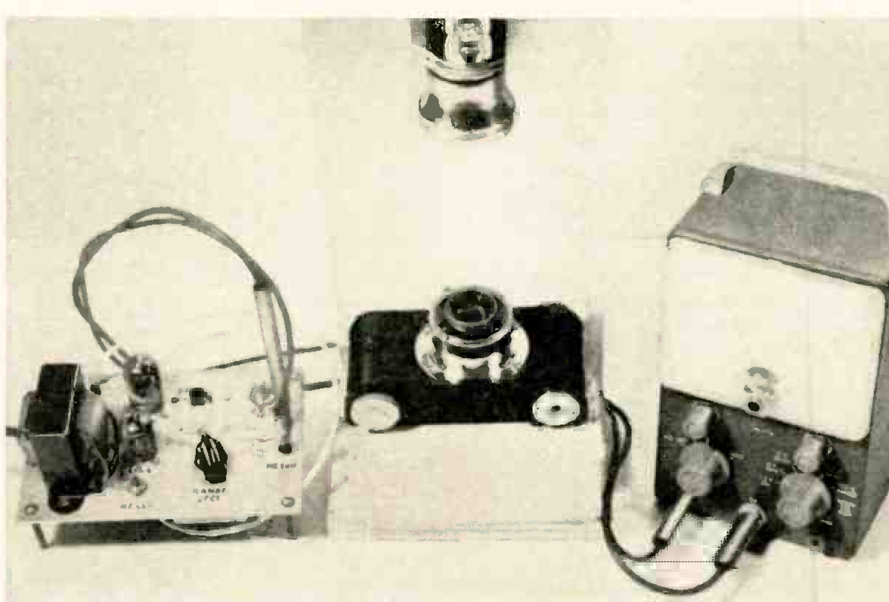


Fig. 3. Test set-up for measuring camera shutter speed. Photocell is located in box under camera. The flashlight is held directly over camera lens by wooden stand.

The mixer unit is placed between the two tape recorders. The mirror behind the mixer is used for speech-articulation practice for a near-deaf child.

MIXER FOR MULTI-USE AUDIO SYSTEM

By LEON WORTMAN

Construction of a simple mixer-control unit that can be used with several tape recorders, phono, and mike inputs.

AT the request of the parents of a near-deaf child, the system described here was designed and assembled to aid in teaching that child to develop his ability to articulate. That was the primary objective behind the development of this equipment which consists of the following units: two commercially manufactured tape recorders, an audio power amplifier, loudspeaker, two pairs of headphones, a record player, microphone, a mirror, and a specially designed mixer-control circuit.

A second objective was to provide a music-voice center for recording fun. The system offers a complete facility for dubbing tape-to-tape or disc-to-tape, for multiple music or voice recording, and for superimposing instrumental or voice on another recording. A third objective was to provide a complete high-fidelity music playback system for music on tape or records, strictly for listening. The fourth and final objective was to provide a setup for a public-address system with built-in recording facilities.

A requirement common to all of these objectives was the ability to mix and fade in or out of any of the sound sources—phono, tape, and microphone. Further, the entire setup had to be simple to operate so that non-technical personnel could use it after brief instruction. The system has been in operation daily for over a year and reports are that all of the stated objectives have been met satisfactorily.

Block Diagram

The block diagram of Fig. 1 indicates the relationships among the several components of the system. The tape recorders can be any commercial units with loudspeaker output. In operation as part of this system, the built-in loudspeakers are disconnected and audio outputs taken from the secondaries of the output transformers. Virtually all commercial tape recorders with built-in loudspeakers incorporate jacks that accomplish the disconnection simply by inserting a phone-type plug into the jack.

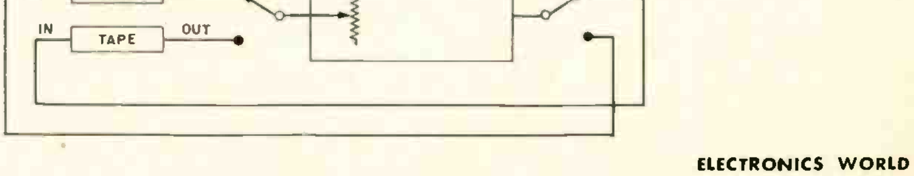
The phonograph pickup should be of the variable reluctance or other magnetic type: the microphone a high-impedance type such as crystal, ceramic, or reluctance. The power amplifier and loudspeaker can be any combination of units, depending only on the desired power and fidelity. The system described here uses a 10-watt high-fidelity amplifier and a 12-inch wide-range loudspeaker. The headphones for the "Mon." jacks should be high-impedance crystal or magnetic units. The ones for the "Aid" jack should be low impedance, matching the voice-coil impedance.

Mixer-Control Unit

Only the mixer-control unit is not commercially available. It is constructed on an 8" x 12" x 3" chassis following the circuitry given in Fig. 2. The cover is another chassis of the same size. A 4" x 1" aluminum strip is installed on the sides of the cover to provide a means for securing it to the chassis. A coat of gray enamel from a spray can applied to the cover gives the assembly a professional two-tone appearance.

The circuit uses two twin-triodes featuring low noise and low microphonics. A vacuum-tube rectifier is used in the power supply. Triode V_{1A} is the preamplifier stage for the phono cartridge. That stage incorporates the approximate equalization essential to proper response for variable reluctance and other magnetic cartridges. Triode V_{2A} is the microphone preamplifier. The tape recorders supply sufficient drive to make additional preamplification unnecessary. An attenuation pad is designed into the circuit to minimize residual hum and noise that may be detected in the output signals of the tape recorders.

Fig. 1. Block diagram showing how the mixer fits into the entire sound system.



Switch sections S_{1A} and S_{1B} select output signals from the "right" and "left" tape units. Sections S_{1C} and S_{1D} switch the output of the mixer-control circuit to the input of the desired tape recorder. Separate volume controls are mounted on the front of the chassis for the phono, microphone, and tape signals. This gives total flexibility for mixing, fading, and selecting the units for playing or recording.

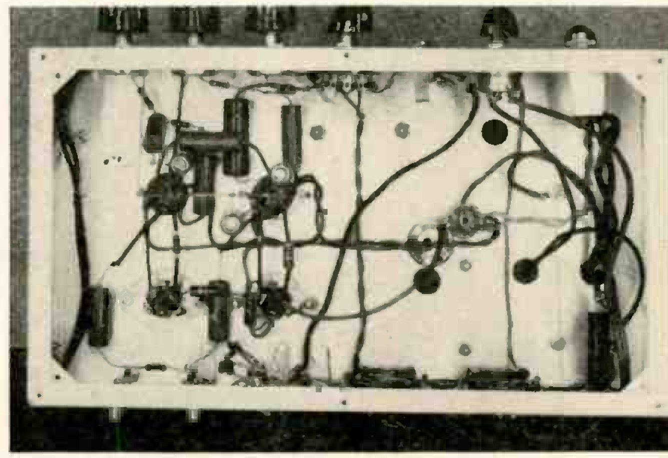
Triodes V_{1B} and V_{2B} are cascade-connected to provide voltage amplification for normal earphone monitoring and for inputs to the power amplifier and the tape recorders. Plugging the headphones into the "Mon.-1" jack automatically disconnects the input to the power amplifier. This prevents acoustic feedback between the loudspeaker and the microphone, should the operator be recording "live" while standing near the equipment. The "Aid" jack (at the output of the power amplifier) provides high audio power levels should they be necessary to permit the near-deaf pupil who wears the low-impedance headphones to hear the instructor's voice. It is usual for the instructor to use the microphone simultaneously with the pupil while both are looking at their reflections in the mirror to study the articulation. The instructor wears the high-impedance headphones which are plugged into the "Mon.-2" jack (also at the output of the power amplifier).

The schematic diagram shows the technique for selecting and mixing signals. Potentiometers R_{18}, R_{19}, and R_{20}, respectively, control the volume of the phonograph, microphone, and tape-recorder output. Note that R_{20} controls the output of the tape recorder that is in the "play" position only. (Only one of the two would be playing at any time.) Potentiometer R_{26} determines the output volume of the mixer signal being fed to the power amplifier. This control is out of the circuit when the headphones are plugged into J_1. Connection is made to the "Aux." or "Tuner" input jack of the power amplifier. Or it can be made to a high-impedance point in the power amplifier circuit immediately following any phono-preamp stage that may be used.

The tape recorder selector switch S_1 has three positions: #1 connects output of "right" tape machine to mixer, input of "left" tape machine to output of mixer; #2 connects output of "left" tape machine to mixer, input of "right" tape machine to output of mixer; and #3 disconnects outputs of both tapes and connects inputs of both tapes in parallel to the output of the mixer. Position #1 enables the operator to play a tape on the "right" unit and copy it on the "left" unit while, if desired, simultaneously using the microphone or phonograph for "recording over." Also, it enables the operator to play a tape through the system from the right unit. Position #2 transposes left and right units. Position #3 enables the operator to record on both tapes simultaneously; ideal for continuous recording of speeches or debates while the equipment is being used as a public-address system. One can go from one recorder to the other as a reel of tape ends without losing a phrase of the speech.

We leave it to your imagination to figure out all the ways this system can perform as a work tool, as an audio aid to education, or as just plain fun at the club or when the gang comes over on a Saturday night. ▲

Unit built by author is shown here with its cover removed.



Under-chassis view showing the simple, uncluttered wiring.

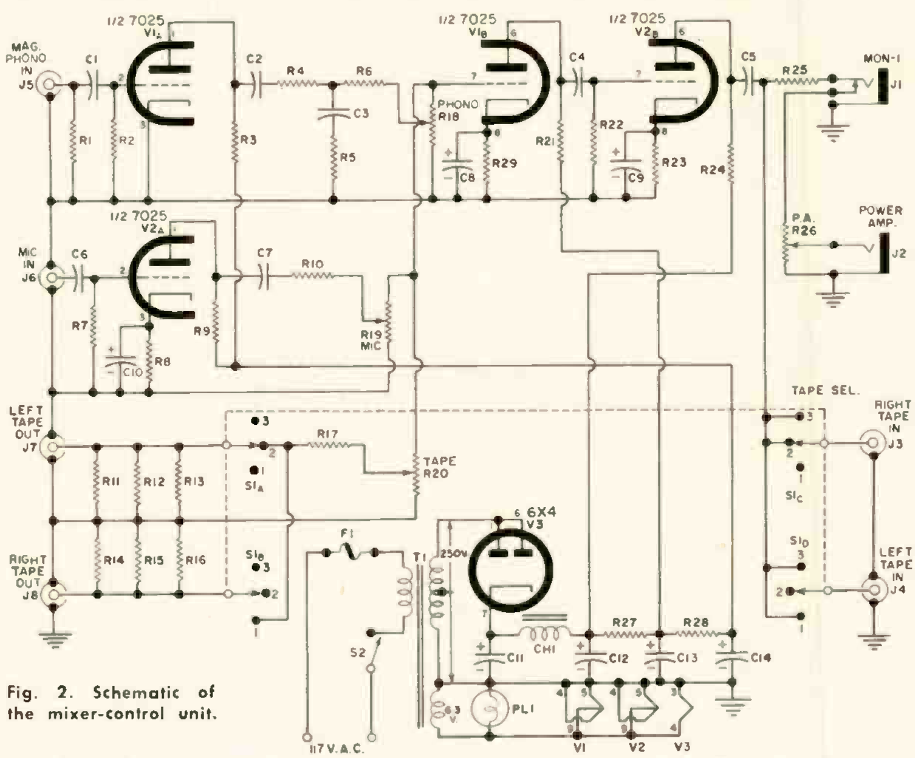


Fig. 2. Schematic of the mixer-control unit.

R_1, R_5, R_{25}, R_{28}—10,000 ohm, ½ w. res.
R_2—2.2 megohm, ½ w. res.
R_3, R_6, R_{21}, R_{24}—100,000 ohm, ½ w. res.
R_4—68,000 ohm ½ w. res.
R_7, R_{10}, R_{17}, R_{22}—470,000 ohm, ½ w. res.
R_8, R_{23}, R_{29}—1500 ohm, ½ w. res.
R_9—47,000 ohm, ½ w. res.
R_{11}, R_{12}, R_{13}, R_{14}, R_{15}, R_{16}—12 ohm, 1 w. res.
R_{18}, R_{19}, R_{20}—1 megohm audio-taper pot
R_{26}—500,000 ohm audio-taper pot
R_{27}—12,000 ohm, 1 w. res.
C_1, C_2, C_3, C_4, C_5, C_6, C_7—.01 µf., 600 v. capacitor
C_8, C_9, C_{10}—25 µf., 25 v. elec. capacitor
C_{11}, C_{12}, C_{13}, C_{14}—20/20/20/20 µf., 450 v. elec. capacitor
S_1—4-pole, 3-pos. rotary switch
S_2—S.p.s.t. switch (part of R_{26})
F_1—3 amp fuse
PL_1—#47 pilot light
CH_1—7 hy., 50 ma. filter choke (Stancor C-1707)
J_1—Closed-circuit phone jack
J_2—Open-circuit phone jack
J_3, J_4, J_5, J_6, J_7, J_8—Phono jack
T_1—Power trans. 125-0-125 v. @ 25 ma.; 6.3 v. @ 1 amp (Stancor PS-8416)
V_1, V_2—7025 tube
V_3—6X4 tube

THE PHOTOGRAPHIC OSCILLOGRAPH

By RAY A. SHIVER
Instrumentation Laboratory, AiResearch Mfg. Company

Description and applications of an industrial instrument that can record 50 or more channels of data and can produce quickly a permanent record of the test results.

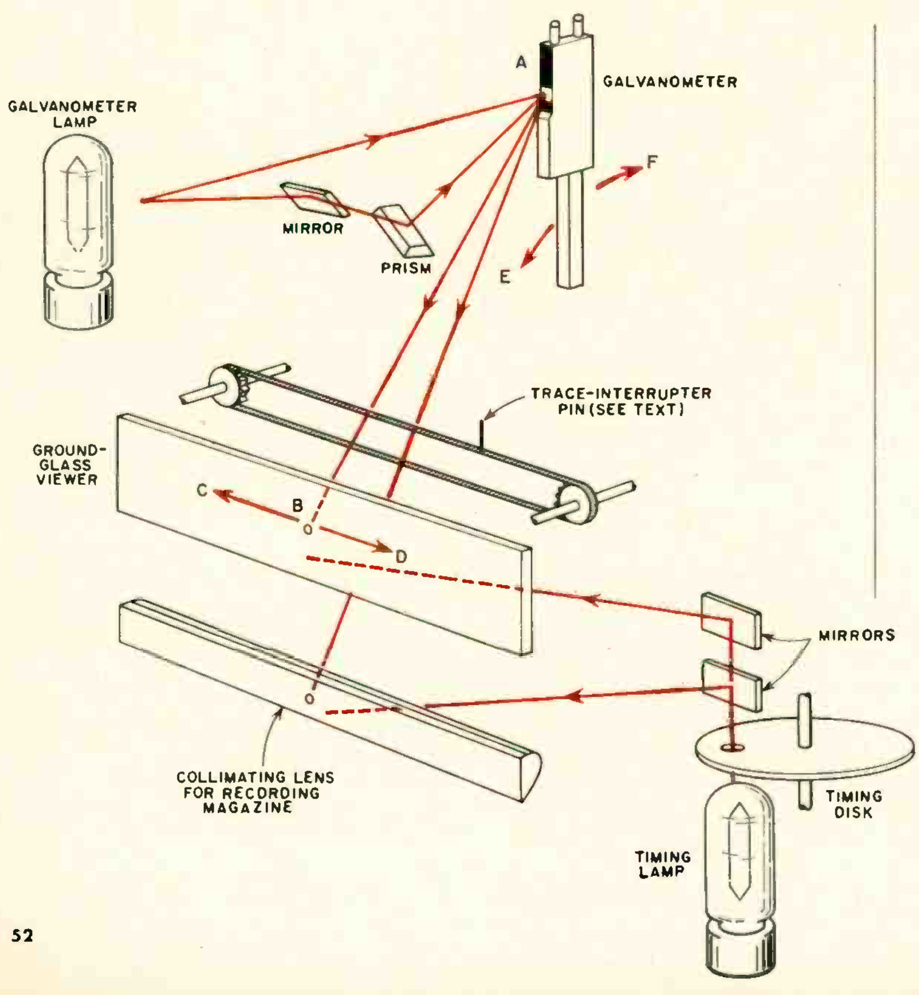
INDUSTRIAL testing requires the recording of great quantities of information in the process of developing new products. In the early days this was done by keeping a written log of all events throughout the duration of the test. As the art of testing progressed, it soon became an impossible job for a technician to keep track of the maze of dials, gages, and other instruments necessary for modern measurements. Thus a need arose for some type of instrument capable of recording many channels of data simultaneously and providing a permanent record of the results.

The photographic oscillograph was developed to fulfill these requirements. This instrument is capable of recording fifty or more channels of data and producing almost immediately a permanent record of the results. While not in itself an electronic instrument, it is almost always used in conjunction with electronic instruments, the type depending on the data to be recorded. It is also very useful for providing data read-out for instrumentation tape recorders. Tape recordings of high-frequency information can be brought into the recording range of the oscillograph by reducing the original tape speed to a point suitable for handling by the particular galvanometers in use (see "Tape Recording in Industrial Instrumentation," April 1961 ELECTRONICS WORLD).

The Writing System

In many respects the writing system of a photographic oscillograph is similar to an oscilloscope. We have a light beam (corresponding to the electron beam) which can be varied in intensity to suit particular requirements. A sweep system analogous to that used in the oscilloscope is provided by the movement of the recording film or paper as it passes the galvanometer light beam. The writing speed of the photographic oscillograph is determined by the response time of the particular galvanometer used, the paper speed, and the rating of the photographic paper or film. The use of present-day high-speed photographic materials, coupled with the development of miniature fast-response galvanometers permits accurate recording of signals from d.c. to as high as 10 kc.

Fig. 1 is an exploded view of the writing system in a photographic oscillograph. The light from the galvanometer lamp is reflected by the tiny mirror in the galvanometer onto a moving roll of recording paper. The distance from *A* to *B* is designated as the optical writing arm and determines the distance the light beam will travel along the path *C-D* while remaining in focus. A typical optical writing arm is 11.5 inches which provides a useful writing length, *C-D*, of about 4 inches. Precise focusing of



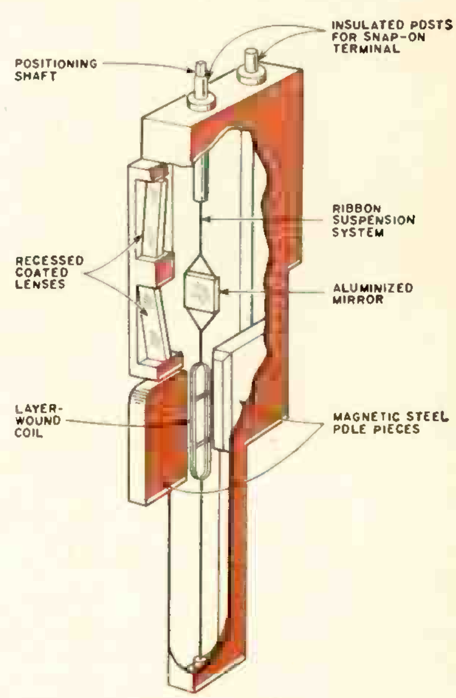


Fig. 1. (Left) Writing system that is used in the photographic oscillograph.

Fig. 2. (Above) Galvanometer construction details. When current flows through the coil, which is located between the magnetic pole pieces, it rotates and carries the aluminized mirror along with it.

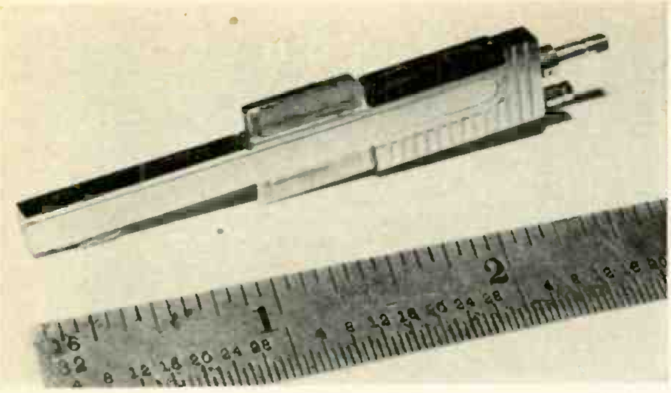


Fig. 3. A typical galvanometer employed in the oscillograph.

Fig. 4. Galvanometer block used in a typical oscillograph.

the light beam is accomplished by an adjustment which permits the galvanometer to be moved a short distance indicated by *E-F* on the drawing. A collimating lens provides pinpoint focusing of the light beam at the point of contact with the recording paper. When the galvanometer is properly focused, the light beam appears on the ground-glass viewer as a small spot about the size of a pencil point.

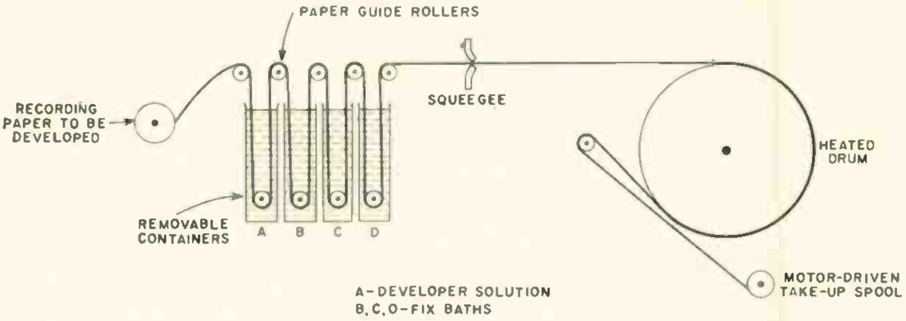


Fig. 5. Automatic processor used to develop, fix, and dry paper.

The Galvanometer

The photograph of Fig. 3 illustrates a typical galvanometer used in a photographic oscillograph. The construction is of the same quality and exactness as that found in a fine jeweled watch. An enlarged sketch showing the internal construction appears in Fig. 2. The mirror and coil bobbin are suspended by means of the thin supporting ribbon between the two magnetic pole pieces. The ribbon is anchored at the top of the galvanometer to a small adjustable shaft which provides a means of setting the no-signal reference point. Two small coated lenses are provided, only one of which is in use at a time. They are of different focal lengths and permit the galvanometer to be used in recorders with different length optical writing arms by simply rotating the quick-change lens turret. Electrical connections for the coil are brought out to the two small posts located on top of the galvanometer. A small snap-on cap with flexible leads provides final connection to the oscillograph.

Frequency response and sensitivity of the galvanometer are determined by the wire or ribbon support system and the characteristics of the coil itself. Since high sensitivity and frequency response are not compatible in the same unit, two types of galvanometers are available. For signal levels from a few microamperes up to about .5 milliampere, a d'Arsonval movement is used with a coil of many turns. The supporting ribbon is very thin, allowing the coil and mirror to deflect very easily for small signal currents. Frequency response for this type of instrument is very low, varying from d.c. to a maximum of about 400 cps. Galvanometers of this type are useful for direct recording from thermocouples, strain-gage pressure transducers, or any device capable of a few microamperes d.c. output.

Galvanometers capable of extended frequency response invariably have very stiff supporting structures for the coil assembly, in fact the supporting ribbon may actually serve as the coil itself, as is the case with the bifilar system. In this type of galvanometer the coil is formed from a piece of stiff ribbon wire into the shape of a hairpin with the ends securely anchored. The mirror is fastened at the center of the loop, forming a very rigid structure. This type of system is capable of quite high frequency response but requires fairly large amounts of driving power for a useful operating range. Thus the type of signal to be recorded determines the combination of galvanometer and electronics to be used. As we shall see in the section on a typical recording problem, many types of galvanometers are available to fulfill almost any recording requirement.

An important factor which must be taken into consideration when using galvanometers is the external damping required for proper operation. Simply stated, a galvanometer is said to be correctly damped when the impedance of the driving source matches the value of external damping resistance stated by the manufacturer for a particular type of galvanometer. Obviously, this cannot always be achieved and either series or parallel resistance must be added to provide the proper match. In general, for a driving source impedance less than the required damping resistance, a series resistance is added so that the total resistance reaches the proper value. Parallel resistance is added where the impedance is excessive. It must be remembered however that these compensating resistors will consume power, thereby reducing the amount of current available to drive the galvanometer. Thus a more sensitive galvanometer may have to be used to allow for losses introduced by the matching network.

High-frequency galvanometers, *i.e.*, those above 600 cps, require a different form of damping in order to achieve a flat frequency response. This is due to the fact that magnetically damped (with external resistors) galvanometers require decreasing values of damping resistance as frequency response increases. Above 600 cps, such a galvanometer would require a damping resistance that would consume almost all of the power available from the driving source. Therefore, internal fluid damping is used for all high-frequency galvanometers.

The fluid used for this purpose is a synthetic silicone oil which maintains a near-constant viscosity over a wide temperature range. However, since recording oscillographs are called upon to perform under a wide range of temperature conditions, even a small change in the viscosity of the damping fluid cannot be tolerated. For this reason, the temperature of the magnetic block which houses the galvanometers must be maintained at a fixed point irrespective of external temperature fluctuations. This is accomplished by the use of a thermostat-controlled block heating element which provides a constant block temperature when the ambient temperature falls below the fixed reference point. To prevent over-temperature excursions of the block, an air blower is provided which automatically operates if the ambient temperature exceeds the reference point.

The photograph of Fig. 4 shows the galvanometer block in a *Consolidated Electrodynamics Corp.* Model 5-119 oscillograph. A full complement of fifty galvanometers is installed in the block. If fewer than fifty active galvanometers are used, dummy units must be installed in the unused slots in order to maintain a uniform flux path. At each end of the block two static mirrors are provided for reference traces. These can be used to provide reference lines on the recording paper, thereby reducing the number of active galvanometers required for this purpose.

Paper Transport & Timing System

To be a truly versatile instrument, the oscillograph must be capable of a great variety of paper speeds from a fraction of an inch-per-second up to several hundred inches-per-second. This requires a very precise and rugged drive system capable of maintaining a constant drive speed for the recording paper or film. Speed ranges are selected by a quick-change gear system or, on some models, by individual push-buttons. The system for the oscillograph shown in Fig. 4 is pictured in Fig. 7, which is a front view of the instrument with the recording magazine removed. By a simple selection of two gears for *A* and *B* or *B* and *C* and the proper setting of the speed-range switch, all paper speeds can be covered.

The speed-range switch also permits the selection of one of two recording speeds without changing gears. This is always by a factor of ten. For example, if the recorder were set to record at a paper speed of one inch-per-second on the low-speed range, ten inches-per-second would be the result of throwing the selector switch to the high range. This is very convenient for catching transient signals when most of the recording time may require only a slow paper speed. *D* and *E* in Fig. 7 are spare gear holders only and have no connection to the drive system. *F* is the drive shaft which operates the photographic paper take-up and supply reels located in the paper magazine.

Timing reference lines on the oscillograph shown are furnished by a separate timing lamp and a rotating shutter assembly driven by a synchronous motor. This is illustrated in Fig. 1. Note that, like the galvanometer lighting system, two light paths are provided: one to the collimating lens for recording and the other to the ground-glass viewer for operator convenience. Timing lines are available on this model for .1-second or .01-second intervals and can be adjusted for full width paper coverage or for edge marking only. For paper speeds of several inches or more per second both timing intervals are generally used. In this case, the .1-inch-per-second lines appear on the recording paper much heavier than the .01-inch-per-second lines and the two can be readily distinguished.

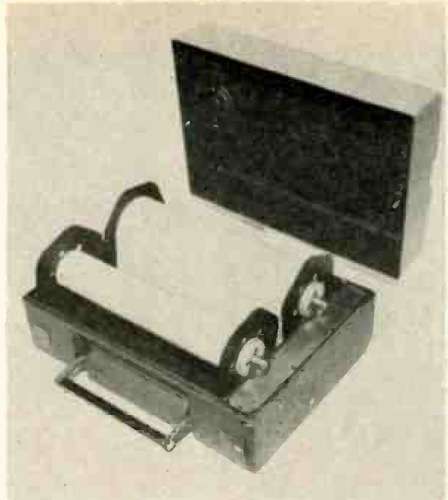


Fig. 6. The light-tight paper magazine.

For paper speeds below about two inches per second only the .1-inch-per-second lines are used and below about .5-inch-per-second paper speed no timing lines are used. For the extremely slow paper speeds an external one-pulse-per-second*timer is generally used, coupled to one of the active galvanometers. This can be simply a small synchronous motor with a cam-operated *Microswitch* and a source of d.c. voltage to activate the galvanometer.

An all-electronic timing unit is available as an accessory which provides all timing ranges from one inch-per-second up to .01 line-per-second. Another important feature of the recording oscillograph is an automatic "events" marking system which provides consecutively numbered recordings for convenient reference. This is accomplished by a small turns counter and a flash tube. The counter is visible to the operator through a small window located in the top of the recorder and at the same time an image path is provided through to the recording magazine. When the record switch is de-energized, the flash tube operates and the recording number is automatically photographed on the recording paper.

Processing the Recording

Once the recording paper has been exposed, it has to be developed and fixed in order to provide a permanent record. Since one recording may consist of a hundred or more feet of paper, it is obvious that ordinary hand developing methods are not very practical. For this reason an automatic processor is available which develops, fixes, and dries the paper in one operation. The processor contains several metal holders for the developer and fix solutions and a series of rollers to guide the paper through each stage of processing. This is shown in the drawing of Fig. 5. As the paper emerges from the processing tank, it is thoroughly dried by the heated drum and arrives at the take-up spool ready

(*Continued on page* 79)

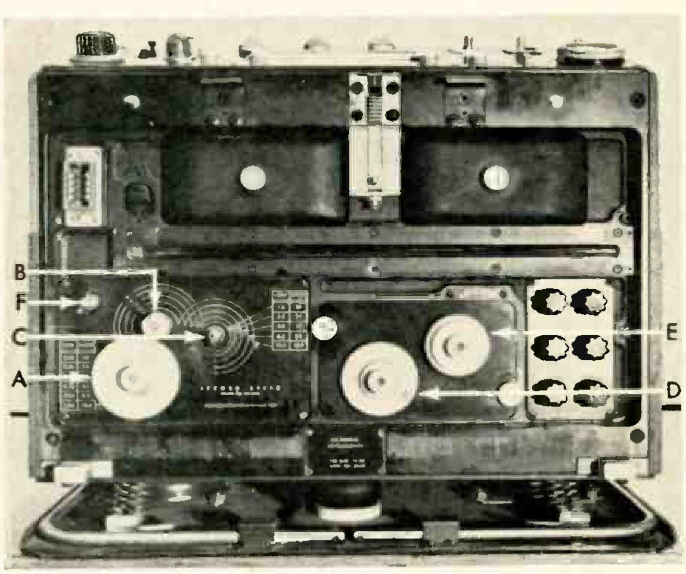


Fig. 7. (Above) Various ranges of sensitive paper speed are obtainable by the use of different interchangeable gear drives.

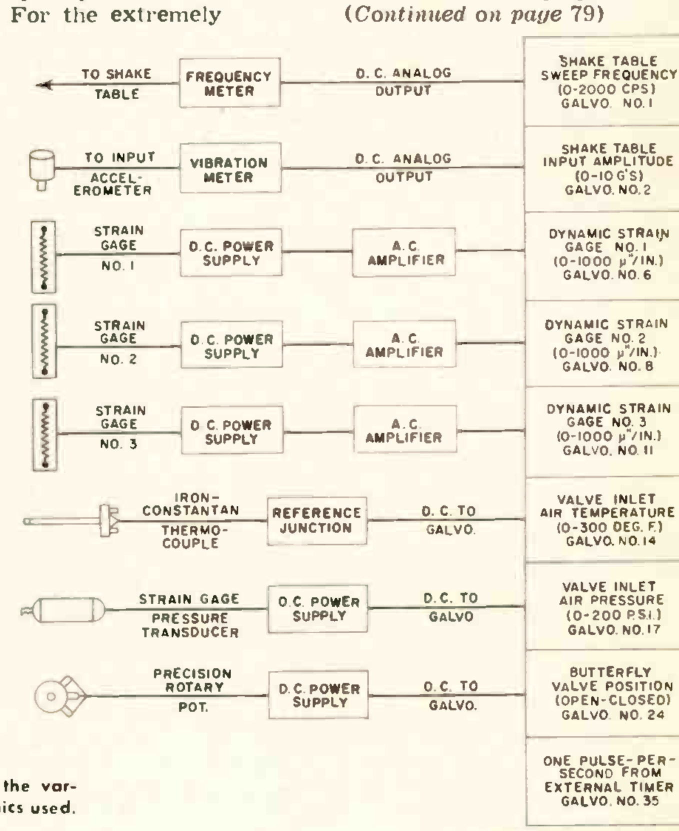


Fig. 8. (Right) Simplified block diagram that shows the various channels of data recorded along with the electronics used.

New Heavy Duty RFI Suppression Kit For Mobile Radio

RADIO HAMS, fleet owners, and CB operators can now enjoy clearer, more readable, less tiring mobile communications at longer effective ranges.

Sprague's new Type SK-1 SUPPRESSIKIT provides effective R-F Interference suppression—at moderate cost—up through 400 megacycles. Designed for easy installation on automobile, truck, or boat engines with either 6-volt or 12-volt generators, the Suppressikit makes possible high frequency interference control by means of Sprague's new, extended range, Thru-pass® capacitors.

The components in the SK-1 Suppressikit are neatly marked and packaged, complete with easy-to-follow installation instructions. All capacitors are especially designed for quick, simple installation.

The generator capacitor is a heavy-duty unit rated at 60 amperes, and will operate at temperatures to 125°C (257°F). This means you'll have no trouble with an SK-1 installation in the terrific temperatures found "under the hood" on a hot summer's day. There's no chance of generator failures from capacitor "short outs," as with general purpose capacitors. The Thru-pass capacitors for use on voltage regulators are also rated at a full 60 amperes.

The Deluxe Suppressikit is furnished complete with an 8-foot shielded lead on the generator capacitor which can be trimmed to necessary length for any car or small truck, preventing R-F radiation from armature and field leads.

Containing only 5 easy-to-install capacitors, the Deluxe Suppressikit is a well-engineered kit. The net price is a little higher than that of many thrown-together kits, but it saves you so much time and aggravation it's well worth the slight extra cost.

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

ON-LOCATION SOUND RECORDING

By **TOM ASHTON**
Sound Mixer, Warner Brothers Studio

Some problems and how they are overcome in motion picture sound recording that is done on the spot.

MOTION-PICTURE sound recording on location presents a number of problems and difficulties which must be overcome in order to secure satisfactory results. Modern wide-screen camera scenes make it almost impossible for the microphone to be placed as close to a player as it should be in order to obtain a clear, high-quality recording.

Because the microphone must be somewhat removed from the speaker it is necessary to raise the microphone gain control (mixer), often to the point where all other extraneous noises are greatly exaggerated—such as footsteps, the closing of a door, the sound of a typewriter, or the conversations of extras in the background. In order to minimize such unwanted sounds, slipper sox are pulled over actor's shoes, a bit of rubber tape is fastened to a lady's spike heels, door-checks and well-oiled hinges are the order of the day, or these noises are carefully timed to occur during breaks in the dialogue. In addition, a typist in a background scene must fake her typing or use an extremely "silent" machine; extras have to fake their conversations to avoid detracting from the main action. These are only some of the reasons why movie-makers insist on absolute silence on the sound stages and why a visitor to the set can often ruin a scene with a small cough or by making even a trivial sound.

The "Boom Man"

As the microphone has a certain area that is more sensitive than others, an experienced "boom man" (so-called because most of the mikes are mounted at the end of booms) can be of tremendous help in getting a top-quality recording. He is familiar with all of the tricks of microphone placement, the angles in relation to the sound source, and the effects of "kick-backs" from walls and furniture surfaces. His boom is so contructed that he can "face" or turn the mike from one player to another in order to get the best pickup. He must memorize the speeches of the players so that he will know at what point to turn the mike toward the next speaker. When two or more players are working close together he must know the best place for the microphone in order to split the sensitive area to cover both. If the camera zooms to another player in the background, it may be necessary to have another microphone near him and the sound mixer turned on at the right moment and with the right amount of gain to make the photographed scene realistic and lifelike.

On location we often use the mike on the end of an aluminum pole called a "fishpole." This is held by hand over the players—just out of camera range. This pole is frequently placed in the groove of a roller mounted in a stand or atop a folding ladder so it can be held and manipulated more easily. Keeping his pickup equipment just above the top line of the picture is one of the many things an experienced microphone man must know.

Both the boom man and the man at the mixer console must be constantly alert for sources of extraneous noise that will be recorded along with the voices of the stars and detract from the action. For example, the whirring sound of an electric fan may be completely unnoticed until half way through a scene the beam of the mike will pick up the sound and ruin the take.

Sometimes animals and/or children playing nearby have to be removed at a great distance from the action. Many times there is inductive interference such as the buzzing sound from fluorescent light starters or hum induced by fields from electric lines.

Hiding the mike on the player is one of the best ways to reduce interference from extraneous noise such as nearby generators or traffic which form a subdued but persistant background. However, the small mike must be placed in such a way as to have a clear path to the speaker's mouth and still not be visible in the picture. Also, it has to be placed in such a way that the actor's clothing does not rub over the face of the mike or cover it, which would cause the voice to be muffled and unintelligible. Another problem is to see that the cable taped to the actor's ankle doesn't trip him up or circumscribe movements called for by the script.

"Looping"

Many companies do most of their sound recording at the studio by "looping." The player listens to the recording made on location, one speech at a time, then repeats it until it approximates the original take, at which time it is re-recorded and the new dialogue replaces the original recording. Many persons claim this re-recorded material lacks the sponteniety and sparkle of the original dialogue—but this objection can often be overcome by careful direction and more time spent in "looping." ▲

Light-Interval Meter

(*Continued from page* 49)

fire again. For fine adjustment around 10 volts, move the flash unit a few inches closer or farther away from the cell.

The "Calibrate" position has a considerably shorter time constant and causes C_2 to charge to its peak value long before the light from the electronic flash extinguishes. A typical electronic flash has a light duration of about 1/2000 sec.

Once you have calibrated the meter, depress S_1, switch to the 1/1000-1/10,000 range, fire the flash gun, read the voltage on the v.t.v.m., and use the chart of Fig. 4 to find the flash speed. The stability test is a check on whether the electronic flash unit light output is changing in intensity or duration. This test is made by simply depressing S_1 and firing the flash unit several times while noting the meter readings. If the light output of the flash unit is stable, the meter readings will all be the same.

Flash Synchronization

The purpose of this test is to determine if the camera shutter is opening and closing at the peak of the flash; this is particularly important when shooting at fast shutter speeds. The following explanation will help in understanding the test procedure:

With S_2 set to "Calibrate," the circuit from PC_1 to C_2 has a time constant of 35×10^{-6} sec. (1/28,000 sec.). Light intervals of as short as 1/7000 sec. will therefore instantly charge C_2 to the peak of PC_1's output. Therefore with a flash gun aimed at the ceiling and fired with the camera shutter held open, the voltage at C_2 will follow the curve of Fig. 1 to its maximum point. (Fig. 1 is the plot of light *vs* time for an M5 flash bulb.) C_2 will then charge up to the peak of the light and remain charged after the light diminishes.

Now, since C_2 is capable of charging so rapidly, if the camera shutter is set to 1/500 sec., and if the shutter opens and closes at the peak of the flash, the indication on the v.t.v.m. should be the same as the indication when the bulb was fired with the shutter open.

Follow this procedure in subdued light:

1. Place the camera with its back open over the photocell and aim the camera and flash gun at the ceiling.

2. Set S_2 to the "Calibrate" position.

3. Depress and release S_1 and zero the v.t.v.m. with R_{10}.

4. Set the camera diaphragm to about $f/5.6$.

5. With the camera shutter held open, disconnect the flash-gun cord and manually flash the bulb. Be careful not to move the camera for the duration of the test.

6. The reading on the v.t.v.m. should be about 5-6 volts. If it is not, increase the diaphragm setting. Reset and fire another bulb. Repeat this procedure until the meter indicates 5-6 volts.

7. Reconnect the flash-gun cord to the camera, select the sync position on the camera, set the camera to the highest shutter speed, and flash a bulb toward the ceiling.

8. The meter indication should be the same as at step 6 if the shutter is synchronized.

You can see, then, by reference to Fig. 1, that if the shutter timing leads or lags the peak of the flash (using this particular bulb) there will be a

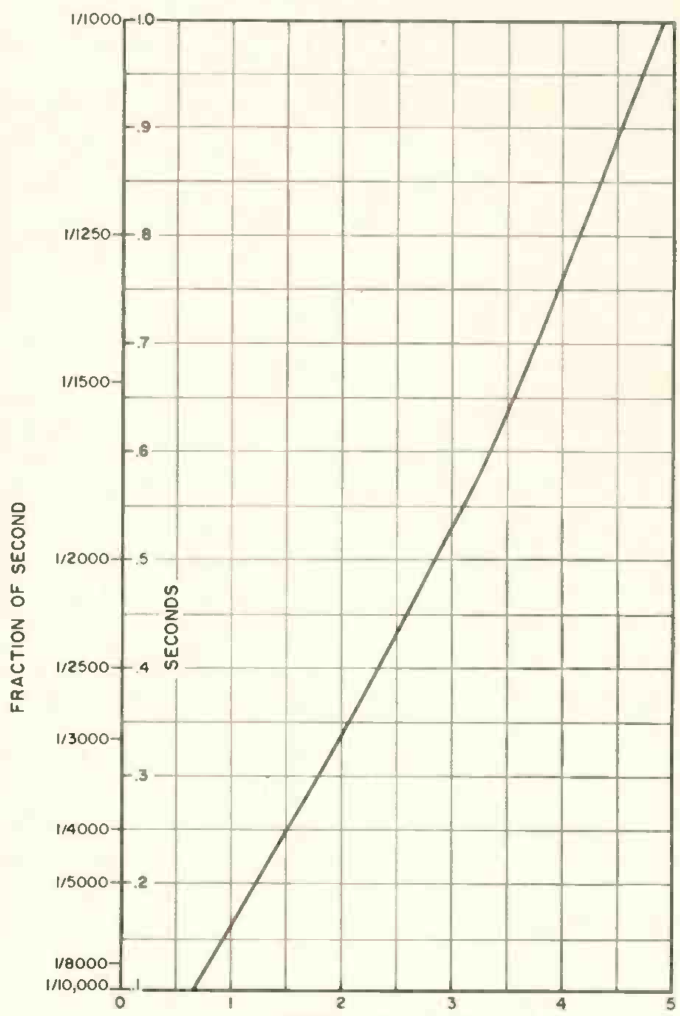
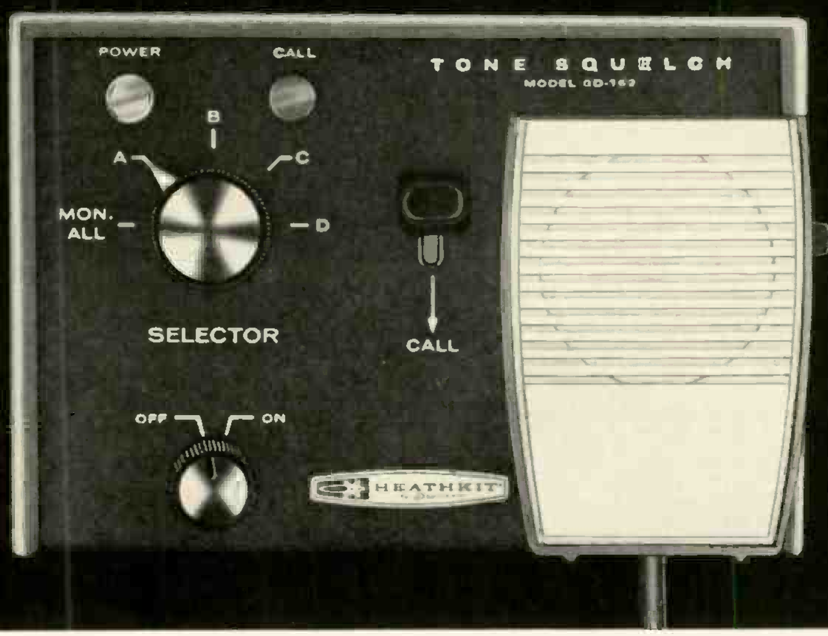
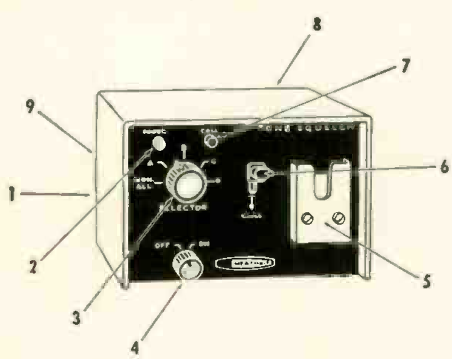


Fig. 4. Move the decimal point to correspond to the range setting of S_2.

First new concept in citizen's band equipment in two years! . . . Heathkit 4-Position Selective-Call kit



an exclusive with Heath, this inexpensive unit converts your CB station from "party line" confusion to "private line" calling convenience



FEATURES

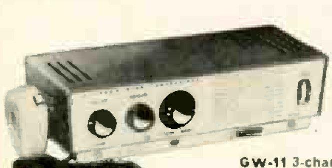
(1) squelch time-delay control. **(2)** power indicator, **(3)** tone selector switch (4 tones plus "monitor all" position), **(4)** tone squelch "defeat" switch for normal operation **(5)** "lift-to-operate" microphone bracket, **(6)** "call" lever **(7)** "call" indicator, **(8)** external alarm contacts to signal received call, **(9)** input and output level controls.

Here's welcome news for the serious user of Citizen's Band two-way radio. Heath's new Selective-Call Kit with tone squelch makes it possible for you to enjoy the calm of a CB station that is completely silent, yet ever alert for a personal call . . . makes it possible for you to call your choice of four specific units in your system at the touch of a button.

Using a unique new method, Heath's Selective-Call Kit features an *exclusive* 4-position rotary selected resonant-reed relay which responds only to calls transmitted by similarly equipped units using the same tone frequency. Upon receipt of the proper tone, your unit will automatically "come to life" permitting you to hear the call letters transmitted . . . you reply by merely lifting the microphone and acknowledging. At all other times, your station is peacefully quiet, allowing you to perform your job without one ear "cocked", for this unit does your listening for you.

To call another unit, just select the correct one of four tone frequencies, press the lever, and the called station will be waiting for you. Nothing could be simpler or more convenient. A "defeat" switch allows normal transceiver operation at any time. Equip all your CB units now with this economical new advance in communication ease . . . instructions included for installation with most popular CB transceivers using PTT.

Kit GD-162A (AC), no money down, $5 mo. **$33.95**; **Kit GD-162D (DC) $37.95**



GW-11 3-channel transceiver from **$69.95**

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Enclosed is $________; send________________

Name________________

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City________________Zone________State________________ reduction of the voltage indication in step 6.

This test will not tell if your camera shutter is leading or lagging the peak of the light—it merely indicates if it is missing the peak and by how much. If the test indicates incorrect synchronization, there are several steps you can take to correct this.

1. Select a different flash bulb. Manufacturers will supply curves of bulbs.

2. Select a different sync setting on the camera. Another may be better for the bulb you are using.

3. If you have installed the sync yourself, or have access to the contacts, try another timing position until the correct sync is obtained.

4. Have a camera technician adjust the shutter timing.

When checking synchronization of focal-plane shutters, put a slot over the photocell as you did during the test of shutter speed.

The procedure for checking flash synchronization of electronic units is the same as for bulbs, but with one exception: since the light *vs* time characteristic for electronic units is very much like a square wave, the effect of incorrect synchronization is more pronounced. Since the voltage reading during the sync test is only for comparison, a v.t.v.m. is not necessary; any 10-volt meter will do. ▲

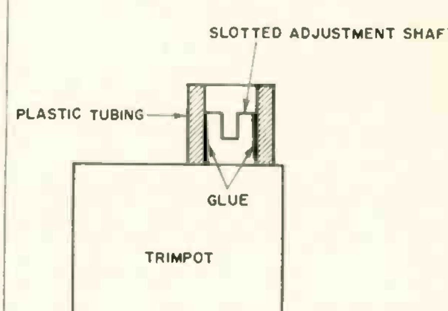
"TRIMPOT" ADJUSTMENT TIP

By ROBERT K. RE

MANY electronic devices use a type of potentiometer known as a "Trimpot." It has a small slotted adjustment shaft about 1/8" in diameter that protrudes 1/8" beyond the body. While adjusting the "Trimpot," the screwdriver often slides out of the slot—usually during a critical moment.

To solve this problem, slip a short piece of tubing (plastic, Bakelite, etc.) over the shaft. A dot of glue will prevent the tubing from coming off. The screwdriver will now stay in the slot and won't slip out during adjustments. Also, the tubing serves as an insulated fingertip adjustment.

This technique can be used for any adjusting screw where the technician must assume an awkward position or where adjustments must be made through a blind hole. ▲



Anode-Follower Preamp

(*Continued from page* 40)

plifier input when earphones are used. Because the monitor phones are connected directly to the preamplifier output stages, which are not capable of furnishing much power, distortion may be objectionable with low-impedance earphones. Crystal earphones are okay.

The low gain of each of the preamplifier stages, which results from the large amount of local feedback, is responsible for the more-than-usual number of tubes in the unit. The amplifier with which the preamplifier is to be used must be capable of furnishing sufficient power. The preamplifier draws about 2 amperes at 6.3 volts for the heaters, and requires a "B+" supply current that depends upon the "B+" voltage as shown in Fig. 3. A separate power supply can, of course, be built for the preamplifier. Little filtering suffices because of the filter sections built into the preamplifier; in fact, a simple rectifier with capacitor-input filter and one additional *RC* filter section is usually adequate.

The basic circuit of the preamplifier described in this article was the result of several months' friendly discussions between the writer and Mr. Jesse Bybee, associated with the *Cincinnati Division* of *The Bendix Corporation*. The writer wishes to express his gratitude for the contributions of Mr. Bybee.

The front panel for the experimental unit was designed with the assistance of Mel Levinson, industrial designer, and executed by *Metalphoto of Cincinnati Corporation*. ▲

REFERENCE

1. Baxandall, P. J.: "Negative-Feedback Tone Control," Wireless World, October 1952, pg. 402.

CB GROUPS TO MEET

M.C.E.U. (Mobile Civil Emergency Units), an organization of CB operators, will hold its National Jamboree in Syracuse, New York on July 6, 7, and 8.

The organization now boasts some 1800 members throughout the country. Both members and CB operators interested in joining are invited to the meet. Full details on the jamboree are available from Tom Wallace, 1203 Butternut St., Syracuse, New York. ▲

* * *

THE Wabash Valley CB Jamboree will be an all-day affair on Sunday, July 15 at Turkey Run State Park near Marshall, Indiana.

Sponsored by the Wabash Valley Citizens Radio League, the committee is planning a full program including games, drawings for prizes, displays of CB equipment, and entertainment for the whole family. Dinner will be served at the Inn but picnic tables will be provided for those who want to bring their own lunch and enjoy it in beautiful setting.

Additional information on this affair will be supplied by R. L. Winklepleck, 107 Berkeley Drive, Terre Haute, Indiana. ▲

Nuvistor Product Detector

(*Continued from page* 27)

nal and the local oscillator heterodyne to produce the audio output. The undesired heterodynes are filtered out of this stage, leaving a clean audio signal not dependent on the strength of the input signal.

In the unit described, the local oscillator is crystal-controlled to overcome the problems of stability that would be encountered from the beat-frequency-oscillator stage of the many different ham receivers. It also provides the proper injection voltage; thus even low-priced receivers can be used for single-sideband reception without trouble in keeping tuned to the station.

The nuvistor product detector, shown in photos, uses four 6CW4 nuvistors and yet is only 3½" square by 2¼" high. If it were not for the crystals, the total height would be only half as much. The nuvistor model works as well as the older models using conventional tubes, but is less than one-quarter the size. All power is obtained from the receiver; only 0.52 ampere at 6.3 volts and approximately 15 ma. at around 100 volts are required.

Construction

In the construction of the circuit, a fiber board is used with mounting lugs for all components. In the club project, this arrangement eliminated wiring errors. *Alden* No. 651T lugs are used in the model, but in their absence several pre-perforated boards and lugs are available in the ham market as substitutes. As a last resort, conventional solder lugs can be screwed to the board; the particular type of lug is not important, nor is the exact layout.

Mounting of the nuvistor sockets requires a little care because the sockets are too small to be bolted on and must be held to the mounting board by two bent lugs. It is best to drill a 31/64" diameter hole and then hand-file two notches for the lugs. At least one lug on each socket must be soldered to the ground lead to insure a ground for the nuvistor shell when it is plugged in.

The switch used to select the desired crystal is best mounted on the receiver panel, but should not be too far from the terminals. The choice of crystal frequencies is set by the receiver's i.f. One crystal should be above and one below the center frequency of the i.f. by about 1.5 kc. For the common 455-kc. i.f., surplus crystals for channel 45 and channel 329 are suitable. Other i.f. frequencies and their proper surplus crystals are shown in Table 1.

Operation

With no tuned circuits, potentiometers, or other adjustable components, this product detector is ready to operate as soon as it is wired up. The only precaution necessary is not to exceed the 6CW4's maximum plate-voltage rating of 110 volts. Actually, the detector works best at about 90 volts, and various values of R_7 can be tried after the unit is in operation. In some receivers, the value of capacitor C_2 may have to be changed to prevent application of too strong an input signal. The value should be adjusted to provide an input signal of between 0.2 and 0.4 volt at the grid of V_1. With the oscillator disabled by removal of V_4, no audio signal should be heard leaking through the cathode-followers.

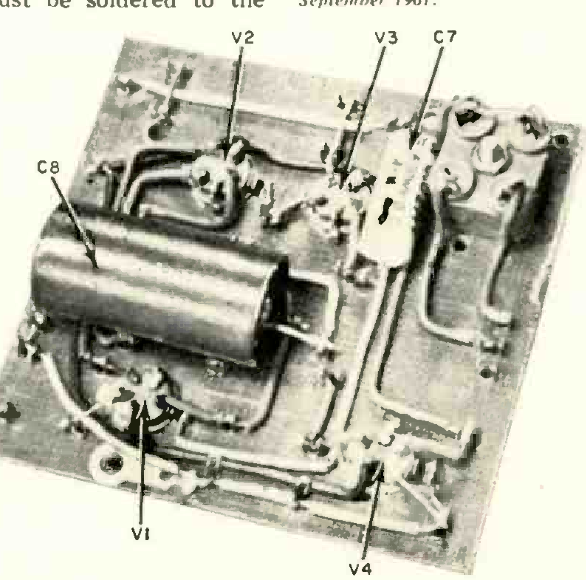
Sideband is here to stay. Let's convert those receivers over to receive it properly and at the same time get better continuous-wave and radioteletypewriter reception. ▲

Receiver I.F. (kc.)	Upper Sideband Crystal (kc.)	Lower Sideband Crystal (kc.)
455	453.7 (Ch. 45)	456.9 (Ch. 329)
915	913.5 (Ch. 87.7)	916.7 (Ch. 88)
500	498.1 (Ch. 69)	501.8 (Ch. 71)
456	451.166 (Ch. 327)	457.4 (Ch. 47)
1600	1598.5	1601.5

Table 1. Crystals required for various i.f.'s.

REFERENCES

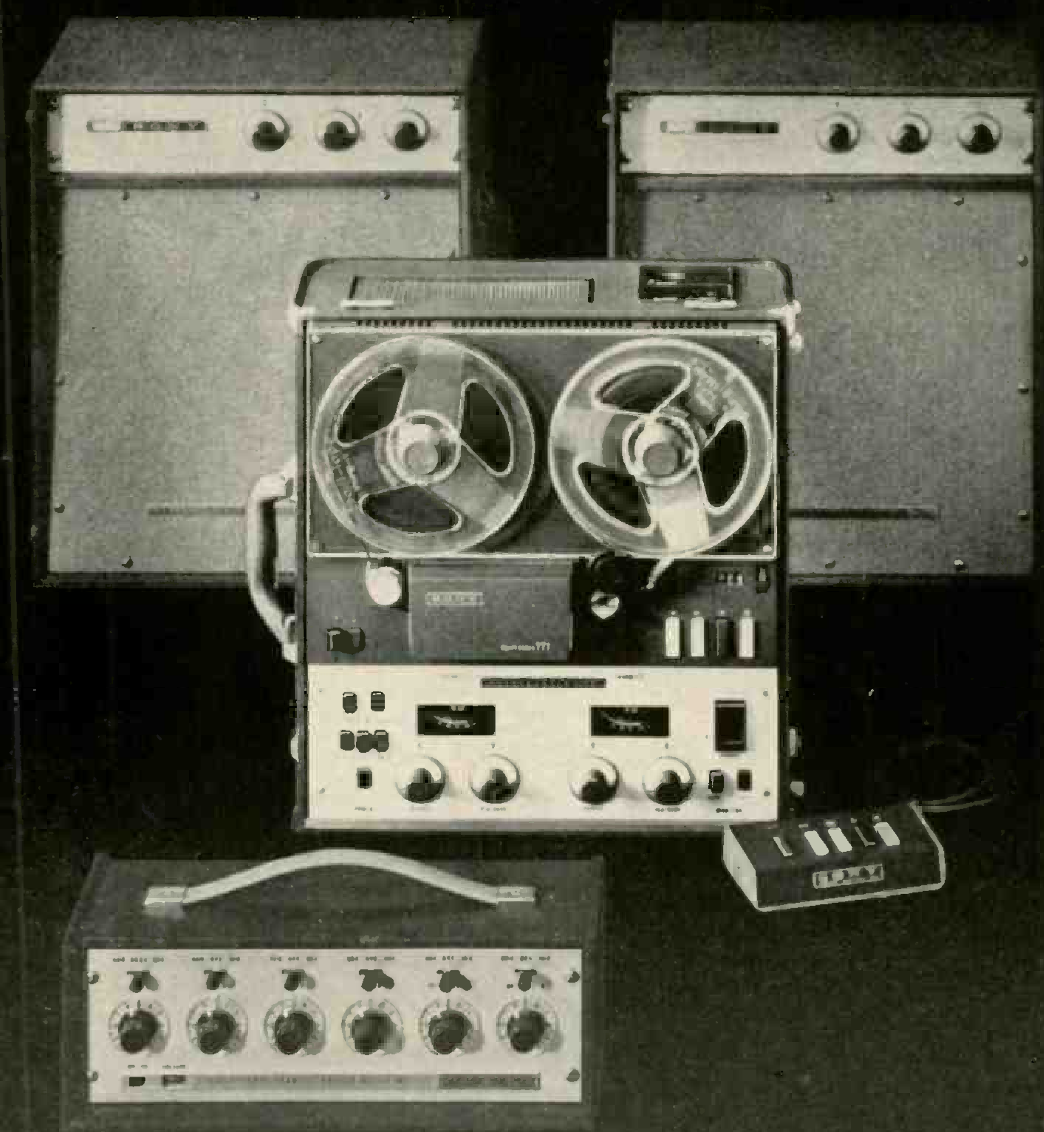
1. "*Nuvistor Two-Meter Converter*," *RCA Ham Tips, May 1961.*
2. "*Nuvistor Preamplifier*," *RCA Ham Tips, September 1961.*



Bottom view of the circuit board showing the various interconnections.

all-transistorized

New Sony Sterecorder 777



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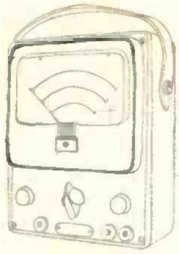
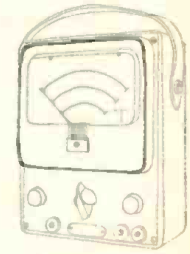
TRANSISTOR TEST TECHNIQUES WITH AN OHMMETER





By WALTER H. BUCHSBAUM
Industrial Consultant, ELECTRONICS WORLD

You can check more than shorted or open conditions with a simple ohmmeter. Semi-dynamic tests, including a rough gain check, can be made in or out of the circuit.

TUBE TESTERS have long been standard equipment in radio and TV service shops. With the advent of transistors, testers for the latter components are now readily available, but they are not yet in widespread use. One reason for this is the fact that many technicians still do not run into any sizable volume of defective transistorized equipment. Another reason is the understanding that the transistor, unlike the tube, is one of the least likely components in its circuit to be the cause of trouble.

Nevertheless occasions inevitably arise when the technician is stumped while working on a transistorized circuit or has some other good reason for suspecting the transistor itself. When such a point is reached, the technician involved may feel quite helpless without special equipment. After all, when a tube is under suspicion, much can be done even without a checker handy. A visual check (for lit filaments or gas) is helpful, and another tube of the same type is likely to be handy for a test substitution. With transistors, a visual check is not likely to be useful and a test replacement is not often on hand. In spite of this, a feeling of helplessness is quite unwarranted. An ordinary ohmmeter can go a long way as a transistor tester.

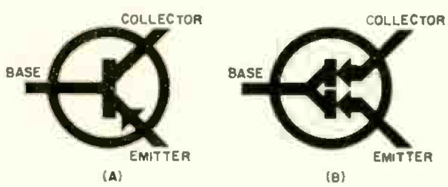


Fig. 1. A transistor (A) may be represented as (B) a two-diode network.

Test Requirements

Obviously not designed for the specific purpose of testing transistors, the ohmmeter will inevitably have certain shortcomings. It can scarcely check all characteristics, especially in the case of high-frequency and switching transistors, and it cannot give absolute readings. These functions are the province of specially designed equipment. But there are many simple transistor testers, quite useful for such run-of-the-mill types as are encountered in broadcast radio and audio circuits, that consist primarily of a low-voltage d.c. supply in conjunction with an indicating device, usually a meter movement. The conventional ohmmeter function of a multipurpose meter, being battery-operated, has this basic equipment.

Before the instrument's test leads are connected across a transistor, a few characteristics of the ohmmeter must be understood. Its internal test potential may be anywhere from 1.5 volts to beyond 6 volts. The higher potential, if used, is likely to be involved only on the highest resistance ranges. Some transistors may be damaged when potentials in excess of 6 volts are applied. To avoid damage due to excessive current, we would also want some current-limiting resistance in series with the ohmmeter's test voltage. Thus an inspection of the ohmmeter circuit will indicate which resistance ranges may be used and which avoided. In general, avoiding the highest resistance ranges (possibly excessive voltage) and the lowest (possibly excessive current) will be sufficient precaution. The $R \times 10$ or $R \times 100$ scales may be considered safe.

Polarity of the internal battery must also be considered. In most instruments, the ground or common lead (black) goes to the positive side of the battery, with the hot or red lead going to the negative side. If this situation is reversed, the user must be aware of the fact. In all tests to be discussed, references to a positive lead or connection, or to a negative lead or connection, are always related to the polarity of the *battery* rather than the identification of the lead, where these two factors do not agree with each other.

The Two-Diode Concept

It is common knowledge that a semiconductor diode can be checked by measuring its forward and reverse resistances and comparing these two readings. It is also reasonably well known that a transistor may be considered as a sort of two-diode device. Thus our first checks, involving separate examination of the diode sections, are scarcely revolutionary. To illustrate them, let us assume we wish to check a low-power *p-n-p* transistor, such as the 2N34 or 2N109, represented by Fig. 1A. One of the effective diodes, as shown in Fig. 1B, exists between base and collector connections; the other exists between base and emitter connections. Quite simply, if either of these diodes is defective (open or shorted), the transistor cannot function properly.

Thus, for our first test, we connect the positive lead of the meter to the base of our *p-n-p* transistor and the negative lead to the collector. Since we are thus trying to force a current through the base-collector diode in the reverse direction, we will get a high resistance reading if this diode is in good condition. The exact reading may vary depending on the characteristics of the ohmmeter as well as of the transistor, but a low-power type should generally read in ex-

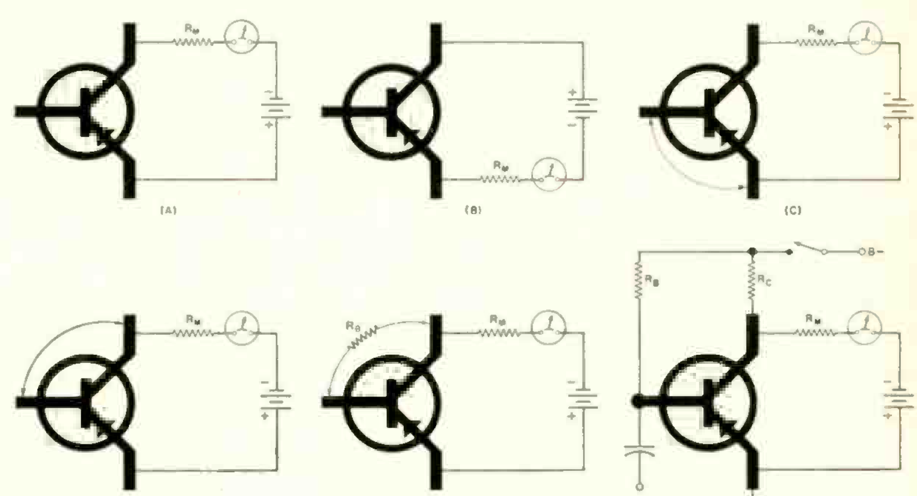


Fig. 2. Transistor-ohmmeter connections for various tests: (A) forward resistance, both diodes, base floating; (B) reverse resistance, both diodes, base floating; (C) cut-off, base shorted to emitter; (D) saturation, base shorted to collector; (E) conduction, with bias resistor; and (F) in-circuit. Polarities are for "p-n-p" types.

cess of 50,000 ohms with this polarity.

Next we reverse the polarity of the meter connections to the base-collector diode, permitting heavy current to flow. The resistance reading will now be quite low, something like 120 ohms. Aside from the specific values read, noteworthy here is the high ratio of reverse to forward resistance—in the order of 500:1 or greater. The two readings just referred to are recorded on the top two lines of Table 1, which is applicable to low-power *p-n-p* transistors generally.

The base-emitter diode can be checked in the same way we tested the base-collector diode. The third and fourth lines in Table 1 indicate connections for this check, forward and reverse, and the readings obtained. Note that the forward resistance of the base-emitter diode is slightly higher than that of the base-collector diode. This is normal for the low-power units.

As set forth so far, the readings we have taken apply only to a minority of the transistors that would ordinarily be encountered. For one thing, nothing has been said of *n-p-n* types. For low-power units in this group, such as the 2N35 and 2N1010, the base-collector and base-emitter diodes effectively have reversed polarity as compared to their counterparts in *p-n-p* transistors. Thus we can check them by reversing the polarity of connections. When this is done (the first four lines of Table 2 can be used as a guide to correct connections), the readings correspond to those obtained with the *p-n-p* transistors we are using for illustration.

We must also take separate account of transistors designed to handle more power than those already considered. Those used in audio-output and power-supply applications may fall into the medium-power and high-power class. However, circuit application is not a reliable guide. The manufacturer's ratings should be consulted when there is any doubt. Transistors with collector dissipation rated below 250 milliwatts may be considered low-power types. Where the rating exceeds 3 watts, we are dealing with high-power types.

To understand why power rating will affect resistance readings, we once more consider semiconductor diodes. A diode designed for use as a video or audio detector passes little current, whereas one intended for use as a power-supply rectifier will handle a current many times greater. This difference is reflected in both forward and reverse resistance readings. The detector diode will measure much higher than the "B+" rectifier. Similarly transistors designed to handle greater power will pass more current and show lower resistance values.

Tables 3 and 4 give ohmmeter connections and typical resistances measured respectively on *p-n-p* and *n-p-n* medium-power types. Readings for high-power transistors are given in Tables 5 and 6. Note how forward resistance of either diode section, for example, drops off from 120-140 to 80 and then 50 ohms as power rating increases. The same pattern is observed in reverse resistance readings. However, a helpful fact can be noted. Although there may be uncertainty concerning exact resistance readings obtained in any single measurement, there is a very clear relationship between forward and reverse resistance, with the latter being a few hundred times greater than the former. If this does not show up on a test, the transistor may be considered defective.

Advanced Checks

A transistor may be defective as an integrated component and fail to function even though each of its diode sections individually checks out. Still using nothing more than the ohmmeter, we can check the component as a whole. The next most obvious reading is across both diodes at once, or from emitter to collector, and the voltage polarity to choose is that used in normal circuit operation. This is shown for a *p-n-p* type in Fig. 2A, but the connections are recorded for all types on the fifth line of each table. The condition of the base, which is left floating at this point, is important. For a normal transistor there should be some conduction, reflected in the resistance readings on line 5.

Reversing the polarity of connections (Fig. 2B for a *p-n-p* unit; line 6 in the tables) should cut off a good transistor, or give a substantially higher resistance reading. But we can go further than this. Can the transistor be cut off properly in normal use? To determine this, we restore "normal" polarity to the emitter and collector connections, but we short the base to the emitter (Fig. 2C; line 7 of the tables). This applies cut-off bias to the operating transistor, and should produce the same high-resistance reading obtained when reverse voltage is applied across the entire component. Compare the readings on lines 6 and 7.

It is also possible to see whether a transistor goes into saturation by connecting the base to the collector, as in Fig. 2D. With maximum current flowing (line 8 in each table), the resistance reading is normally the lowest obtained in any of the test set-ups for each transistor type. Now we can understand why it is so important to use an ohmmeter scale that insures adequate current-limiting resistance in series with the battery and the meter movement. Excessive current may otherwise do some damage.

It might be mentioned that this last check, in conjunction with the one made

Reference charts with test connections and readings for various transistor types.

Test Step	Meter Connections B	C	E	Ohmmeter Reading	Fig. Ref.
1	+	−	none	50k+	1B
2	−	+	none	120Ω	1B
3	−	none	+	140Ω	1B
4	+	none	−	50k+	1B
5	none	−	+	6k	2A
6	none	+	−	50k	2B
7	+	−	+	50k	2C
8	−	−	+	100Ω	2D
9*	−	−	+	2k	2E

*R_B from base to collector = 100k

Table 1. Low-power "p-n-p" (2N34, 2N109).

Test Step	Meter Connections B	C	E	Ohmmeter Reading	Fig. Ref.
1	+	−	none	50k	1B
2	−	+	none	80Ω	1B
3	−	none	+	80Ω	1B
4	+	none	−	50k	1B
5	none	−	+	2k	2A
6	none	+	−	20k	2B
7	+	−	+	20k	2C
8	−	−	+	50Ω	2D
9*	−	−	+	200Ω	2E

*R_B from base to collector = 10k

Table 3. Medium-power "p-n-p" (2N68, 2N143).

Test Step	Meter Connections B	C	E	Ohmmeter Reading	Fig. Ref.
1	+	−	none	30k	1B
2	−	+	none	50Ω	1B
3	−	none	+	50Ω	1B
4	+	none	−	50k	1B
5	none	−	+	100Ω	2A
6	none	+	−	5k	2B
7	+	−	+	5k	2C
8	−	−	+	7Ω	2D
9*	−	−	+	10Ω	2E

*R_B from base to collector = 1000 ohms

Table 5. High-power "p-n-p" (2N301, 2N458).

Test Step	Meter Connections B	C	E	Ohmmeter Reading	Fig. Ref.
1	−	+	none	50k+	1B
2	+	−	none	120Ω	1B
3	+	none	−	140Ω	1B
4	−	none	+	50k+	1B
5	none	+	−	6k	2A
6	none	−	+	50k	2B
7	−	+	−	50k	2C
8	+	+	−	100Ω	2D
9*	+	+	−	2k	2E

*R_B from base to collector = 100k

Table 2. Low-power "n-p-n" (2N35, 2N1010).

Test Step	Meter Connections B	C	E	Ohmmeter Reading	Fig. Ref.
1	−	+	none	50k	1B
2	+	−	none	80Ω	1B
3	+	none	−	80Ω	1B
4	−	none	+	50k	1B
5	none	+	−	2k	2A
6	none	−	+	20k	2B
7	−	+	−	20k	2C
8	+	+	−	50Ω	2D
9*	+	+	−	200Ω	2E

*R_B from base to collector = 10k

Table 4. Medium-power "n-p-n" (2N144).

Test Step	Meter Connections B	C	E	Ohmmeter Reading	Fig. Ref.
1	−	+	none	30k	1B
2	+	−	none	50Ω	1B
3	+	none	−	50Ω	1B
4	−	none	+	50k	1B
5	none	+	−	100Ω	2A
6	none	−	+	5k	2B
7	−	+	−	5k	2C
8	+	+	−	7Ω	2D
9*	+	+	−	10Ω	2E

*R_B from base to collector = 1000 ohms

Table 6. High-power "n-p-n" (such as 2N326).

in Fig. 2A (line 5 of the tables) can be used for an indication of *beta*. The reading in the first set-up (from emitter to collector with base floating) is noted. Then the base is shorted to the collector. The greater the meter swing, the higher is the *beta* of the transistor. This fact may be used when a number of transistors of the same type are being screened to select the one with the highest *beta*. It may also be used, when a transistor is suspected of having low *beta*, by comparing the readings obtained on it with those taken on another of the same type known to be good.

In actual circuit applications, we do not find a transistor base connected directly to the collector supply, as was done in the test. This connection is usually made through a biasing resistor or network. The condition can be simulated by using resistor R_B instead of a shorting bar (Fig. 2E) from base to collector. While this prevents saturation, it nevertheless permits enough current flow to reduce resistance readings (line 9 of the tables) well below those obtained with the floating-base test. Note the different values of bias resistor recommended for the different power classes. For a low-power transistor, anything less than 100,000 will probably permit enough current to approximate saturation. Decreasing resistance for higher-power types permits more current to flow.

In-Circuit Testing

When equipment uses transistor sockets, it is quite easy to remove the components for testing them out of their circuits. However, it is quite common to find the transistors soldered directly into the circuit. When this is the case, especially where printed wiring is involved, testing in the circuit will be much preferred if at all possible.

The basic methods already described still hold true, but they must be modified somewhat to take into account circuit elements that may be associated with those being measured. Take the in-circuit transistor in Fig. 2F. With the regular power of the equipment turned off, ohmmeter battery power is applied as shown between emitter and collector. This is a typical situation where a base bias resistor and a collector resistor are used. The combination of these two will be in place of the resistor used in the external test of Fig. 2E, approximating the test condition of line 9 on the tables. The saturation test (Fig. 2D, line 8) is readily performed by shorting base to collector. The cut-off test (Fig. 2C, line 7) is easily performed by shorting base to emitter. In the latter, we still have a path from base to collector, through R_B and R_C, to reckon with. However the values of these two is usually made sufficiently high relative to the transistor type used so that the cut-off condition can be achieved readily. In other circuits where voltage dividers are used to provide base bias, their resistance can similarly be taken into account. Where an emitter resistor is used, the ohmmeter lead can be connected directly to the emitter or the resistor can be shorted out for testing.

Conclusion

If one wished to be more thorough, he could look up the characteristics of the transistor under test and calculate from them exactly what readings he should be getting on his particular ohmmeter. But a good transistor tester is preferable to so cumbersome a procedure. In the long run, anyone who must deal with transistors on any regular basis will want such a tester. Until he is ready for one, however, obtaining readings that approximate those given in the tables will be quite reliable for evaluation. If the circuit of a particular ohmmeter should happen to be sufficiently different from the average instrument so that readings tend to be different from those given, the pattern of normal readings will show up quickly after some tests on good transistors. The tables can then be corrected individually.

A reminder concerning voltage polarity: since the illustrations show test connections for *p-n-p* transistors only, remember that polarities are reversed when dealing with *n-p-n* transistors. The tables give complete information in each case. When unidentified transistors are encountered in equipment, their type must be determined before any testing can be started. Comparing the voltage applied to the collector with that applied to the emitter will always indicate whether the component is *n-p-n* or *p-n-p*. ▲

JAPANESE ELECTRONICS PRODUCTION INCREASES

ACCORDING to figures just released by the U.S. Department of Commerce's Electronics Division, Japanese electronic production totaled $1,022-million during the first nine months of 1961, a 19% increase over the $857-million in the corresponding period of 1960. This represents a slowdown from the 1959 to 1960 growth rate when the comparable figure was 31%.

Consumer electronic products accounted for 56% of the 1961 production, with TV and radio receivers alone totaling $486-million or 48%. TV receiver output showed an increase of 18% over 1960 while the total for radio receivers was up only 2%. The production of tube-type receivers registered a 27% decline.

Gains were reported in the value of production of the following items for the nine months of 1961 over the same period of 1960: radio-phonographs, 70%; recorders and reproducing equipment, 77%; hi-fi amplifiers, 200%; capacitors, 26%; transformers, 55%; electronic computers, 134%; and industrial measuring and control equipment, 29%.

Declines were registered in the following items: receiving tubes, 44%; TV picture tubes, 8%; transmitting and special-purpose tubes, 4%; and transistors, 6%.

The Electronic Industries Association of Japan estimates total production of transistors in 1961 at 180 million pieces, a 28% increase over 1960. ▲

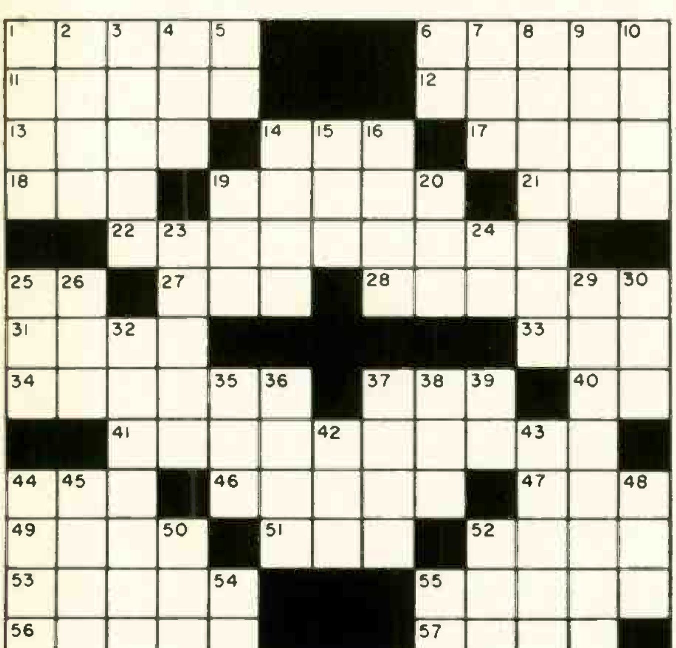
ELECTRONIC CROSSWORDS

By **BRUCE BALK**

(*Answer on page* 92)

ACROSS
1. Part of a phonograph or recording needle.
6. Wire used to carry current.
11. Rack sheet.
12. Brass or bronze, for example.
13. Operation of time-delay relay.
14. Uninsulated conductor.
17. Device to prevent overloading of a circuit.
18. Man's name.
19. Retune a frequency dial.
21. Feminine suffix.
22. Small coil used to measure a magnetic field.
25. Type of current (abbr.).
27. Printers' measure (pl.).
28. Antenna matching devices.
31. Volume control.
33. At present.
34. Assimilate.
37. Prone.
40. No load (abbr.).
41. Changes in the value of a variable.
44. Wire standard (abbr.).
46. Electronic device used for underwater detection.
47. Grain.
49. Novel by Zola.
51. Adjust.
52. Kitchen utensils.
53. Types of tuned circuits.
55. Cost.
56. Runs motor without performing work.
57. .001 inch (pl.).

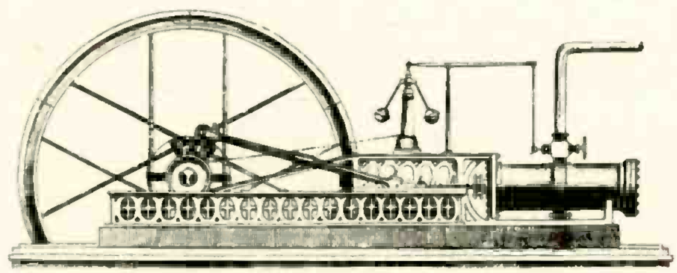
DOWN
1. Type of switch (abbr.).
2. Small aura of light on a fluorescent screen.
3. Radio-tube element.
4. Original condition.
5. Liquid measure (abbr.).
6. Chemical element (abbr.).
7. Candidate from Kansas (familiar).
8. One of the elements in color-TV picture tube.
9. Energy dissipated without accomplishing useful work.
10. Organs of sight.
14. Units expressing differences in power amplitude.
15. Keeps our troops happy (abbr.).
16. Eastern European.
19. Turntable speed (abbr.).
20. Aunt (Sp.).
23. Rare gas used in thyratrons.
24. Classical language (abbr.).
25. Spiritual head of the Moslems.
26. Governmental regulatory agency (abbr.).
29. Short term for vibrators which do not rectify.
30. Avid dial twirler (abbr.).
32. In-phase component for color TV.
35. Type of coupling (pl.).
36. Relatives (abbr.).
37. He loves (Lat.).
38. At the rate of.
39. Chemical (abbr.).
42. Compass reading.
43. Woodland path.
44. Against.
45. Part of a hospital.
48. Suffix referring to locality.
50. Simian.
52. Transformer winding (abbr.).
54. Sea-going vessel (abbr.).
55. One type of speaker (abbr.).



Patent Information for the Inventor

By JOSEPH F. VERRUSO
Senior Lab Technician, Westrex Corp.

Part 1. Basic knowledge about our patent system and a step-by-step procedure on obtaining a patent.



"The Congress shall have the power . . . to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive rights to their respective writings and discoveries." (United States Constitution: Article I, Section 8)

THIS clause in the Constitution gave birth to the modern-day patent system. To be more specific, it provides the inventor with exclusive rights to his discoveries and inventions and gives Congress the power to enact laws relating to patents. One of the basic purposes of the patent system is to protect the inventor. This protection helps stimulate and promote the progress of the useful arts within the United States.

To promote this progress even further, the Patent Office makes available to anyone, pertinent publications and patents that will provide others with the knowledge of the invention and, with this knowledge, may conceive of a better way of doing the job. All these factors induce the inventor to invent, and if his idea is a success, will give the public the opportunity of using it.

Over three-million patents have been granted since the first patent was signed by George Washington in 1790. The applicants have ranged from the unknown to the famous. Most of us picture the inventor as a person working alone, painstakingly, and without aid. This image goes back to the time of Bell and Edison when precision equipment and components were at a minimum. In today's world of electronics, the modern-day inventor is usually an engineer or scientist working for a large corporation. Any discoveries or inventions developed during the work-day are usually assigned to the corporation.

The purpose of this article is to provide the industrial or independent inventor with basic information concerning patents and the patent system. Many details are omitted and many complications have been ignored, for to fully cover the patent system in such limited space would be impossible. References at the end of next month's article are listed for those who want more detailed information on the subject.

What Can Be Patented

What is patentable? This is a common question asked by potential inventors. In the language of the statute, any person who "invents or discovers any new and useful process, machine, manufacture, or composition of matter or any new and useful improvements thereof, may obtain a patent," subject to the conditions and requirements of the law.

A new process or method, related to the industrial or technical field, in most cases is patentable. The term "manufacture" describes articles which are made and includes all manufactured items. The word "useful" is an important part of the statute and failure to understand its meaning has been the downfall of many possible patents. The word "useful" in the statute means that the invention has a useful purpose and that it will perform as intended. A patent is not granted for an idea or suggestion for a new machine, but for a new invention and its usefulness. A complete description of the actual machine or other subject matter is required before a patent will be issued.

Patents are not granted for methods of doing business, methods for solving mathematical problems, or alleged inventions of perpetual-motion machines. An invention must be new. If the invention has been made public either by printed publication or sale, the inventor must apply for a patent before a year has passed or, otherwise, the right to a patent will then be lost forever.

An invention that was known or used by others or patented in this or a foreign country, cannot be patented. Minor changes which would be obvious to a person having skill in the art of invention, such as the substitution of one material for another or changes in size, are not considered patentable inventions. Inventions relating to special nuclear material or atomic energy for atomic weapons are not patentable, in accordance with the Atomic Energy Act of 1954.

A careful study of the invention, its applications and/or the feasibility of other ways of doing the job, should be made by the inventor himself. Contrary to public opinion, a profit can only be made on an invention if it is salable. Therefore, the invention should have features that would attract the public (or a manufacturer if the invention involves a machine or process used in fabricating a product) before any money is spent on patenting it. The following steps should be taken by an inventor to insure maximum protection.

Basic Steps for Inventors

The inventor should keep a careful record of all data, purchases, correspondence, and drawings covering his invention. The data and the drawings should be signed by the inventor and witnessed and dated by one or more trustworthy friends. If an interference should ever occur, the only thing that will satisfy the Patent Office or a United States court is the testimony of one or more persons having knowledge of the facts. In this way, one person other than the inventor can testify that the facts presented are true. Many people believe that mailing a registered letter to themselves, describing the invention, will protect them from infringement litigation. This is not true. An inventor's priority right can only be supported by a witness other than the inventor.

Once it has been determined that the invention is useful and practical and the decision has been made to seek a patent, a preliminary search should be made. A search is important, because it will show if the invention has patentable features by comparing it with other related patents in the same field. A search can be made either by the inventor or a patent practitioner. A patent practitioner is a person registered to practice in the Patent Office and to prepare and prosecute patent applications. These persons are either patent attorneys (most of whom are lawyers) or patent agents (non-lawyers). The Patent Office has a roster listing registered practitioners qualified to prepare and prosecute patent applications. This roster may be consulted at any of the field offices of the Department of Commerce or the Small Business Administration. A copy of the roster "Patent Attorneys and Agents Available to Represent Inventors Before the Patent Office" can be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. The Patent Office will forward, without charge, at the request of the inventor, a list of patent practitioners in his region.

A search involves a trip to the search room of the Patent Office in Washington. A proper search requires both time and skill and for this reason most inventors choose to employ persons who have had experience in this type of work. However, if the inventor decides to make the search himself, the staff at the search room will assist him in deciding which patent classes and subclasses should be searched. The search room and scientific library are open from 8:30 a.m. to 5 p.m. on work days and Saturdays, 8:30 a.m. to 12:30 p.m.

If the inventor cannot make the trip to Washington, he may order from the patent office copies of lists of cross-referenced patents in the sub-classes which are being searched. However, there are certain libraries and institutions, such as the New York Public Library and New York University, which have on hand a set of numerically arranged patents which can be inspected by the inventor. Once the inventor finds the patents which come close to his invention, copies may be ordered from the Patent Office for 25 cents each. Some libraries have the Manual of Classification (list of classes and subclasses of patents) and copies of the Official Gazette (a weekly publication announcing new patents), so that the inventor does not have to communicate with the Patent Office until he finds the patents that will help him.

A comparison of the patents found in the search and the advice of the practitioner should govern the inventor's decision on whether or not to seek a patent. If a search has revealed that the new invention includes valuable features not already covered by patents, an application should be drawn up by the practitioner.

Patent Application

If the inventor wishes, he may prosecute the patent application himself, but this requires professional knowledge and skill which only comes from years of training and experience. Most inventors choose a patent practitioner to make the search and prosecute the patent application because in this way the attorney or agent, being in on the ground floor, is aware of all the facts and can provide the greatest possible protection. It should be understood at this point that if an interference arises only a patent attorney can represent the inventor in a court of law.

The application consists of three parts: the Formal Papers, the Specifications, the Claims, and also a drawing illustrating the invention. There is no official form for patent applications, but the general format can be found in the publication "General Information Concerning Patents," which can be purchased from the U.S. Government Printing Office.

The Formal Papers include a petition which is basically a request for a patent; the power of attorney, which gives the attorney the right to prosecute the patent application; and the oath that the inventor takes in which he states that he believes himself to be the first and original inventor of the invention described in the application. The oath must be taken in the presence of a notary public or other official authorized to administer oaths. The inventor must place his full name on the oath, including his middle name or initial. The full post office address of the inventor must also appear on the oath. This represents the subject matter covered by the Formal Papers of the patent application.

The Specification portion of the application is a complete description of the invention, written in such a manner that one skilled in the art of invention would have no difficulty in making or using the invention from the description. The specifications must include all features which make the invention different from other inventions and from what is already in widespread use. If the invention is an improvement on another invention, the Specification must point out the part or parts involved in the improvement. When drawings are included in the Specifications, there should be a brief verbal description of the drawings while the description of the invention in the text should relate to the drawings by means of reference numbers or letters. All drawings must be signed by the inventor and must meet the standards for drawings, as prescribed by the patent office.

At the end of the Specifications, there is a section which is called "Claims." It is the "Claims" that fix the boundries and the amount of protection provided by the patent. The Claims must be written in such a way as to provide the inventor with the greatest amount of protection. For this reason, "Claims" are written in broad language so as to provide the inventor with protection while still including one or two features which distinguish the invention from earlier inventions. The claims cannot be too broad to the point where they infringe on the claims of earlier inventions, therefore the writing of claims requires a high degree of skill and professional experience.

Once the application is completed and carefully checked by both the practitioner and the inventor, a filing fee of $30.00 and a fee of $1.00 for each claim in excess of twenty should be enclosed with the application. The application should then be mailed to the Commissioner of Patents, Washington 25, D.C. Models were once required with the patent applications, but this is no longer necessary unless requested by the Patent Office. Models were deemed to be unnecessary since the required specifications and drawings are to be full, clear, concise, and exact terms so that a person skilled in the art of invention can understand the invention without the aid of a model.

In the concluding installment next month, the author will discuss the procedures followed by the Patent Office leading up to the granting of a patent.

(Concluded next month)

Marine Radio Service

(*Continued from page* 32)

are a number of others that will facilitate transmitter testing and adjustment.

The most useful of these is a g.d.o. or grid-dip oscillator (Figs. 8 and 9). Uses of this instrument range from checking capacitors in circuit and checking the operation of resonant circuits, to acting as an r.f. generator to power other instruments. Some such instruments will also act as sensitive absorption-type wavemeters (by turning off oscillator plate voltage), with which spurious transmitter outputs can be tracked down. If you have a g.d.o. that will not serve this dual purpose, you should also have a wavemeter, which consists of a coil and variable capacitor, to cover the desired frequencies, and a pilot-lamp resonance indicator connected in series. *Eico*, *Heath*, *Paco*, and *Millen* are among the manufacturers of g.d.o's. It is not too difficult to build a g.d.o. "from scratch." The *Millen* "Industrial" type covers frequencies from 220 kc. to 300 mc., which gives it extra utility.

Larger transmitters have built-in plate-current and r.f. antenna-current meters. These can be used in making routine adjustments on the equipment aboard the boat. Smaller units have only an indicator lamp for "output." A portable d.c. milliammeter (which may be a v.o.m.) and an r.f. ammeter for inserting in the antenna lead are required to adjust these units. An antenna-current meter covering 0-1.5 r.f. amperes will suffice for low-powered equipment.

There are various untuned r.f. pickup devices, such as low-priced r.f. power meters, that can be used for relative measurements of output in the tuning operation. These amount to a small pickup antenna, to which a diode and microammeter are connected. The pickup antenna is loosely coupled to the radiotelephone output circuit. It is simple to make a substitute for one by just connecting a 1N34 diode across the v.o.m. test-lead terminals. When the leads are brought near the radiotelephone antenna circuit, a relative indication of power output and the correctness of tuning adjustments can be gaged on the microampere scale.

Careful workmen will want to know more than just that the transmitter output adjustments are peaked. Knowledge of the antenna-system impedance is necessary to be sure of getting maximum output.

Fig. 10. A "Q" meter, like the Heath QM-1, is useful. High "Q" of antenna-loading coils assures efficiency of transmission.

A rough idea can be obtained by calculation. It can be assumed that transmitter power output is about 50% of the plate-input power, measured by a voltmeter and a milliammeter. In the resonant condition, the total antenna-circuit resistance equals P/I^2, when P = transmitter output power and I = antenna current.

An antenna bridge of the antennascope variety can also be used to measure antenna resistance. These instruments require a g.d.o. adjusted to the frequency of operation for r.f. power. The measuring terminals of the bridge are connected in series with the antenna circuit, with the transmitter antenna-switching relay mechanically blocked in the "transmit" position and transmitter power off. Total antenna resistance is read directly from the instrument.

Coil resistance, important in checking antenna-loading coils, etc., can be determined by means of a "*Q*"-meter. In addition to laboratory instruments, the *Heathkit* instrument (Fig. 10) is useful for this purpose. By slightly more involved processes, "*Q*" can be measured with an r.f. signal generator and current meter.

Routine Instruments

Here the requirements are much as in any radio-service shop. In addition to the usual high-resistance v.o.m., both d.c. and a.c. v.t.v.m.'s are necessary. A capacitor checker is also useful. An r.f. signal generator that will cover from about 100 kc. to 30 mc. is required. Frequency stability and accuracy are important in this instrument, as well as the accuracy of its attenuator.

The modern shop will need both tube and transistor checkers (Figs. 11 and 12). Sometimes a signal tracer will facilitate receiver service, but it is not essential. An oscilloscope and audio generator, which have already been mentioned, are of course on the list.

Much of the above equipment can be constructed from kits. Except where measurements of extreme accuracy are necessary, kit equipment is perfectly satisfactory.

Outside Equipment

Boats are sometimes hard to get to, and it is impracticable to lug a laboratory with you on a service call. The smart technician can increase his efficiency tremendously by constructing miniature equivalents of certain instruments. For example, transistorized spot-frequency signal generators and relative field-strength indicators are very helpful and easy to make.

For calibrating radio direction finders, a pelorus is usually necessary for visual sights, and small boats generally do not carry them. You can find surplus instruments, or adapt one from devices such as the aircraft drift sight. Equip yourself with a navigation chart of your area, and on it mark the location of all radio-station antennas for DF calibration checking.

A pair of 27-mc. walkie-talkie radiotelephones are also handy to have on tap; as well as a very loud police or gas-operated whistle. There may be times when such a simple device can keep you from being marooned if you are depending upon a launch service to get you back ashore.

A four-foot-high, open-top tank of small diameter full of water can be useful in testing and demonstrating echo-sounder indicator and transducer operation. An old barrel will do.

Black and Decker has come out with a "cordless" electric drill that operates from a self-contained battery. This is very useful for installation work. A battery-operated soldering iron is also valuable.

Get instruction books from all of the manufacturers of marine-electronic equipment, including radiotelephones, direction finders, echo sounders, and automatic pilots. These can save you much time. Familiarize yourself with the operation of these devices—you will be expected to act as an instructor as well as a technician.

With the equipment described, you will be in a position to install and service any of the electronic equipment used on small boats. That is, as long as you don't forget to develop the long, slim hand and extensile eye. They are just as useful today in marine electronics as they were in the 30's, and probably always will be. ▲

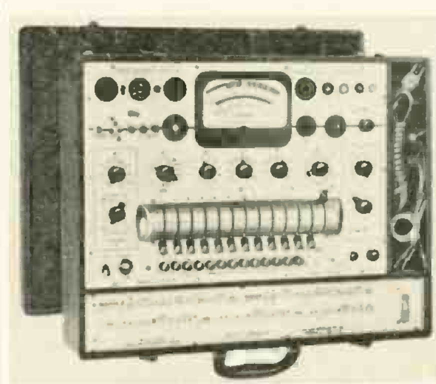


Fig. 11. The tube tester should accommodate old as well as new tube-pin configurations. This Precision 10-60 can also be used for testing transistors.

Fig. 12. A supplementary transistor tester (this one by Heath) is needed if the tube tester lacks this facility. Use of transistors is now common in marine radio.

Technical Books

"THE THINKING MACHINE" by John Pfeiffer. Published by *J.B. Lippincott Company,* Philadelphia. 236 pages. Price $5.95.

This is a not-too-technical work on computers, data processors, and electronic brains, which explains their operation, design, and construction in layman's language.

The text material is based on a television script presented originally in the fall of 1960. It points out how these "thinking machines" are involved in almost every facet of our everyday life —from figuring bank balances, to analyzing brain waves, and plotting football strategy.

The author is an entertaining writer who, knowing his subject intimately, has managed to convey both his knowledge and his sense of wonder at these computing devices. The text is illustrated with line drawings, sketches, and photographs of actual equipment.

* * *

"ELECTRONIC EQUIPMENT MADE EASY FOR THE BOAT OWNER" by John D. Lenk. Published by *John F. Rider Publisher, Inc.,* New York. 191 pages. Price $5.95.

This manual is written for the boat owner rather than the technician involved in marine installation and service work. The text is divided into ten easy-to-understand chapters that cover power requirements and wiring, radiotelephones, radio direction finders, depth sounders, automatic pilots, radar and loran, fuel vapor detectors, the prevention of galvanic and electrolysis corrosion, recommended equipment, and emergency repairs.

The manual is lavishly illustrated with line drawings, photographs, partial schematics, and tables covering frequency assignments, operating codes, and a list of broadcast stations (with operating frequencies) bordering on navigable waters. Bound in a sturdy cloth cover, this manual could easily weather life in a ship's library.

* * *

"BASIC PRINCIPLES AND APPLICATIONS OF RELAYS" by Harvey Pollack. Published by *John F. Rider Publisher, Inc.,* New York. 102 pages. Price $2.90. Soft cover.

This is the first volume in this publisher's new series on industrial electronics applications and covers relay construction, operation, and application at the technician level.

Since relays are to be found in such a wide variety of electronic equipment the technician making any pretense of servicing electronic gear must know relays thoroughly. In six concise chapters the author has covered the fundamentals of electromagnetic relay construction, relay contact arrangements, circuits of d.c. relays, electronic relay circuits, relays in timing circuits, plus considerations in selecting and applying relays.

Each chapter carries review questions covering the material discussed, making this volume suitable for classroom use as well as self-instruction.

* * *

"BASIC RADIO COURSE" by John T. Frye. Published by *Gernsback Library, Inc.,* New York. 220 pages. Price $4.10. Soft cover.

This is a completely revised and considerably enlarged edition of John Frye's popular and practical 1951 volume. Readers of this magazine are well aware of the author's unique talent for conveying practical technical know-how in a painless and entertaining manner, as witness his "Mac's Electronics Service" column which appears regularly in these pages.

This same light touch has been carried over into this volume without in any way detracting from the value of the information he imparts. The text is progressive, starting with Ohm's law and moving logically through resistors and capacitors, to tubes and the circuits in which they are used, and then on to transistors, instruments and tools needed in servicing, and servicing techniques.

Even practicing technicians will find this volume instructive and entertaining while would-be servicemen will enjoy Mr. Frye's technique for the painless assimilation of knowledge.

* * *

"FM MULTIPLEXING FOR STEREO" by Leonard Feldman. Published by *Howard W. Sams & Co., Inc.,* Indianapolis. 157 pages. Price $2.50. Soft cover.

This volume is written for the service technician faced with the conversion and servicing of FM receivers and tuners for FM-stereo reception. The principles of operation are discussed in considerable detail, including a reproduction of the FCC rules and specifications for this type of service.

Both SCA (storecast) and multiplex broadcast techniques are covered, along with circuit details, equipment operation, and theory. The seven chapters cover the history and specifications for FM stereo, an analysis of the approved stereo signal, converting to FM stereo, multiplex decoder circuits, servicing multiplex circuits, FM-stereo test equipment and multiplex circuit alignment, plus commercial multiplex circuit analysis—including units by *Altec, Bogen, Crosby, Eico, Fisher, Harman-Kardon, Pilot, Sherwood,* and *Zenith.*

* * *

"HANDBOOK OF ELECTRONIC TABLES & FORMULAS" compiled and edited by D. Herrington & S. Meacham. Published by *Howard W. Sams & Co., Inc.,* Indianapolis. 181 pages. Price $3.95.

This is a completely revised and expanded edition of a popular 1959 reference work containing all the charts, tables, laws, formulas, symbols, and standards used in electronics. In addition, this volume includes a six-page full-color chart showing the latest FCC allocations for the entire frequency spectrum.

The editorial material is divided into seven categories and covers electronics formulas and laws, constants and standards, symbols and codes, service and installation data, design data, mathematical tables and formulas, plus miscellaneous data such as temperature conversion, measures and weights, etc.

This new volume should be a real boon to anyone involved in electronics since it eliminates the need to consult an assortment of textbooks to locate a required formula.

* * *

"MASTER CARTRIDGE SUBSTITUTION GUIDEBOOK" by Jack Strong. Published by *John F. Rider Publisher, Inc.,* New York. 86 pages. Price $2.00. Soft cover.

This tube-caddy substitution manual covers cartridges produced by major manufacturers since 1930, listing them both numerically and alphabetically for speedy selection. Each cartridge (mono or stereo) carries a cross reference to all possible replacements. Another section of the book lists manufacturers alphabetically along with the model numbers of their record players and the part number of the cartridge used in that model.

Technicians handling audio service work will find this guidebook invaluable in speeding phono repairs.

* * *

"DESIGN & OPERATION OF REGULATED POWER SUPPLIES" by Irving M. Gottlieb. Published by *Howard W. Sams & Co., Inc.,* Indianapolis. 108 pages. Price $2.95. Soft cover.

The material covered in this book offers practical advice on the design, theory of operation, and applications of regulated power supplies for the technician, engineer, radio amateur, and experimenter.

The author covers both positive and negative regulation and explains how voltage regulator tubes, semiconductor diodes, and other components are used in various configurations to obtain the desired results. Component values are given for various types of circuits so that the reader can build the specific regulated power supply he needs.

The text is divided into six chapters and is lavishly illustrated with schematics, line drawings, and tables. ▲

EW Lab Tested
(*Continued from page* 18)

the shell makes cueing a simple matter.

The tracking error was less than 2 degrees when the arm was installed with the recommended overhang. On our test arm, the stylus force indications were reasonably accurate (within 0.5 gram) up to 4 grams, with larger errors at higher settings.

The *ESL* S-2000 arm sells for $34.95. Additional aluminum shells, available in several colors for cartridge identification, cost $5.50. ▲

Eico Model 680 Transistor & Circuit Tester

For copy of manufacturer's brochure, circle No. 60 *on coupon* (*page* 96).

SERVICE technicians are by now well aware of the new techniques that are required to repair transistorized equipment. Experimenters, too, are becoming accustomed to using transistors and are revising their design approach in terms of semiconductor circuitry. To make complete the transistion from tubes to transistors, it is necessary to include test equipment as well. When working with transistor circuits you will need two basic test instruments—a transistor tester and a low-range volt-ohm-milliammeter. The Eico Model 680 Transistor and Circuit Tester is a combination of these two instruments in one package.

The specifications stated by the manufacturer are as follows: Transistor Tests: I_{cbo}, I_{ceo} for small-signal and power transistors; d.c. beta in two ranges, 2-30 and 20-300; and a.c. beta indirectly. D.c. current: 50, 500 μa., 5, 50, and 500 ma. Dc. voltage: 5, 50. D.c. resistance: 2000, 200k, and 20 megohms. The voltmeter d.c. sensitivity is 20,000 ohms-per-volt; a.c. cannot be measured.

The d.c. beta (I_c/I_b) test is conventional. It is measured by first adjusting the calibration potentiometer so that the collector current is 1 ma. The meter is then switched into the base circuit to measure the base current required to produce the 1-ma. collector current. Since the collector current is 1 ma., the d.c. beta is equal to the reciprocal of the base current and is indicated directly on the meter.

The simulated a.c. beta test is an extension of the d.c. beta test and is performed by obtaining two sets of collector and base-current readings. The difference between the collector currents (0.75 and 1.25 ma.) is divided by the difference between the measured base current. The result is the a.c. beta.

Power-transistor d.c. beta is not measured directly; it is approximated by computation using the measured leakage currents and the formula $I_{ceo}/I_{cbo} = \text{beta} + 1$.

Construction of the kit was straightforward; the wiring time was about 3½ hours. There were no difficult steps or ambiguities in the construction manual or the unit.

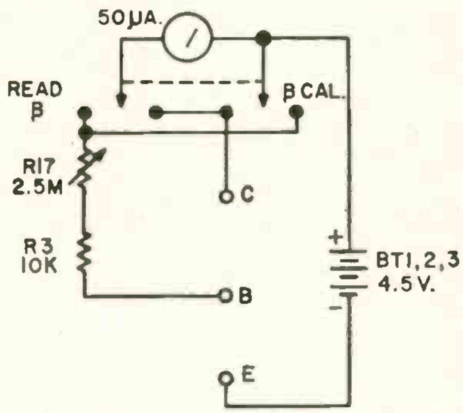
Eico states that with 1% resistors and a 2% accuracy meter, the accuracy of the instrument is 3%. We compared the d.c. voltmeter readings with those of a v.t.v.m. that had been calibrated against a laboratory standard and found the claim to be substantially correct.

We also checked the transistor test functions with a number of new 2N1193 transistors. Motorola's spec sheet rates the d.c. beta at minimum 100, typical 160, maximum 250. We checked the d.c. beta of four transistors and it was found to be 170, 180, 180, and 160. We then measured the d.c. beta of a 2N1192, which is rated at 50 minimum, 75 typical, and 125 maximum, and found it to be 80. The simulated a.c. beta of the 2N1192 was 77, the I_{ceo} was 70 μa., and the I_{cbo} was 3 μa.

If you have used a tube tester you know the precautions that must be taken to prevent damage to the tube or the meter when changing from one test to another. Often the selector switches must be re-positioned in a specific sequence.

Similarly, when going from one test to another in the 680, it is advisable to remove the transistor under test or to re-position the selector and range switches in the reverse order to protect both the transistor and the meter movement.

At $25.95 for the kit or $39.95 for the wired model, the 680 is a worthwhile basic instrument for transistor work .... E.W.



Simulated a.c. beta test circuit in which base currents are measured for two different collector currents. Meter can be set to indicate 50 or 500 μa. in base circuit.

LIVE vs RECORDED CONCERT FOR MUSIC FAIR

ACOUSTIC Research and Dynakit are sponsoring a series of concerts by The Fine Arts Quartet in conjunction with the World's Fair of Music and Sound to be held August 31 through September 9 at McCormick Place, Chicago.

This "Live vs Recorded" concert will be presented from 8 to 8:30 p.m. daily and at 3, 4, and 5 p.m. daily during the Fair. ▲

A Day with the Scope

(*Continued from page* 43)

fed the generator output into the video-detector load and connected the scope to the video-amplifier plate. As he tuned the generator this time, amplitude of the scope display started dropping after 1 mc. and was way down after 2 mc. The bandwidth loss, then, was after detection rather than in the aligned circuits. The culprit, a shorted peaking coil, was found in two minutes.

"That's just one of the things you can't do without wide-band response," Dick noted. "A narrow-band scope would have masked the frequency drop-off here with its own roll-off. It can also distort the true shape of sync pulses in a circuit, so that you can miss distortion being introduced by a defect. And yet you don't want to give up sensitivity for bandwidth. A good TV scope should have both, if possible. If you want to scope signals in early i.f. stages, as we have done today, for example, you're dealing with low levels."

It Works on Radios Too

Toward the end of the day, Bill mentioned something about the old-fashioned radio, at least, not benefiting particularly from scope techniques. As his last performance, Dick took up this challenge. With the r.f. generator set up for modulation, he traced signal through from beginning to end on a 5-tube set, showing how troubles could be localized and alignment performed visually, without sweep-frequency signals. The i.f. peaking was particularly simple. Signal could be observed as r.f., i.f., or audio. "Using the scope here may seem like stretching a point," he said, "but it's not true if the instrument is always ready and you're used to handling it. The techniques come to you quickly. I stick to it on many radios because it's already there and I don't have to switch to other equipment and other methods. That saves time. After all, it's a good signal tracer."

It was late in the day and we were getting ready to leave. As we were wrapping up our scope, Bill spoke: "You've made a point. I got my scope seven years ago. Maybe I wasn't ready for it then, and maybe it wasn't ready for me either. Another try is certainly worth while."

"Planning to dust yours off?" Dick asked. Bill frowned: "Well, yes — at least to start with. I know that half the things you did here today I either couldn't do at all with it or couldn't do conveniently. It doesn't have the specs. But I want to see how far I can go. If the technique is still attractive, maybe I can make the old job do. If it has too many drawbacks but I take to the idea, a new one with all the frills could well be worth another investment."

As we went through the door of the shop, we turned to say good-bye. Bill was gazing at the departing scope — wistfully, we thought. ▲

Multi-Watt CB Transceivers

(*Continued from page* 47)

and is used as a crystal-controlled oscillator. The circuit is similar to the oscillator in Fig. 2 but an external capacitor (C_{26}) is used to supplement the feedback through the transistor junction capacity. Resistors R_{35} and R_{36} form the base-bias network while R_{37} provides emitter stabilization and CH_1 increases the emitter impedance. The oscillator is inductively coupled to the power amplifier, V_6.

Although the final appears to operate in common-collector, close examination will reveal the stage is actually a grounded - collector, common - emitter configuration. Base current flows through resistor R_{38} which develops a class C bias across its terminals. Coupling between the transistor and transmission line in through a *pi*-network consisting of C_{29}, C_{30}, C_{31}, and inductor L_1. Audio modulation is applied to both the oscillator and power amplifier from two separate connections on the modulation transformer. Modulation is applied to both the base and emitter of V_6 which eliminates the frequency-modulation component that would occur due to variations in collector capacity.

The final is shunt-fed with an r.f. choke at a low-impedance point in the antenna-matching network. The diodes in series with each modulation line are used for negative speech clipping which increases the "talk power" or the ability to get through under marginal conditions.

Other Units

Several other companies have announced completely transistorized 5-watt units. However, at the present time, these companies are rather reluctant to reveal details and no circuit information was available at the time this article was written. These units will be followed by many others as manufacturers convert to transistorized equipment. Observing the revolution in second-generation CB equipment should prove interesting—to say the least. ▲

Within the Industry

HOWARD W. HIBSHMAN has been named manager of marketing for *Pilot Radio Corporation,* a subsidiary of *Jerrold Electronics Corporation.*

In his new post Mr. Hibshman will be responsible for directing an intensified marketing and sales promotion program. He has had more than 15 years experience in marketing and sales management having formerly served as sales manager for consumer products for *General Dynamics/Electronics* in Rochester, N.Y. Prior to that time, he was national market development manager for *Magnavox Company.*

* * *

BRUCE VINKEMULDER has been elected president of the Association of Electronic Parts & Equipment Manufacturers, Inc. and will also represent the association on the board of directors of the Electronic Industry Show Corporation. He is marketing manager of *Centralab,* the electronics division of *Globe-Union, Inc.*

Serving as first vice-president is Walter A. Clements, vice-president in charge of sales, *Littelfuse, Inc.* Second vice-president is Norman Triplett, marketing manager of *Triplett Electrical Instrument Co.*

J. Wayne Cargile, midwest manager of *United Catalog Publisher,* was re-elected treasurer and Kenneth C. Prince was re-elected executive secretary.

* * *

ALFRED A. GOLDBERG is the new vice-president, sales for *Power Designs, Inc.,* where he will be responsible for both the commercial and military sales and marketing programs for the firm's expanding line of stabilized d.c. power supplies and systems.

Prior to taking his new post, Mr. Goldberg was sales manager of *Polarad Electronics Corporation* and before that was with *CBS-Columbia* as assistant general manager of defense operations.

He is a graduate of Polytechnic Institute of Brooklyn, a member of Pi Tau Sigma, and the IRE.

* * *

ACCURACY, INC. of Waltham, Mass. has acquired **RAYTRON ELECTRONICS, INC.** of Hicksville, Long Island and will operate the firm as its potentiometer division . . . **CALIFORNIA COMPUTER PRODUCTS, INC.** has acquired a minority interest in **SIERRA RESEARCH CORPORATION** of Buffalo, New York . . . Frank M. Viles, Jr., former president of **ITT**'s distributor division has resigned that post to establish a world-wide market counseling organization for domestic and foreign electronics manufacturers under the name of **MARK INTERNATIONAL CORPORATION.** The new organization will have representatives in England, Germany, France, Italy, and Japan as well as in the major U.S. markets . . . **GENERAL PRECISION, INC.** has acquired full control of **ROYAL PRECISION** and will operate it as the data processing division of the firm . . . The Armament Division of **UNIVERSAL MATCH CORPORATION** has been renamed **UNIDYNAMICS.** Administrative offices are located at 472 Paul Avenue, St. Louis 35, Mo.

* * *

J.R. BALLINGER has joined *Packard Bell Computer Corporation* as manager of the Industrial Systems Department. In this capacity he will direct the firm's entry into this relatively new and growing market.

Mr. Ballinger previously served as engineering manager, assistant general manager, and in general management for several prominent companies in the fields of industrial control systems, industrial instrumentation, and servo systems.

He was most recently connected with the *Aeronutronic Division* of *Ford Motor Company* where he was manager of the Industrial Systems Department. He is an MIT graduate.

* * *

EDWIN J. MARX has joined the *Delco Radio Division* as advertising and sales promotion manager . . . **RICHARD E. DeMORNAY,** president and chairman of the board of *DeMornay-Bonardi,* died recently at the age of 48 . . . *The Sampson Co.* has named **ROBERT A. DONNER** to the post of director of sales of its electronic division . . . **JAMES R. BRENNAN** is the Rocky Mountain regional marketing manager for *Sylvania Electronic Systems* . . . **EUGENE V. DiSCIULLO** is the new national marketing and sales manager for *Don Bosco Electronics Inc.* . . . **CLIFFORD R. GASPARINI** has been named sales manager of *Photo-Diagramics,* a division of *The Bond Press, Inc.,* Hartford, Conn. . . . **SAMUEL J. PIASER** has been appointed sales promotion manager for *Pacotronics, Inc.* of Glendale, N.Y. . . . **W. R. KIEGER** is the new director of material for *Ling-Temco-Vought* . . . *Bogen-Presto Division* has named **GERHARD E. KADISCH** to the post of vice-president of marketing . . . **JACK M. GUTZEIT** has assumed his new duties as national sales manager of *Sonar Radio Corporation* . . . *Ex-Cell-O Corporation* has elected **RUSSELL E. BAUER** vice-president, electronic and servo systems group.

* * *

WILLIAM H. HARMAN, III, a 21-year-old native of Philadelphia and a senior electrical engineering student at the University of Delaware, has been awarded the 1962 National Electronics Conference Fellowship.

The Fellowship, valued at $3000, is granted annually to an outstanding graduate in electrical engineering to further his studies in electronics. The Fellowship covers a year of graduate study at any of the ten colleges and universities participating in the National Electronics Conference.

* * *

ARMED SERVICES ELECTRO-STANDARDS AGENCY is being transferred to the Engineering and Standardization Directorate, Defense Electronics Supply Center, Defense Supply Agency, Dayton 20, Ohio.

This government agency was formerly located at Fort Monmouth, New Jersey.

* * *

CONSOLIDATED SYSTEMS CORP. has moved all of its operations to Pomona. A 150,000-square-foot building, located on a 35 acre site in the Pomona Valley Colleges Research and Development Center, will house the firm . . . **RADIO ENGINEERING LABORATORIES, INC.** has established a Bethesda, Maryland office at 4925 St. Elmo Avenue . . . **GENERAL PRECISION, INC.** has optioned 111 acres of land in both Totowa Borough and Wayne Township, N.J. for a system research, development, and evaluation facility . . . The instrument division of **AMERICAN ELECTRONICS, INC.** has moved from Culver City, California to Fullerton . . . **WEBCOR, INC.** is building a new million-dollar plant in Berkeley, Illinois to house its expanded government electronics division.

* * *

WILLIAM A. McCRACKEN has been named to the newly created post of vice-president, operations of *General Instrument Corporation's* Capacitor Division.

Mr. McCracken, who was formerly vice-president of appliance operations at *Philco,* will be responsible for all engineering and manufacturing operations of the division. The Capacitor Division, with administrative and sales headquarters in Newark, N.J., has facilities in Darlington, S.C., Tazewell, Va., and Gastonia, N.C.

A graduate of Drexel Institute of Technology, Mr. McCracken was also associated with the *Kellogg Division* of *ITT.* ▲

Photographic Oscillograph

(*Continued from page* 54)

for immediate use. Thus several hundred feet of recording paper can be developed, fixed, and dried in less than a half hour.

Recording paper is transported to and from the oscillograph in a light-tight magazine like that shown in Fig. 6. The magazine contains the paper take-up and supply reels and the gear drive system which engages the main drive shaft previously shown as F in Fig. 7 when the magazine is installed on the oscillograph. The magazine handle also serves as a lock to hold the magazine in place on the oscillograph when in use. Included in the magazine is a footage counter which indicates the amount of paper or film remaining.

Two rapid-processing systems are available which, basically, convert the photographic oscillograph into a direct-writing recorder. One of these, like the *Consolidated Electrodynamics'* "Datarite" unit, makes use of a special magazine which has a built-in container for developing fluid and a heated platen for drying the recording paper. Such a system is very valuable for development work since data is available almost instantly. However, this type of recording will deteriorate rather rapidly unless fixed in the normal manner.

The second system involves the use of ultraviolet light instead of the usual incandescent galvanometer lamps. The recording paper used in this type of system is especially sensitive to light in the ultraviolet region. To develop a recording, the paper is exposed to fluorescent light for several seconds. This type of recording has the advantage of simplicity and the ability to produce recordings without the use of chemicals or a drying stage. However, like the first system, the recording must be subjected to a fixing solution if a permanent record is desired.

A Typical Recording Problem

In order to better illustrate the use of the photographic oscillograph we shall examine a typical recording setup and the results obtained. In this instance several channels of data were recorded from an instrumented hot-air valve which was subjected to severe vibration testing on a shake table. A shake table is a device used to simulate vibrations that may be encountered in an operational aircraft, missile, or other vehicle. They are used extensively in industry to check component parts for fatigue and other types of structural failure.

A block diagram showing the various channels of data recorded, along with the electronics used, is given in Fig. 8. Note that for several of the channels galvanometers of suitable sensitivity are used and the time response requirements are such that they can be worked directly into the transducer without amplification.

From the information obtained in Fig. 8, a recording job sheet was compiled, listing all information pertinent to the test. Table 1 shows such a sheet that would be suitable for this particular test. The job setup sheet will be used later in the data reduction process.

In the left-hand column are the galvanometer numbers which correspond to their position in the galvanometer block. This number also identifies the trace on the recording paper as will be shown on the sample recording in the next section. The description column lists the particular parameter to be recorded and the scale column designates the particular range selected. Reference lines are selected for each galvanometer on the basis of location in the galvanometer block and convenience for maximum readability. General practice is to locate no more than two or three traces to a reference line unless a full complement of galvanometers is to be used. In this case they are divided as evenly as possible over the available recording space.

Under the "Remarks" column such information as galvanometer type, time response desired, type of transducer used, or other pertinent information may be entered. A running log sheet is also compiled during the test listing the time and number of each recording.

The Completed Recording

A recording that has been developed, fixed, and dried would look like that shown in Fig. 9. Note that the d.c. traces appear as continuous lines which vary in distance from their no-signal reference lines analogous to the transducer output signal. Thus to determine the signal level at any particular point on the recording it is only necessary to measure the distance from the trace to its original no-signal reference line. This type of trace is produced by thermocouples, strain-gage transducers, recording tachometers, and other electronic d.c. analog output devices.

Examples of a.c. traces are shown by traces 6, 8, and 11 in Fig. 9. Here the a.c. signal from the transducer is amplified and fed to the galvanometer without rectification for maximum accuracy. It is a peak-to-peak signal and appears on the recording paper exactly as it would appear if viewed on an oscilloscope. In this example the amplitude of the signal is measured from peak-to-

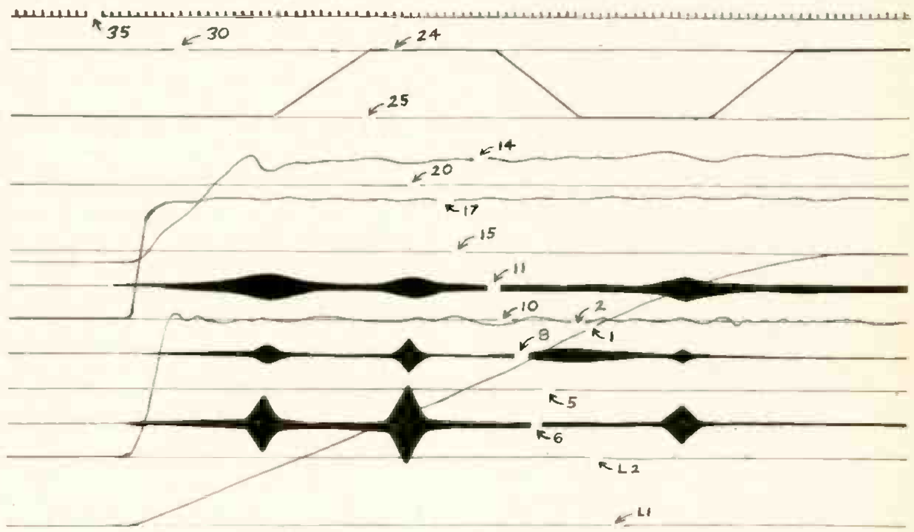


Fig. 9. An actual example of a recording that was made with the setup shown in Fig. 8.

Galvo. No.	Description	Scale	Ref. Line	Remarks
1	shake table freq.	500 cps/in.	0.0 in.	analog trace from freq. meter
2	shake table input amplitude	5 g's/in.	1.0 in.	analog trace from vibration meter
6	dynamic strain gage #1	500 μin./in.	1.5 in.	a.c. amplifier required; use 3000-cps galvanometer
8	dynamic strain gage #2	500 μin./in.	2.5 in.	"
11	dynamic strain gage #3	500 μin./in.	3.5 in.	"
14	inlet air temperature	100° F/in.	3.0 in.	use iron-constantan type thermocouple
17	inlet air pressure	50 p.s.i./in.	3.0 in.	low-response galvanometer OK for this
24	butterfly valve position	closed @ / open @	6.0 in. / 7.0 in.	use precision rotary pot for this
		Reference Lines		
L1			0.0 in.	
L2			1.0 in.	
5			2.0 in.	
10			3.0 in.	
15			4.0 in.	
20			5.0 in.	
25			6.0 in.	
30			7.0 in.	
35	one pulse/sec.		edge of paper	

Table 1. Recording job sheet to be utilized along with example shown in Fig. 9.

peak and the reference point is of no consequence. The a.c. traces in the sample recording have been purposely darkened for photographic purposes and would ordinarily appear much lighter than the d.c. traces due to the rapid movement of the light beam.

Since the paper speed in this example is quite slow, a one-pulse-per-second marker signal is recording along the paper edge, provided from an external marker and an active galvanometer. The small gaps in the traces on the sample recording are a means by which the trace can be identified by number and are caused by a slender rod which rides a timing chain in the recorder and successively interrupts the light beam from each galvanometer. Thus a particular break in a trace can be identified by measuring the distance to the nearest reference line. For example, by inspection we can see that the break line for trace 6 immediately follows (is to the left of) the break in the two-inch reference line. We originally designated galvanometer 5 as the two-inch reference point and the next successive trace break would be number 6. This identifying system clearly becomes necessary when a great number of traces are recorded since otherwise they would become a maze of indistinguishable lines.

This example serves to illustrate the importance of the photographic oscillograph in modern industrial instrumentation. For flight testing, research and development laboratories, missile telemetering systems, medicine, and other specialized industrial applications, it is an invaluable tool. ▲

RADIO SETS UP 70% IN DECADE

According to figures just released by the Radio Advertising Bureau, there are now 183.8 million operating radio sets in the U. S. This represents a gain of 70% in total sets in use over the last decade.

More than 60 million sets have been sold in the last three years. In 1961, 22 million sets were sold at retail, an all-time high according to the RAB. There are now 126.9 million home and portable sets in use, 46.9 million auto radios, and 10 million sets in public places.

These figures indicate that there are three times as many radios as TV sets or 3.4 radios per home. ▲

"Now for heaven's sake don't try to tell this one how to fix it!"

Mac's Electronics Service

(*Continued from page* 44)

nician alive is really guilty of all those faults," Barney said with a grin; "but most of us have been guilty of at least one at some time or other."

"I can only think of one technician who may not," Mac reflected. "This fellow was a jeweler before he went into radio and TV service, and just watching him work was a real treat. You'll laugh when I say this, but his deft, sure movements are almost like poetry in motion.

"To begin with, his bench was absolutely empty of everything except the chassis on which he was working and the tool he intended to use. The chassis was always blocked up securely, and the light had to be just right before he went to work. Then those big, steady, gentle hands of his would start inserting slender test probes, snipping loose defective parts with special long-nosed wire cutters, and soldering new parts in place. Almost always he managed to perform these acts without disturbing a single other part or wire. When he was forced to move a part aside, he moved it no more than absolutely necessary and he did it gently. When the operation was finished, he returned the part exactly to its original position. Heat from his soldering iron was applied just to the joint he was soldering or unsoldering and nowhere else. His solder joints, of course, were perfect.

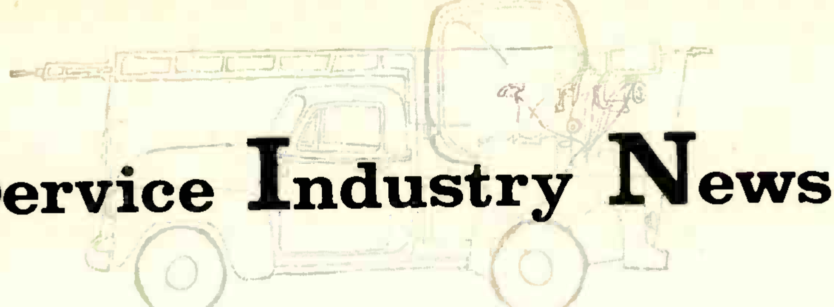
"In all the times I watched him work, I never saw him put a scratch on a cabinet, bend a dial pointer, punch a hole in a speaker cone, or injure a set in any way. The odd thing was this: he always seemed to be working very slowly and deliberately; yet he would regularly turn out three sets to every two turned out by the fellow working beside him, who always seemed busier than a Dixieland drummer on a hot number. Every move he made counted: that was the difference."

"Come to think of it," Barney said slowly, "gentleness is usually a sign of complete and confident mastery. Take driving, for instance. The good driver is the one who takes off smoothly and quietly, who brings the car to a gentle stop, and who makes his turns easily. It's the beginner who starts with a jerk, brakes hard, and darts crazily around corners. Getting back to service work, did you ever wonder what a radio or TV chassis would say to the technician working on it if it could talk? I know it sounds kookie, but I've wondered about that sometimes."

"So have I," Mac admitted with a chuckle, "and I think I know the answer. Remember the *Rubaiyat* of Omar Khayyam? In one verse the Tentmaker describes how he stopped by the way,

"To Watch a Potter thumping his wet Clay:
And with its all-obliterated Tongue
It murmur'd—'Gently, Brother, gently, pray!' "

"That's what I think the chassis would say to the technician if it could talk—and he would do well to listen!" ▲



Service Industry News

IF THE INDUSTRY'S next year-end statistical run-down does not confirm the fact that color TV is finally in full orbit, this department will toss its crystal ball into the trash basket. The accumulating evidence cannot be ignored. While we have made color the main theme of this department more than once in recent months, the rapid succession of events involving different segments of the industry commands repeated attention. Significantly, these events are unlike the false starts of past years, chiefly characterized by words. Today we see impressive action, with interested parties putting their dollars on the line.

Set manufacturing is one frontier. With *Motorola's* announcement that it will sell color receivers this fall (using the *RCA* CRT, since its own picture tube is not yet in regular production), every major receiver maker is now in the color market. What is more, it seems certain that *Motorola* will be fabricating its own chassis. Just a few years ago, whatever the label on the cabinet, *RCA* was making all chassis. Today *Zenith* also makes its own set. So does *Warwick*, for marketing by *Sears, Roebuck* under the *Silvertone* brand name. (Incidentally *Sears* has expanded its color line to five models, doubtless reflecting public acceptance.)

Another firm undertaking its own manufacture is *Wells-Gardner Electronic Corp.*, the source for several private-label brands including *Airline (Montgomery Ward)* and *Western Auto*. Thus there are at least five domestic manufacturers in actual production. Add to these the domestically sold *Delmonico* receiver, made in Japan. Finally, consider the recent statement of L. C. Truesdell, president of *Zenith Sales Corp.*, to the effect that color sales are "very satisfactory—better than we had anticipated."

More Color Picture Tubes

The evidence is not confined to set making. Until recently, the only available picture tubes have been those made by *RCA*. Considering the substantial tooling costs for CRT manufacture, others have held off pending assurance that demand will be significant. The *Rauland Corp.*, a *Zenith* subsidiary that makes monochrome picture tubes, is putting several million dollars into an expansion program. As one result, *Rauland* expects to become a supplier of color CRT's early in 1963. *Sylvania's* plant in Seneca Falls is also reported as running off some three-gun picture tubes, with an eye to swinging into regular production. *Sylvania* is also said to be keeping an open mind with respect to different color-tube versions.

Meanwhile *Motorola* and *National Video*, a CRT manufacturer, are hopeful about the former's design for a rectangular, 90-degree configuration. Although *Motorola* is going ahead with the *RCA* tube rather than waiting for production of its own version, it stands ready to drop in additional models as soon as the rectangular type is available.

In the meantime, *RCA* is not resting on its laurels. A new CRT, retaining the round shape but with deflection angle increased to 90 degrees, will be available as 1963 opens. Its shorter depth (by six inches) will cut cabinet bulk substantially. Neck diameter, now two inches, will be narrowed by more than half an inch to improve deflection efficiency. Another indicated benefit is even greater increase in brightness over that achieved last year with high-efficiency phosphors. A rectangular shape is also reported in the works, but not expected soon.

Nor are variations of the three-gun, shadow mask design the only ones to be reckoned with. For years, champions of the single-gun Lawrence tube have been saying that it is "ready," needing only someone to undertake production. With no takers here, a leading Japanese firm has been licensed for manufacture. As experience has taught us, an electronic success in Japan is soon felt here.

NATESA-ESDA Squabble

Beyond those noted in this space last month, no direct statements are in our hands at this writing, from the parties involved, concerning expulsion of the Electronic Service Dealers Association of Western Pennsylvania from the National Alliance of Television & Electronic Service Associations. However, Frank Teskey, editor of the "Hoosier Test Probe" (IESA of Indiana), offers some interesting comments.

First he states that the conflict should not stop any group now considering NATESA membership from joining. One reason he gives is that NATESA *is*, in effect, the national voice for the service industry, whether non-member groups like the fact or not. Another reason is his belief that NATESA machinery remains essentially democratic. As a regular participant in the national's annual conventions, he insists that problems and conflicts can be brought into the open without obstruction. He urges that this be done through more active participation in the organization. Indeed, he appears to have some issues to raise himself.

As to the ESDA battle, he has launched a series in the "Probe" on this and other controversial matters. The first two installments document the ESDA side of the story. From this it appears that the dispute centered about a group of service dealers in Pittsburgh that NATESA wished to be accepted as ESDA members, despite conflict between the dealers and ESDA leadership. After a period of negotiation without tangible results, the Executive Council and the Internal Affairs Committee of NATESA acted concurrently to "withdraw recognition as a NATESA affiliate from the group commonly known as ESDA of Western Pa." Leaders of the ousted association charge that expulsion in this way, not provided in the NATESA constitution or by-laws, is arbitrary, illegal, and indicative of unwarranted meddling in the affairs of the local. They want a full hearing before a broader body, such as the annual directors' meeting or national convention.

We assume that Teskey will follow up with documentation for the other side, as we intend to do when we have it.

Advertising Deception

As "TSA Service News" (TESA-King County, Wash.) points out, many people feel that price advertising inclines to be misleading almost automatically when it concerns any *service*, as distinguished from a commodity. A product, such as a pound can of branded coffee, is the same wherever it is sold, so legitimate price comparison is possible. A service is intangible. Thus the $7 house call offered by one man may be a much better buy than the $4 fee another man commands. Aside from the quality of service, price ads say nothing about how much time is included in the fee, what work is included or excluded, and what the basis is for extra charges. Yet the $7 man suffers, perhaps unjustly, in a necessarily superficial comparison based on price alone.

Taking this view into account, the Legislature of the State of Washington has passed a fairly stiff law concerning false and misleading advertising. Under it, an ad need not be considered only on the basis of what it says, but also on what it fails to disclose in the way of pertinent facts that might mislead the reader. In other words, a price ad that does not reveal all terms and conditions may thereby violate the law. Violations are punishable by fines and jail sentences.

One of the law's provisions relieves newspapers and other media from responsibility for such ads if they are not aware of the deceptive content. This can work in either of two ways. On the one hand, it is unfair to punish an innocent publication. On the other, a greedy newspaper could relax its former vigilance over the advertising copy it accepts. ▲

New Motorola TV Design

(*Continued from page* 37)

requirements from getting out of hand. Both of these measures, employed here in a 95-degree system, substantially reduce the demand made on the sweep output tubes.

With the low level of maximum available "B+," this still leaves quite a bit to ask from conventional output tubes. The screen grid of the horizontal-output stage, for example, has only 125 volts applied to it. The problem is solved here with new, specially developed, high-current types. The 27GB5, used for horizontal output, can handle 200 ma. This is impressively higher than the figures we are used to seeing for such tubes in a characteristics manual.

The high-voltage supply is conventional, putting out 17kv. Although we are accustomed to second-anode voltages of 20kv. these days, the 23DAP4 permits some reduction without sacrifice of brightness or spot resolution. A variable inductor in series with the horizontal winding of the yoke permits control of width.

Another high-current pentode, the 15CW5, is used twice in the receiver. Capable of delivering 50 ma. with voltages available in the receiver, it serves as vertical-output tube. It is more than adequate to provide audio power to the speaker, for which another is used.

There are other points of interest in the circuit. A 9A8 triode-pentode serves as sync clipper and sine-wave horizontal oscillator. With a pair of semiconductor diodes serving as the phase detector, a single vacuum tube is required in this part of the circuit, helping to keep the tube complement down. The two sections of another 9A8 serve as gated a.g.c. amplifier and externally adjustable noise inverter. Still another tube of this type provides the audio i.f. stage and one half of the vertical multivibrator (the other half being the vertical output tube). A 6DT6 provides quadrature detection for audio.

The short neck-and-gun design of the CRT offers still another advantage. It permits the use of a shallow cabinet (Fig. 4) for housing. This has been an important consideration to the prospective set buyer since the advent of the wide-angle picture tube. Finally, a sealed gasket is used between the faceplate and the safety glass, providing the advantages of using bonded-on glass without the cost increase entailed by that practice.

Time alone will tell what degree of success the designers have achieved in their goal. In any event, the problem has been approached with intelligence and, at the very least, a good degree of accomplishment can be conceded at the outset. We may assume that this is not just another "stripped" design.

Are TV design and pricing, as a result, entering a new phase? As sets reach market in the year ahead, they will answer the question for us. ▲

Cryogenics

(*Continued from page* 26)

have no resistance, a very small wire could easily carry a tremendous current, creating magnetic fields of undreamed of strengths. There would be no heat problems, since there would be no dissipation of power across a zero resistance. Even better, once the current was flowing, the loop could simply be made continuous. With zero resistance, the current would continue to circle and the magnetic force would persist indefinitely with no further expenditure of energy. The small amount of power needed to run the cryostat and keep the magnet in a superconducting state would be negligible, compared to savings in power which would otherwise be used to operate the magnet.

There was only one problem. As the cryotron illustrates, superconductivity is destroyed by a magnetic field. If an electromagnet produces a strong enough field to be useful, it quenches its own superconductivity.

This was the state of affairs until J. E. Kunzler of *Bell Laboratories* set to work in 1957 to determine if there were any superconductive alloys in which the "critical field"—the magnetic field strength at which superconductivity is destroyed—was high enough to be useful in an electromagnet. Among the alloys he tried was niobium-tin (Nb_3Sn). An ingot of the material remained superconductive in a magnetic field at the astonishing level of 88,000 gauss. (By comparison, gigantic scrap-metal-lifting magnets as big as an automobile and which weigh 20 tons, have strengths in the range of 25,000 to 30,000 gauss.) Eighty-eight thousand gauss was as high a strength as *Bell Labs* could produce with its biggest research electromagnet. Furthermore, at that field strength, the alloy would carry currents up to 3000 amperes per square centimeter. Obviously, such material could be made into an electromagnet of fantastic strength.

But there was one other difficulty. Niobium-tin is so brittle that *Bell* metallurgists were unable to draw it into a wire suitable for magnet winding. Their solutions to the problem: pack a quarter-inch tube of niobium with a mixture of powdered niobium and tin. Draw it into a wire .015 inch diameter with the powdered metal mixture still inside. Wind it into a solenoid, heat it to 1000° C. At this temperature, the niobium and tin powders fuse into the proper alloy.

To their delight, *Bell* scientists found that the metal made this way had even better magnetic properties than it did in ingot form. In an 88,000-gauss field, the new compound could carry a current density of 150,000 amperes per square centimeter, over 50 times the current density of the ingot material. And although there is no present equipment capable of measuring it, calculations indicate that the material will remain superconductive up to or perhaps even in excess of 200,000 gauss. *Bell Labs* says the problem now is to design a magnet which will be strong enough to generate such a field without tearing itself apart.

Super-Strength Magnets

Masers and traveling-wave tubes, which require strong magnetic fields for their operation, will be able to operate at much higher frequencies—and thus over broader bandwidths—with the stronger magnetic fields. (The maser, by the way, is another cryogenic device. It doesn't operate at all until cooled to within a few degrees of absolute zero.) Scientists will have opened up to them a whole new field of research involving the physics of super-high magnetic fields. At present, only a few companies can afford the tremendous machines like *Bell Labs'* 88,000-gauss unit. (It fills several rooms, consumes 1.5 megawatts of power, and requires thousands of gallons of cooling water per hour.)

The supermagnet may lead to a breakthrough in the field of nuclear fusion—harnessing the power of the hydrogen bomb. Scientists think they know how to sustain fusion, but there are many practical problems. First, the temperature must be maintained at about a million degrees to sustain the reaction. The reaction, then, must be contained in a "magnetic bottle"—a powerful magnetic field.

Until now, there has been no way of producing a sufficiently intense, persistent field. Besides, it has been calculated that if a method of generating it by conventional means were developed, most of the energy produced by the fusion would have to be used just to maintain the field. Superconductive magnets may be the answer. Once the field is established, no further power will be required to keep the super-current coursing endlessly through the supermagnet. The only power required will be that needed to maintain the refrigerative system, a negligible amount.

More Powerful Microscopes

Scientists may soon actually see atoms with a powerful new cryogenic microscope hundreds or perhaps even thousands of times more powerful than today's best instruments. The resolution of present-day electron microscopes is limited by the fact that the magnetic lines of force which form the "lenses" of the units are hard to control. Fig. 5 shows how the lines spread into unwanted patterns.

Cryogenics may supply the answer to this problem. Superconducting metals are opaque to magnetic lines of force. By covering the focusing coils with superconducting shields, the lines are confined to more exact paths so that the magnetic lens can be shaped more precisely and the magnification increased substantially.

Frictionless Motors & Bearings

The magnetic opacity of superconductors makes possible the old dream of completely frictionless bearings. Fig. 6 illustrates the principle. As the weight of the disk presses down over the coil, it compresses the magnetic lines of force into a much smaller space. Finally, they are dense enough to support the weight of the disk. A superconducting gyroscope has already been built using this principle. A superconducting ball which becomes the rotor of an electric motor floats in a magnetic field in a vacuum. With friction eliminated, no friction errors are introduced and the gyro is from 10 to 100 times more accurate than conventional models.

There seems to be no reason why

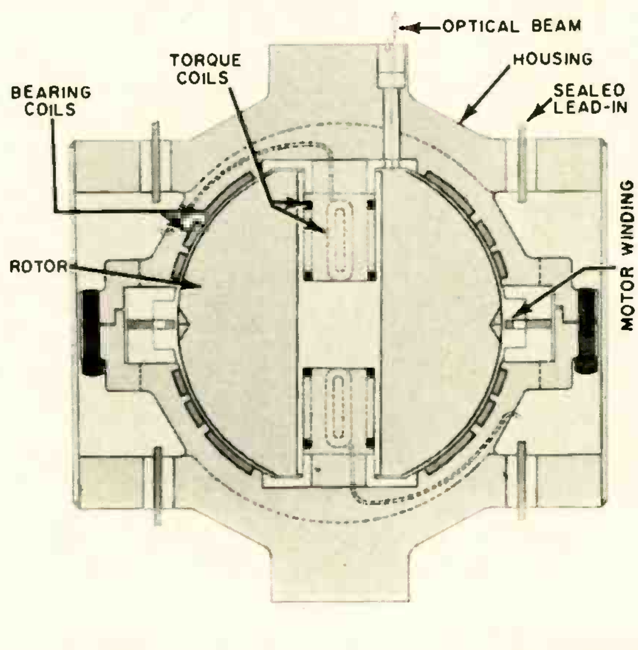


Fig. 7. Cutaway showing design features of cryogenic gyroscope under development by G-E. Promising accuracies many times greater than conventional gyros, it features a rotor designed for rotation at high speed inside a vacuum. Superconductivity induced by temperatures near absolute zero makes possible suspension of the rotor solely in a magnetic field. Eliminating mechanical bearings, the electric losses and friction are reduced so that they practically disappear.

completely frictionless bearings, such as those shown in Fig. 7 couldn't be built. The difficulties of keeping such bearings at temperatures within a few degrees of absolute zero are many, of course, but these are engineering matters which could be solved in any applications where the savings would be great enough in order to make the engineering worthwhile.

Many Other Uses

Literally dozens of other jobs have been suggested for cryogenic devices, some of which are under construction. Infrared detectors, for example, are far more sensitive when operated within a few degrees of absolute zero. Heat-seeking missile detector satellites, such as "Midas," must depend on such detectors. The big problem has been to design a cryostat (a super-low-temperature refrigerator) with the necessary performance characteristics which is still small and light enough to be included in a satellite. Although the exact status of the "Midas" program is secret, several companies have already demonstrated units which apparently meet all the qualifications.

Superconductive resonant cavities for microwave generation have already been built. Since electrical resistance is zero, almost infinite "Q" (probably in the millions) can be obtained. In addition, at near absolute zero, such a device's dimensions remain extremely constant. The accuracy of the output signal consequently approximates that of the atomic clock.

Since current circulating in a closed superconducting ring remains absolutely constant, the magnetic flux it creates can be used as a standard against which to measure unknown values of flux with great accuracy.

Power Generation

Much of the electrical power generated today never does any useful work at all. It is dissipated by the resistance of conductors. This I^2R loss may be completely eliminated in most of the power distributing and generating networks some day by making much of the system superconductive. Although there are formidable engineering problems involved, several approaches to such a system have already been suggested. Super-cold liquid gases could flow through the hollow conductors in the stator of a generator, for example, allowing the unit to produce far more power. Low-resistance coaxial power transmission cables—also internally cooled—might transmit the power generated more efficiently. Power transformers could be improved substantially by making one of the windings superconductive. This wiring could be made of ultra-thin printed circuits and yet carry a full load of current. This would reduce the mass of material to be super-cooled. These applications probably depend on the discovery of alloys which become superconductive at much higher temperatures than today's known superconductors.

A professor at the Illinois Institute of Technology has suggested a novel cyrogenic approach to powering vehicles. According to his idea, a massive circulating current would be trapped in a closed-circuit superconductive inductor. This circulating current could then be tapped and used to run an electric drive motor.

He calculates that a superconducting wire with a current-handling capacity of 100,000 amperes, formed into a 1-henry inductor, would store 1390 kilowatt-hours. Using a 200-horsepower electric motor operating at 75% efficiency, a car or truck could run at top speed for seven hours.

Cryogenics is having a profound effect on the field of electronics. The few devices now operating—masers, a super-magnet, cryotrons, and other devices, all of which will seem unbelievably crude in a few years—are only indications of things to come. As a *General Electric* researcher put it, "The present stage of this work is about where electrical technology stood during the last half of the 19th Century." ▲

New Products and Literature for Electronics Technicians

Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, simply fill in the coupon appearing on page 96.

WIDE-BAND SCOPE

1 **Sencore, Inc.** has just released a completely new wide-band oscilloscope, the Model PS120, which has been especially designed with the needs of technicians, engineers, and service personnel in mind.

The instrument will accurately reproduce any waveform from 20 cps to 12 mc. The 3" extended-

view scope has only two major controls. There is an automatic range indicator on the vertical input control which enables the direct reading of peak-to-peak voltages. A standby position on the power switch adds hours of life to the CRT and other tubes.

AUTOMATIC EASEL

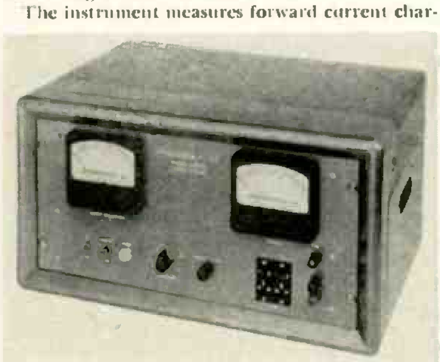
2 **Easel-Matic Binder Co.** has issued an automatic easel visual aid which has been specifically designed as a service aid in the electronics field. Technicians can use the new unit to enable them to read detailed schematic diagrams at eye level, or to bring data charts, tube replacement and interchangeability charts, and price lists within range for easy reference.

The standard easel or flip-over model is available in two sizes: 8½"x11" and 11"x 14". It comes in 1" or 1½" ring capacity, any spacing, and is made of virgin vinyl for durability.

DIODE TESTER

3 **Trans Electronics Division** is marketing its Model DT 928 diode tester which provides laboratory accuracy in a regulated current source for testing semiconductors devices.

The instrument measures forward current char-



acteristics with the accuracy demanded for research and development work and for instrument maintenance and repair. Meter range is 0-3 amps. A 6-position rotary switch selects milliamp ranges of 0-10, 30, 100, 300, 1000, and 3000 ma. Telephone-type lever switches select voltmeter ranges of 0-1 and 0-3 volts d.c. The unit provides line and load regulation of 0.1%; ripple and noise is 0.2% maximum.

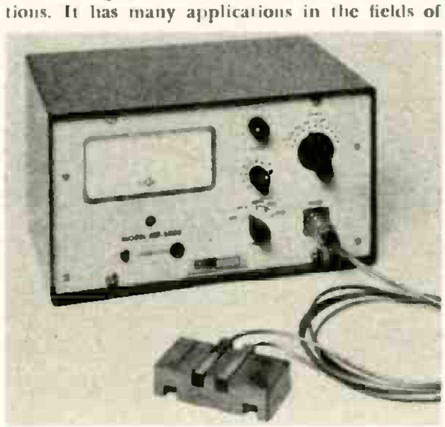
MINIATURE I.F. TRANSFORMERS

4 **Stancor Electronics, Inc.** has added two new series of miniature top-tuned i.f. transformers to its line. The 24 units are currently available for immediate delivery.

The RTC-9284-RTC-9295 series has hollow hexagonal-hole cores, permitting either double or single ended tuning. The transformers are mounted with unique snap fasteners permanently attached to the shields, providing a positive ground connection without an extra soldering operation. Included are 262- and 455-kc. input and output units, a 4.5-mc. input and interstage, and a 4.5-mc. ratio detector. A second series is for the same applications but is equipped with ground lugs designed for printed-circuit boards.

PORTABLE MAGNETOMETER

5 **Forster/Hoover Electronics, Inc.** is now marketing a lightweight, portable magnetometer for measuring d.c. magnetic fields. Fully transistorized, the instrument responds to such magnetic fields as the stray fields of d.c. equipment and the magnetic field of the earth and its fluctuations. It has many applications in the fields of



geophysics, magnetic investigations, and the nondestructive testing of magnetic materials. It can also be used for degaussing and for the determination of the amount of residual field remaining in a piece after demagnetization.

The Model MF-5000 measures 12¾" x 8⅜" x 7¼" and weighs 15 pounds. It will operate from 110-volt power lines or from a rechargeable battery.

WELDING CALIBRATOR

6 **Raytheon Company's Commercial Apparatus** and Systems Division has just introduced a welding calibrator that will measure the output of any precision welding system. The new device reads pulse amplitude and length accurately within 1% to set up a welder or to match the outputs of various welders on a production line and to insure consistent repeatability of welds.

The calibrator can be used to indicate polarity, detect drift in welder output and indicate necessary correction, and to determine weld energy for use in iso-strength diagram formulation. Applicable to a.c. or d.c. welders of any make, the Model 2-250 is fully transistorized and portable,

operating from either 110 volts a.c. or its own self-contained batteries.

MINIATURE GLASS TRIMMERS

7 **Corning Electronics Components** has developed a line of hermetically sealed miniature glass trimmer capacitors for use in severe environments. Ideal applications are where the trimmer interior must not be subjected to moisture in uses such as potted circuits or airborne, missile, and satellite electronic systems.

Fixed cavity tuning is smooth and linear, according to the company, with a change in capacitance of only .4 μμf. per turn. Capacitance ranges of four models, each available with panel-mount or printed-circuit hardware, are 1-4.5, 1-8.5, 1-12, and 1-18 μμf.

SCANNER CR TUBES

8 **Sylvania Electric Products Inc.** has added two new flying-spot scanner CR tubes to its line of special types for industrial and military applications.

The tubes, designated 5DKP15 and 5DKP16, are 5" round glass types featuring aluminized screens, magnetic deflection, magnetic focus, and high resolution. They can be supplied with other phosphors including P4, P11, and P24. The tubes are designed to operate at a typical anode voltage of 8000 volts d.c.

CAPACITANCE CHECKER

9 **Jackson Electrical Instrument Company** is marketing a new wide-range capacitance checker, the Model 691, featuring a low-voltage bridge for testing electrolytics in transistorized circuits.

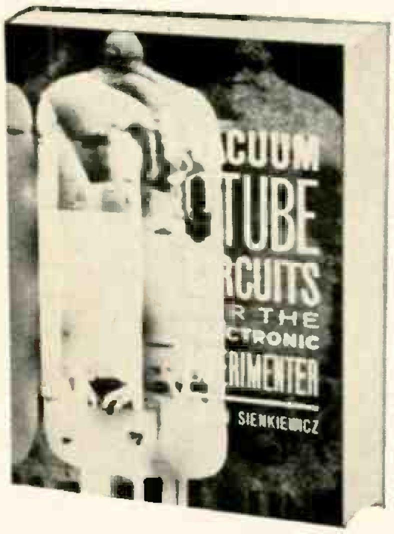
The instrument uses color-coded range push-buttons with matching scale colors for easy selection. Its four ranges test capacity from 10 μμf. to 1000 μf. Graduated leakage tests for both polarized and unpolarized capacitors are possible.

TRANSISTOR MOUNTING PADS

10 **Regan Plastics Company** has recently introduced a new line of injection-molded plastic transistor mounting pads designed to eliminate the difficulties encountered in mounting transistors on etched circuit boards.

The pads provide stable mounting for all JETEC #12 and #30 transistor cases since they are elevated on four integrally molded feet, min-

LIVELY READABLE HOW-TO BOOKS FOR THE EXPERIMENTER AND ELECTRONIC HOBBYIST



VACUUM-TUBE CIRCUITS FOR THE ELECTRONIC EXPERIMENTER

by Julian M. Sienkiewicz

How many times has the experimenter wanted a diagram of a basic vacuum-tube circuit which he could use as a guide in building some practical electronic device? At last, in one book, he can find all the basic diagrams, schematics, and other vital information on vacuum tubes and their circuits. One hundred vacuum-tube schematic diagrams, plate-characteristic curves, simplified schematic diagrams, test circuits and other selected illustrations supplement the informative text to make this new publication one of the most useful and informative books available for the rapidly growing legion of experimenters and electronics hobbyists. 192 pages, 100 illustrations.

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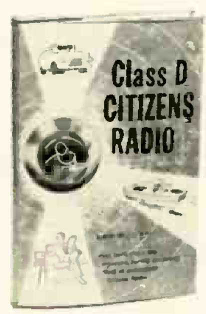

CLASS D CITIZENS RADIO

by Leo G. Sands

The first and only book to be published in this important and rapidly expanding field. Leo Sands, author of almost 500 technical articles and 4 books, gives complete information on this important commercial class of radio and explains just what Citizens Radio service is and what are its many applications. Many illustrative circuits are shown and there is a special appendix of FCC rules and regulations. 181 pages, 72 illustrations.

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COMPUTERS AND HOW THEY WORK

by James D. Fahnestock

A solid and acclaimed introduction to this ever-expanding field. A completely understandable and comprehensive study that describes in clear and precise terms computer principles, manufacture, operation and maintenance. Provides a solid foundation for the study of computer techniques. Discusses computer memories, flip-flops, programming, etc. The 113 special illustrations provide a visual explanation of computer operation and principles. 228 pages.

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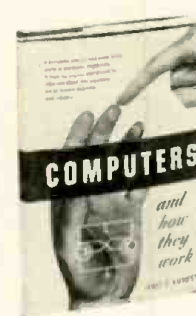

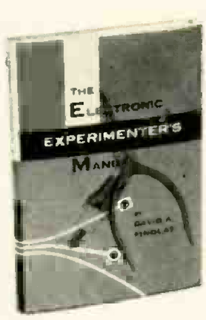

THE ELECTRONIC EXPERIMENTER'S MANUAL

by David A. Findlay

The ABC's of electronics experimentation and project construction are presented in this book in such plain language and in a style so easy to read, that anyone will become absorbed from the very first chapter. The projects advance from the simple to the more advanced. Through these pages the reader will acquire the knowledge and skill to turn out his own short-wave receivers, intercom systems, transistor radios, etc. 169 pages, 170 illustrations.

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imizing surface irregularities of the board and allowing insulating air space.

Six standard versions are in production with specials available on a custom basis.

BATTERY ELIMINATOR/CHARGER

11 Precision Apparatus Co., Inc. is now in production on the Model P-25 transistor radio battery eliminator and battery charger.

The P-25 eliminates the need for batteries in transistorized equipment under test and during repairs. It also simulates weak battery conditions during servicing and supplies adjustable d.c. voltage, continuously variable, from 0-25 volts d.c. and up to 100 ma. d.c. It also provides an automatic center tap for transistor radios with no output transformers and includes a ± 1.5 volt d.c. fixed tap for convenience in servicing.

TRANSISTOR TESTER

12 GC Electronics Company has developed a compact transistor tester which is being marketed as the Model No. 36-560. Capable of testing "p-n-p," "n-p-n," power transistors, diodes, and semiconductor rectifiers, the unit measures 5"x 5"x 1⅞" and weighs only 1¾ pounds.

The circuit includes a wide-angle meter, three tests (shorts, leakage, gain), transistor socket for

"out-of-circuit" testing, and zero adjustment on the meter. An "off" switch eliminates possible battery and/or meter damage through accidental shorts.

HI-FI—AUDIO PRODUCTS

NEW 12-INCH SPEAKER

13 Hartley Products Company has just released a 12-inch speaker as its Model 312. Featuring a cast-aluminum frame, the new speaker has a 5¾ pound Alcomax II magnet with 16,000 lines per square centimeter.

The full-range polymerized cone has a double "U" cloth suspension. The encapsulated voice coil has an impedance of 8 ohms. A hemispherical dome serves as the high-frequency propagator for wide dispersion. Response is 20 to 20,000 cps. The cabinet is of oiled rubbed walnut.

A 10-inch version, the Model 310, is also available with a frequency response from 25 to 20,000 cps.

MULTIPLEX ADAPTER

14 Dynaco Inc. is now offering a multiplex adapter, FMX-3, to complement its FM-1 tuner.

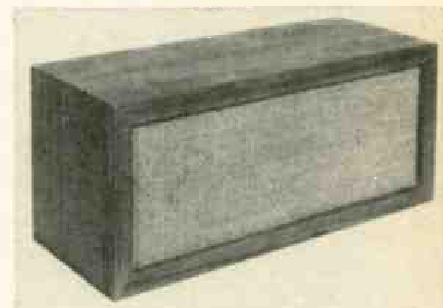
The new multiplex integrator is designed to fit all "Dynatuners" and can be wholly contained on the tuner's chassis. Automatic in operation, the FMX-3 provides identical mono signals from both channels or 30 db of stereo separation if the station is broadcasting stereo. A stereo broadcast automatically announces its presence on the front-panel "Stereobeam" by lighting up the word "Stereo." Complete suppression of SCA carriers and a 38-kc. rejection filter eliminates beats, whistles, and interference problems when tape recording off-the-air. A dual volume control operates both channels.

Available in kit form, the FMX-3 can be assembled in approximately three hours.

BOOKSHELF SPEAKER SYSTEM

15 Anglo American Acoustics Ltd. is now marketing a compact bookshelf speaker system which features a British-made speaker with a frequency response of 45-16,000 cps.

These new systems are designed to perform best with amplifiers from 8 to 50 watts. The



"Kent" offers a 3" hardened tweeter diffusion cone and an 8" high-compliance woofer with almost ¾" cone displacement. The cabinet is of solid wood, unfinished, and measures 24" wide, 10" high, and 9" deep.

The system is also available in an oil-finished walnut cabinet as the "Windsor."

RECORD CLEANING DEVICE

16 Grado Laboratories, Inc. has recently introduced its "Dustat" which cleans records as they are being played. The unit is designed to be mounted by means of a thread and wing nut which seat in a ¼" hole to be drilled in the turntable. For those unwilling to tamper with their phonograph motorboards, a suction cup and cement are provided for mounting the device.

The unit operates without fluids and is cleaned by wiping the dirt off the velvet pad with the fingers.

MULTIPLEX ADAPTER

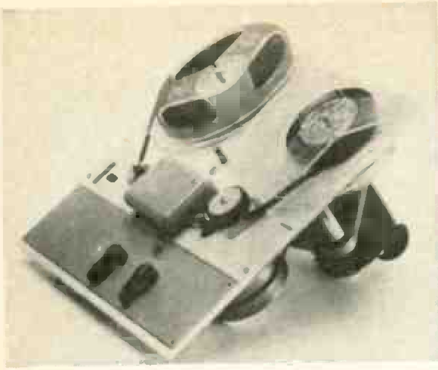
17 Grommes, Division of Precision Electronics, Inc. is now offering its Model M-1 FM stereo multiplex adapter. Designed to be used

with any quality FM tuner, the unit connects to the multiplex output of the tuner and to the auxiliary inputs of the amplifier.

The adapter provides full frequency response and has a noise filter switch for fringe areas. It has a low-heat silicon power supply and is without controls.

TAPE TRANSPORT

18 Vega Electronics Corporation is now marketing a simple magnetic tape deck which features conventional reel-to-reel design but incorporates a major simplification of parts to minimize service requirements.



The "AV" deck is presently available only without electronics and in quantity lots for language-lab installations and school classroom use. Features include constant-tape-tension system rather than head pressure pads; rigid mounting of the entire transport mechanism to a one-piece solid aluminum-alloy die casting top plate for permanent alignment; dual speed; ¼" wide tape and 7" reel handling capabilities; plus flutter and wow of less than .20% r.m.s. @ 7.5 ips and less than .30% r.m.s. @ 3.75 ips.

TRANSCRIPTION TONE ARM

19 **Thorens Division** has just introduced its BTD-12S stereo transcription arm for use with 12" hi-fi turntables. Among the features claimed for this new unit are extremely low inertia in both vertical and horizontal planes, complete independence of turntable leveling due to precise balancing and spring-applied stylus force, resonance frequency well below 16 cps with ordinary pickups, and a precision cueing device integral with the arm which permits lowering and lifting the arm without touching it.

Over-all arm length is 12½". The arm is supplied with a mounting board for use on the firm's Model TD-124 and TD-121 turntables but will fit any standard 12" turntable.

NEW MICROPHONE SERIES

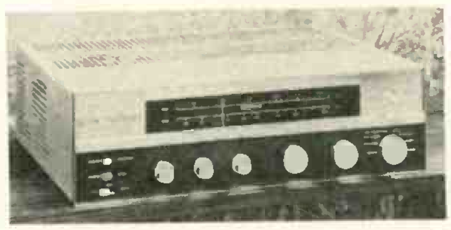
20 **American Microphone Co.** has recently developed the new 215 series of crystal and ceramic microphones which feature quality performance, attractive design, and low price. The crystal unit delivers a frequency response of 40 to 8000 cps and an output level of —51 db at 1000 cps. The ceramic unit is rated at an output level of 58 db at 1000 cps.

Housed in a high-impact polystyrene case, the series is offered with an optional "on-off" slide switch and equipped with a five-foot single-conductor shielded cable.

STEREO RECEIVER KIT

21 **Allied Radio Corporation** is now marketing an all-new "audio center" kit that combines an AM-FM-multiplex stereo tuner with a 32-watt stereo amplifier in a single unit.

The KU-45 incorporates dynamic sideband



regulation that reduces overmodulation and fringe-area distortion while a.f.c. locks in the FM broadcast signal and prevents drift.

The circuit features a simple point-to-point wiring method and a special prewired and prealigned FM "front assembly" assures good performance. The kit comes complete with parts, tubes, wire, solder, and easy-to-follow instructions. A built-in loop antenna for AM and a folded dipole antenna for FM are also included.

MUSIC CENTER

22 **Transis-Tronics, Inc.** has recently introduced its Model 320 "Combination" which features a record changer, stereo amplifier, and FM

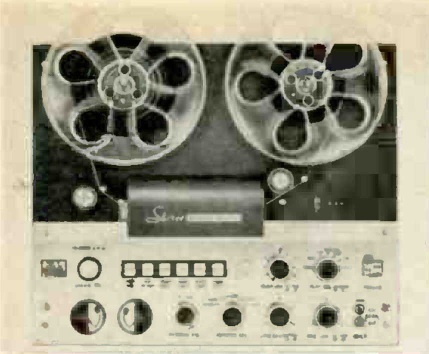
multiplex tuner housed in an oiled-walnut cabinet measuring 14" high x 23" wide x 15¾" deep.

The instrument incorporates the firm's FM-15 MX multiplex FM tuner, an all-transistor unit which provides frequency response of 20-20,000 cps ± 1 db and the S-15 stereo amplifier. The record changer is selectable by the buyer.

STEREO/MONO TAPE DECK

23 **Eico Electronic Instrument Co. Inc.** has released an improved version of its RP100 tape deck, a transistorized stereo/mono, four-track unit.

Among the new features are a professional studio recording hysteresis-synchronous capstan motor; two new take-up and rewind reel motors; a cored-out steel capstan flywheel with all the mass concentrated at the rim for improved flutter filtering; newly designed capstan drive belt; automatic end-of-tape stop switch; shock-absorbent helical spring tape lifters; and recording level adjustment during stop-standby.



The unit is offered as a semi-kit with the tape transport assembled and tested and the electronics in kit form or as a completely factory-assembled unit.

WIRELESS INTERCOM

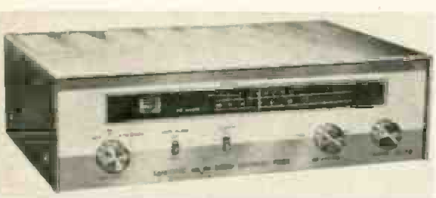
24 **Fanon Electronic Industries, Inc.** is now marketing a restyled line of intercoms headed by the **Fanon-Masco Model FW-40**, a wireless and fully transistorized unit.

By plugging the units into a.c. current outlets, the system is ready for instantaneous use. Because of its transistorized circuit, no warm-up period is required. The intercoms are housed in high-impact styrene enclosures which are functional as well as decorative.

FM-AM-MULTIPLEX TUNER

25 **Lafayette Radio Electronics Corporation** has recently introduced a moderately priced FM-AM tuner which includes multiplex facilities.

Designated the LT-78, the tuner has plate-follower output which permits remote connec-



tion to the amplifier. The superhet AM circuit features three i.f. stages, a.v.c., 8-kc. bandwidth, and level control. The FM circuit has a 200-kc. bandwidth, Foster-Seeley discriminator, and a frequency response of 20-20,000 cps. The a.f.c. is of the variable type for fine adjustment.

The instrument is housed in a gold and white enclosure which measures 15" x 9½" x 5".

CB-HAM-COMMUNICATIONS

CB TRANSCEIVER

26 **Lafayette Radio Electronics Corporation** has added the HE-20B to its line of CB equipment.

The 5-watt-input, crystal-controlled transmitter may be operated on any eight of 23 channels with the operating channel selected by a front-panel control. The superhet receiver section also has eight crystal-controlled "receive" positions and is tunable over all 23 channels with a sensitivity of 1 μv.

The circuit includes an effective squelch and series-gate noise limiter. An "S" meter with switch permits measurement of incoming signal strength and final amplifier wattage. The unit comes with matched crystals for channel 9, push-

to-talk ceramic microphone with mounting bracket, and built-in 117-volt a.c./12-volt d.c. power supply for mixed operation. A special bracket allows simple mobile installation.

AMATEUR RECEIVER

27 **Hammarlund Manufacturing Company, Inc.** is now marketing an improved version of one of its popular ham receivers as the HQ-110A. Featuring improved mechanical and electrical stability over its predecessor, the new receiver is a dual-conversion, 12-tube superhet with good image response rejection and high selectivity.

The circuit includes an accessory socket for preamp or converter applications; an expanded dial—144 to 148 mc. calibrations for use with 2-meter converters; and a 6-meter coax input for rapid shift from v.h.f. to l.f. operation.

TUNABLE TVI FILTER

28 **Gavin Instruments, Inc.** has introduced its "Maverick II" 50-mc. tunable filter and output power indicator which will be marketed to the amateur and CB fraternity through electronic distributors.

Designed for stations in the 35-54 mc. range

with TV interference problems, the tunable feature assures optimum impedance match between transmitter and antenna, minimizing mismatch and power losses due to s.w.r.

The meter is directly calibrated in watts output from 0-50 and 0-400 watt ranges. The filter will handle up to 400 watts plate input with less than 1-db loss and at least 35-db harmonic attenuation.

TWO-WAY RADIO

29 **Dare, Inc.** has entered the growing FM radio communications field with its "Darector" series of two-way radio equipment operating in the 148-175-mc. range.

The circuit features nuvistors, has a selectivity control by means of an 8-section crystal filter, and includes a high-gain antenna for mobile ap-

plications. Available in either under-dash or trunk-mounted styles with the speaker enclosed in the remote-control head, the new units can be had with either 40 or 75 watt output. The unit also offers the unique option of two-channel operation with up to 24-mc. separation between the channels.

IGNITION NOISE SHIELD

30 **Hallett Manufacturing Company** is now offering a new, comprehensive mechanical ignition shielding system to protect mobile radio users from communications-degrading ignition noise and interference.

Known as the "Signal Saver," the new unit blankets both conducted and radiated noise. Features include snap-on plug shields, braided metal high-tension cables, a shielded distributor cap which clips into position, and a coil enclosure. All components are corrosion protected and weatherproofed.

MANUFACTURERS' LITERATURE

CARTRIDGE REPLACEMENTS

31 **Sonotone Corporation** has just issued a newly revised phonograph replacement manual which lists the complete line of the company's cartridges which can be used as replacements for original-equipment pickups.

The manual lists 1200 models of phono cartridges made by 33 manufacturers with the correct Sonotone replacement for each model. The booklet also carries a replacement needle guide and a brief listing of the firm's other audio products.

INDUSTRIAL KIT CATALOGUE

32 **Heath Company** has assembled all of its electronic lab and test instrument kits into a single 24-page catalogue for the convenience of industrial users in all categories.

Among the products listed are test meters, analog computers, oscilloscopes, intercom systems, amplifiers, walkie-talkies and similar electronic equipment. Each item is priced, illustrated, and described in precise detail. One especially valuable feature is an estimate of the time required to assemble each kit and the degree of technical know-how required of the constructor.

MAGNETIC HEADS

33 **International Electro-Magnetics, Inc.** has just issued a folder containing typical configuration and specification considerations for magnetic heads for professional and instrumentation purposes.

The new publication also lists specifications for high-frequency heads.

PANEL METERS

34 **Ideal Precision Meter Co., Inc.** has issued a comprehensive catalogue covering its line of panel meters for a wide variety of applications.

Complete specifications are given on d.c. milliammeters, d.c. voltmeters, d.c. ammeters, d.c. microammeters, d.c. millivoltmeters, a.c. milliammeters, a.c. voltmeters, a.c. microammeters, volume level and db meters, all offered in an extensive range of electrical characteristics and various housings. Dimensional drawings are included for each type to assist the design engineer in specifying the correct unit.

SLIDE MECHANISMS & ACCESSORIES

35 **Jonathan Manufacturing Company** has issued a 20-page, two-color catalogue covering its line of precision ball-bearing slide mechanisms and accessories especially designed for the electronic and scientific industries.

The line includes a variety of precision sliding mechanisms to facilitate the movement of drawer-stored equipment. Close tolerance, telescoping ball-bearing slides in two- or three-member types are available, all with pivoting, disconnecting, and locking features, if required.

Detailed line drawings and complete specifications make this catalogue useful as a design handbook as well as a product listing.

INSTRUMENT CATALOGUE

36 **Keithley Instruments, Inc.** has issued a short-form catalogue which lists five new products introduced since the publication of its regular catalogue. A new line of millivolt discriminators, Models 710 and 711, is described. Also included are the Model 103 low-noise a.c. amplifier and the Models 502 and 503 milliohmmeters.

ADHESIVE LITERATURE

37 **Minnesota Mining and Manufacturing Company's Adhesive's Division** has issued a 12-page, two-color illustrated catalogue describing properties and typical uses of elastomeric adhesives, coatings, and sealers in the electrical manufacturing field.

The publication lists and illustrates representative examples of where adhesives, coatings, and sealers can be used to improve product performance and reduce costs.

ULTRASONIC GENERATORS

38 **National Ultrasonic Corp.** has issued a two-page illustrated data sheet covering specifications on a complete line of ultrasonic generators for conveyorized, batch, or manual production-line cleaning and degreasing. All of the generators are designed to operate either transducerized tanks or immersible transducers interchangeably. The bulletin gives instructions for ordering units for any given cleaning requirement.

MICROWAVE MEASUREMENTS

39 **Polarad Electronics Corporation** has issued a revised and enlarged edition of its booklet "Notes on Microwave Measurements."

This handy digest of measurement techniques is useful to microwave engineers and technicians and serves as a comprehensive guide to methods and techniques of microwave measurements. The booklet covers general procedures and equipment.

SERVO MOTOR DATA

40 **Kearfott Division** has published a 16-page condensed catalogue of its servo motors containing application data and mechanical and electrical characteristics of more than 60 motors from Size 5 through Size 30.

In addition, typical outline drawings and photos are included for various motor sizes and classifications.

PULSE TRANSFORMERS

41 **Forbes and Wagner, Inc.** is now offering copies of its 20-page pulse transformer brochure which covers a general description and functions plus methods of selecting an extensive line of blocking oscillators, coupling transformers, passband and pulse units. Characteristics are also listed for a line of coupling transformers. The publication is complete with graphs and tables.

CALIBRATED PANEL METERS

42 **Assembly Products, Inc.** has covered two new types of indicating panel meters in its recently issued Bulletin 30.

The publication covers four classes of super-calibrated meters, with taut band construction, dials individually fitted to each meter movement, and exceptional resistance to vibration. The bulletin includes a brief discussion of engineering details of the meters, complete price lists, and ordering information.

LANGUAGE-LAB DATA

43 **Edwards Company, Inc.** has issued a 12-page illustrated brochure describing the principles and functions of language laboratories and detailing the firm's complete line of language teaching equipment and accessories.

The booklet defines the elements required for an electronic learning center and outlines the three basic systems for language laboratory operations.

POTENTIOMETER DATA

44 **Duncan Electronics, Inc.** is offering a new four-color short-form catalogue detailing specifications and performance characteristics on the firm's complete line of single- and multi-turn potentiometers, trimmers, non-linear pots, turns counting dials, and contactless potentiometers.

D.C. POWER SUPPLIES

45 **General Electric Company** has issued a four-page data sheet (GEA-7338) which explains the features and capabilities of its high-voltage d.c. power supplies for cathode-ray display tubes and similar applications. Units described can be designed for 2 kv. to 25 kv., d.c., up to 1 amp output, for any a.c. source. Circuit and performance information plus application notes and a simplified specification guide are included.

PHONO NEEDLE GUIDE

46 **Duotone Company, Inc.** has announced the availability of its 1962 phono needle and replacement guide which is being supplied to distributors and their dealers and servicemen.

Consisting of 48 pages, the new guide includes a cross-reference by needle numbers, illustrations of needle replacements, and the record speed and needle number in diamond, jewel, or osmium.

TEMPERATURE-MEASURING UNITS

47 **Pyrometer Instrument Company, Inc.** has published a new 12-page catalogue, No. 176, which covers a complete line of precision temperature-measuring instruments. Full descriptions, technical data, specifications, prices and applications are included on an optical pyrometer, surface pyrometer, micro-optical pyrometer, as well as a full line of interchangeable thermocouples.

SEMICONDUCTOR CATALOGUE

48 **Motorola Semiconductor Products Division** has issued an 18-page condensed catalogue covering its complete line of standard industrial and MIL-type semiconductor products.

The catalogue lists major electrical specifications on the firm's full line of transistors, zener diodes, and rectifiers and provides mechanical characteristics and outline drawings for all of the company's semiconductor devices.

NIBBLING TOOLS

49 **Hedstrom Tool Company** has issued a single-page data sheet covering its "Nibblex" metal cutting attachment for electric and air drills. The unit, which is designed for cutting

sheet metal, fiberglass, Formica, and similar materials up to .55" thickness, is described in detail and illustrated, along with the accessories consisting of a holding bracket, handle, side punch, and one spare set of punch and die.

PRECISION RELAY DATA

50 Cornell-Dubilier Electronics has detailed operating data and characteristics on an extensive line of precision relays in its 12-page bulletin #240.00.

Types covered include 5-pole, 12-position program relays, bistable, telephone, and glass-reed relays as well as units for general and special applications. Data is also presented on contactors and solenoids.

FERRITE FILTER INDUCTORS

51 Indiana General Corporation's Electronics Division has issued a 10-page bulletin giving complete specifications on its "Ferramic" TC core assemblies for filter networks.

Several "international series" sizes are available in 21 standard inductances. These are described in detail with complete electrical, mechanical, and performance specifications. In addition, electrical curves, selection nomograms, and complete testing procedures are covered.

POWER SUPPLIES

52 Behlman-Invar Electronics Corp. has published a short-form catalogue covering its line of a.c. and d.c. power supplies.

Included in Catalogue No. 1200 are a standard line of a.c. supplies with over 375 models in both fixed and variable frequencies, transistorized power supplies, fully adjustable laboratory supplies, and a series of 54 modular supplies for data processing and ground support applications.

AUTO RADIO CATALOGUE

53 ATR Electronics, Inc. has issued a four-page two-color data sheet covering its line of "Karadios." The line, which features transistor-powered and tube-operated radios of both custom and full-custom types for all popular cars, are pictured and described in some detail in this publication. A price sheet, on a separate page, is also available with this brochure.

INDUSTRIAL RELAYS

54 Potter & Brumfield has issued a 16-page catalogue featuring a complete line of electromagnetic relays for industrial applications.

Divided into illustrated sections, the new publication describes five different categories of relays: high performance, power, special purpose, general purpose, and telephone types. Pertinent engineering data and special features are listed for each type of relay. UL and Canadian Standards Association listed relays are so designated.

DESIGNERS' DATA SHEET

55 Motorola Semiconductor Products Inc. is offering a designers' data sheet which represents a new concept in specifying transistor characteristics.

The new data sheet was developed by the firm's applications engineers in close cooperation with practicing design engineers. It is said to be the first data sheet to include curves and graphs that permit complete switching-circuit design from the given data without resorting to tests and extrapolations. The first of the series covers the type 2N964A high-frequency switching transistor.

POWER SUPPLIES

56 Communication Measurements Laboratory, Inc. has published a 14-page catalogue on its line of a.c. power sources, including power amplifiers ranging in output from 10 to 180 kw.; electronic generators with single-, two-, and three-phase output in rack-bench and console models, and test equipment such as stroboscopes and megohmmeters.

Complete specifications, dimensional illustrations, and other features are included. ▲

NEW MIL SPECS PROPOSED FOR PLASTIC KNOBS

On July 14, 1961 the Armed Services Electro-Standards Agency at Fort Monmouth, N.J. issued a proposed revision of specification Mil-K-3926A and of Military Standard MS91528.

Highlights of the new proposal include, for the first time, a flammability requirement . . . the plastic material shall be self-extinguishing by ASTM D635-56T. The following environmental tests are to be performed: (1) Salt Spray (Mil Std. 202B, Method 101A); (2) Accelerated Weathering Test (Fed. Std. 406, Method 6023); (3) Moisture Resistance (Mil. Std. 202B, Method 106A); (4) Thermal Shock (Mil. Std. 202B, Method 107A).

In addition, all knobs are to be marked according to Mil. Std. 130, with the MS part number and the supplier's name or code symbol.

A new series of knobs has been proposed. This will obsolete the small 0.500 series. The o.d. of the new knob is to be 0.575.

The Services and Industry representatives met on the 24th and 25th of May for the purpose of resolving comments on this initial draft. The results of this meeting have not been released. ▲

Answer to Electronics Crosswords
(Appearing on page 69)

S	H	A	N	K	■	■	■	C	A	B	L	E
P	A	N	E	L	■	■	■	A	L	L	O	Y
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31 (bottom center), 32 (bottom right)	Paco
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36, 37	Motorola Inc.
43, 73	Precision Apparatus Co.
47	Osborne Electronics Corp.
53, 54	AiResearch Manufacturing Co.

Calendar of Events

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

JUNE 25-27
Sixth National Convention on Military Electronics. Sponsored by Professional Group on Military Electronics of IRE. Shareham Hotel, Washington, D.C. Details from John J. Slattery F315, The Martin Co., Baltimore 3, Maryland.

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

JUNE 27-29
1962 Joint Automatic Control Conference. Sponsored by PGAC of IRE, AIEE, ISA, ASME, AIChE. New York University, University Heights, New York City. Program details from Dr. H.J. Hornfeck, Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

JULY 13-15
"Telerama"—Annual Convention of the Tri-State Council of TV Service Associations (N.J., Pa., & Del.). Traymore Hotel, Atlantic City, N.J.

JULY 16 - AUGUST 3
NBS Course on Radio Propagation. Sponsored by NBS Boulder Laboratories, Boulder, Colorado. Details from E.H. Brown, Graduate School, Boulder Laboratories.

JULY 26-AUGUST 12
Fourth Annual International Trade Fair. Sponsored by the Chicago Association of Commerce and Industry. McCormick Place, Chicago, Ill. Open to public and trade at specified hours. Details from Association, 30 W. Monroe St., Chicago 3.

AUGUST 8-10
1962 Standards Laboratory Conference. Sponsored by National Conference of Standards Laboratories. Boulder Laboratories of National Bureau of Standards, Boulder, Colo. Further details from Alfred E. Hess, Circuit Standards Div., NBS, Boulder.

AUGUST 13-16
Pacific Energy Conversion Conference. Fairmont Hotel, San Francisco. Registration information from Wendell B. Freeman, c/o General Electric Co., 235 Montgomery St., San Francisco 4.

AUGUST 14-16
International Conference on Precision Electromagnetic Measurements. Sponsored by NBS, IRE, AIEE. NBS Boulder Laboratories, Boulder, Colo. Program information from Dr. George Birnbaum, Hughes Research Labs., Malibu, Calif.

AUGUST 21-24
1962 Western Electronic Show & Convention. Sponsored by Los Angeles & San Francisco Sections WEMA, all professional groups of IRE. Statler Hilton & Sports Arena, Los Angeles. Details on program from WESCON Business Office, c/o Technical Program Chairman, 1435 S. La Cienega Blvd., Los Angeles 35, California.

AUGUST 22-SEPTEMBER 1
29th National Radio and Television Exhibition. Earls Court, London S.W. 5. Details from Andrew Reid, Press Officer, Radio Show, 17 Fleet St., London E.C. 4, England.

AUGUST 23-26
NATESA Annual Convention. Pick-Congress Hotel, Chicago. Details from Frank J. Moch, Executive Director, 5806 S. Troy St., Chicago 29, Ill.

AUGUST 29-SEPTEMBER 1
1962 Congress on Information Processing. Sponsored by International Federation of Information Processing Societies. Munich, Germany. Program information from Dr. E.L. Harder, Westinghouse Electric Corp., East Pittsburgh, Pa.

AUGUST 28-30
Fourth EIA Conference on Maintainability of Electronic Equipment. Sponsored by Engineering Dept. of EIA in cooperation with the Dept. of Defense. University of Colorado, Boulder. Details from EIA, 1721 DeSales St., N.W., Washington.

SEPTEMBER 3-7
International Symposium on Information Theory. Sponsored by the PGIT, Benelux Section & Belgian Societies. Free University of Brussels, Brussels, Belgium. Program details from F.L. Stumpers, Philips Research Labs., Eindhoven, Netherlands.

SEPTEMBER 5-7
Symposium on Measurement of Thermal Radiation Properties of Solids. Sponsored by Aeronautical Systems Division USAF, NBS, NASA. Biltmore Hotel, Dayton, Ohio. Details from C. Robert Andrews, Chairman of Arrangements, University of Dayton, Dayton 9, Ohio.

SEPTEMBER 13-14
Sixth National Symposium on Engineering Writing & Speech. Sponsored by PGEWS of IRE. Mayflower Hotel, Washington, D.C. Program details from J.E. Durkovic, c/o ARINC, 1700 K Street, N.W., Washington. ▲

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JULY, 1962

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The coupon below can also be used to obtain additional information on the new product items shown on pages 86 through 92 as well as on the ads as listed above.

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