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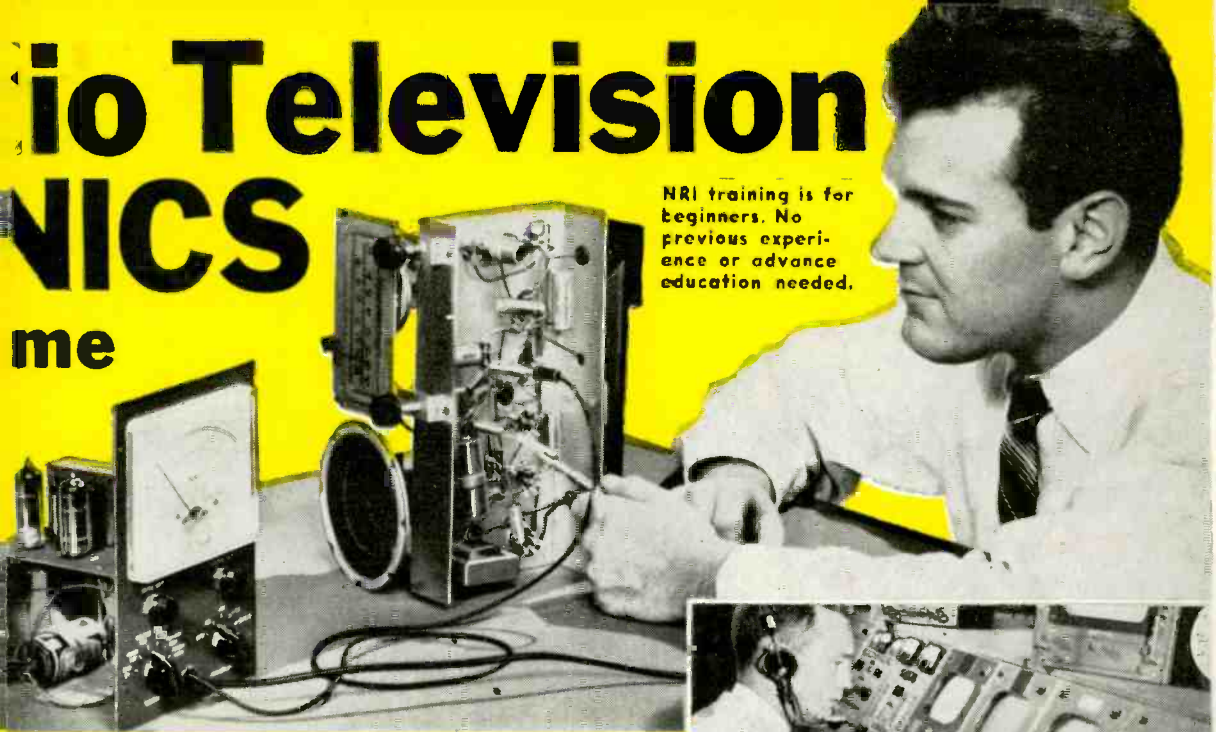

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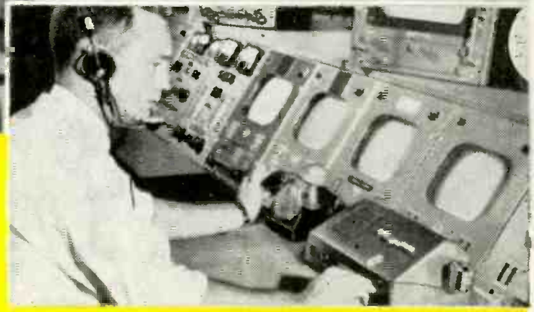

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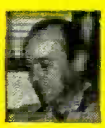

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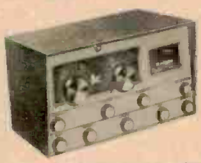

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August, 1960 Vol. 3, No. 8

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FEATURES

BUILD-IT ARTICLES

Cover illustration by Aubrey Kochman.

On the cover: ERA Dynamics, Heathkit and Sonar depth finders.

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A Message From the Editor

Complete Novice amateur radio station for under $40

I recently read something interesting relative to our space satellite program. It seems that some scientists believe we are wasting money and scientific effort on our plan to put someone into space. These scientists claim that the volume an astronaut would have to occupy in a space vehicle could more profitably be used for electronic instruments which can tell us more about space than a man could. We in electronics would be the last ones to underestimate the efficiency and data gathering ability of electronic gear but, what computer, what oscilloscope, what detector is as imaginative and ingenious as a highly trained, alert astronaut? And, isn't it impossible to accurately predict all the results of an exploration—isn't the chance discovery often of greatest importance? Yes, by all means, let's send a man into space after we're sure we can get him back safely.

And now to get down to earth, have you seen the special 16-page section in this issue devoted to electronics for the small boat? This is not intended to be a buyers' guide, but an explanation of how to use the new electronic depth finders, direction finders and 2-way radios. Also, you will find many practical installation hints and data to guide you when installing this gear on your boat.

Our 16-page section for the September issue is devoted to Novice amateur radio. The Novice license is a special amateur radio class set up by the FCC to encourage an increase in the ranks of amateur radio. All you need to know to get a Novice amateur radio license will be included in our special 16-page section as well as plans for a complete Novice station: transmitter and receiver. This complete station can be built for less than $40.

Nicholas Rosa, W1NOA, new *EI* Feature Editor

We have pre-tested this thoroughly and assure you that you will find it highly satisfactory. We hope, however, that you will go on to a General class ticket at which time you may modify the *EI* Novice ham rig for more advanced use.

We have a letter here from one of our Canadian readers who would like to petition the Canadian Government to set up a Class "D" type Citizens Band service. Those of you in Canada who are interested should write to Henry Ruhl at Box 25 in McCord, Saskatchewan if you live in the West; Eastern Canadians should write to Larry D. Whiting at L. W. Electronics in Strathroy, Ontario. Incidentally, there are many Citizens Band Clubs now in existence in the United States. We have the names of several and plan to make up a complete list. If you belong to such a group or know of one, write to us.

The feature articles in this issue are the last ones that Ed Nanas, our Feature Editor, prepared for us. Ed left us to join the staff of an engineering newspaper. The new *EI* Feature Editor is Nicholas Rosa whose radio amateur call is W1NOA. He comes to us after almost four years with the Woods Hole Oceanographic Institution on Cape Cod, an important part of the team that found out so much about our oceans during the International Geophysical Year. A radio amateur since 1941, Nick was an electronics tinkerer before that and is an old hand at hi-fi, having built his first amplifier in 1942.

We are very gratified at your response to the *EI* Hi-Fi Test Record in our June issue. As a matter of fact, I am looking over some of the many letters that we have received, here is part of one: "I would like to congratulate you on the test record that was included in your June issue. Not only did I find it to be of the same quality as many of the commercial test records, but I found it to be just as useful." Another reads: "Just received my copy of *EI* and got the hi-fi test record out first thing. The results were great. Keep up the good work!" Another says: "Your record is really something, especially the way it comes unscathed through the magazine fabrication and delivery process." Thank you again for your response and remember, you saw it first in *EI*.

In our next issue we have an exclusive article on electronic frauds and how to protect yourself from them. "Electronics" is a glamorous word right now, people think it can do anything and there are some vendors who are trying to cash in on this feeling. You, as someone in the know electronically, can help yourself and your neighbors by being alert to electronic frauds.

As a result of many requests from our readers, in our next issue we are reprinting a build-it-yourself project from an early *EI*. This is the automatic lawn sprinkler which will water your lawn without your individual attention, based upon the moisture of the earth itself. As usual, the September *EI* will also have the Electronic Brain and Hi-Fi Clinic columns and many more build-it-yourself items. Be sure to be with us.

Charles Tepfer

...electronics in the news

LONG DISTANCE DIALING TV? Yup! Telectro Industries has come up with a transmitting system to allow any closed circuit TV user to hook up with any other closed circuit TV user merely by dialing-in. The system (Telectrovision) sends live or graphic pictures over ordinary telephone lines; no costly coaxial cables.

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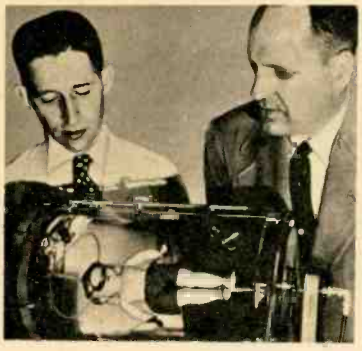


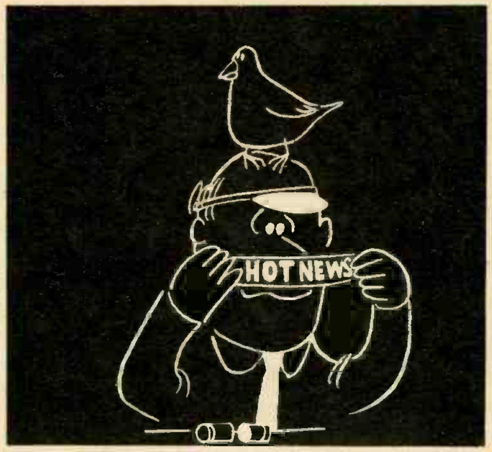
THIS IS NOT A VOODOO RITE, BUT RATHER AN experiment at Marietta, Ga., to learn how man reacts to weightlessness in outer space over long periods of time. Lockheed Aircraft, conducting "human factors in space travel" tests, calls this device a "null-gravity simulator." Doll symbolizes man who soon will be placed in huge revolving tank of water. Immersion will give him a weightless environment and his reactions will be monitored by electronic transducers on body.

• • • • •

SCHOOL SCIENCE PROGRAMS ARE SOON DUE FOR A BOOST. A series of electronic kits for students from age 10 through college are being developed by Arkay International. One kit, already tested in New York City, can perform at least ten rocket and missile functions with the addition or deletion of certain parts from the basic kit. It sells to schools for less than $10. Similar electronics kits are available commercially at a slightly higher price. A complete catalog of educational kits can be obtained from Arkay at 88-06 Van Wyck Expressway, Jamaica, N. Y..... Hertz Engineering Scholarship Foundation has expanded its student assistance programs to include all fields of engineering. Write to the Foundation, 1314 Westwood Blvd., Los Angeles 24, Calif.

• • • • •

NO, IT ISN'T A RECORDING SESSION, AND THAT MAN IN THE WHITE JACKET isn't holding a microphone. He is Dr. Wallace Gardner, a Cambridge, Mass., dentist, who has discovered that sound can be used to block the reception of pain in the brain. Madeline Coubre still has a happy (rather than pained) expression on her attractive face after having a molar extracted. The trick of the pulling was in the headset and control box held in Madeline's hands. Instead of hearing ineffective assurances by the dentist, she heard the sound of music and the soothing rush of a waterfall.



DATA from a number of new ionospheric and solar observation stations set up during the International Geophysical Year have improved the accuracy of National Bureau of Standards' predictions of maximum usable frequency for radio communications between any two points in the world. The NBS, with their new facilities for observing the everchanging ionosphere, can now make predictions three months in advance.

—o—

HUGHES AIRCRAFT ENGINEERS predict space savings of over 40 percent in car radios through the use of subminiature semiconductors in automotive design. To illustrate their point, they built and displayed a complete auto radio tuner no larger than a pack of cigarettes—and located the unit in a standard automobile steering wheel assembly. The radio, with manual dialing and pushbutton control, is not planned for company production, but rather to demonstrate a possible consumer use of their silicon capacitors, each no larger than a grain of rice, which do the job of conventional mechanical tuners.

—o—

BIGGER AND BETTER STEAKS—that's the object of research at Penn State University in which custom-built X-ray gear is used to detect any compression in the last five thoracic vertebrae at the base of the spine of calves under 10 days old. Object: to eliminate dwarf strains from breeding stock.

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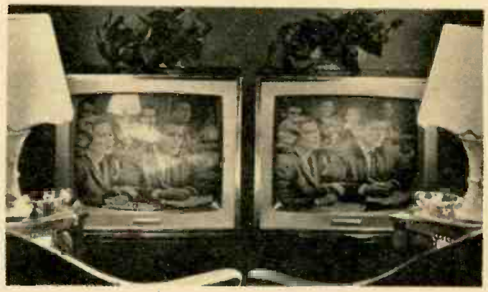


These TV sets are identical in all but one respect: The one at the right is sporting a new reflection-free picture tube cap introduced by Corning Glass that diffuses 75 percent of reflected light. Set at left, with conventional tube cap, reflects lamp and chairs.

—o—

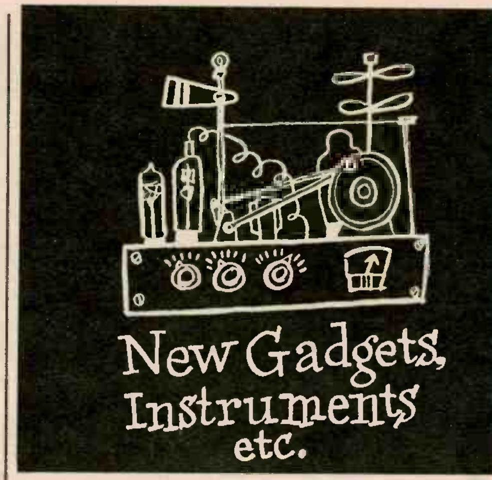
INSTANTANEOUS EDITING OF VIDEO TAPE is said to be possible with the electronic TVola, developed by Paramount Television Productions. This gadget will enable the editing of tape with accuracy and speed down to a single TV frame—1/30 of a second. Any given frame can be isolated within one minute as compared with 15-40 minutes required under existing videotape editing techniques. TVola is built around a 200-transistor timing circuit coupled to four Hughes memory tubes, which can freeze a TV frame for a period up to 20 minutes.

—o—

BY RELIEVING PRISONER TENSIONS, TV is proving beneficial to some 2000 men locked up at Cook County Jail in Chicago, as well as to the security guards who are charged with keeping order. Some 37 sets, operated by the guards, keep the men's minds occupied, relieve their tensions, and disciplinary problems have been cut to a minimum, says Warden Jack Johnson. In TV, the criminal always gets caught, a gentle reminder that crime doesn't pay.

—o—

TEN YEARS FROM NOW, says Clair Lasher, general manager of the General Electric Computer Dept., more than 80 percent of electronic computers will be used in applications unheard of today.



POCKETPHONE is a two-way Citizens Band radio that stays under the 100 milliwatt power input limitation to the final RF amplifier. Its operators, therefore, require no FCC license at all, according to Part 15 of FCC Rules and Regulations. Manufactured by Globe Electronics, Council Bluffs, Iowa, Pocketphone weighs only 13½ ounces, is said to have an average range of about one mile, can be used with other CB installations, has a rechargeable battery and sells for $125 each.

—o—

A $4.50 remote TV speaker is available from Lafayette. The "Duo-Remote" has two separate volume controls, one for radio, TV or hi-fi and a second for the volume of the remote's own self-contained speaker.

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Harold W. Johnson, 5070 Hermosa Ave., Los Angeles, Calif.	1st	15
Ralph Frederick Beisner, 2126 Grand, Joplin, Mo.	1st	12
N. B. Mills, II, 110 So. Race St., Statesville, N.C.	1st	12
Dean A. Darling, 403 S. Chase Ave., Columbus 4, Ohio	1st	12
Gerald L. Chopp, 518 Audubon Road, Kohler, Wisc.	1st	12

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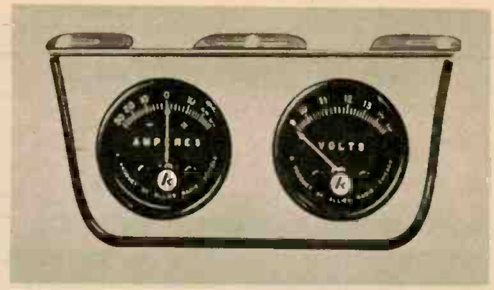
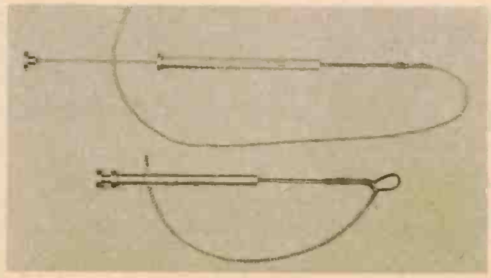


AMMETER-VOLTMETER KIT for cars and boats with 12V systems has vibration-proof pilot lights. Voltmeter reads 9-15 volts and ammeter reads 30-0-30 amps. It is Knight-kit 83 Y 711, priced at $10.75.

—o—

BROADCAST AND MARINE BAND transistorized radio by Toshiba costs $59.50 from Transistor World Corp., 52 Broadway, N. Y. 4, N. Y. It is pocket-size, has two antennas—one a telescoping 10-section rod.

—o—



LEAD EXTRACTOR is a new tool to provide a safe, quick way of ejecting insulated leads through the shields of braided wire. It comes in five color-coded sizes from Macdonald & Co., Glendale 7, Calif. and costs $4.25.

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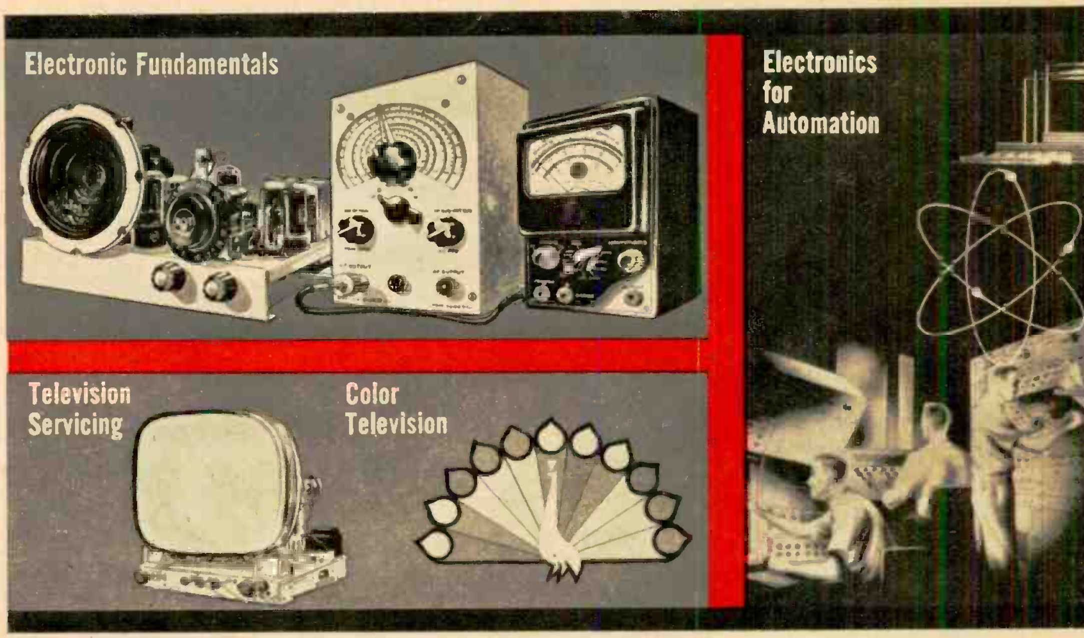

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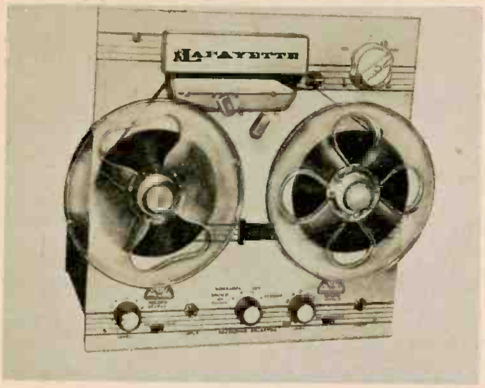
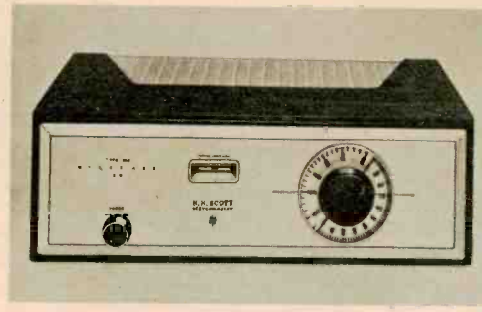


INTEGRATED TAPE DECK from Lafayette Radio, 165-08 Liberty Ave., Jamaica, N. Y., has a separate recording preamp with individual VU recording level meters for each stereo recording channel. In combination with a component stereo system it can play ½ or ¼ track tapes and record ¼ track monophonically or stereophonically from discs, radio or mike. Price: $239.95.

—o—

FM TUNER with 2 mc detector and limiter bandwidth is available from H. H. Scott, 111 Powdermill Rd., Maynard, Mass. Called model 314, it retails at $114.95 and has a multiplex output as well as Scott's silver plated front end.



—o—

BRITISH 2-SPEED TURNTABLE with a hysteresis synchronous motor has been announced by Ercona Corp., 16 W. 46th St., N. Y., N. Y. Called the Connoisseur, it plays both 33⅓ and 45 rpm records. Motor mechanism is mounted outside the turntable rim to reduce hum pickup by the cartridge due to magnetic radiation of the motor. The price of this stereo unit is about $59.50.

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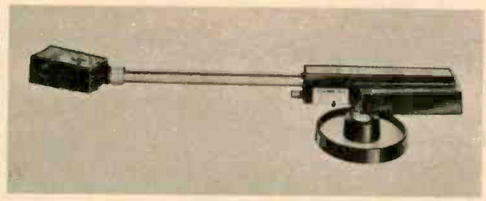
KIT OR WIRED, that's how Arkay's RPA 7 record changer is available. It plays all size records, mixed or otherwise. Price: Kit, $31.50; wired $52.50. 88-06 Van Wyck, Jamaica, N. Y.

—o—



NEW STEREO ARM by Shure Bros., Inc., 222 Hartrey Ave., Evanston, Ill., is called the Professional. No soldering is required to install the arm; one end of the furnished cable plugs into the arm, while the other end plugs into amplifier. Price for 12" arm is $29.95; 16", $31.95. They are designed to accept any universal stereo cartridge, as well as Shure's M7D and M3D.

—o—

TWENTY-SEVEN CONTROLS on the Fisher Radio 400-CX stereo master control do everything the audiophile would ever want to do, including "sonic null balancing" and achieving any desired degree of stereo separation (from zero to full). Price: about $199.50 from Fisher, 21-21 44th Dr., Long Island City 1, N. Y.

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8. Continuous consultation and help.
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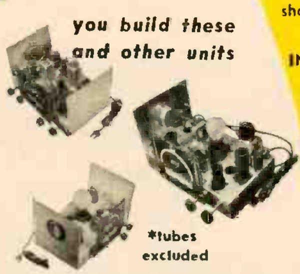
10. The right to use the Famous Trade Mark.

you build these and other units



*tubes excluded

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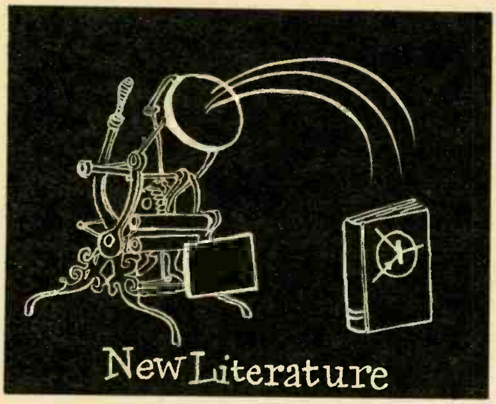

Detailed and illustrated information is contained in a new paperback from Gernsback Library (No. 59) called "Servicing Record Changers," by Harry Mileaf. It has a section on turntables and cartridge and pickup arms. Price: $2.90 . . . 136 pages of circuits for audio amplifiers has been printed in England by Mullard and is available from International Electronics Corp., 81 Spring Street, N. Y. 12, N. Y., for $2.50. Included are power amplifiers and preamps for both mono and stereo.

New catalogs come from East Coast Radio and TV Co., Miami, Fla.; Zack Electronics, 1422 Mark Street, San Francisco, Calif.; Hughes Peters Inc., 481 E. 11th Ave., Columbus 3, Ohio (parts and equipment for broadcasters, industry, radio and TV technicians); Arrow Electronics, Inc., 65 Cortlandt St., New York City (hi-fi, ham); Carolina Radio Supply Co., Inc., 221 W. Washington St., Greenville, S. C.

"Servicing the Vertical Sweep System" has just been published by Stancor, 3501 W. Addison St., Chicago 18, Ill. Booklet contains practical hints on how to locate defects in vertical deflection systems of TV sets, etc. It was prepared in part by *EI* author Milt Kiver and is available free from Stancor . . . The sixth edition of Centralab Packaged Electronic Circuit Guide contains complete replacement data covering over 250 equipment brands and over 1400 replacement applications. Free from Centralab . . . 160 pages of "Transistor Projects" skips over theory and gets down to build-it projects. Gernsback Library No. 89, $2.90.

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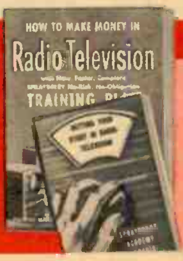

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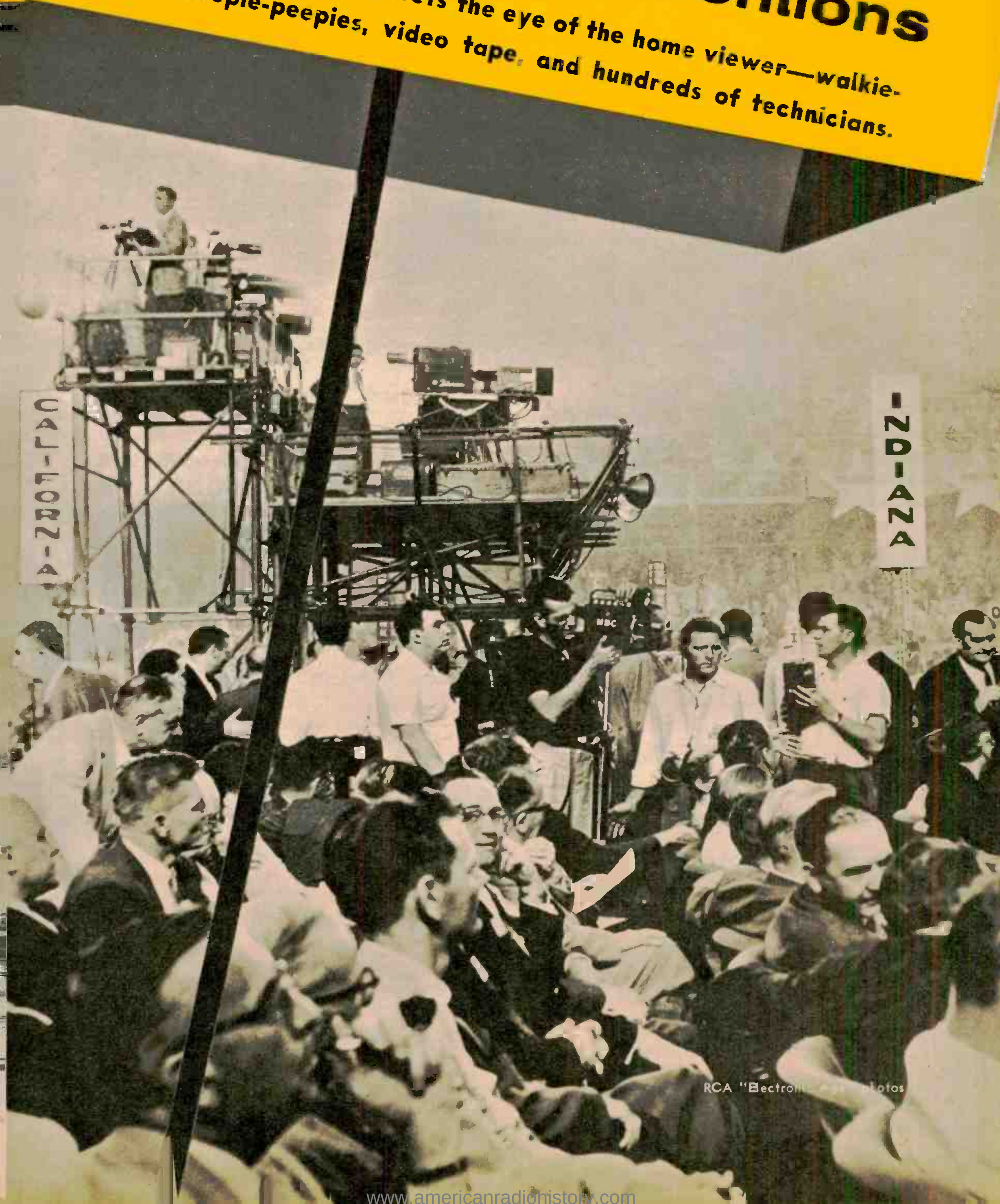
◀ See Page 22 for the BEST BUYS in CITIZENS TRANSCEIVERS, "HAM" GEAR and TRANSISTOR RADIOS.

behind the scenes with electronics at the

1960 Political Conventions

More goes on here than meets the eye of the home viewer—walkie-talkies, creepie-peepies, video tape, and hundreds of technicians.



RCA "Electro[illegible] photos

Program directors in "on-the-air" control room not only call the shots for their own network, but also keep jealous eye on the competition.

NBC's Huntley-Brinkley team are just two of thousands of newsmen on hand to bring full gavel-to-gavel coverage of the conventions.

AS this issue of *Electronics Illustrated* hits the newsstands, the United States finds itself in the grip of a quadrennial madness known far and wide as National Political Convention time. On July 11, thousands of Democratic delegates, alternates and would-be candidates (the number of candidates often seems to equal the number of delegates) swarmed into the Los Angeles Sports Arena, both followed and preceded by thousands of newsmen, cameramen and technicians. In two weeks the political battleground shifts across the Rockies and Great Plains to Chicago, where the Republican Party Convention will be called to order.

The National Conventions may or may not pick the best men for this nation's highest offices, but one thing is certain: the conventions get the best news coverage Americans can possibly expect or hope for.

Since the 1948 conventions, television has been on the scene with a fantastic array of electronic gear peeping here, there and everywhere—the result of months of planning, hard labor and millions of dollars spent by the networks. In 1952, television had over $4-million in equipment alone at Chicago. NBC, one of three major networks, managed to mobilize more than twenty cameras.

But this year will be the biggest yet for TV and politics. Delegates will be projected into some 46-million television homes from coast to coast by more than 70 live television cameras ranging from shoebox-sized "creepie-peepies" carried by reporters prowling the Sports Arena floor, to cameras located high in the rafters reaching out for "cathedral shots." With video tape now firmly entrenched in television, important events will not be missed because a camera was covering an equally important and simultaneous event.

At both conventions the networks will have on hand more than 1000 newsmen and technicians with enough cameras, microphones, video tape units, control centers and newsrooms to make up at least a half-dozen completely equipped television stations. Much of the equipment and layout will be new this year, such as the complex and versatile convention "control center," which is said to have more electronics "on board" than a modern aircraft carrier. From this control center one television editor can handle his network's coverage with the precision and efficiency of a pier boss

Legman on floor uses wireless mike for local description of fast-breaking event, while video engineer (above) monitors TV picture density.

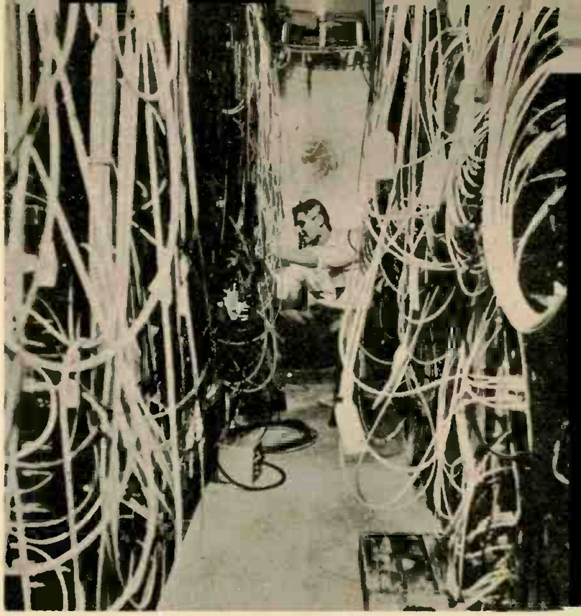
assigning tasks to his longshoremen . . . and do it at electronic speeds.

At Los Angeles, the on-camera commentators work, for the most part, from a broadcast booth high above the convention floor. NBC commentators, for instance, will be in direct two-way communication with a specially-designed layout covering about 10,000 square feet under the Arena stands. The area includes a master control console, studios for quiet interviews, film processing facilities, and a complete newsroom.

Twenty reporters outside the Arena will be on tap using walkie-talkies, miniaturized wireless microphones and creepie-peepies to pass along developments likely to take place in hotel rooms, ballrooms, train stations, etc.

The creepie-peepie had not been perfected four years ago and floor reporters were pretty much restricted to using walkie-talkies for voice with long-range cameras zooming in for the video. In the fluid crowds, TV cameramen often had a hard time finding the man on the floor with the walkie-talkie and the interesting interviewee.

Back in 1952, the year that Univac first predicted the election results, Democratic Convention Chairman Sam Rayburn, speaker of the House of Representatives, made the delegates well



Several complete network repair shops are set up at convention site. Above, a technician checks out some of hundreds of miles of cable.

aware that their candidates were being viewed by more people in one hour on TV than they could reach in three solid years of old-style whistle-stopping—so would parading delegates with placards and balloons kindly refrain from obstructing the TV camera's view of the speaker at the rostrum. A leaflet was circulated to warn delegates that a camera lens might zoom in on them at any moment without their knowing it.

The TV directors don't like such warnings, for the most exciting feature of "live" politics for the home viewer is spontaneity—the candid shot that humanizes the candidate, the delegate, the hitherto unseen public figure, catching him in an expression that all at once reveals his personality to the voter.

Broadcasting's recent penetrating and complete coverage of politics has created new interest and excitement that has been reflected in an ever increasing number of eligible voters going to the polls. In 1920, the campaign year before the start of radio coverage (and the first year of women's suffrage), only 43 percent of potential voters actually voted. In 1952, television's first big presidential campaign, a whopping 63 percent of eligible voters cast their ballots. In 1960, with more television coverage, we can look for a new record turnout.

Here is another view of a convention control room, with newsroom in background. Newsmen do their best to bring order out of chaos.

Amateur and professional Scuba divers will find this receiver-less rig a boon to underwater efficiency. System weighs 10 pounds. At left Scubacom amplifier-speaker unit is strapped to air tank. The mask shown at right contains the microphone and a push-to-talk button. Range is 150 feet in all directions.

Voice Communications ... Underwater!

THE hottest news for skin divers this summer is the first complete underwater voice communications system that isn't priced for millionaires alone. Scubacom, as it's called, is made by Electro-Voice, Buchanan, Mich., and has an underwater range of up to 150 feet—plenty far if you stick to the buddy system—and operates down to 120 feet. The system consists of two basic components. The combination mask-microphone houses a special microphone and a press-to-talk button and can be used in conjunction with any standard eye-and-nose diving mask (after removing the standard Scuba mouthpiece and barrel assembly).

The speaker-amplifier is strapped to the air tank and receives signal voltages from the mike-mask. The amplifier circuit is conventional, but miniaturized. The audio output (500-2500 cps) is coupled to the speaker, which contains a circular bladder to equalize pressure for linear diaphragm operation. Due to the non-directional pattern of sound waves in water, it is not necessary for the speaker to be aimed. And the sounds can be heard without any receiving devices—other than human ears.

Two standard 6-volt pressurized underwater batteries, such as "Aqualite," provide the necessary power for the rig.

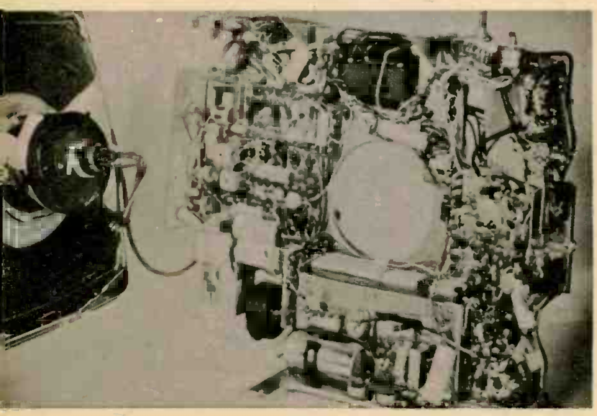
The performance ratings of Scubacom are said to be actual performance ratings and not laboratory-calculated. The mask and harness are made of Neoprene and natural rubber, with exposed metal hardware of brass and aluminum treated against corrosion.

The price: $210.

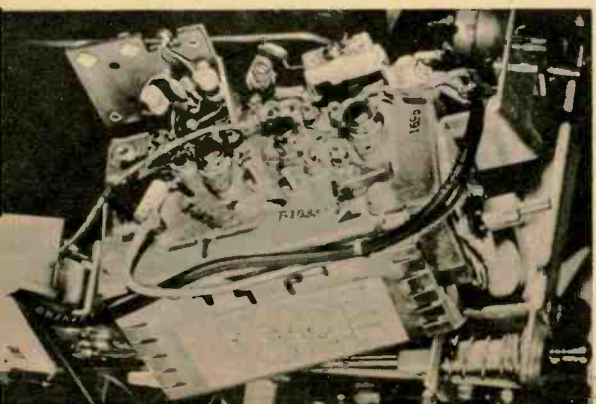
Two New Battery

Motorola

Top-mounting controls at left are horizontal and vertical holds, brightness, contrast. At right, channel selector with concentric fine tuning, range switch, volume. Antenna telescopes.



Above: Six screws separate Astronaut's chassis from 19" picture tube. Components are handwired. Below: Three high-frequency transistors are visible in this close-up of tuner.



FIRST American direct-view battery operated portable television set comes from Motorola, and it's a whopper! It has been tabbed the "Astronaut" and facts available at press time are listed below.

SIZE: 15.5" high, 18" wide, 12¾" deep
WEIGHT (including battery): 40 lbs.
PICTURE TUBE: 19" (19AFP4), a modified 19XP4 CRT with following characteristics:
- Filament: 12.6 V @ 150 ma
- Screen (G2): 100 V
- Cathode drive: 50 V for cut-off

POWER REQUIREMENTS: 100-120 VAC @ ⅓ amp. or 20 VDC @ 1.5 amp.
POWER SOURCES: 117 VAC line or silver cadmium cell with:
- 5-6 hour operating cycle
- 500 recharge cycles (minimum)
- Recharge time of 3 hours for each discharge hour
- Constant voltage delivery until end of discharge cycle
- No damage due to complete discharge
- Recharged when line cord is plugged into AC outlet. Relay cut-out automatically prevents over-charging
- One year factory guarantee

CIRCUIT FEATURES:
- 22 transistors
- 12 diodes
- 3-stage tuner with hi-pass filter
- 3-stage IF amplifier
- 2-stage video amplifier
- 2-stage amplified AGC
- 2-stage transformer-coupled audio amplifier
- 15 KV flyback-type high voltage supply

SENSITIVITY (mid-channel): 15 microvolts
AVAILABILITY: This summer
PRICE: $275 without energy cell ($88). With the energy cell, ideal for "patio living." Otherwise a very compact big-screen portable receiver.

Operated TV Sets

Sony

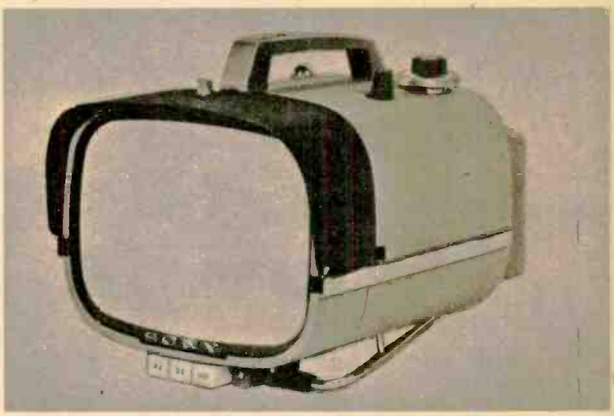
THE first Japanese entry into the direct-view portable TV market is this Sony transistorized set, somewhat smaller than the one on the opposite page and not yet available.

SIZE: 6¼" high, 8" wide, 8¾" deep
WEIGHT (including battery): 16 lbs.
PICTURE TUBE: 8" CRT with "smoked glass" face to eliminate glare out-of-doors. Tube has 1" neck diameter as opposed to usual 1½" neck.
POWER REQUIREMENTS: 100-120 VAC @ 1/5 amp. or 12 VDC at .9 amp.
POWER SOURCES: 117 VAC line or "red acid" battery with:
- 3 hour operating cycle
- 10-12 hour recharge cycle
- 300 playing hours battery life
- 2 recharge methods: (1) remove battery unit, plug into wall; (2) "floating" charge with battery unit intact, cord in wall outlet and AC and OFF keys depressed
- Replacement battery will retail for about $5, somewhat lower in cost than present nickel or silver cadmium batteries

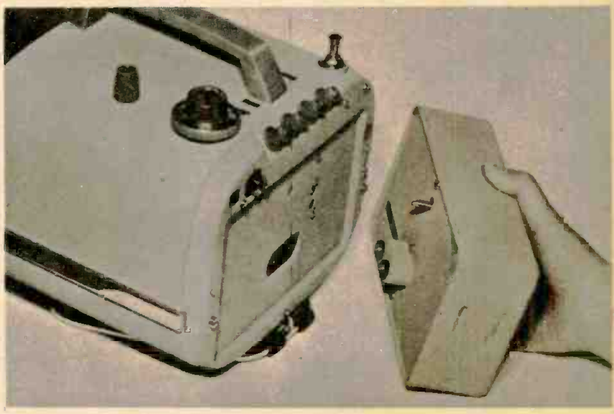
CIRCUIT FEATURES:
- 23 transistors
- 14 diodes
- 3-stage tuner
- 3-stage IF amplifier
- 2-stage video amplifier
- 2-stage audio amplifier with discriminator
- AGC
- 12-15 KV high voltage supply
- Automatic temperature control for vertical output transistor

SENSITIVITY: 100 microvolts
AVAILABILITY: Late fall or early winter
PRICE: Approx. $200

Soon it will be impossible to get away from television anywhere. "Little Brother" and you will be watching each other wherever you go.



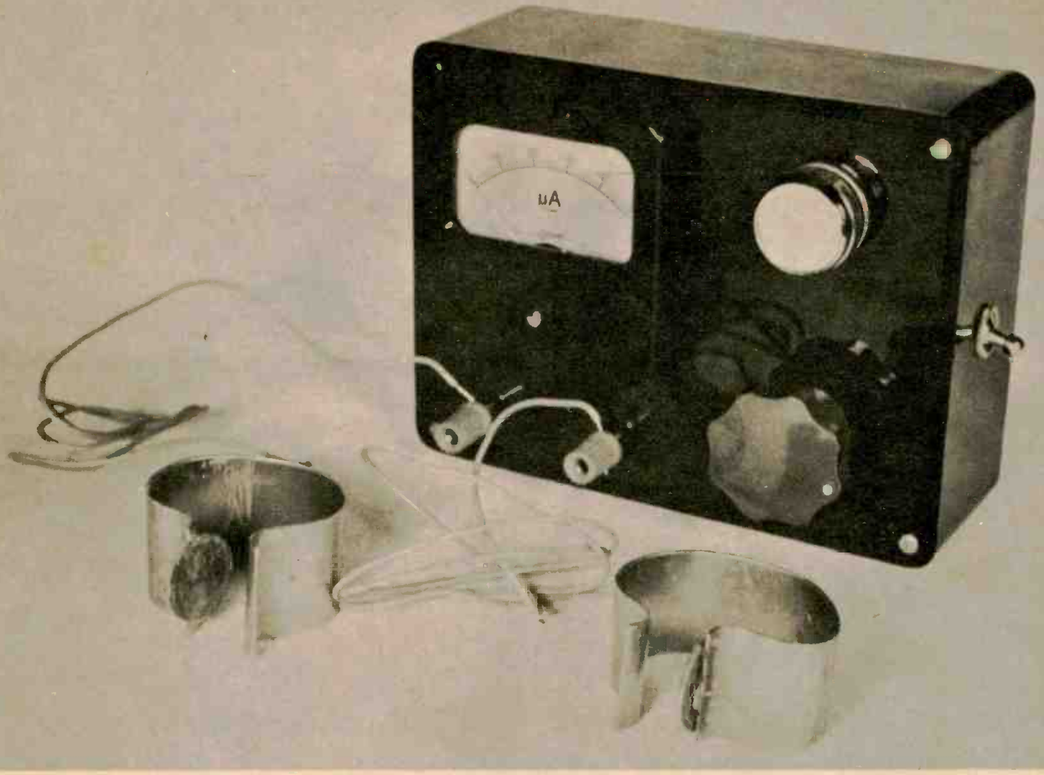
Eight-inch Sony screen has smoked glass face plate, and is hooded to keep out direct light. Channel selector and volume are top-mounted. AC, DC, OFF are pushbuttons at front.



Low-cost battery is in unit that may be unplugged from set for charge. Four knobs at rear are brightness, vertical, horizontal and video gain. Below, note phone size of set.

A Lie Detector

By Harry Kolbe



Meter your emotions with this super-sensitive transistorized skin resistance detector device.

SO you say you worked late at the office last night. It may ordinarily be possible to sell your wife on this story. But if you were really out with the boys and the little woman hooks you up to this little lie detector, it will definitely be "no sale."

The commercial "polygraph" type of lie detector is beyond the capabilities and pocketbook of the home experimenter. Fortunately, however, there is a physiological factor which can be easily and inexpensively measured by the amateur. This factor is skin resistance or G.S.R. (Galvanic Skin Resistance) as it is called by the psychologists. G.S.R. is an extremely sensitive barometer of emotional activity and therefore an excellent indicator of deception.

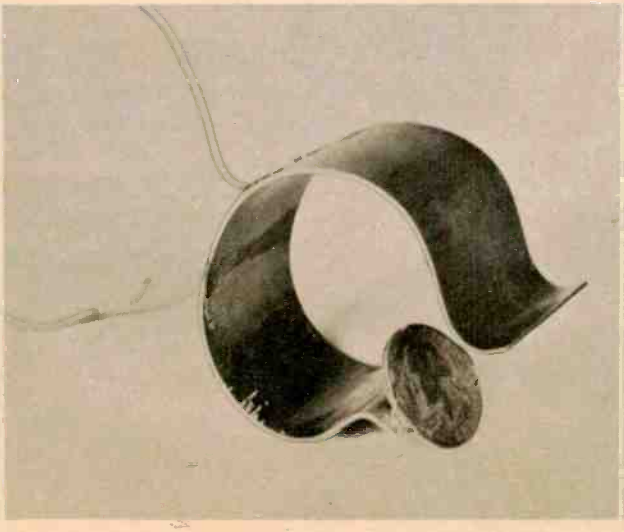
Of the various methods for measuring G.S.R., the most accurate is the Wheatstone bridge connected to a sensitive galvanometer. However, the high cost of a galvanometer rules out its use for our purpose. Instead, our lie detector uses an inexpensive meter preceded by two stages of transistor amplification. This results in an indicator at least as sensitive as an expensive galvanometer.

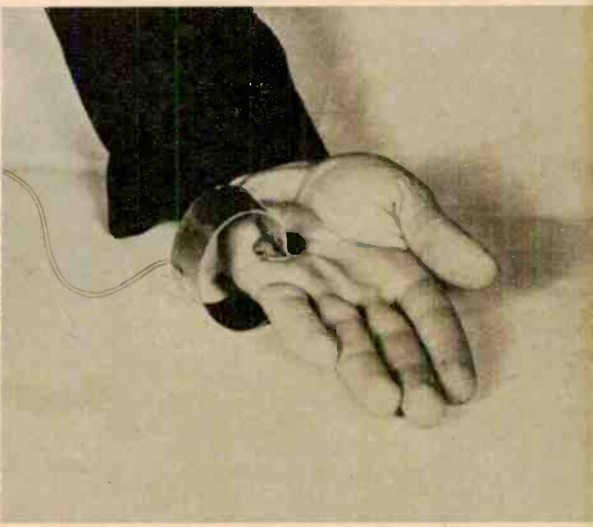
Since the G.S.R. never stays constant, but varies, it takes a great deal of experience and practice to be able to interpret the difference between normal variation and a change due to telling a lie. To make this task easier, a second indicator has been incorporated into the circuit. After the subject's skin resistance has been brought to proper calibration point on the meter, the second indication, the lamp, (PL1) which is turned on by the relay (RY1) in the collector circuit of Q2, will ignore variations unless they exceed a 5% drop in G.S.R. (The telling of a lie usually causes a 5-10% drop in G.S.R.) When the bridge is unbalanced by 5% in the downward direction, RY1 closes and turns on the light. This should occur between 2 and 5 seconds after the subject has lied.

The first step in construction is the preparation of the panel. Drill holes for and mount meter M1, pilot light assembly PL1, J1 and J2 and balance pot R3. Switch SW1 is mounted in the side of the case. The two transistor amplifier is built on a $2\frac{7}{16}$" x $3\frac{3}{8}$" perforated phenolic board. The amplifier board is mounted directly on the back of the meter and is held in place by the two meter terminal screws. Make the proper connections between the various components and batteries which are taped down in the cabinet. Construction is completed by mounting the front panel to the case.

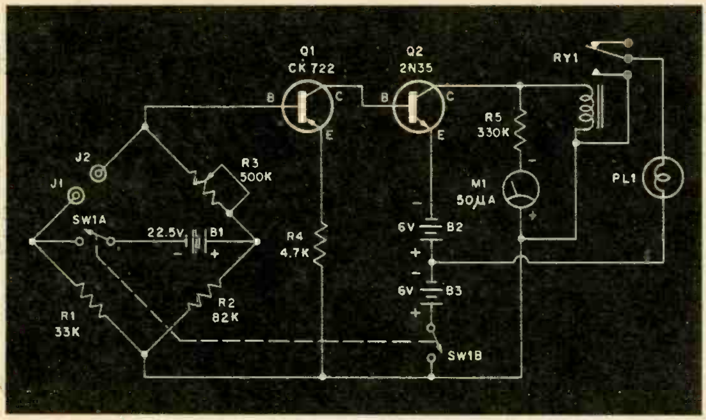
As an extra gimmick, you can hand letter or type a small transparent disc of thin paper to be inserted in the pilot lamp assembly cap. Then when the lamp lights it will illuminate from behind a comment such as SEZ YOU or TILT or some similar statement.

Now for the electrodes—these warrant special attention. We could use just two pieces of metal held by a rubber band on each palm. However, you would find that after you have set the instrument to the subject's skin resistance, the meter would begin to drift in a direction indicating increasing skin resistance. You might try to follow the drift but eventually you would come to the extreme end of R3. This happens at the point of contact between skin and electrode because the direct current between the electrodes through the skin causes electrolysis to occur. In more common terms, the current ionizes the salt present in the skin perspiration and deposits a layer of ions on the surface of the electrode which increases the electrode resistance as the ion layer gets thicker. To prevent this, we must construct non-polarizing electrodes known

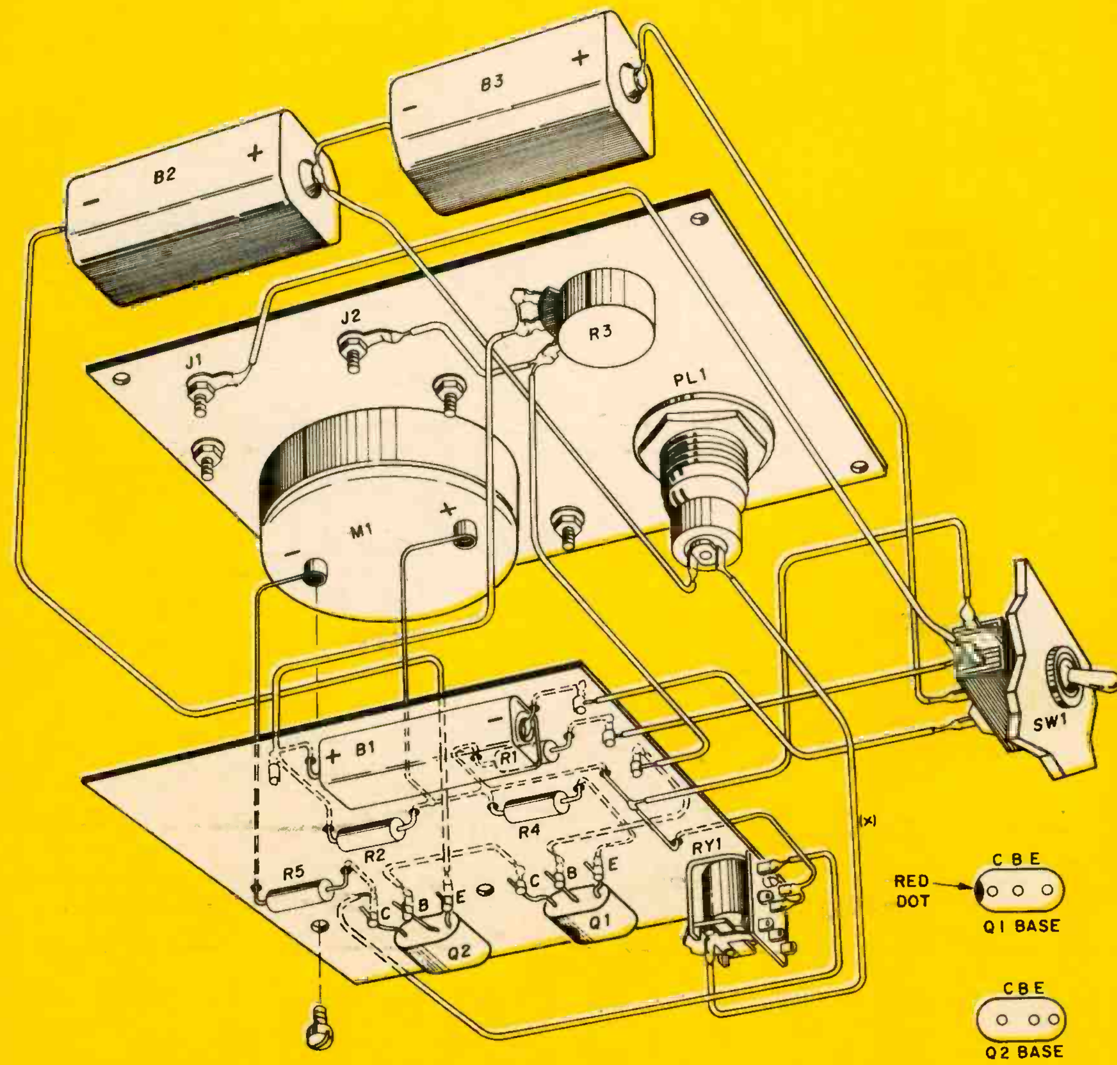


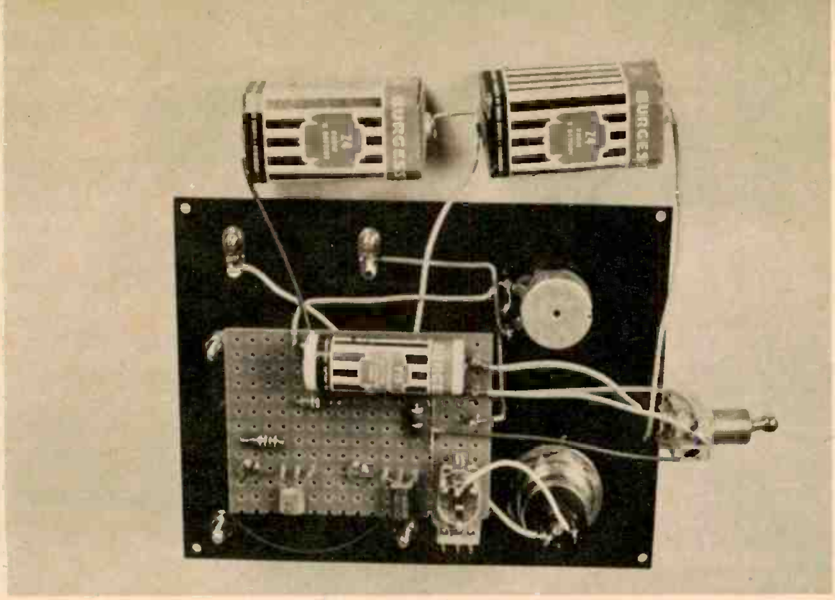


C clamps made of brass or copper use silver pieces as electrode contacts. Above right, the C clamp electrode is shown properly adjusted to hand palm.



A Wheatstone bridge circuit balanced by R3 effectively calibrates the unit. J1 and J2 are the electrode terminals. Microammeter M1, may be as small as desired.





Bottom view of Bakelite cover. Miniature relay RY1, fits nicely on the perforated board. Two 6 volt batteries B2, B3, above cover, rest in main case not shown in photo.

technically as a silver-silver chloride type. They are prepared as follows:

Two silver pieces (25c size) are used as the electrode contacts. First solder them to the C clamps. The C clamps are made by bending two 1¼" x 6" strips of brass, copper or similar material into a C and then bending up the ends of the C as shown in the photo. Solder wires to the back of the C clamps close to the silver. These wires serve as the connections between the detector and the electrodes. Carefully paint the back of the electrode, solder joint and the half of the C clamp attached to the electrode with nail polish or coil dope. Now treat each silver electrode as follows: steel wool the unpainted side of each piece until shiny. Immerse the silver and only that part of the C clamp which is covered with paint into a solution of salt water *in a glass container*. Attach the wire from the C clamp to the *positive* terminal of 1.5V or 6V battery. The negative terminal of the battery is connected to another piece of silver by a clip lead. Partially immerse this silver in the salt water being careful not to immerse any part of the clip lead. Electrolysis will now occur and cause a deposit of purple-gray silver chloride on the positive electrode. Allow the process to carry on for 15 minutes. Withdraw the electrode and set aside to dry taking care not to touch the silver chloride deposit.

Repeat the process with the second electrode. After the electrodes are dry, very carefully coat them with a thin layer of electrode paste. The electrode paste is made by mixing equal parts of glycerine and bentonite (hydrated aluminum silicate) which is obtainable from your local drugstore. Dilute the mixture with a weak salt solution (one teaspoon in a pint of water) till it reaches the consistency of putty. You can store the paste in a jar. After each use of the detector a new layer of paste is needed. You should also reverse the electrode connections to the detector after each use. This process may sound

[*Continued on page* 104]

PARTS LIST

Resistors—½ watt, 10%
R1—33,000 ohms
R2—82,000 ohms
R3—500,000 ohm potentiometer
R4—4,700 ohms
R5—330,000 ohms
Transistors
Q1—CK722
Q2—2N35
Batteries
B1—22.5 volt (Burgess Y-15 or equiv.)
B2,B3—6 volt (Burgess Z4 or equiv.)
M1—50 microamp meter movement (size and type optional)
SW1—DPST toggle switch
SW2—DPDT toggle switch (optional, see text)
PL1—6.3 V pilot light assembly with #50 bulb (Dialco No. 314001-437, clear)
RY1—5000 ohm, 1.5 ma, relay (Lafayette "Little Jewel")
Misc.—2 5-way terminal posts, perforated phenolic board 2 7/16" x 3⅜", Brass or "Nugold" or other spring metal strips 1¼" x 6" (available at craft shops), coil dope or nail polish, flea clips, etc.

Loudhailer-Intercom for the Boatman

By Len Buckwalter

Nautical voice communication over great distances is made possible by combination public-address trumpet and sound amplified "big ear" pickup.

THE unit shown here grew out of a kind of electronic "payola" between the author and one of his yachting friends. The arrangement was simple: "You take me out on the boat this summer, and I'll build you a power megaphone." But the design quickly grew from a simple 1-transistor job to a sensitive, versatile *two-way* system.

Weatherproof horn is shown being mounted atop cabin. At right, amplifier is mounted next to instrument panel in cabin. This is just one of many positions for convenient operation.

As a loudhailer, it is perfect for directing mooring maneuvers, dock landings and communications with other boats. However, when the talkback or *talk-listen* switch (SW1) is flipped to the *listen* position, the outside speaker horn becomes a sensitive "ear" with important safety features. While running in foggy or foul weather the captain has difficulty hearing fog horns, bells and other warning signals—the rumble of the engine inside the cabin tends to mask them. Without this unit, one of the crew had to stand watch up on the bow and shout back instructions. And of course, the *listen* feature has many other uses in small-craft handling.

Construction

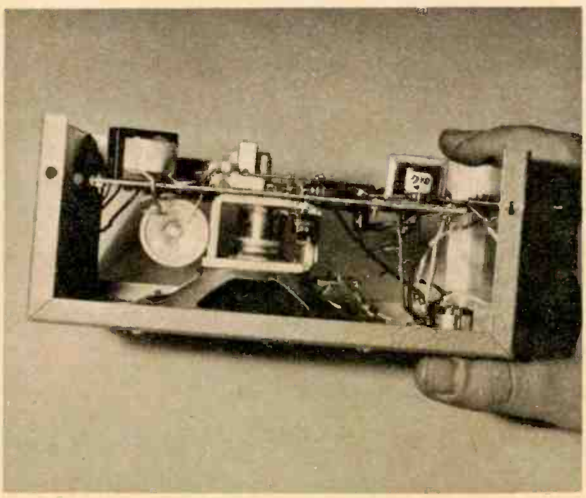
Building the unit starts with cutting a 3½" hole in the front panel of the cabinet. A 4¼" piece of perforated board is placed over the hole, and the speaker bolted in place. The talkback switch, volume control, binding posts and large power transistor are then mounted. Note that J1 and J3 are insulated from the cabinet and J2 and J4 are grounded.

The builder must use *utmost care* in mounting the power transistor (TR4). It has to be insulated from the cabinet by a thin mica washer, sometimes packed with the transistor. To avoid piercing the mica washer, remove the burrs from the four mounting holes drilled in the metal cabinet before bolting TR4 in place. The two mounting screws must be insulated from the cabinet by two fiber washers inserted into the screw holes. These washers can those removed from J1 and J3. The only other precaution is to grasp the transistor leads with a long-nose pliers during soldering to draw the heat away.

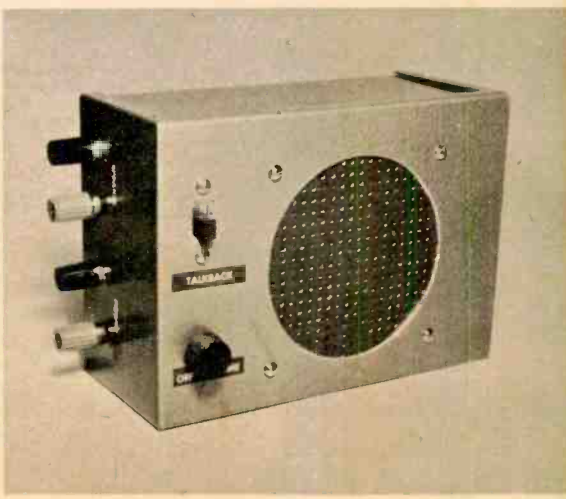
The rest of the circuit is wired to a piece of 5½" x 3¼" perforated board bolted or glued to the speaker frame. The speaker specified in the Parts List is already drilled with two holes. Before screwing the board down, note that one screw should have a solder lug under its head, while the other holds one lip of transformer T2. If the speaker used has no predrilled mounting holes, an extra ground wire must be run from the solder lug to a convenient ground point on the cabinet.

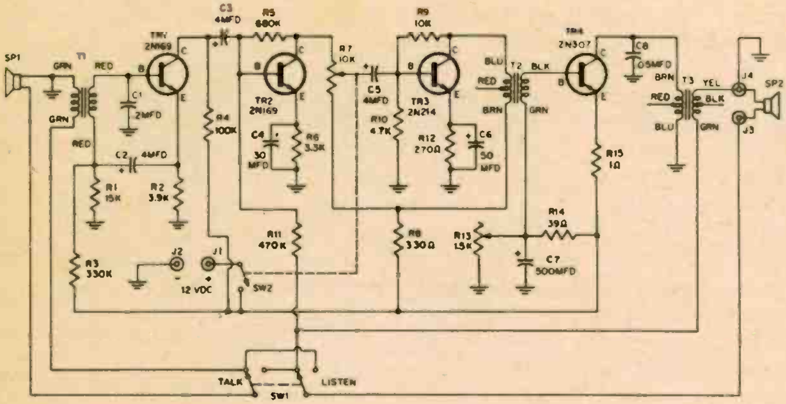
A buss bar (#18 tinned wire, approx.) serves as a convenient ground for most of the components. Ground is made through the speaker frame, so be certain that at least one of the speaker screws on the front panel cuts through the paint and makes contact with bare metal of the cabinet.

Side view of unit reveals how perforated sub-chassis fits on top of the speaker frame.



Completed unit. Perforated board protects speaker. Knob is volume control, power switch.



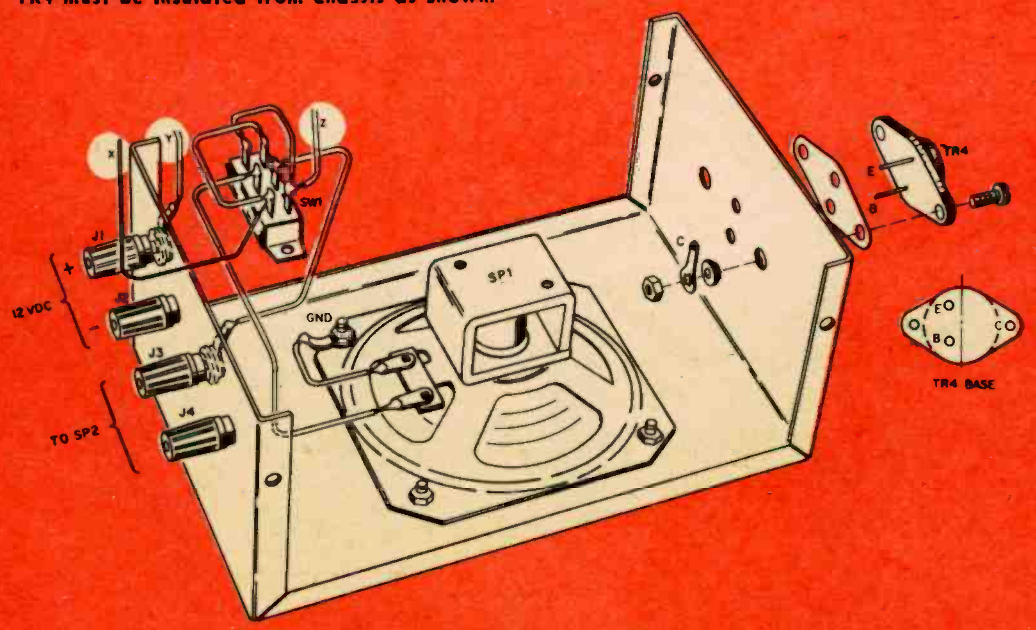


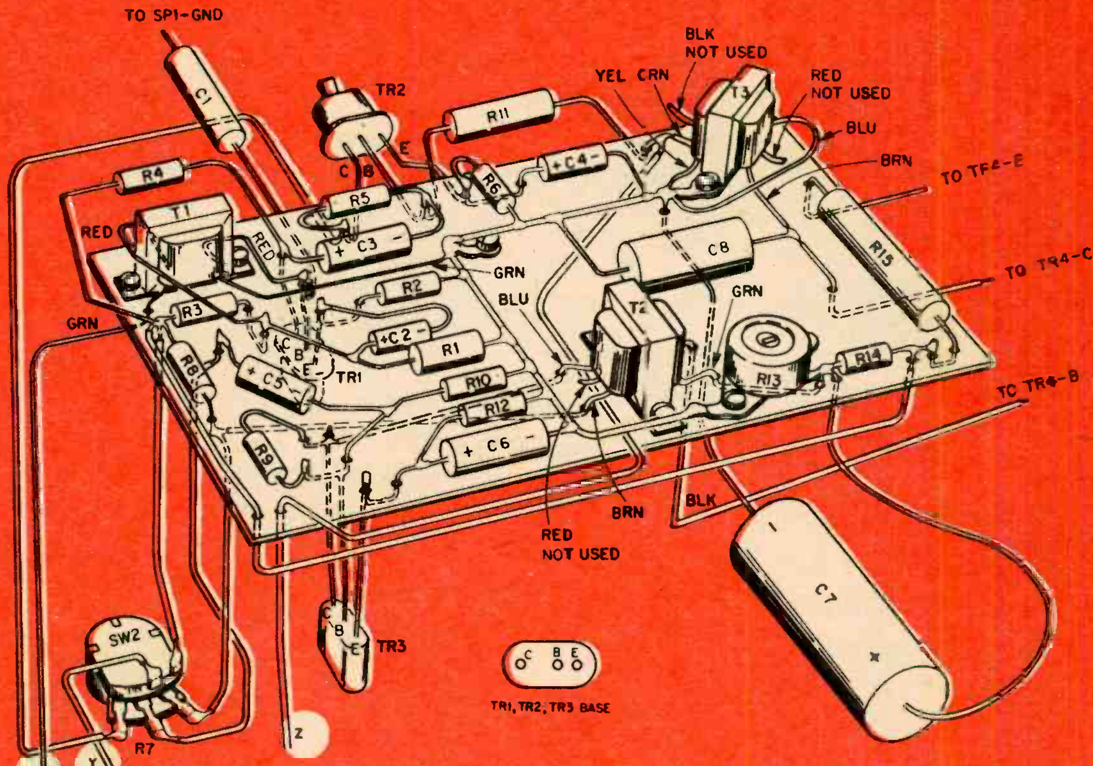
Value of resistor R11 may have to be changed if too much gain results in howl. See text for details. Schematic shows 12 volt requirement but 6 volts may be used.

Adjustment

After all components have been wired into place, there are two points of adjustment; resistor R11 and control R13. Hook up the outside speaker and connect a milliammeter (at least 0-500 ma) in series with the positive battery lead. To prevent howling feedback, locate the outside speaker in another room and close all doors. Insert a screwdriver into R13's slot and turn on the power. Quickly adjust for a 200 ma meter reading. This setting is a good compromise between distortion and audio power. Output will be just under two watts, which gives a surprising amount of volume—especially when an efficient horn-type speaker is used.

Letters (X, Y, Z) indicate lead connections. TR4 must be insulated from chassis as shown.





Wiring of chassis board. Dotted lines indicate the below board wiring. Some leads are shown longer than necessary for sake of clarity.

Flip SW1 up and advance the volume control to full on. If the outside speaker remains quiet, the second adjustment does not have to be made. But, if it breaks into a high-pitched howl, resistor R11 (470,000 ohms) will have to be changed to a somewhat lower value (430,000 ohms, etc.). Don't lower its resistance too much or the gain of the amplifier will fall. In any case, before changing R11 be sure that the whistling howl is not due to acoustic coupling between the external speaker and the small one in the cabinet—keep them away from each other.

Operation

Although designed for 12-volt operation, the unit will operate on 6 volts DC. Although volume dropped slightly, there was still plenty of reserve for most applications. The only change required is a readjustment of R13 to bring TR4's current back up to 200 ma.

[*Continued on page* 111]

PARTS LIST

Resistors—½ watt, 10% unless otherwise noted
R1—15,000 ohm
R2—3900 ohm
R3—330,000 ohm
R4—100,000 ohm
R5—680,000 ohm
R6—3300 ohm
R7—10,000 ohm volume control with switch SW2
R8—330 ohm
R9—10,000 ohm
R10—4700 ohm
R11—470,000 ohm
R12—270 ohm
R13—1500 ohm wirewound control (Mallory FI-1.5K)
R14—39 ohm
R15—1 ohm, 2 watts

Capacitors
C1—.2 mfd, low-voltage paper or ceramic
C2,C3,C5—4 mfd, 6-volt electrolytic
C4—30 mfd, 6-volt electrolytic
C6—50 mfd, 6-volt electrolytic
C7—500 mfd, 25 volt electrolytic
C8—.05 mfd. 200 volt or higher paper or ceramic

Transformers
T1—3-4 ohm to 2000 ohm voice coil (Argonne AR-93 or equiv.)
T2—1000 ohm to 100 ohm (Argonne AR-136 or equiv.)
T3—48 ohm to 4 ohm (Thordarson TR-8)

Transistors
TR1,TR2—2N169, TR3—2N214, TR4—2N307

SP1—Standard 4" speaker, 3.2 ohm voice coil
J1,J2,J3,J4—5-way binding posts (J1 and J3 insulated)
SP2—Weatherproof horn speaker, 4-ohm voice coil (University MIL-A type)
SW1—DPDT slide switch
SW2—SPST on R7
Misc.—Four binding posts, Bud Minibox 7"x5"x3" (CU2108-A), solder lugs, perforated board, etc.

EI visits NAFEC where they plan for Skyways of the Future

By Myron B. Gubitz

The electronic "big push" is on toward safe, sure and efficient travel in our jet-laden air lanes.

THE American public will stand for nothing less than absolute safety in our more-and-more crowded skies. You're the public—and in aviation matters your representative is the Federal Aviation Agency, created just two years ago to play traffic cop and traffic expert for our vast national airways system. What has been done in the past two years to make air traffic control and air safety more reliable—especially in the face of ever-growing commercial, military and civilian aviation activities? What's on the line electronically, and what's yet to come?

In order to answer these questions, *Electronics Illustrated* took a trip down the New Jersey coast to a spot near Atlantic City—the sprawling 6000-acre National Aviation Facilities Experimental Center (NAFEC), operated by the FAA to develop the most advanced electronic equipment possible for safe and efficient air traffic control.

NAFEC's nearly 600 scientific and technical people work in more than 100 buildings and have three runways at their disposal along with a host of their own aircraft for test flying. A number of experimental runway lighting systems have been installed, and the field is dotted with many different types of radar antennas.

In brief, NAFEC is a proving ground where techniques and equipment developed by private industry and government agencies are tested and evaluated. Here is the future of aviation today.

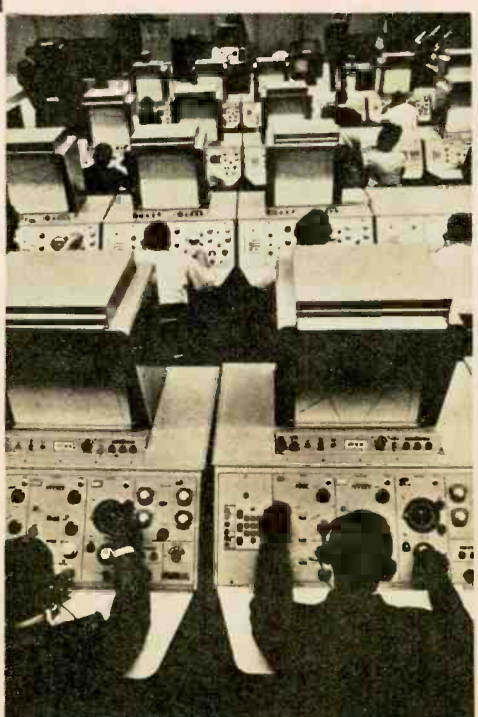
Data Processing Central

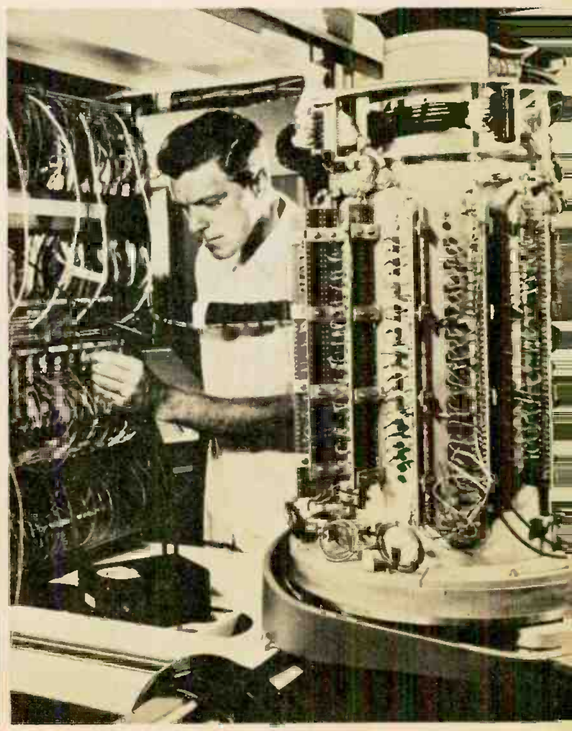
Top-priority project at NAFEC is to give machines those things that they do best (data processing, monitoring, computing, etc.) and give to man those things which he does best (decision-making).

General Precision, Inc., the contractor, has come up with a DPC capable of printing and processing 1,600 ever-changing flight progress reports per hour; checking 440 pilot-filed flight plans and storing the information contained in up to 1000 plans per hour, and can set up 90 arrivals and departures every 60 minutes.

You may ask: Of what value is the flight plan and progress data once a plane is in the air? Well, suppose two planes have

Left: At NAFEC some 48 consoles feed simulated individual plane movements into unique data processing computer in realistic program of air traffic control designed to evaluate new gear. Right: Computer memory drum is checked. It stores flight data such as plane speed, altitude, weather.





conflicting routes. That is (if they stick to their flight plans), they will be over the same spot at the same time at the same altitude. This means mid-air collision or a near miss that can age a man 10 years in as many seconds. But with the quick efficiency of electronic computation in DPC, and clean-cut electronic displays of data, the air traffic controller will have a visual picture of routing conflicts some 30 minutes *before* the conflict becomes a crash or near miss. DPC will also provide alternate routing information to be passed on to the pilots involved. By providing constantly up-dated sequential information, time-wasting holding patterns (stacking) in terminal areas can be replaced by an orderly flow of air traffic into and out of major terminals.

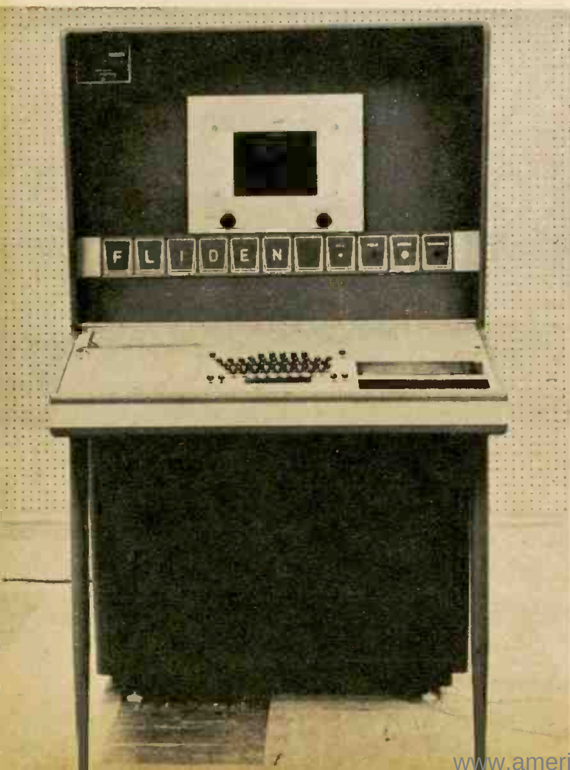
The heart of DPC is a large, solid-state digital computer designed and built by Librascope Division, General Precision, Inc.

Precise information as to type, speed and altitude of aircraft, the wind direction and velocity, departure and estimated arrival times at specific checkpoints all can be fed into the computer's 16 magnetic memory drums for instantaneous electronic comparison, computation and readout in the form of visual displays, teletype messages, and "flight strips" to back up the electronics with printed information on flights—information which can be handled manually.

All in all, Data Processing Central has some thirty consoles, each with a distinct control or information function, such as the *Precision Approach Radar Console*, *Sequence Console* (with a charactron-tube display which allows a controller to sequence arrivals and departures to avoid "stacking"), *High Resolution Closed-Circuit TV* (to display up-dated flight strips of the next five arrivals at the *Local Control Console* position) and a *Ground Control Console* (which takes over final direction of the aircraft, and through which the flight plan may be cancelled and removed from the computer).

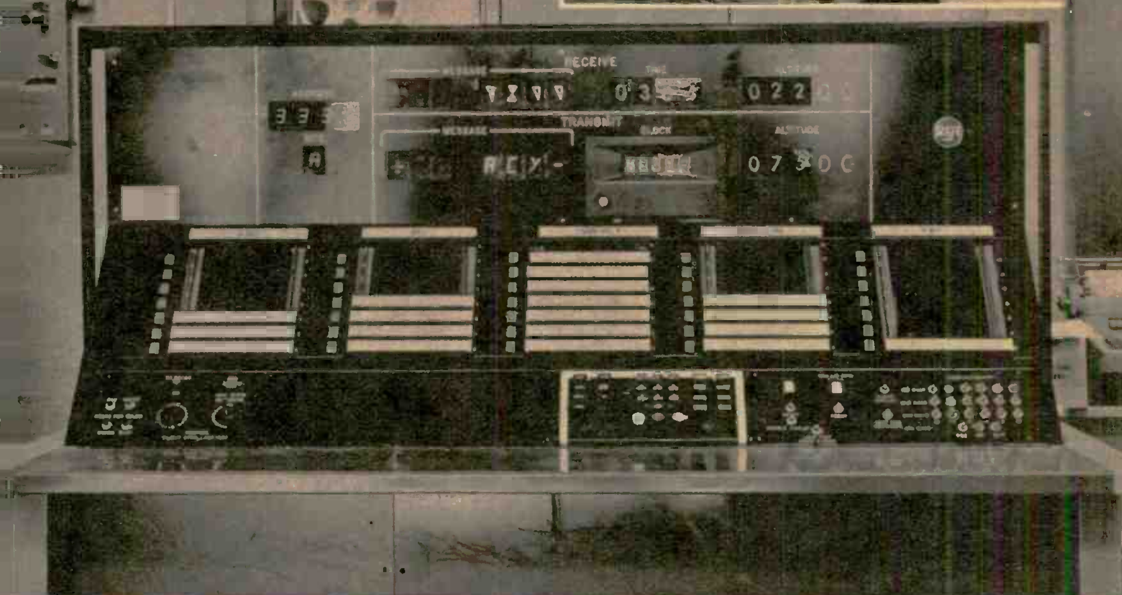
A flight processed through DPC goes something like this: The pilot files his flight plan. If he does so by voice, a controller [*Continued on page* 100]

Flight data entry machine quickly integrates pilot's flight plan into air traffic control system. Operator types flight plan at console and it is automatically fed to computer memory.



One of many computer readouts is punched paper tape being checked by programmer at console. It takes only a half-second to search through a quarter-million pieces of ATC data.

At right is hectic scene in present ATC with controllers manually "tracking" aircraft, updating strips by hand. Below is new automatic controller's console with computer-printed flight strips.



Airborne AGACS display: Incoming messages appear in slot at top. Messages to ground appear in lower slot. Pilot selects message by turning dial at right, presses "report" button and the rest is entirely automatic.

Doppler VOR antenna now under test is expected to improve the accuracy of VHF range stations by which transcontinental aircraft can navigate with radio signal comparisons. Old VORs were subject to reflection problems.

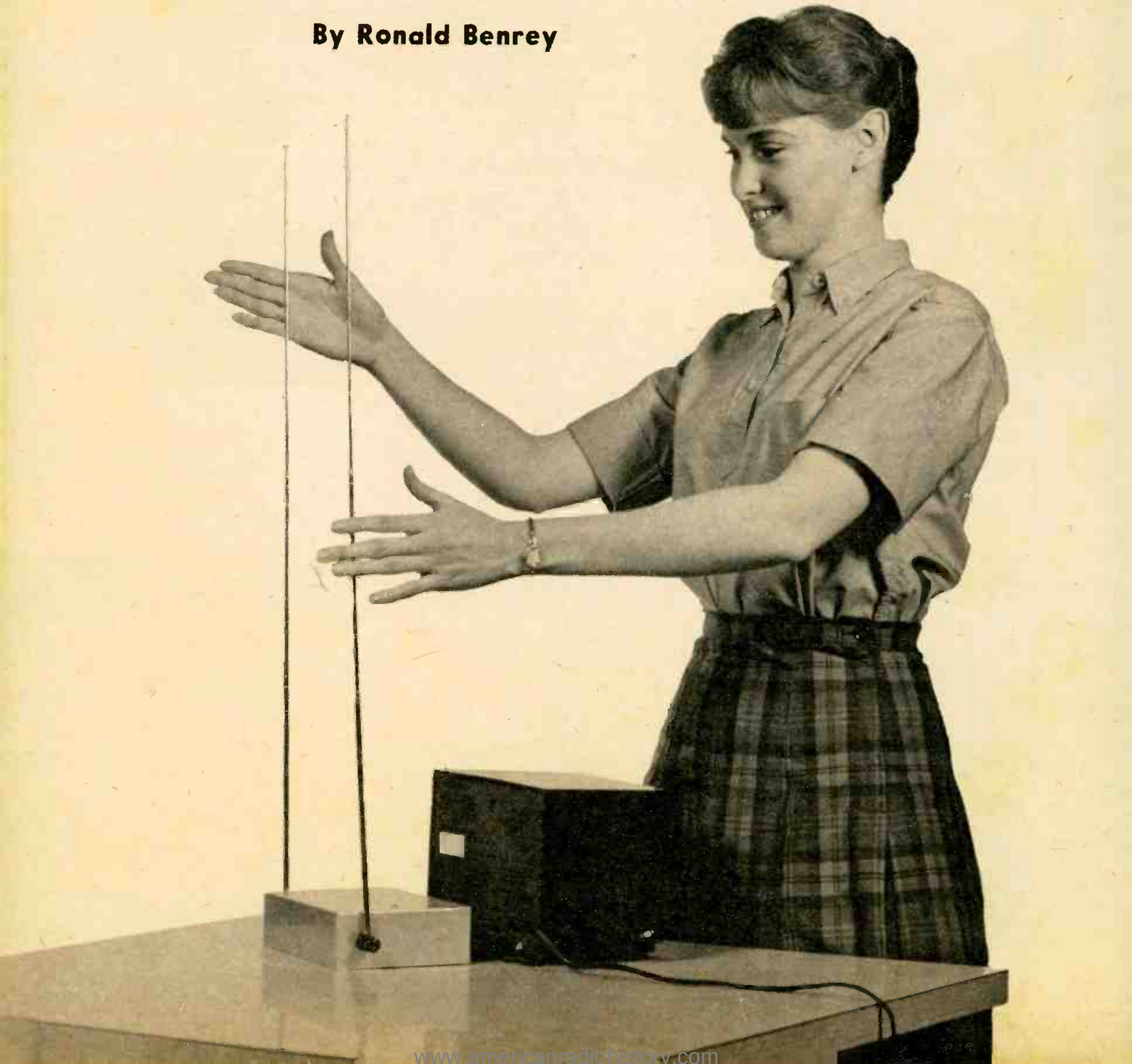
Transistorized Theremin

Conduct with semi-conductors!

Portable instrument plays through any AM radio.

IN science-fiction and horror movies the arrival of the flying saucers, the entrance of the monster, and the blast from the death ray, are usually emphasized by the weird, semi-musical tones of a theremin. In addition, theremins are frequently used to enhance portions of orchestral music, or as solo instruments. For less than ten dollars, and with a few hours work, you can construct a portable transistorized theremin that will operate with any standard AM broadcast band receiver. If the receiver is also portable, the theremin can be taken almost anywhere. The com-

By Ronald Benrey



pleted instrument can be used either to produce sound effects for home movies, tape recordings, etc., or, with practice, as an actual musical instrument.

Construction

The theremin is constructed on a perforated Bakelite board with flea clips used as terminal points. All connecting leads should be short and direct.

Transistors Q2 and Q3 (both 2N1264) are tetrode drift transistors and have a fourth lead, and a shield, in addition to the collector, base, and emitter. In this circuit however, the shield lead is *not* used, and should be cut short.

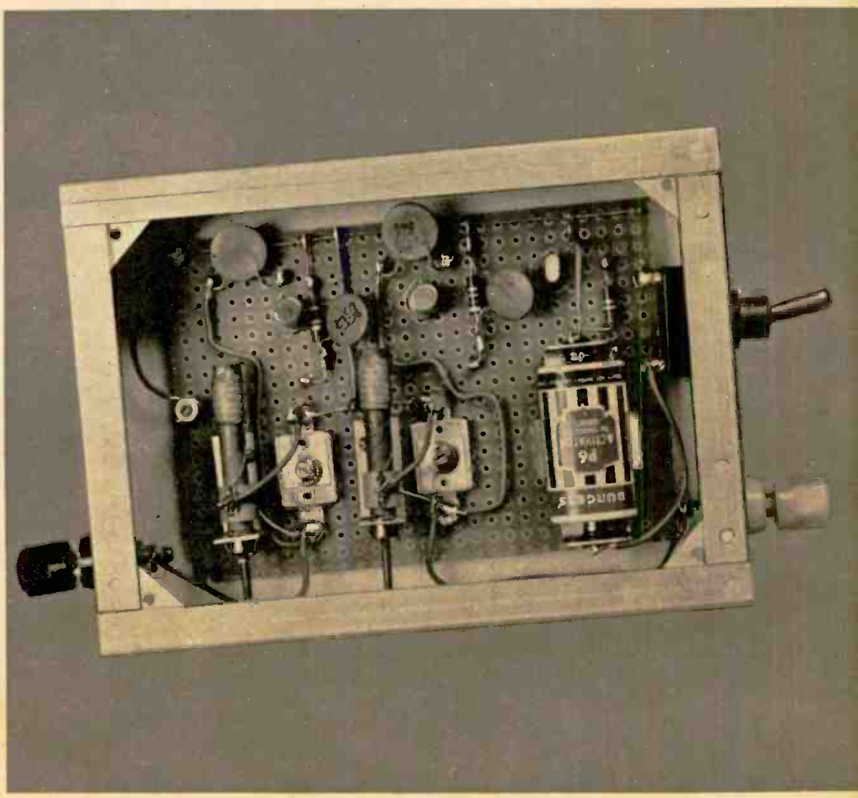
A standard 7″ x 5″ x 2″ aluminum chassis with bottom plate is used as a cabinet. The board after wiring is mounted in a standard aluminum chassis with long bolts and ½″ spacers. Be sure that no part of the wiring on the bottom of the perforated board comes in contact with the aluminum case, and try to keep the loop sticks in the approximate center of the chassis.

The two antennas are mounted with the aid of standard insulated five-way binding posts. As supplied, the antennas come with threaded bases that screw into the supplied sockets. The sockets are not used, however, and the threaded protrusions are inserted into the hole in the binding post shaft, and the binding post tightened.

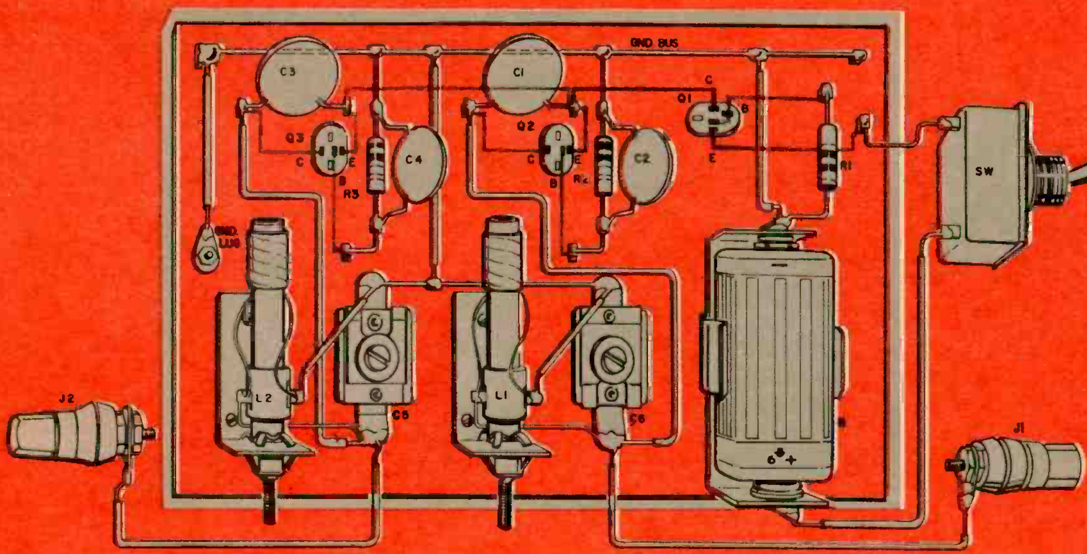
After the perforated board is mounted, run a wire from the ground "buss-bar" to one of the mounting bolts, (at point marked "gnd. lug") so that the chassis is grounded to the aluminum case.

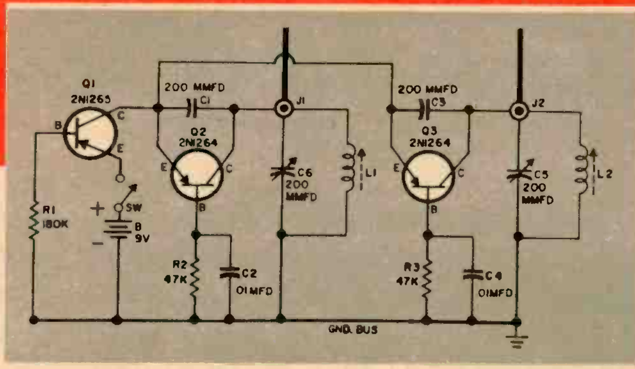
Theory

Transistors Q2 and Q3 operate as two independent low power RF oscillators. They are set at two different frequencies, differing by a low audio frequency. When these different frequencies are received, the difference frequency is detected and amplified, and appears as a "squeal." Each antenna is connected to one loopstick, making the circuit very



Bottom view of unit. All components fit on perforated board except toggle switch and the antenna 5-way terminal posts, J1, J2. Use short leads.





Transistors Q2 and Q3 have an unused shield lead between collector and base. All wiring is insulated from chassis. Ground the buss-bar to one of the mounting bolts.

sensitive to "body" capacitance. If a hand is brought near either antenna, the frequency of the oscillator changes, changing the difference frequency, and hence the frequency of the "squeal."

Operation

Place the completed instrument close to a standard radio tuned to a clear spot near the center of the dial. Fully extend the antenna and lay the instrument on its side so as to have access to the perforated chassis. Both loopsticks should have the ferrite cores set about halfway in. With an insulated alignment tool adjust C6 until you hear a hissing noise on the radio. Now, adjust C5 until you hear a loud whistle. There may be several adjustment points where you will hear a whistle. Pick the loudest. Now, carefully adjust C5 to obtain the lowest pitch. The instrument is now ready to be played.

By manipulating your hands around the antennas you can produce many sound effects. The most pleasant tone [*Continued on page* 111]

PARTS LIST

R1—180,000 ohms, 1/2 watt
R2,R3—47,000 ohms, 1/2 watt
C1,C3—200 mmfd disc ceramic
C2,C4—.01 mfd disc ceramic
C5,C6—9-180 or 200 mmfd trimmer capacitors
Q1—2N1265 transistor
Q2,Q3—2N1264 transistor
L1,L2—ferrite loop antenna
B1—9 volt battery (Burgess P6 or equiv.)
SW—SPST toggle switch
J1,J2—five-way binding posts
Aluminum chassis and bottom plate 7"x5"x2"
Misc.—2 whip antenna (Lafayette F-343), battery clip, transistor sockets, perforated Bakelite board 3 1/2"x5 1/4", flea clips, hardware

citizens band

Alignment Generator

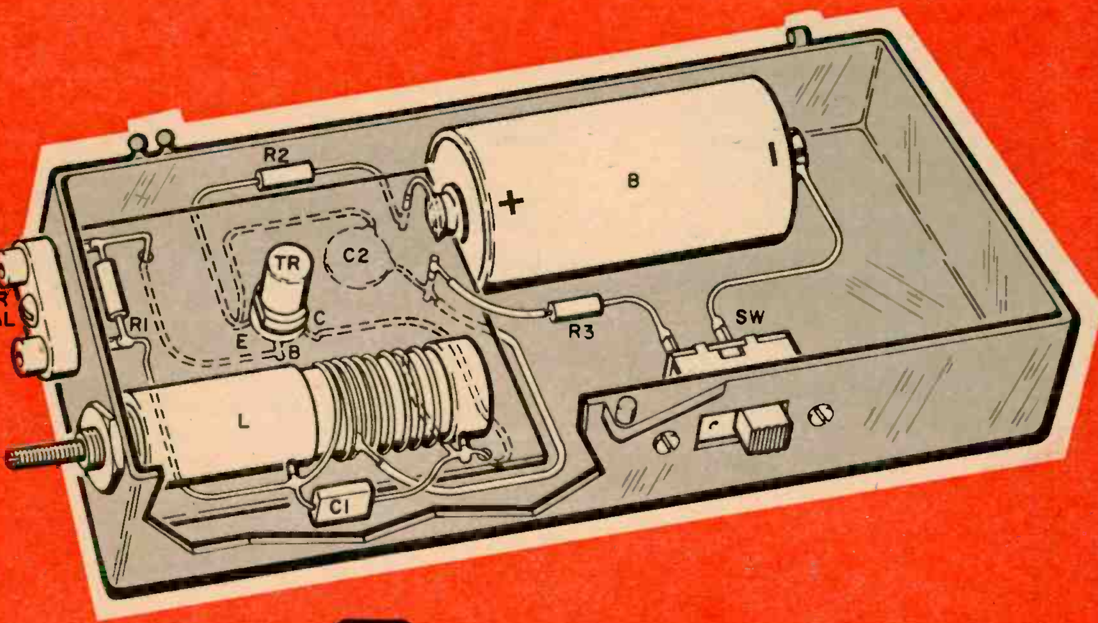
By Herb Cohen

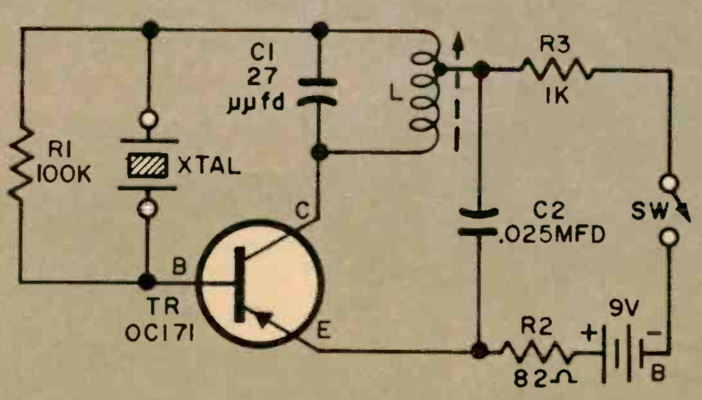
WITH the widespread use of super-regenerative receivers on the Citizens Band, a need arises for a low-powered alignment generator. Anyone who has tried to align his receiver using his transmitter signal has found that the receiver overloads if within a hundred feet of the transmitter. This makes receiver alignment a difficult and tedious job—and virtually impossible to do properly in your home workshop. Even aligning the receiver from an RF signal generator becomes a touch-and-go process since the differences between the signal generator setting and your transmitter's crystal may be just enough to give faulty CB reception.

The alignment problem was solved rather easily by the construction of a low-powered Citizens Band crystal oscillator with low enough power to be put next to the receiver without overloading it. Use the crystal from the transmitter to insure exact alignment to the receiver.

The entire circuit can be built in less than an hour and is housed in a clear plastic case. The most expensive part is the transistor (TR) which sells for less than two dollars and has an alpha cut-off of 100 mc. A mesa transistor, the OC 171, is the first such unit to be mass-produced so cheaply.

To insure accurate alignment of the receiver, the transmitter crystal is used to tune the 1-transistor signal generator.





Shield lead (S) of transistor (TR) is cut short and not used. Because of long life, battery (B) is soldered directly into the oscillator circuit. The Amperex OC171 although in a cylindrical case has inline lead setup.

Construction

A piece of perforated board is cut to 1⅝" x 1⅞" and the transistor socket mounted in its center. After the components are soldered in place, the board is fitted into a 4¾" x 1⅛" plastic box. The crystal holder is mounted on the outside of the box so its two lugs are on top of the circuit board. Be sure to allow enough room for the coil form to be mounted next to the crystal holder.

Stiff wire is used as solder terminals to connect the battery into the circuit and no battery holder is necessary. Before the battery is permanently connected into the circuit, the oscillator coil must be tuned to the crystal frequency. The crystal should be placed in its holder and a 5 or 10 ma meter should be connected in series with the battery line. The circuit will draw about 4 ma when not tuned. The coil slug is then adjusted until the current dips sharply indicating the point of resonance. Once the coil has been adjusted to maximum dip, the meter is removed and the battery connection soldered.

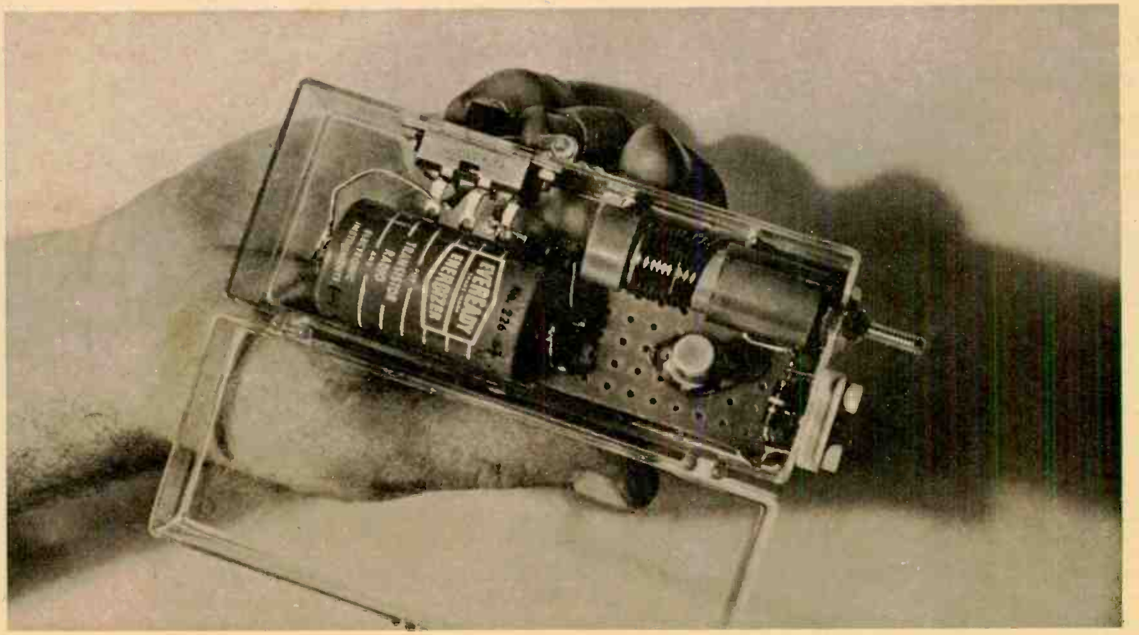
When mounting sockets, switches, coils, etc., on plastic boxes certain precautions should be taken when making the mounting holes. To avoid splitting the box, it's a good idea to first make a small hole with a heated ice pick or awl, and then ream it slowly to size with a hand reamer.

If desired, a small pad of ¼" foam rubber or the equivalent may be glued to the top cover of the plastic cabinet. This will serve to keep the components in place and provide a certain amount of shock protection. The edges of the cabinet may be sealed with Scotch cellophane tape to prevent tampering.

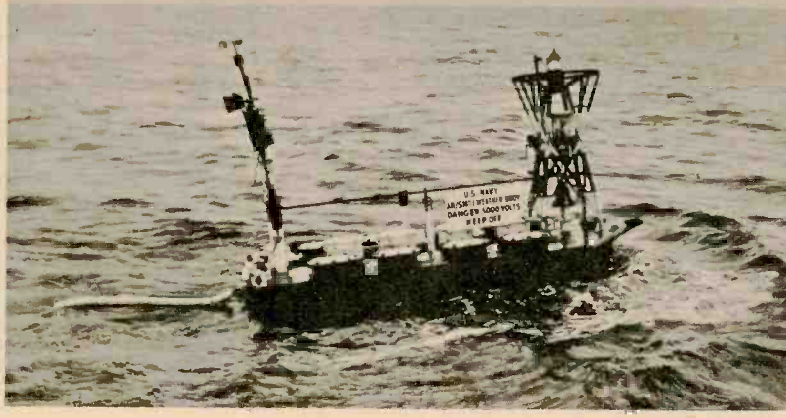
The circuit is a basic Hartley oscillator with a collector-to-base feedback network. The crystal is placed in the base circuit to control the frequency of signal to the base. Resistor R2 is placed in series with the circuit to serve as a current-limiting resistor.

PARTS LIST

R1—100,000 ohm, ½ watt, 5%
R2—82 ohm, ½ watt, 5%
R3—1000 ohm, ½ watt, 5%
C1—27 mmfd (mica)
C2—.025 mfd (disc ceramic)
TR—Transistor OC 171 (Amperex)
SW—SPST slide switch
XTAL—Crystal from your transmitter plus matching socket
L—9 turns of #14 wire tapped 3 turns from end; wound on National XR-50 coil form
B—9V. battery (Eveready #226 or the equiv.)



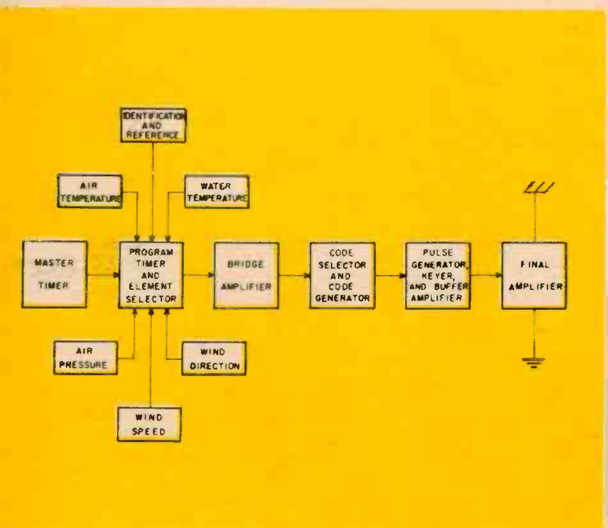
Anchored in about 2,000 fathoms with a special slack line anchor system, 20' x 10' weather station goes on the air every six hours with up-to-the-minute information from most remote ocean areas.

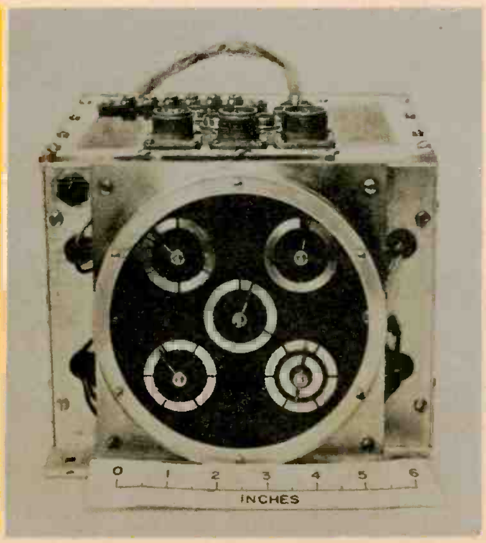


Weather At Sea

SHIPS and intercontinental planes need accurate and timely marine weather information no matter where they go. That's why, if you look real hard, you may see a bobbing buoy anchored in some remote ocean area—and it isn't just bobbing for apples. It's the U. S. Navy's new automatic weather station which transmits in code at regular intervals the air and water temperatures, speed and direction of surface winds, and the local sea-level barometric pressure.

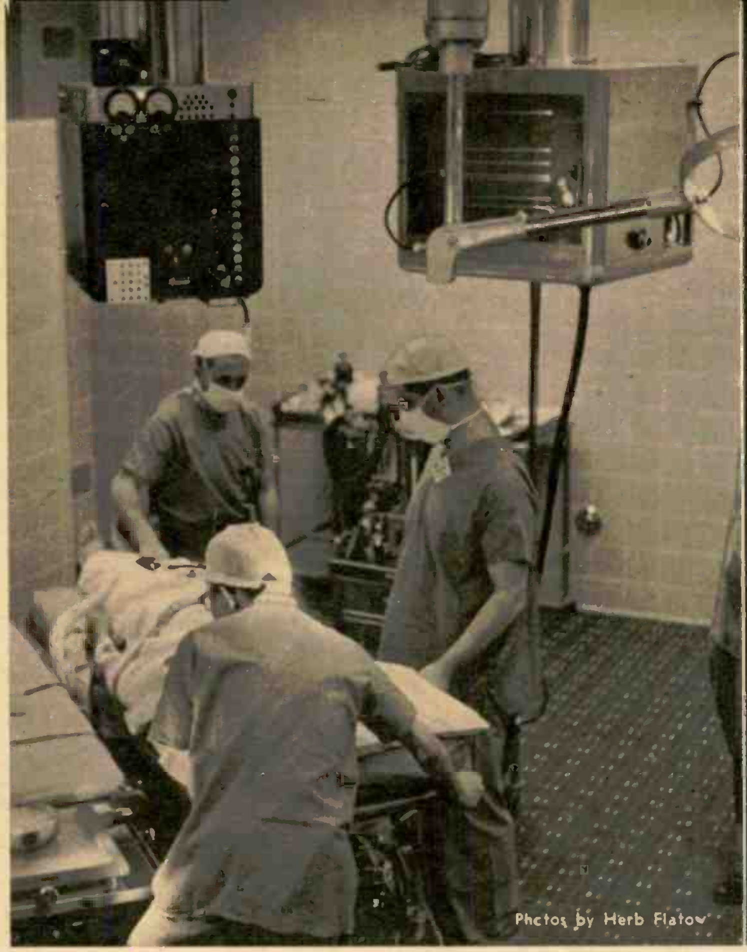
The master timer, a chronometer, is rewound by a small electric motor during each transmission period. Contacts on the hour and minute hands of the chronometer ener- [*Continued on page* 109]





Above is block diagram of the various electronic elements contained aboard the weather station. Power is from batteries below decks.

This is the program timer and element selector. Its circular switches see that the weather transmissions go on air in a precise manner.

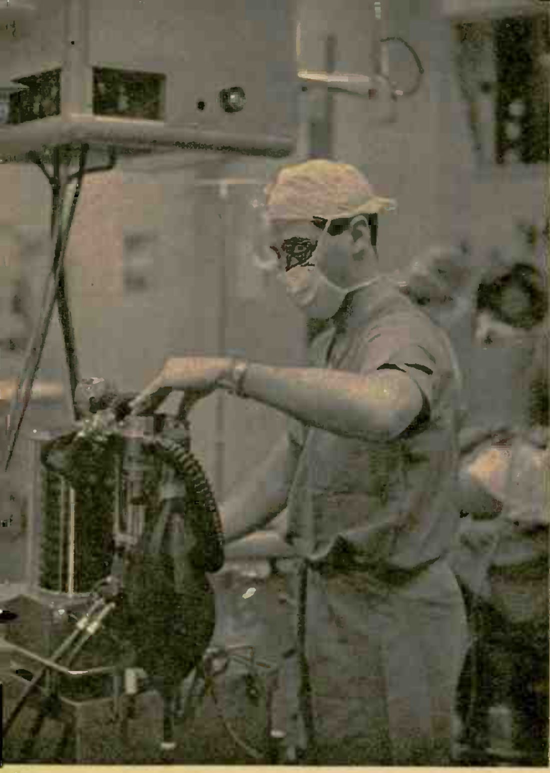


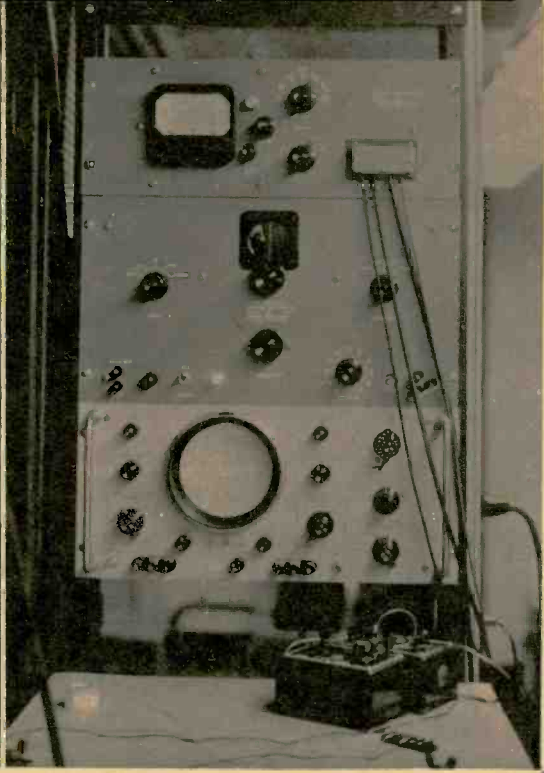
Surgery of the Future... Today!

The pictures here were taken especially for this magazine so you, our readers, might see medical-electronics' latest advance in the war on disease.

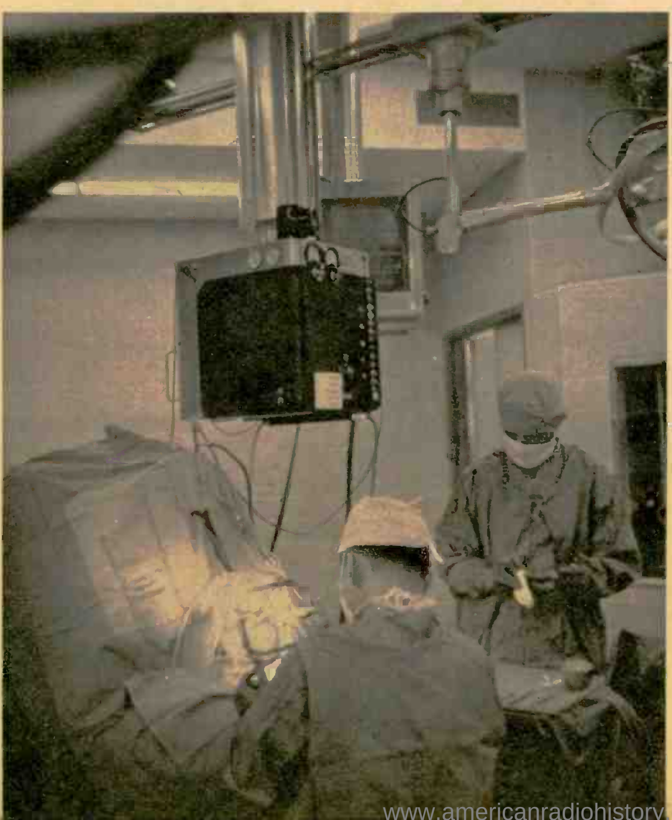
THE electronics engineer is a very important member of the neurosurgical operating team at New York City's St. Barnabas Hospital. A unique operating room, part of the hospital's new surgical center for chronic diseases, makes full use of electronics. Delicate brain surgery is performed here by doctors whose skilled fingers and talent are aided every step of the way by precision electronics. The surgeon has an eight-channel oscilloscope monitor above the operating table which records visually the patient's heart waves (EKG), brain waves (EEG), muscle-waves (EMG), blood pressure, pulse, neurological stimulation pulses, heart sounds and nerve impulses. From a special panel, nearby facilities are available for almost any kind of surgical procedure—remotely-controlled electrocautery and electro-cutting, X-ray, timing devices and communications with the electronics room which overlooks the operating room.

"Cold sleep" (hypothermia) can be induced electronically. Closed-circuit TV may view the operation. Oxygen analyzing gear, tape recorders and about 100 additional electronic helpers monitor, record and provide for the surgeon's and patient's needs.



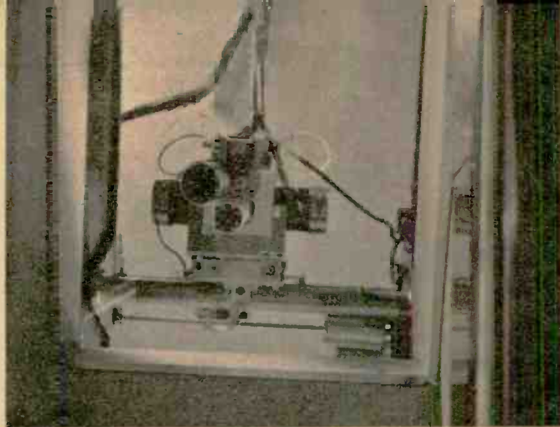


Left, assistant prepares portable aspiration and resuscitation machine for use. It was designed by hospital's anesthesiologist with consulting engineer. At right is some of electronic test gear rack-mounted in balcony above operating room. Top unit is a VTVM; center unit, a low frequency generator; bottom instrument, an oscilloscope. These are part of electronics laboratory.



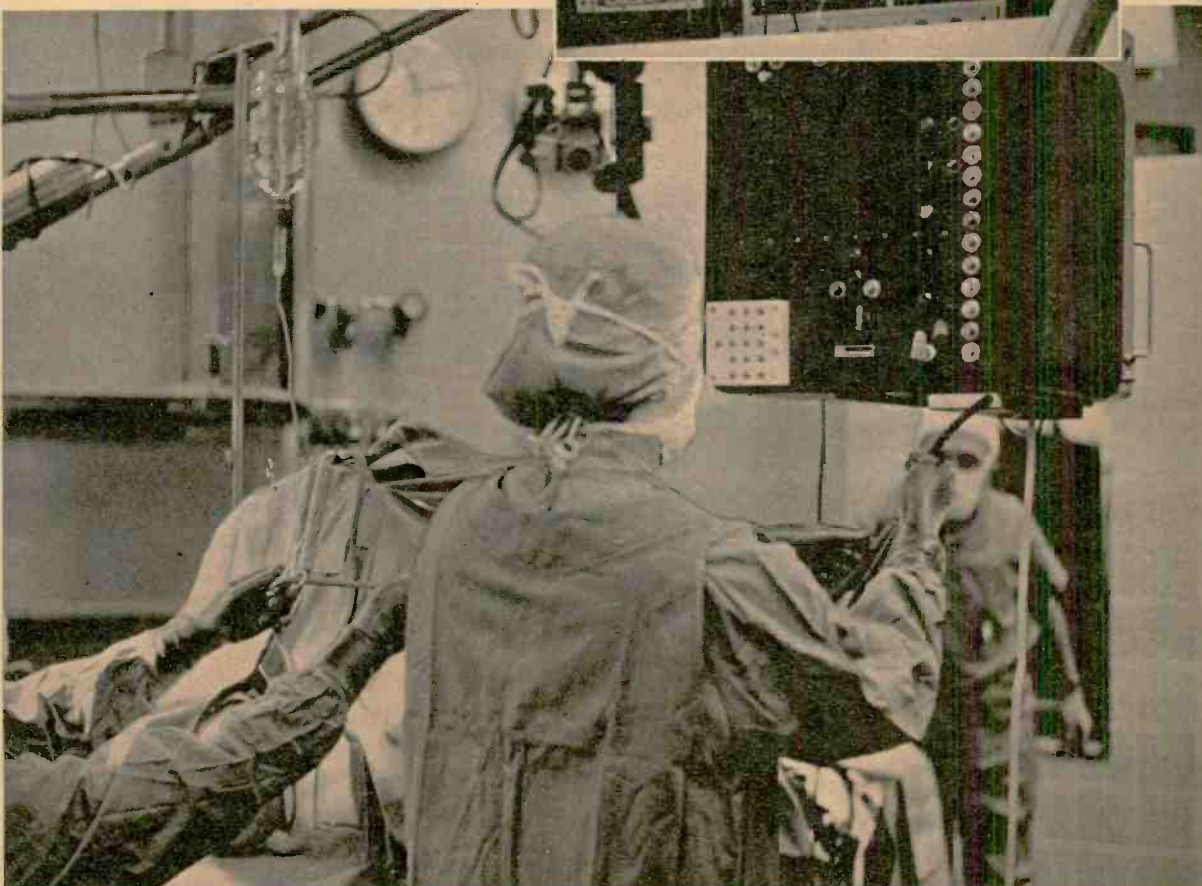
With new operating facilities, doctors at St. Barnabas can perform a new brain operation which has been 85 percent successful in correcting Parkinson's disease. Large unit on boom over operating table contains controls for almost every surgical procedure.

This is one of three built-in remote control X-ray tubes for the frequent radiography required during brain surgery. One is mounted directly above patient, two in side walls. They are safe, precise.



Looking up from floor of neurosurgical operating room, one can see large bank of electronic devices which provide EEG, EKG, EMG gear, closed circuit TV and electronically induced "cold sleep."

Tube is supplied to surgeon from boom-mounted instrument which contains thermostatically controlled sterile saline, electrocautery and electro-cutting probes, and mike/speaker for intercom.

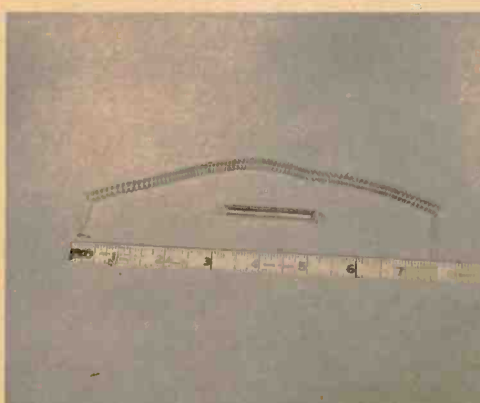


Echo
El Echo Chamber
Echo
Echo
Echo

Inexpensive gadget can add artificial echo to your high fidelity system.

by David Gordon

Perforated disc with solder bead sweated in center is glued over speaker voice coil.



Light spring of about 2" in length is stretched as shown to make the reverb element.

AUDIO engineers have long recognized the value of a slight echo (they call it *reverberation*) for spicing up an otherwise "dead" recording. Therefore, there is not only a never-ending search for recording halls with good acoustic properties—which usually means the right amount of reverberation—but a number of techniques have been devised to introduce a controlled amount of artificial "reverb."

Here's the *EI* version of the artificial echo machine, which is not only inexpensive to construct, but is flexible enough to be adapted to a large number of different setups.

The basic electro-mechanical reverb unit consists of a 4" or 5" replacement type PM speaker (SPI), a small electrolytic capacitor (C7), a potentiometer (R6) a high output crystal cartridge (Xtal) and a spring. These assorted components are assembled as shown.

Before assembly the speaker must be modified. As can be seen in the photos and drawing several sections are cut out of the cone. This is to prevent the speaker from adding its own voice to the proceedings for we only want it to serve as a driving element for the spring. A 1" perforated or screen type metal disc (a chassis ventilating hole cover) is glued to the center of the speaker. Before gluing, sweat in a layer of solder on the disc to serve as an anchor for the spring which is later soldered to it.

The spring is the most critical element as far as the overall sound of the unit is concerned. The author's model used a standard light 2" spring permanently stretched to a length of about 7½". Don't be afraid to experiment in your choice of springs. In general, it would appear that the lighter the spring, the better the results. Try not to mount the spring too slackly or it will tend to resonate at a low frequency of its own.

Artificial Reverberation Techniques

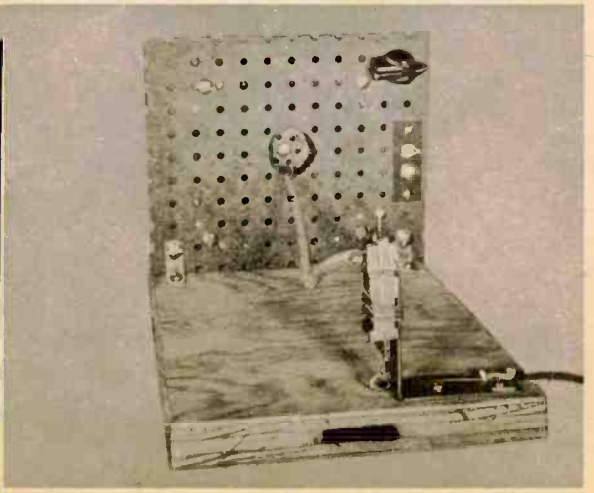
THERE are a variety of tricks in use by recording engineers to obtain artificial echo effects. One of the major recording companies, for example, uses an abandoned elevator shaft as an echo chamber. They place a monitor speaker reproducing the original program at the bottom of the shaft and a microphone to pick up the sound a certain distance above it. The reverberated sound picked up by the mike is then fed to an audio console which mixes the reverberated sound with the original in the desired ratio. The advantage of this technique is that the recording can be made in an absolutely "dead" studio and the exact amount of reverb desired can be added by simply setting a level control. This is a lot simpler than a repeated shifting of microphone placement in an effort to achieve the correct balance between direct and reflected pickup.

A two-mike reverb technique is also used. There, one mike directly picks up the performer and the other, further away, picks up the room acoustics. Then outputs are mixed for proper balance.

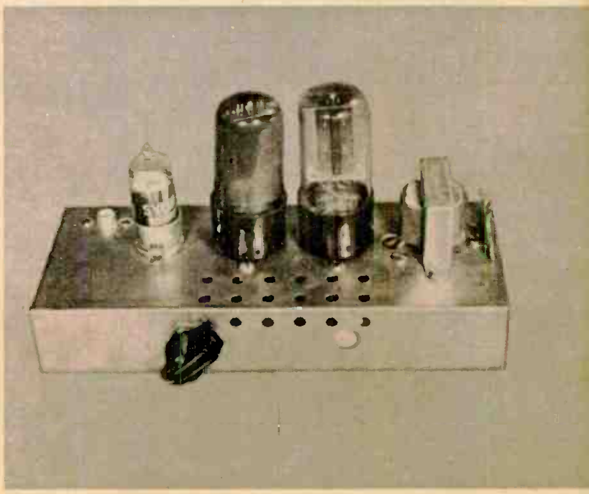
Another common echo technique requires a reverberation machine. There are several professional types available which utilize various mechanical-electronic devices including continuous-loop tape recorders and vibrating plates or springs.

The tape recorder reverb machine constantly records the signal and then after delaying it a fraction of a second, mixes it back into the original signal. The effect simulated the time delay of a normal echo situation.

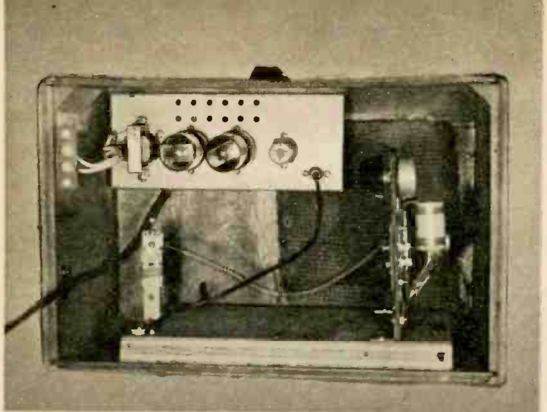
On the other hand, machines using vibrating springs or plates produce what audio men refer to as "hangover." As each musical transient comes along, it "twitches" the spring or plate which then continues to vibrate after the pulse has passed. Coupled to the vibrating element is a transducer whose job it is to convert the vibrations to electrical energy; which in turn is fed to a mixer and recombined with the original sound. You may come across variations on the above techniques, but most echo devices hold to the same basic idea.

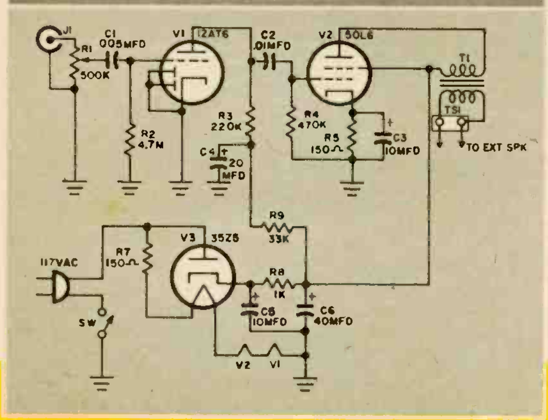


Completed electro-mechanical echo assembly. Speaker disc is seen through center hole.

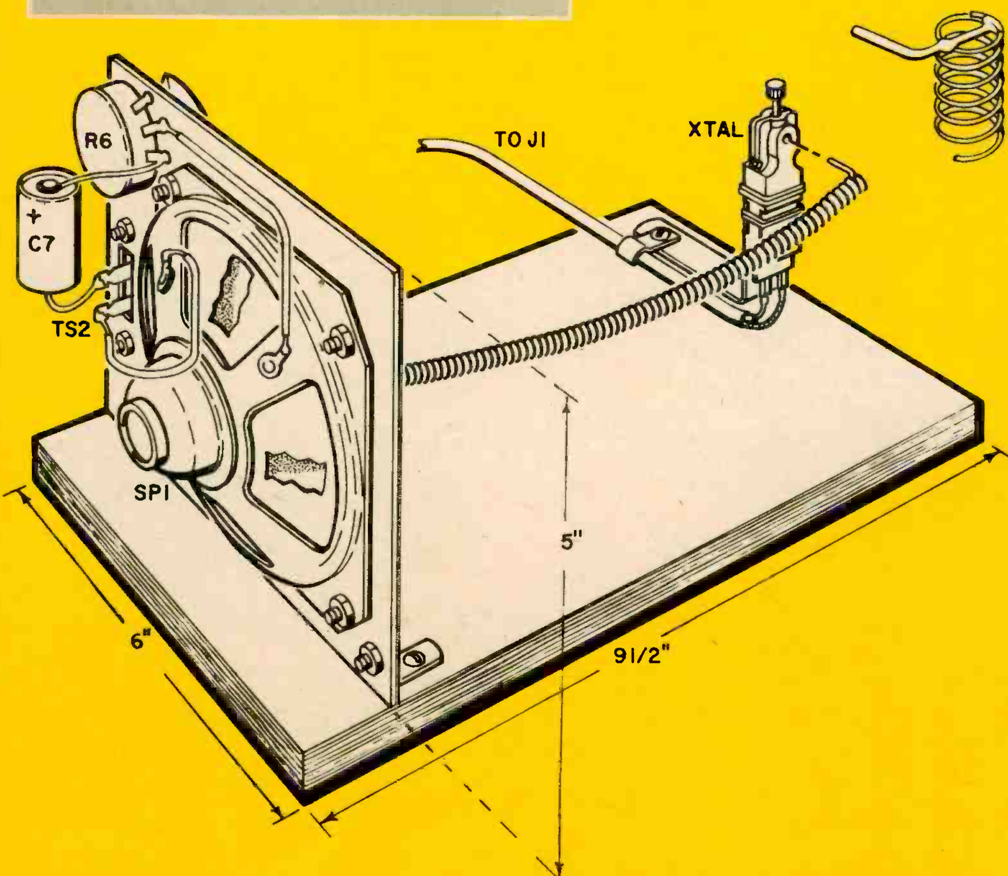


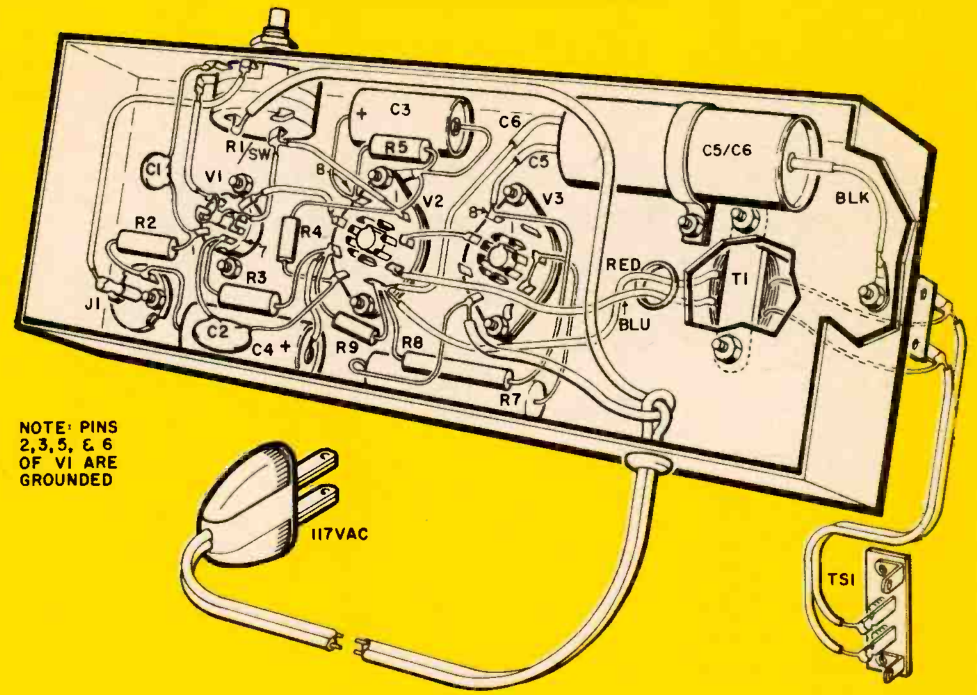
Simple AC/DC amplifier used to drive separate external speaker reproducing echo effect.





Completed unit (above, left) assembled inside a replacement type wooden cabinet. Nut on volume control shaft is used to hold internal amplifier unit in place. Straightforward schematic (left) is representative of most simple AC/DC amplifiers used in inexpensive phonographs. Assembly of electro-mechanical section of echo unit is shown below. Dimensions are not critical; length of base board depends on specific spring used. Note short length of buss bar soldered to end of reverberation spring for mounting in chuck of crystal cartridge.





AC/DC amplifier unit uses one 7-pin miniature tube and two octal types. Note pin numbering.

On the other hand, if mounted with too much tension, the spring will pull the speaker voice coil out of position.

One end of the spring should be tinned and then soldered to the metal disc so that the speaker in effect pulls and pushes along the length of the spring. The other end of the spring has a small piece of buss wire (about the thickness of a phono needle shank soldered to it as shown. Make sure that when it is in place in the cartridge chuck, neither the spring nor the buss wire rubs against the cartridge proper. It may be necessary to bend the buss wire rather sharply to avoid problems.

The cartridge (Xtal) is held in place on a small brass angle bracket by a tightly wrapped rubberband. This enables it to be slid up and down for optimum positioning.

The speaker (SP1) is mounted face in on a small piece of perforated Masonite board. A 1" hole is drilled or reamed in the board to permit the spring to be soldered to the voice coil plate. On the same board are mounted the speaker drive control (R6) and the high-pass capacitor (C7).

The amplifier shown is a standard AC/DC job such as is found in small phonographs. Any standard unit sold by the mail order parts supply houses will serve nicely [*Continued on page* 111]

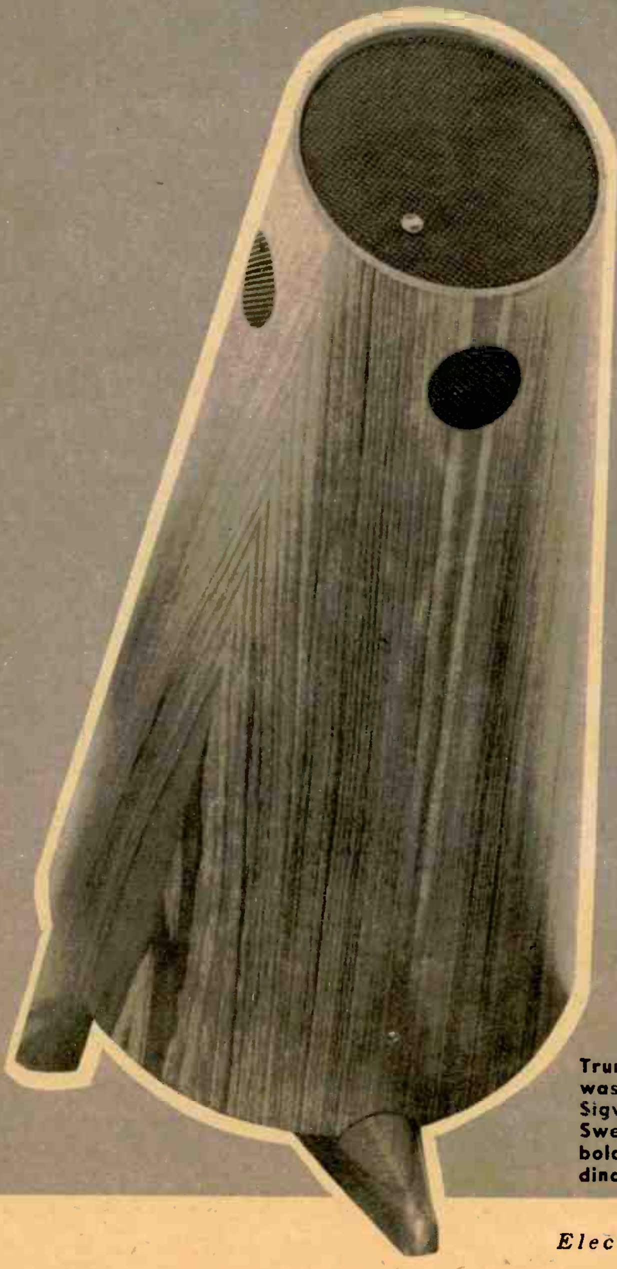
PARTS LIST

Resistors—½ watt, 20% unless indicated
R1—500,000 ohm potentiometer with switch SW
R2—4.7 megohms
R3—220,000 ohms
R4—470,000 ohms
R5—150 ohms
R6—50, 75 or 100 ohm wirewound potentiometer
R7—150 ohms, 1 watt
R8—1000 ohms, 4 watts
R9—33,000 ohms
Capacitors
C1—.005 mfd disc ceramic
C2—.01 mfd disc ceramic
C3—10 mfd @ 25 volts electrolytic
C4—20 mfd @ 150 volts electrolytic
C5,C6—10 mfd/40 mfd @ 150 volts dual electrolytic
C7—50 mfd @ 50 volts electrolytic

V1—12AT6 tube
V2—50L6 tube
V3—35Z5 tube
T1—50L6 output transformer
J1—phono jack
TS1,TS2—2 screw terminal strip
SP1—4" or 5" PM speaker modified as per text
X-TAL—high output crystal cartridge Lafayette PK-11 or Argonne AR-77 or the equivalent (3.5 volt output)
Misc.—hardware, line cord, 2 octal sockets, 7-pin miniature socket, ground lugs, etc.
Kit of prepunched amplifier chassis, 3 tube sockets, transformer T1, and potentiometer R1 is available from Edlie Electronics, 154 Greenwich St., NY 6, NY. @ $1.75, postpaid.

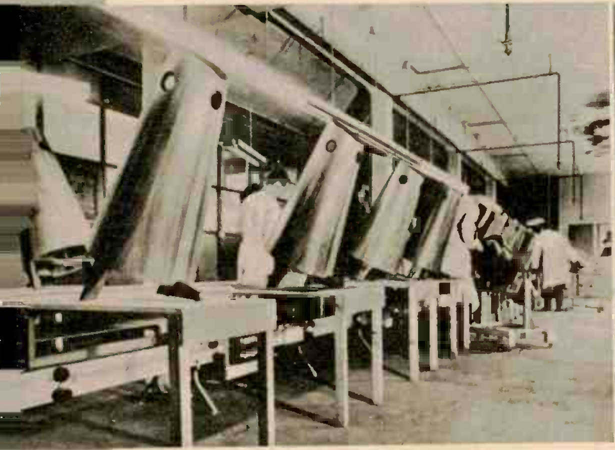
New Style in Sound

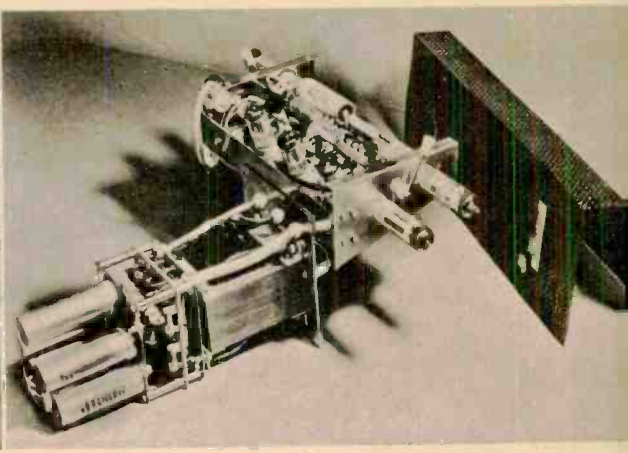
Swedish speaker system, with its unique engineering, may look like a cannon—but it sounds like hi-fi.

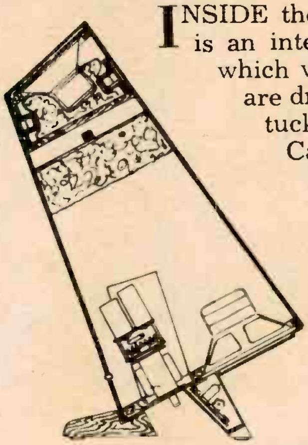


Truncated conical shape was conceived by Count Sigvard Bernadotte, son of Swedish king. It reflects bold, clean lines of Scandinavian modern furniture.

Below is the "assembly line" of Elektron Lund in Malmo, Sweden. Speakers' amplifier power supply is shown at left of other photo, while the tubes jutting out vertically (EL86/6CW5's) are the two amplifiers' output stages. Price of the Lund "1001" speaker system in the United States is about $395.







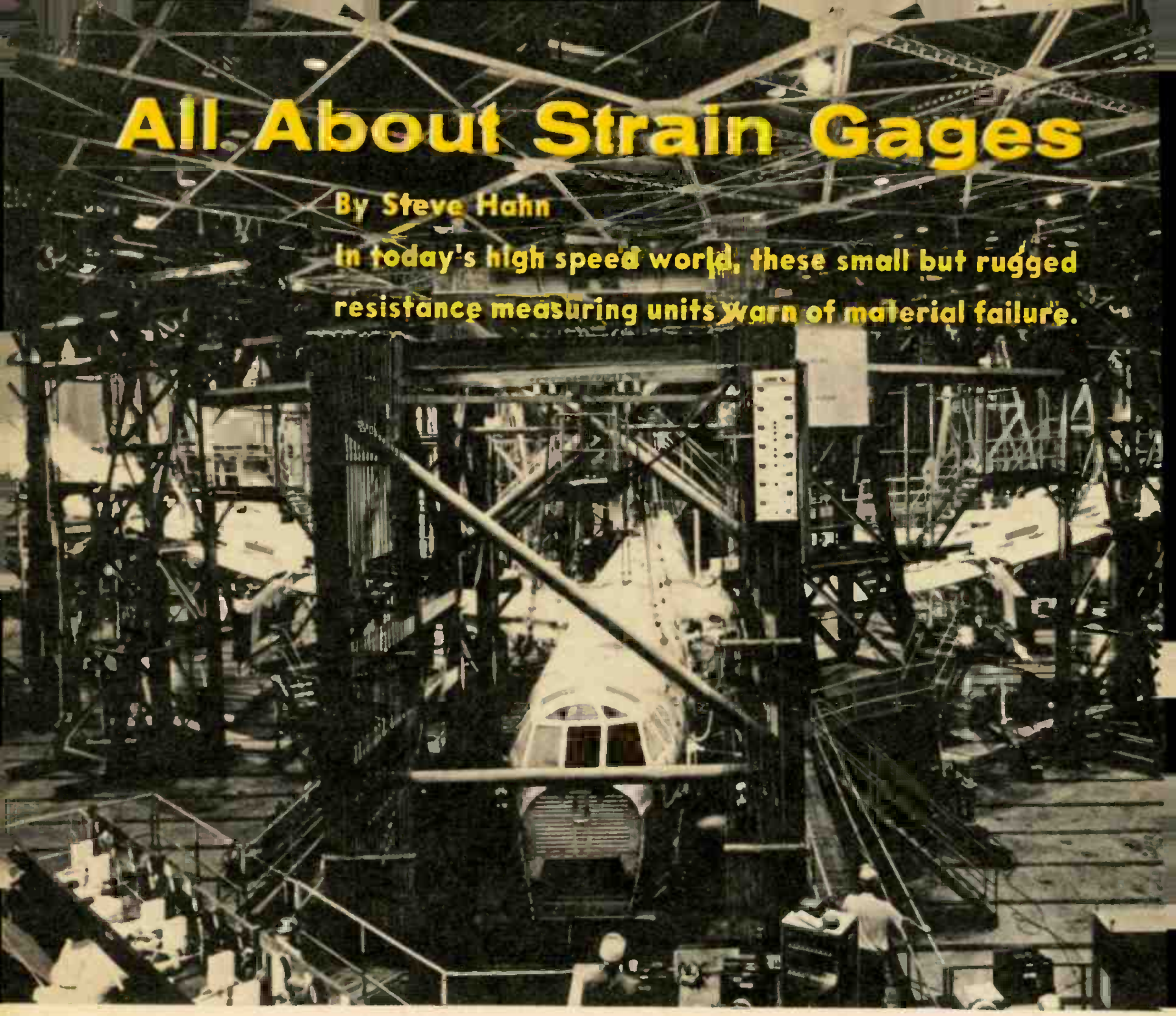
INSIDE the unusual shape on the opposite page is an integrated high fidelity sound system in which woofer, midrange and several tweeters are driven by two transformerless amplifiers tucked away inside the speaker cabinet. Called the "1001" by the manufacturer, Elektron Lund AB of Malmo, Sweden, the system departs radically from the conventional, with much engineering attention given to the elimination of the "keyhole" effect. The sound is not perceived as coming from inside the speaker cabinet, but rather seems to exist around the speaker. This feat is accomplished by placing the woofer at the bottom of the cabinet where it can radiate near one or two walls and the floor, and putting the midrange at the top, encircled by the tweeters radiating a full circle of sound. The woofer's bass reflex portion of the enclosure is isolated from the midrange and tweeter section. The midrange speaker sits in a sound absorbing medium, and radiates directly out from the "cannon's mouth."

Lund's approach is that no speaker is likely to perform at its best when driven by an amplifier with a flat frequency curve. And a truly flat speaker in itself is impossible to manufacture. The speakers in the "1001," therefore, are fed by two separate amplifiers whose frequency responses are *not* flat, but which compensate the frequency curve of the speakers so that the sound reaching the listener *is* basically flat. One built-in amplifier handles from 20-250 cps, and an electronic crossover sends the midrange and high frequencies to the other amplifier which goes from 250 cps to beyond the audible range. The desired response is obtained chiefly by feedback, and since the amplifiers have transformerless output stages, a very large amount of feedback can be applied—approximately 45 db.

All About Strain Gages

By Steve Hahn

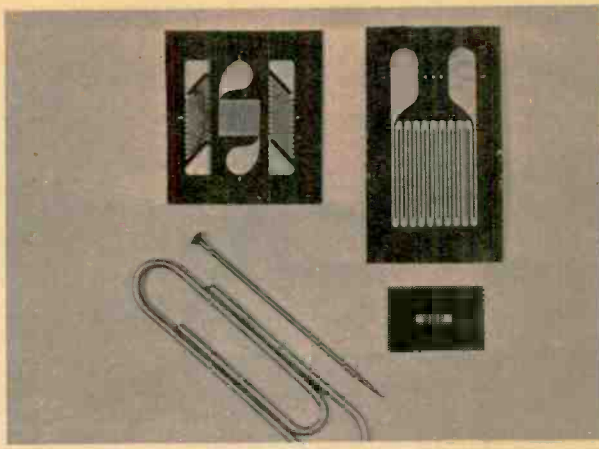
In today's high speed world, these small but rugged resistance measuring units warn of material failure.



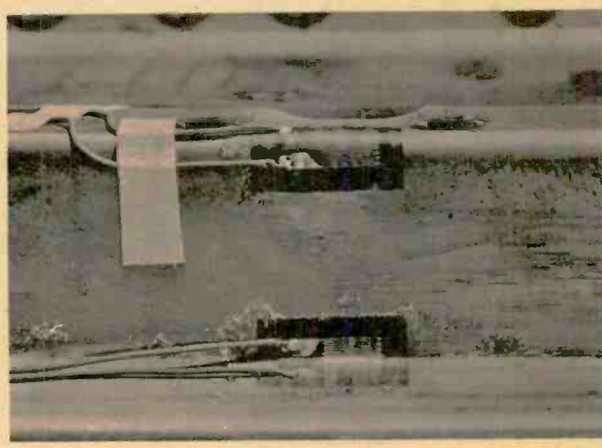
Boeing B-52G is subjected to stresses greater than those it will encounter in flight. Strain gages in wings, fuselage and tail are monitored in foreground.

THERE is hardly a commercial airplane flying today which does not have a number of strain gages mounted in its wings to detect instability as a result of fatigue or operational conditions which exceed the aircraft's structural limits. Shafts and housings on high speed turbines used in the generation of power are almost always equipped with a permanent strain gage system. Critical points on these turbines are located where they are not easily accessible to operating personnel. Prior to the development of the strain gage, very serious accidents and costly breakdowns resulted because a high speed rotor would suddenly fly apart as a result of a progressively worsening dimensional instability which could not be detected until too late.

How does a strain gage work? We generally think the ability of a material to conduct electricity is a function of its resistance. Copper, a good conductor, has low resistance. Glass, a poor conductor, has a high resistance. To change electrical resistance, you either change the material involved or change the amount of

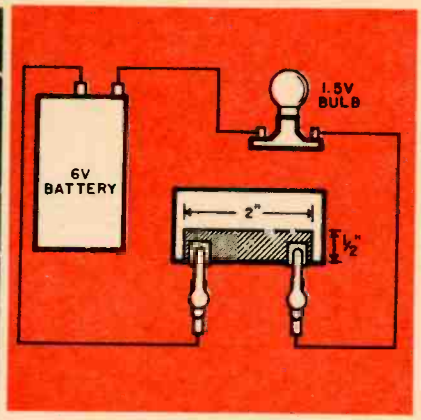


Tiny strain gages by Tatnall Measuring Systems are used in rocket and supersonic aircraft applications. The gages are of MetalFilm foil which is fixed to the base material by a special photoengraving process.

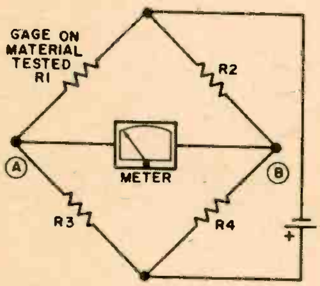


Here thin gages are bonded to underframe of truck with Eastman 910 adhesive for fast installation. The gages easily conform to the curves and irregularities of the surface of material being stress-tested.

Monitored by TV (and strain gages) is a missile guidance system mounted on end of high acceleration centrifuge. Components under test are blanked out because of security classification. I-beam also is mounted with strain gages (arrow).



Home-built strain gage: Paint 2" of flexible Bakelite with ½" strip of conductive printed circuit repair paint. Place two snips of aluminum foil between alligator clips and the paint at extreme ends of paint strip. Hook up circuit as shown, left. Bulb will be bright. But when Bakelite is flexed, resistance in the painted strip will change and the bulb dims accordingly.



Here is a diagram of the simple Wheatstone bridge described in the text. R1, the strain gage, is attached to material to be monitored.

material. If a 3″ steel finishing nail has a resistance of one ohm, two 3″ nails wired in parallel will have a resistance of ½ ohm, while the same two nails wired in series will have an electrical resistance of two ohms.

But the electrical resistance of the nail can also be changed *without* adding or taking away material. If you physically compress it, the resistance would decrease; if it were stretched, its resistance would increase.

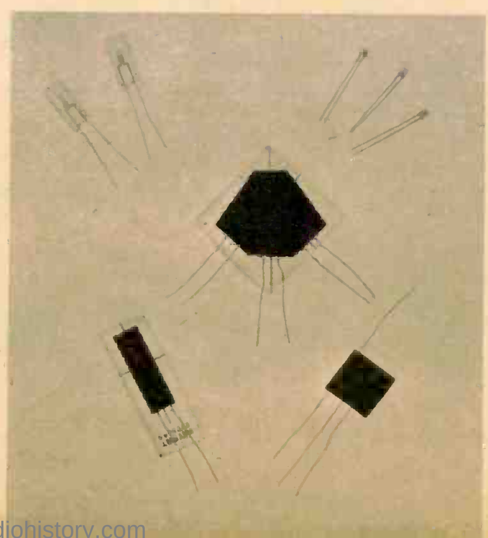
This ability of some materials to change electrical resistance due to mechanical strains forms the basis of a very accurate measuring device called the electronic strain gage.

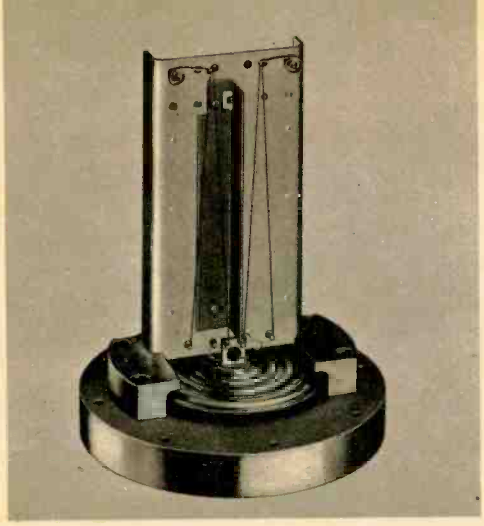
You can actually construct a simple but effective strain gage with about $2.00 worth of components—a 6-volt battery, any flexible piece of non-conductor (such as Bakelite), a few snips of tin foil, a 1½-volt flashlight lamp and socket, and some alligator clips with leads. The only special item is a bottle of low-resistance, printed circuit repair paint, General Cement Printing Circuit Repair Paint No. 20. (See illustrations.)

Strain gage measurements play a vital part in industry. Large suspension bridges have cables whose stability must be constantly checked. They must have a certain amount of elasticity, but the elastic limit of the cable must not be exceeded. Attached to the many structural cables in the bridge at strategic points are strain gages, all feeding a master alarm circuit.

Industrial strain gages usually do not use the simple stretching principle in a series circuit illustrated here. The "gage" we used indicates stresses in only one direction. Also, the simple series circuit is not sensitive enough for

The "filament" material of these Baldwin-Lima-Hamilton strain gages is imbedded in plastic. Largest unit is little more than an inch.





Unbonded strain gage by Stratham Instruments has pressure transducer pickup. Transducer movement changes length of flexible wire element and its resistance as well. See text.

delicate strain measurements in critical missile and aircraft applications.

In industrial strain gages the ratio of resistance change to mechanical strain must be as high as possible. The ratio is known as the "gage factor" and the gage wire is usually called the "filament."

Typical strain gage filaments are made of nickel or precious metals and their alloys. The choice of a specific filament material depends upon where and how the gage will be used and the kind of gage factor desired. Some common strain gage filament materials are iridium-platinum, constantan, manganin and nichrome.

The configurations of strain gages vary widely, depending again on the use. Some consist of complex patterns such as wires wound in a helix, in rosette or grid. These arrangements reflect strain changes in virtually any direction.

Strain gages are generally classified into two broad categories: "unbonded gages" and "bonded gages." In the former the filament is wound on a grid structure, usually made of inert support rods. As this grid structure is subjected to stresses and strains, the filaments stretch and compress accordingly and a resistance reading is taken.

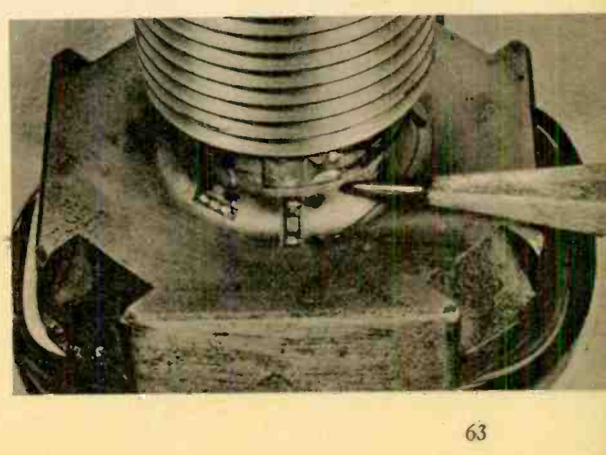
Bonded strain gages are those in which the filament is glued on or buried in some solid material such as paper or plastic. In some versions the filament is cemented directly to the material being tested.

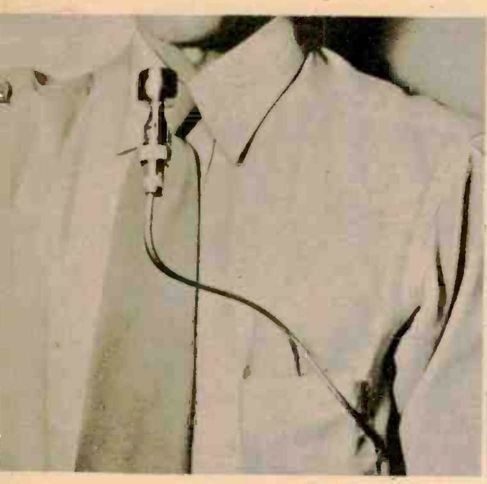
The bonding and mounting of strain gages is a very delicate operation involving special cements and nimble fingers. The electrical characteristics of the cements and glues used must be carefully analyzed to neutralize their effects on the resistance change of the gage itself.

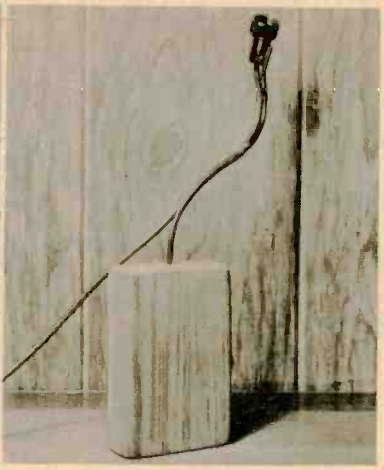
Where high sensitivity is required and operating environments are not severe, strain gages may be bonded to ordinary paper. The paper strain gage can then be glued to the material under test. In other applications, strain gage filaments are etched or embedded into plastic, Bakelite or one of several phenolic resins.

The most commonly used strain gage circuits are not simple series circuits, but variations on the Wheatstone bridge. (See diagram). Four resistors are used with the strain gage forming one branch of the circuit. When the resistance of R_1 is equal to R_2 and the resistance of R_3 is equal to R_4, the voltage drop across R_1 and R_2 is equal and no current flows between points A and B. As soon as the resistance of R_1 (the strain gage element) changes even slightly, current flows across points A and B and meter, oscilloscope or alarm circuit takes note. The direction of the current flow depends upon whether the resistance of [*Continued on page* 106]

Several strain gages, smallest being 1/64" in length, are placed for fillet stress analysis in threaded attachment of aircraft component.



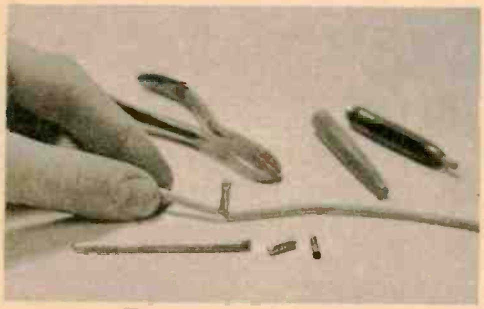




Try These

Lightweight Mike Support

About 30 minutes work with scrap materials will give you this novel "third hand" for supporting small lightweight microphones. Drill a hole in one end of a smoothly sanded 4" x 2½" x 1" wood block to a depth of about 2½" with a drill slightly smaller in diameter than #10 copper wire. Drip a few drops of Duco cement into the hole and force one end of the copper wire securely into the hole. Put the wood block in your shirt or coat breast pocket, bend the copper wire to the right shape and cut it off to a convenient length. To the free end of the copper wire solder a male or female (depending on mike) cable connector. Connect free end of mike cable to the connector.

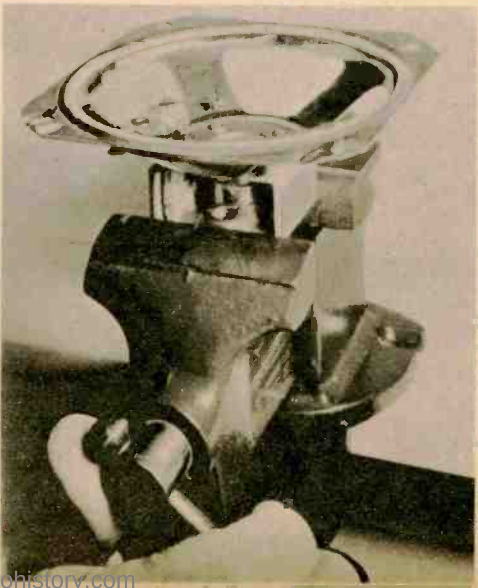


Solderless Wire Connectors

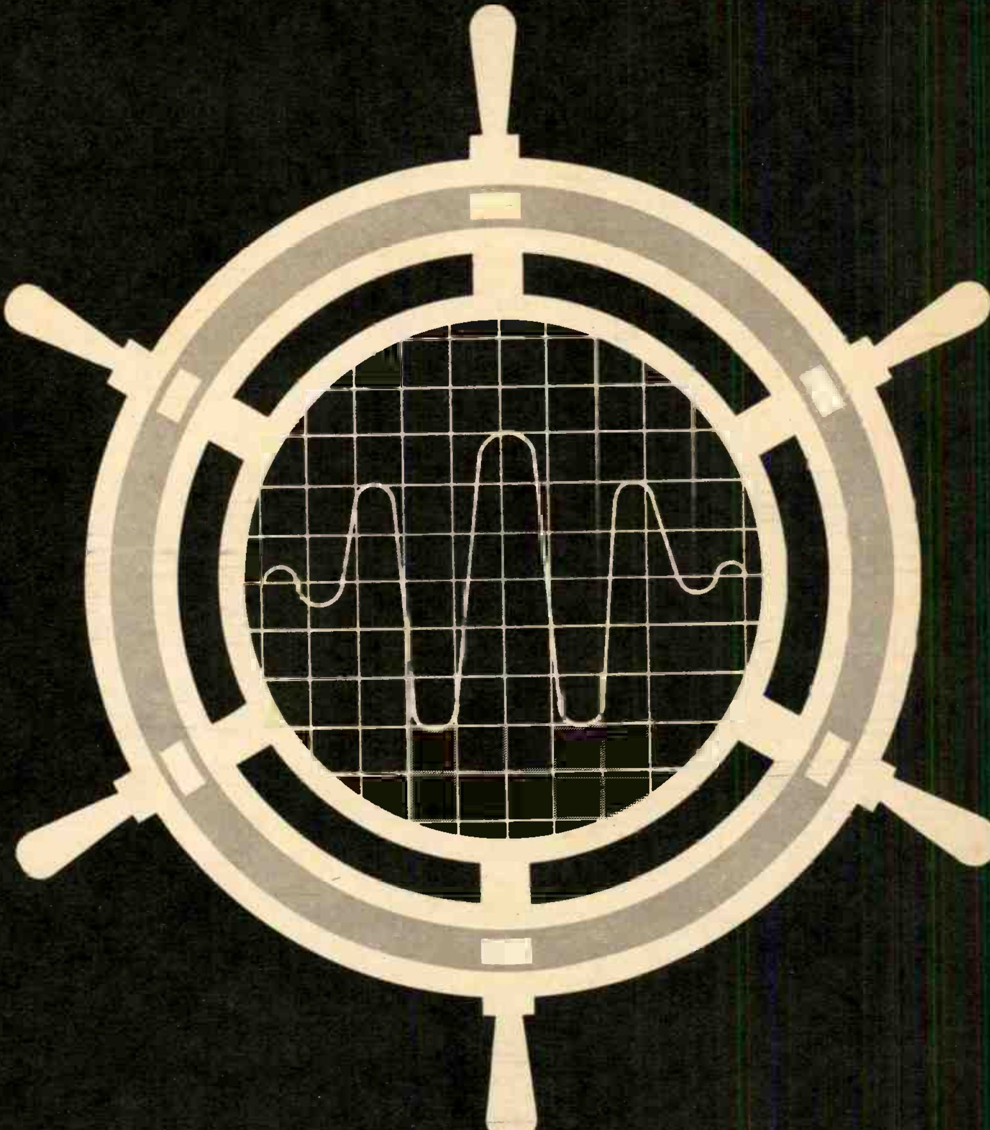
The brass ink cartridge from an exhausted ball-pen can be cut up into several solderless wire connectors. First wash out cartridge and clip into 1" lengths. Slip over each wire splice and crimp with a diagonal cutting pliers.

Removing Speaker Magnets

When junking damaged PM speakers salvage the magnet slugs as they have many uses around the house and shop. To remove slug, use a vise and a large nut as shown. Tightening the vise breaks the cement bond which holds the slug, sliding it to one side. Remove the speaker from the vise and pry out the slug. Never drive out the slug with a hammer as you may weaken the magnetism.



Small Boat Electronics



HOW TO INSTALL:

Marine Radiotelephone
Citizens Band Gear
Echo Sounders
Radio Direction Finders
Build-It-Yourself Antennas
plus **Manufacturers Listing**

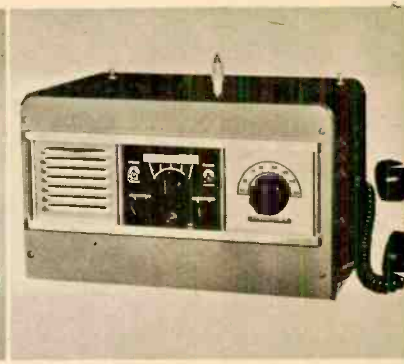
TODAY even the owner of a diminutive dinghy can avoid sailing into trouble by having a properly installed radiotelephone, a direction finder, and an echo sounder. And while these instruments once cost a fortune to own and took a crew of technicians to hook up, today you can painlessly do it yourself. This is not to say that you just tote the equipment on board, lay it down, and immediately a pink cloud of safety surrounds your boat. Marine electronic equipment and installation technique is different from any other kind, and the wise boat owner will know what must be done in advance. This special section tells you exactly what to expect and how to handle and install the gear. First, let's see what gear is available and what it can do for you.

Marine Radiotelephone

This service was set up by the FCC for the exclusive use of boats. The frequencies are from 2-3 mc, with transmitters ranging 15 watts plate input and up. With a small boat rig, the "up" doesn't

Aerosonic 20-watt transistor Marine Band transceiver, $299.

Pearce Simpson Bimini has 30 watts for MB, also tunes BCB.



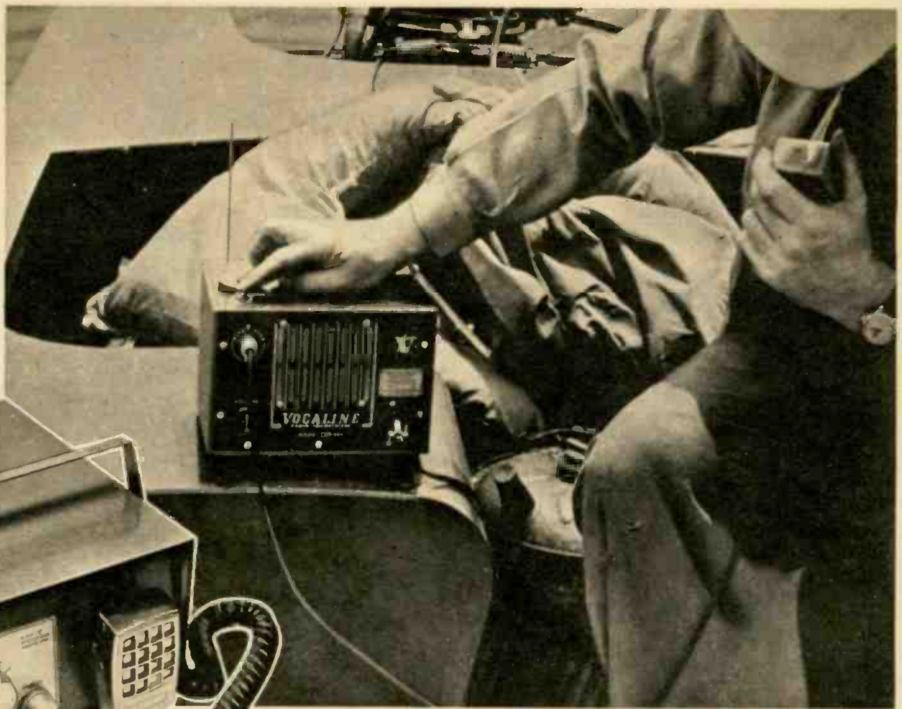
Ray Jefferson model 535 is 35 watts, 4 channels, $395.

go very far because battery power must be conserved; but even so, communication ranges of from 20 to 50 miles are common. In U. S. coastal and harbor waters, the Coast Guard, shore-telephone stations, and all ships, including Naval vessels, monitor the "calling and distress" frequency of 2.182 mc. In the larger ports you can connect to shore telephone lines through commercial stations at a cost of a little over $1 per call; and wherever there are similarly equipped boats, you can talk to them. Boats carrying over six paying passengers are required by law to carry a marine radiotelephone.

The equipment itself usually consists of a single small cabinet that houses a pre-tuned and crystal-controlled transmitter and receiver and a power supply. Vibrator power supplies, to step up the six or 12 volts from the boat battery are common, while some units use transistorized power supplies. To get the calling frequency, shore telephone stations, or other boats, you shift channels by flipping a channel switch on the panel; you talk through a hand mike, and listen to the loudspeaker. A push-to-talk switch controls transmission and reception. An efficient antenna and ground are necessary.

Citizens Radio

Suppose you do your boating on Pactola Lake in the Black Hills of South Dakota. Plenty of people do—and on other bodies of water not covered by the Marine Radiotelephone service. You don't have to be out of touch with other boats or the shore. This is one of the situations for which the Citizens Radio Service was intended. Practically everyone is familiar with the characteristics of these little "boxes" by now and the antenna systems that go with them. There is just one hitch: a single Citizens Radio transceiver is about as useless as a solid brass insulator. But if there are other similarly equipped boats around, or if you install another set in your home, or car, or on the dock, you can keep in touch as long as you stay within the roughly line-of-sight distance limits of from 10 to 20 miles or so. Like marine radiotelephones, Citizens radiotelephones require a six or 12 volt battery. Some of the less expensive types built basically for 110 volts AC operation also need a DC power pack.



CITIZENS BAND: Left, Multi-Products "Citi-fone" for popular Class D (5-watt limit), $134.50. Above: A Class B transceiver (465 mc) by Vocaline.

While there are 23 channels available for Citizens use, it is recommended that all pleasure boats reserve Citizens Band channel 13 (27.115 mc) to be sure of being able to contact other boats in range in an emergency.

Direction Finders

There are no signposts or paint stripes on waterways. You tell roughly where you are by guessing the bearings and distances of known objects and figuring your location in your head. Or you can do the job more precisely by measuring bearing angles with a sighting instrument and plotting the angles on a chart.

When landmarks are blotted out, the radio direction finder takes the place of the visual sighting instrument, aiming at radio stations whose positions are known. Just as with visual sighting, you can guess your position from the bearings or plot the bearing angles for a more accurate "fix."

A radio DF is simply a sensitive receiver equipped with a directional loop antenna and a bearing circle. Modern sets run from self-contained batteries and their loops are usually compact ferrite "sticks." There is no external wiring necessary, so installation is comparatively simple. However, there are some important qualifications, and it is necessary to calibrate the instrument to be sure of accuracy.

Echo Sounders

Sound travels at a constant speed through the water—4800′

per second. Measure the time it takes for a sound pulse to bounce off the bottom and you can compute the depth of the water. Early echo sounders worked exactly in that manner, with an electrical oscillator in the boat's hull and a sailor with a stopwatch listening through a headset.

The modern echo sounders measure the time and translate it into depth automatically. They consist of two units: the indicator (which generates sound pulses, detects their echos and indicates the depth on a dial) and; the transducer, which is a combination loudspeaker and microphone fastened to the bottom of the boat. The equipment can be run from the boat's engine battery or, in transistorized types, from self-contained batteries. Most inexpensive indicators have a revolving flashing light to show depth, but some have a voltmeter movement with the needle showing depth instead of voltage.

Radiotelephone and CB Installation

Proper placement is essential and the same principles apply in both marine band and Citizens radio stations. Pick a spot which is protected from rain and flying spray. In an open boat, or one with an exposed cockpit, this may call for building a cabinet or housing, or providing some form of watertight cover of wood, metal, or even waterproof canvas or plastic sheeting. Another way to lick the water problem is to mount the equipment inside the cabin or under a protective deck.

Heathkit DF-3 ($99.95) is 9-transistor radio direction finder kit for aeronautical, broadcast and marine bands.

Remember that the licensee of radiotelephone equipment is responsible for its operation. You should be able to lock up the cabinet or compartment in which the gear is housed to prevent pilferage and unauthorized persons from going on the air in your absence. Some units are designed for easy dismounting, so the equipment can be taken ashore when not in use.

Also, find a location at which the battery cables and antenna lead-in and ground wire will all be as short as possible. In case no one position will satisfy these requirements, favor the one that will keep the antenna and ground leads short. Then too, the farther away from the engine, which generates electrical interference, the better.

Still another factor is to keep the set (and this goes for any other equipment, such as receivers and direction finders that have loudspeakers) *at least three feet* from the boat's steering compass. The magnetism of the speaker will pull the com-

Sonar model DF-6X 3-band RDF, $249.50.

pass needle from its correct heading.

A boat is a bouncy thing. Through-bolt fastenings or husky screws are preferable, and they must be non-corrosive bronze, Monel, or Everdur. Anything inferior will break, rust out, or look like a junk-box job.

REMOTE CONTROL: If the best location for the phone proves to be so far from the helm that you cannot hear or talk over the set from that point when you are handling the boat, you can install a remote control. Manufacturers of some radiotelephones can supply these ready-made. Otherwise, you can hook one up yourself.

To be able to hear calls all you need is a remote speaker which can be wired across the voice coil of the speaker in the equipment. With a telephone having the push-to-talk switch on the microphone, wire the entire mike circuit to a three or four-terminal socket on the telephone panel and connect the microphone cord to a mating plug. Make up an "extension cable" with a plug and socket for the microphone connectors and run it from the equipment to your helm. Then, if you wish to talk from the equipment position, just plug the mike into the panel. To talk from the helm, remove the mike from the panel socket, plug in the extension cord, then connect the mike to the helm end of the extension.

Munston "Bay Shore" RDF has BFO. $230.

POWER WIRING: If there should miraculously be an outlet on your boat, you can bet your favorite tooth that the feed wire is too light. On shore, a #14 wire will take care of most equipment, but on a boat, radiotelephone efficiency may require cable of 10, 8, or 6 gage, and there are cases where wire the size of automobile-starter cable should be used.

The proper cable size will be specified in the equipment instruction book. It depends upon the battery voltage and the length of the cable run. In measuring your cable run, be generous, allowing plenty for corners and for a little slack at the ends. And it is a good idea to use wire a little heavier than called for: voltage drop in battery cables will rob a transmitter of considerable power.

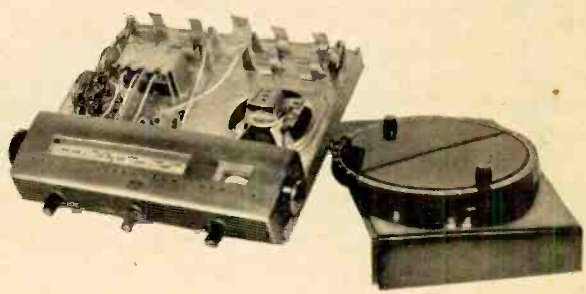
Run the cables in the most protected route possible, keeping them well out of the bilge or positions where they will be exposed to moisture or abrasion. Use plastic clips and non-ferrous screws

Allen-Bradford DF-O-Matic ($299) is portable.

to hold them in place—*never staples.* Use terminals on all cable ends. The crimp type are easy to apply. Tape the shanks and the end of the insulation with black plastic tape.

Some outboard motors have terminal boxes for the connection of external equipment. If the motor is not so equipped, and in the case of inboard engines, find the point where the main battery cables connect to the motor. One will usually be fastened under a bolt into the engine block or head; while the other connects to a heavy terminal on the starter solenoid. Connect the cables to these points. If this is not possible, connect your cables to the battery terminal bolts. This, however, is the least desirable point of connection.

Mark the cables on both ends as to their polarity, and observe the manufacturer's instructions regarding the ground polarity. Most equipment today is set up for a *negatively* grounded system. However, there are engines which have a positive ground, and in this case you may have to make some special provision. If you have any doubts about your boat's electrical system ground polarity, set a voltmeter for the 50-100 range (to protect the meter) and hold the negative probe at a grounded point (the engine head or block) and touch the positive probe to the hot lead of your battery. If the meter reads forward, the system is negatively grounded. If it reads backward, it is positively grounded.



Sperry RDF ($249) has 9 transistors.

Some telephones have a short length of battery cable attached to the set. Cut this cable to give plenty of slack to allow removal of the equipment for service, then splice it to the main cable using terminals and nuts and bolts, heavily taped for insulation. Or you can use a two-terminal junction board or electrical box available from an electrical supply store. If there is no "pigtail cable," connect the power leads directly to the equipment input terminals.

If you wish, you can fuse the power circuit. Install a single-fuse box at the engine end of the cable, using a fuse of about twice the amperage of the equipment current consumption. Connect a fuse in the "hot" line only—never in the lead which is attached to the ground or engine-block side of the battery circuit.

ANTENNA INSTALLATION: A proper antenna system is the

Depth indicator should be near helm in shade. Transistorized unit is Raytheon DE-708 ($125).

most important single part of a radiotelephone installation, especially in the case of 2-3 mc marine equipment. This is because the allowable length of antenna a small boat can carry is such a small fraction of a wavelength that radiation resistance is very low—less than one ohm for the shorter antennas. Loss resistance must therefore be kept as low as possible, or the percentage of transmitter power radiated will be very small. Loss resistance is caused by "leaky" insulation, long and meandering lead-in wires, wire of too small gage, nearby metallic objects or wires which soak up power, and ground resistance.

Place your antenna as high as possible and where it will not be grabbed by passengers, or brush against objects when the boat is at a dock. With antennas that are supported by a base-mounting insulator, a good site is in the center of the deck forward of the windshield, or on the cabin roof. Otherwise, stand-off insulators are used to secure the antenna to the side of the windshield or cabin structure. If the boat has a mast of some kind, side-mounting insulators can be used to secure the antenna to the mast.

One of the difficulties in marine installations is that there are so many curved and offset surfaces on a boat. It is often necessary to cut mounting blocks or pads of wood to give a flat surface on which equipment can be secured. The best material for this purpose is mahogany because it is close-grained, knot-free, easy to work, and it has good weather resistance. In fastening hardware of any kind to the outside surfaces of a boat, always use a plastic *bedding compound* underneath and around the screw or bolt heads. Otherwise, water may get beneath the fitting, leak through to the inside of the boat and rot the wood.

The lead-in should be heavy, plastic-insulated wire, routed as far as possible from metal railings, trim, or electrical wiring. With a low-power transmitter and heavily insulated wire, it may go into the boat through a tight-fitting hole and sealed with bedding compound. A better method of entry is to use a glass or ceramic feed-through insulator. Smear the inside of the hole with white lead or other sealer and make sure that the conducting bolt does not touch the wood.

Inside the boat, the wire should be mounted so it does not flop around. A

Bendix DR-19 depth recorder for small craft gives constant record of bottom and fish.

W. O. White echo sounder, transducer—$155

poor lead-in will affect the antenna tuning and the power output. Fasten the wire down with plastic clips or small ceramic stand-off insulators.

HOME-BREW ANTENNA: There are "package" radiotelephones that come complete with antenna and hardware. You can also make your own and obtain excellent performance.

A very effective antenna can be constructed of thin-wall aluminum tubing made of two sections: one, 1" diameter, the other, ½" diameter, both 6' long. Get a piece of 1" bakelite rod 1" long. Bore a ½" hole 2" deep in one end and have the other end machined or filed down so it is a press-fit inside the 1" tubing for a distance of 2". Assemble the aluminum tubing and the bakelite rod and secure with through bolts. One caution: glue a plug in the top of the upper tubing—otherwise it will fill with rainwater and soak the bakelite insulator.

Now, you can either wrap the rod with plastic-insulated wire of at least 18 gage, or mount a pre-wound commercial coil to the through bolts, connecting the coil ends to the tubings. The resonant frequency of this coil-loaded antenna should be higher than the highest frequency on which the telephone is to be operated. This can be measured with an antenna bridge.

A simple method of antenna mounting is to use ceramic feed-through insulators secured to the side of the windshield or cabin and bolted to the bottom of the 1" aluminum tubing. One of them can be used for the antenna lead-in connection.

GROUND CONNECTION: A marine radiotelephone will work, after a fashion, with just the engine for a ground connection. However, efficiency rises as the area of the ground connection in contact with the water is increased. For this reason, a radiotelephone performs at its maximum on a boat with a metal hull. The telephone ground terminal is simply connected to some convenient point of the hull structure. Next best is a copper sheet (such as flashing copper obtainable from plumbers or the hardware store) secured to the bottom of the hull by a generous number of "marine metal" screws. The *ground plate* can be any convenient shape, shaped to the hull lines and preferably

Heathkit DS-1 ($69.95) depth sounder is completely transistorized. Note light spot reading.

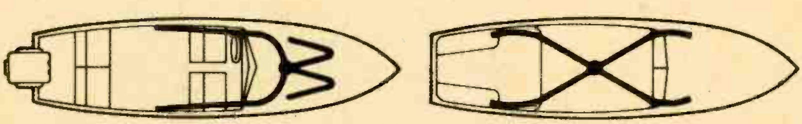
Radiotelephone goes aboard *Short Wave* on calm day. Careful work requires steady platform. Companionway location is protected, convenient to helm. Right, power cables are connected to starter solenoid "hot" terminal, engine block. Be wary—fireworks if you ground wrench while on hot terminal.

located immediately under the equipment. Install a ¼" bronze bolt through the plate and hull, liberally calked with compound and supplied with a large washer inside for connection to the phone ground wire. Use a torch to solder the bolt head to the copper sheet. Use ground wire of the same gage as your power wiring, route it as directly as possible, and fasten it securely.

On many boats a ground plate is impracticable. In this event, bond all of the metal inside the boat, such as piping and tanks, to the engine to increase the ground area through capacitance. Your capacitance ground can be augmented by placing copper screening or a network of heavy wires in the bottom of the boat and connecting it to the engine.

(NOTE: Several manufacturers produce special ground plates or discs composed of porous metal which can be installed on the bottom or transom of a small boat.)

TUNING: "Package" radiotelephones require little or no tuning upon installation. For any necessary touch-up in antenna tuning, there are controls on the panel. Indicator lamps are provided to show when tuning is at peak. A good way to keep tab on your transmitter tuning and output is to connect an antenna-current meter in series with the lead-in. Use a one-ampere RF ammeter. (The RF transformer, thermocouple and meter found in surplus command set antenna boxes will also work.) If your meter goes off-scale (miraculous!) shunt it with a loop of wire, shortening the loop as required to bring the reading down to a safe value.



Antenna mounting on foredeck of runabout (left) and on top of cabin boat (right). Ground plane can be added at the base of CB antenna.

You can also make a relative output indicator from a 1N21 or similar diode and a 1-mil meter movement. Just connect the diode with the meter in parallel (watch the polarity) across a short section of the antenna lead-in wire. Start out with the diode shunting the minimum length of lead-in, then increase the length until a satisfactory reading is obtained. This will tell nothing about the actual output, but it will show from time to time if the transmitter is "up to snuff," and it makes a convenient tuning indicator.

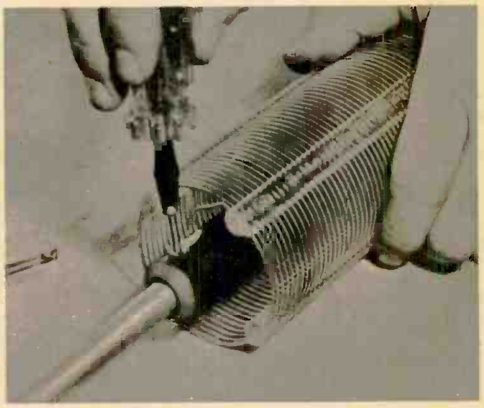
Before the equipment is put on the air, a licensed radiotelephone technician must check the frequency and adjustment of the transmitter and enter this information in your station log.

Citizens Band Antennas

The main difference between Citizens Band and Marine Band radiotelephone installation is in the antenna. A number of manu-

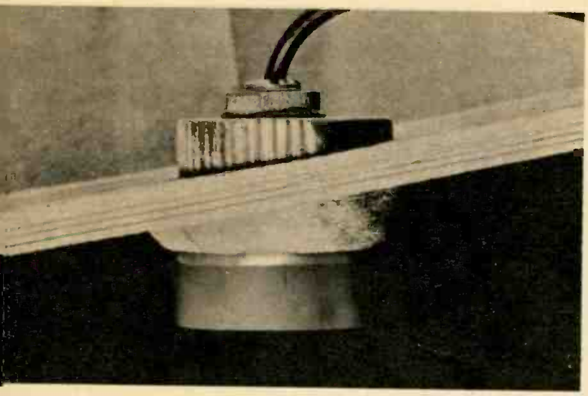
Mahogany block fitted for curved deck will level antenna mount. Make hole for lead-in wire and seal. Use nonferrous hardware.

Make antenna with aluminum tubing, bakelite rod for center insulator and loading coil. Use thru-bolts as shown. Coil is 2¾", 8 turns/inch.

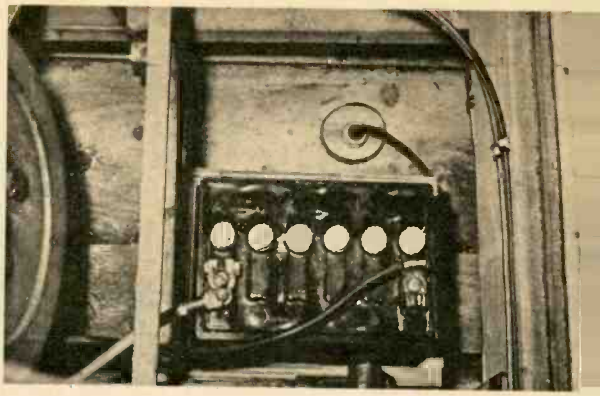


"Home brew" antenna may be secured to a base mounting insulator. Center-loading coil increases the efficiency of a short antenna.

You can bolt ceramic feed-through insulators to windshield frame or cabin side for antenna supports. Bottom feed-through serves lead-in.



This is the way levelling blocks are used to secure transducer to sloping bottom of boat.



Use bedding compound on top and bottom of transducer mount. Route cable out of bilge.

factured antennas are available at a reasonable price. However, you can make your own. Use a length of aluminum ½" tubing mounted on stand-off or feed-through insulators. The tubing *plus the lead-in* should total exactly 9 feet. The ground lead should be heavy, short and direct.

If a short ground lead cannot be realized, use a tubing 9' long and, at the antenna base, mount a ground screen of copper (one or two-feet square), and connect four ground-plane wires 9' long. These can be stretched out under the cabin roof or deck and folded back on themselves if necessary. Connect the antenna to the telephone with the type of coaxial cable recommended by the equipment manufacturer.

Vehicular antennas have a tendency to corrode when they are on salt water, therefore go over the antenna with a plastic spray.

Direction Finder Installation

Since the usual small boat DF is essentially a battery-operated radio receiver, installation is not complicated, although caution should be observed with regard to protecting the equipment and securing it solidly in place. Accuracy depends upon an undistorted radio field; therefore, keep the loop well away from wiring, window screens, railings, or other metal objects.

The spot on which the DF is mounted should be level. If it is slanted one way or the other, bearing accuracy will be affected. If necessary, use a levelling block, or shim up the mounting shelf.

Next, accurately orient the DF so it is squared-off with the keel line of the boat, or else there will be a constant error in all bearings.

To insure accuracy (and also to gain practice and confidence in the instrument) it should be calibrated after installation. This simply means that you check radio bearings of a transmitter tower against visual bearings. For this operation, it is best, where possible, to bring the boat to within sight of a radio transmitting station.

Holding the boat accurately on course and heading directly for the station, tune in your signal and get a bearing on it by listening for the null or watching the swing on the meter. Then immediately sight over the loop and note if the transmitting tower is exactly in visual line with it. If not, turn the loop until it is and note the number of degrees difference, plus or minus, between the radio and the visual bearings. This is the amount of your deviation on this heading, and it must be algebraically subtracted from any subsequent radio bearing in this direction to obtain the correct angle.

There are several methods of recording deviations and the corresponding correction, but the simplest system is just to use a china marking pencil and to mark the error on the DF cabinet close to the bearing scale.

Now, steer the boat on another course 15° or 20° higher and "take another cut" on the station, again marking down any deviation found. Go all the way around the compass in this fashion. With this system, any time you take a radio bearing, the amount of correction to be applied is directly in front of your nose.

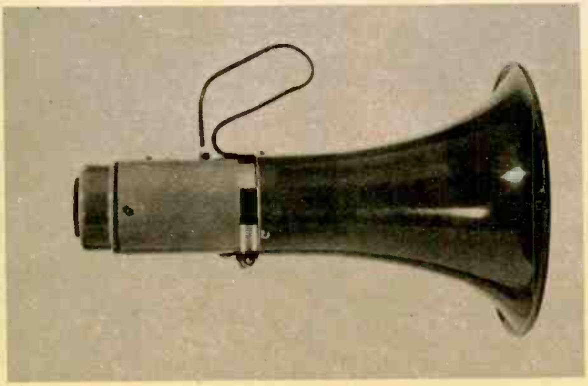
Echo Sounder Installation

The indicator should be in sight of the steering wheel and close enough for good visibility. At the same time, it should be kept away from the compass because of the magnet in the sounder motor (or meter). It is a good idea to mount flashing-light indicators where they will not be exposed to direct sunlight (which makes them hard to read). A dimly lit cubbyhole alongside the helm might be ideal.

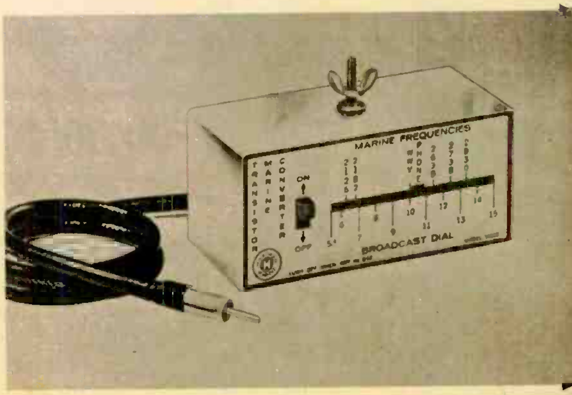
Electric-current requirements of modern echo sounders are small. Even so, when installing the type that is operated from the boat's battery, it is not a good idea to tap into some nearby circuit (as for the lights or horn), but rather route a separate pair of wires to the power connection at the engine. This will prevent possible overloading and fluctuating voltage as other items on the shared circuit are turned on and off. As a general rule, electronic equipment circuits should be kept separate from all others.

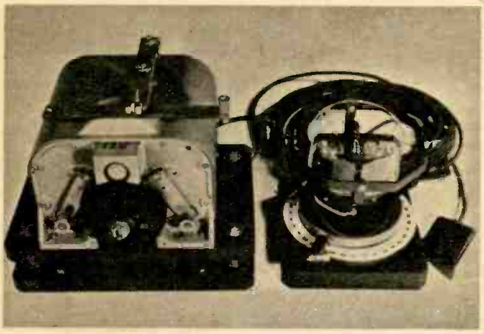
The location for the transducer should be carefully chosen because the range and the accuracy of the instrument depends upon it. Some compromise may be necessary, and here are the points to keep in mind:

Transistor megaphone (3¼ lbs.) is $45 from Guest Corp., 35-04 30th St., L. I. C., New York.



Marine frequency converter ($19.95) by Hartman makes car radio into 2-3 mc receiver.





Here is automatic pilot for small craft by Hill Cunningham (about $400 with remote control).

First of all, the transducer must be installed with the face perfectly horizontal or the sound beam will be projected downward at an angle and the echo may miss the boat completely. This calls for levelling blocks to compensate for the curve or *deadrise* (V-shape) of the hull. The outside block should be streamlined to create the least turbulence. A badly shaped block can affect high-speed boat performance.

To prevent leaks, the transducer and the blocks should be bedded in a good grade of marine bedding compound. The inside block should also be bedded down, as well as the nut and washer on the transducer through-hull tube.

The location should be far enough aft that the transducer will always be in the water. Placed close to the bow it might come out of the water, or miss soundings due to air sweeping under the hull.

On the other hand, it should be kept away from the propeller because of the possibility of noise interference. Be certain that the point chosen will be well clear of cradle members or the trailer bed when the boat is hauled ashore. Also keep it away from other through-hull fittings that might cause turbulence.

The wooden block should be painted with bottom paint, but the face of the transducer should be kept clean. Before the boat is launched, wipe off the transducer with detergent. This will remove air bubbles underwater and hasten complete wetting of the face, necessary for sound transmission.

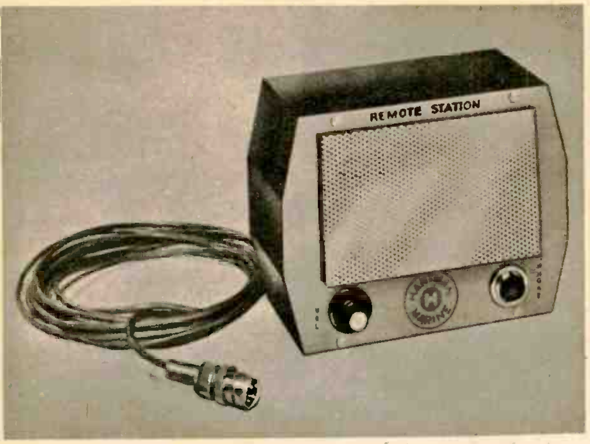
Clip the transducer cable up under deck beams to keep it out of the bilge and coil up and secure any excess cable. The capacitance of this cable has been figured in the design of the equipment, so none of it should be cut off.

Electrical Noise Suppression

To obtain true satisfaction in the operation of your radiotelephone and direction finder, it will be necessary to work on electrical noise suppression. Obtain the type of resistor spark plugs recommended for your engine, or if these are not available, use external suppressors in the cable at each spark plug. A suppressor can also be connected in the ignition lead at the spark coil.

Connect a 1 mfd generator capacitor from the generator ground to the armature terminal (the heavy one). Ground capacitors should also

Transistor power inverter by RCA (DC-AC) for shipboard use of TV, power tools, etc.



Hartman Marine's remote station for topside extension of master radiotelephone is $29.95.

be connected to the engine end of the wire which goes to the ignition key on the control panel, and across the "battery" terminals on the voltage regulator—the case to negative and the pigtail to the positive terminal.

Outboard motors equipped with alternator/rectifier battery chargers should have .5 mfd coaxial feed-through capacitors installed in the leads from the alternator under the flywheel to the rectifier. The capacitor bodies should be bolted to the motor frame.

The metal covers of outboard motors will help shield the noise, providing you bond the cover to the engine block with heavy pieces of flexible wire. There are also metal shielding covers available for inboard motors and these must be connected solidly to the engine for maximum noise reduction.

If your boat has electric windshield wipers, put noise filter capacitors across their terminals. Otherwise, they might drown out reception just when you need it the most.

Unless you are lucky, complete noise elimination may be impossible to achieve. This is the nature of the beast. All you can do is to slow down (which reduces noise) when communications are desired. And with suppressors or resistor spark plugs, you may find some lessening of engine performance at different speeds. If there should be some difference, this is the price of quiet reception.

Licenses are required for radio transmitting stations, both in the Marine Band and the Citizens Band. For the Citizens Band the station license only is required; however, for the marine radiotelephone service, both a station license and a Third Class Radiotelephone Operator's Permit must be obtained. Forms for all of these may be obtained from the Federal Communications Commission, Washington 25, D.C., local FCC field offices, or from the dealer from whom you bought your equipment. No examinations are required for an operator's permit but age and citizenship requirements must be met.

The best in electronics won't replace you, the skipper, but will enhance your boating fun and safety.

SEE MARINE DIRECTORY NEXT PAGE

A complete radar system for the small boat is offered by Raytheon for $2195. Range is 12 mi.

ELECTRONIC GEAR FOR THE SMALL BOAT

This chart tells you where to get more information. It does not list every type of product handled by a given company, and readers are reminded that manufacturers make frequent additions and deletions to their product lines. When writing for information, it is a good idea to specify the size of your boat. Many of these companies market large boat and ship installations, and you certainly don't need literature on a large sonar installation if you have a rowboat that only can handle a small transistorized fish finder. The makers of accessories such as power megaphones and battery packs are so numerous that space precludes our listing them here. Incidentally, fish finders and depth indicators are lumped under "Echo Sounders."

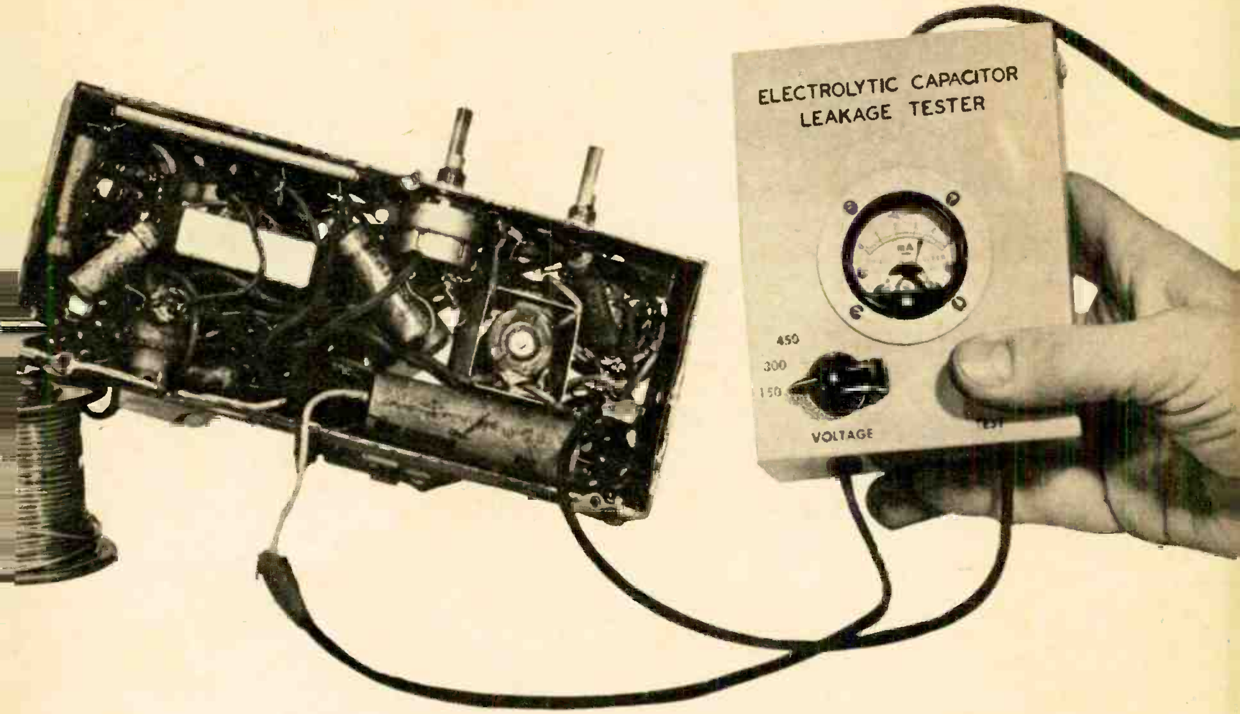
PRODUCTS / COMPANY	MARINE BAND	CITIZENS BAND	DIRECTION FINDERS	ECHO SOUNDERS	MARINE ANTENNAS	AUTOMATIC PILOTS
Aerosonic Marine, Inc. 1212 Hercules Rd. Clearwater, Fla.	✓		✓	✓	✓	
Acton Laboratories Acton, Mass.		✓				
Allen-Bradford, Inc. 3181 N. Elston Ave. Chicago 47, Ill.			✓			
Allied Radio 100 N. Western Ave. Chicago 80, Ill.		✓				
Apelco Sales Corp. 213 E. Grand Ave. So. San Francisco, Calif.	✓		✓	✓	✓	✓
Bendix-Pacific 8211 Lankershim Blvd. North Hollywood, Calif.	✓		✓	✓		✓
Edo Corp. 13-10 111th St. College Point, N. Y.			✓	✓		
Electro-Voice Cecil & Carol Sts. Buchanan, Mich.		✓				
Era Dynamics, Inc. 67 Factory Pl. Cedar Grove, N. J.	✓			✓	✓	
Globe Electronics, Inc. 3417 W. Broadway Council Bluffs, Iowa		✓				
Gonset 801 S. Main St. Burbank, Calif.		✓				
Hallicrafters Co. 4401 W. 5th Ave. Chicago, Ill.		✓				
Hartman Marine Equip. Co. 30-30 Northern Blvd. Long Island City 1, N. Y.	✓		✓	✓	✓	
Heath Co. Benton Harbor, Mich.		✓	✓			
Hill Cunningham Autopilot Co. P.O. Box 8593 Fort Lauderdale, Fla.						✓
Ray Jefferson, Inc. 40 E. Merrick Rd. Freeport, N. Y.	✓	✓			✓	
Kaar Engineering Corp. 2995 Middlefield Rd. Palo Alto, Calif.	✓		✓			

PRODUCTS / COMPANY	MARINE BAND	CITIZENS BAND	DIRECTION FINDERS	ECHO SOUNDERS	MARINE ANTENNAS	AUTOMATIC PILOTS
Multi-Products Co. 21470 Coolidge Hwy. Oak Park 37, Mich.		✓		✓		
Munston Mfg. & Svc., Inc. Beech Street Islip, N. Y.	✓		✓	✓		
N. Y. Marine Radio, Inc. 501 Fifth Ave. New York 17, N. Y.	✓		✓	✓	✓	
Pearce, Simpson, Inc. 2295 NW 14th St. Miami 35, Fla.	✓	✓		✓	✓	
Philmore Mfg., Co., Inc. 130-01 Jamaica Ave. Richmond Hill, N. Y.		✓				
Raytheon Mfg. Co. 101 River St. Waltham 54, Mass.	✓		✓	✓	✓	
RCA Radiomarine Products Front & Cooper Sts. Camden, N. J.	✓	✓	✓	✓	✓	
Regency 7900 Pendleton Pike Indianapolis 26, Ind.		✓				
Rowe Industries 1702 Wayne St. Toledo 9, Ohio					✓	
Sonar Radio Corp. 3050 W. 21st St. Brooklyn 24, N. Y.	✓		✓	✓	✓	
Sperry Piedmont Co. Rt. 29 Hydraulic Rd. Charlottesville, Va.	✓		✓	✓	✓	✓
Stickell Marine Products 1616 Mt. Royal Ave. Baltimore 17, Md.			✓	✓		
Tivoli Radio & Marine Co. 414 City Island Ave. New York 64, N. Y.			✓	✓	✓	
Vocaline Co. of America Coulter St. Old Saybrook, Conn.	✓	✓				
Wilfrid O. White, Inc. 40 Water St. New York 4, N. Y.				✓		✓
Winston Electronics Div. Jetronics Industries, Inc. 4000 NW 28th Miami 42, Fla.				✓		

Electrolytic Capacitor Checker

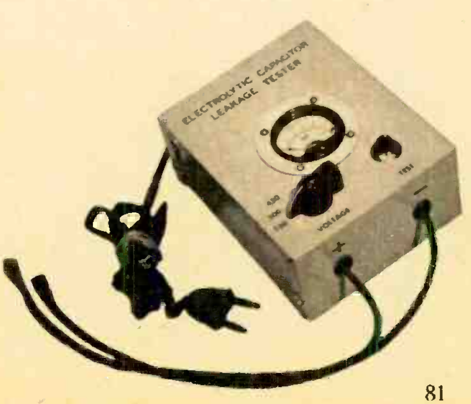
Metered unit provides direct leakage reading

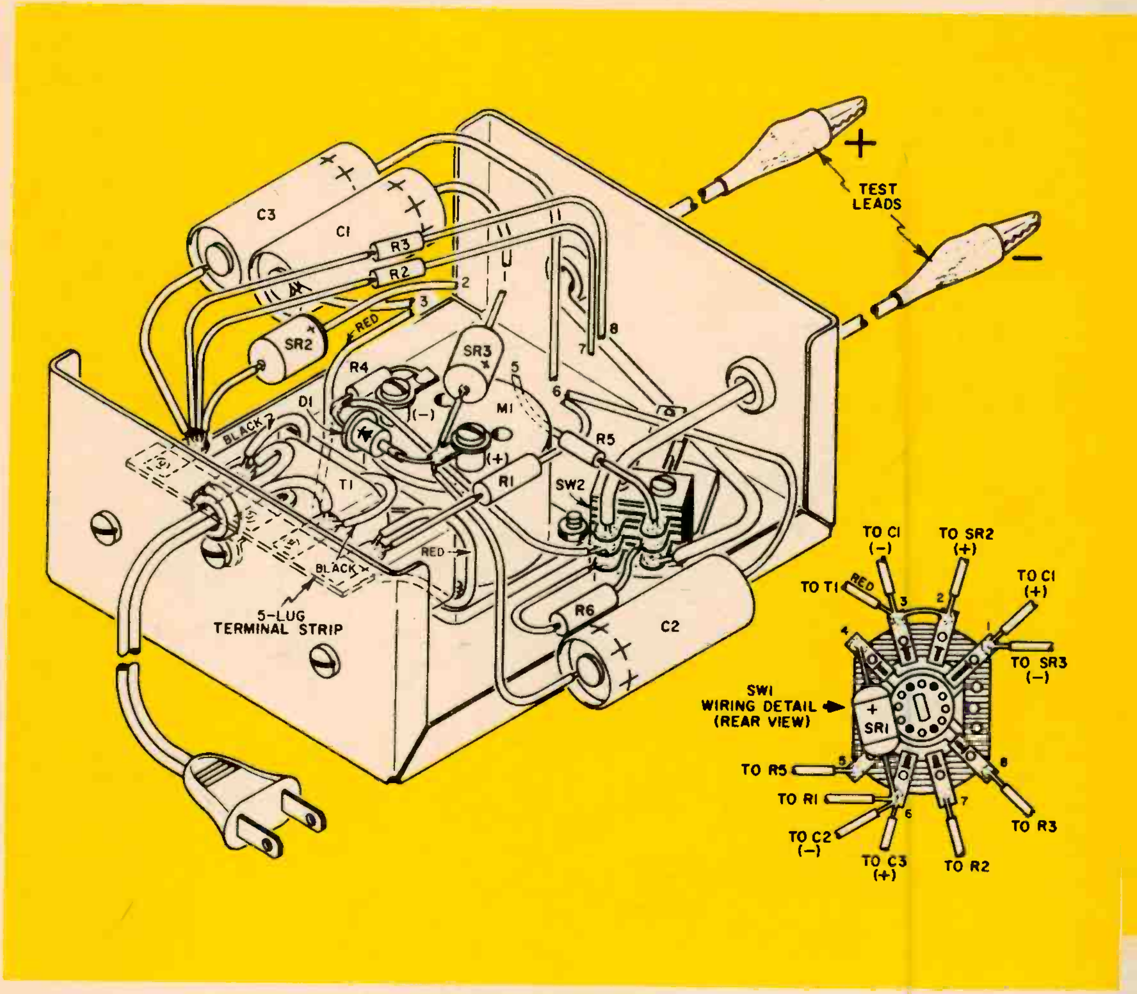
By R. L. Winklepleck

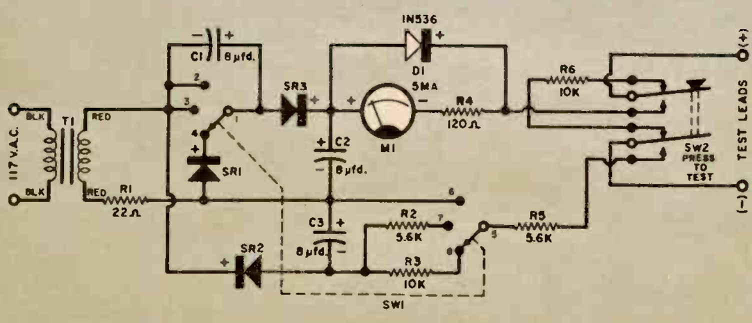


FOR the service technician or part-time troubleshooter, leaky electrolytics can be a headache. They frequently turn a simple repair job into a dog because they are usually located only by substitution which most of us consider absolutely the last resort.

The symptoms of leaky electrolytics are legion. It's a lucky day when it shows up as hum in the audio—even though this indication can be caused by many defects. But when we get into low voltage, marginal performance, unstable sync, distorted sound, etc., then we have problems. A lot of substitutions may be required and there always seem to be a dozen leads hung on each terminal. The picture is made even more cloudy, especially in older re-







Switch SW1 above, has been lifted out of chassis for clarity. Numbered ends of wires match numbers at SW1 contacts. Observe polarities of the electrolytic capacitors, silicon rectifiers (SR1, 2, 3) and silicon diode D1.

ceivers and amplifiers, when not one but several bad capacitors contribute, en masse, to the problem.

Note that it's seldom that we're interested in the exact value of an electrolytic since they normally have wide tolerances. The much-used ohmmeter test for leakage is extremely deceptive. Not only is the applied voltage too low to "reform" the electrolyte (in which case the presence or absence of leakage is almost meaningless) but it doesn't test for high voltage breakdown, a rather frequent cause of trouble.

Principle Of Operation

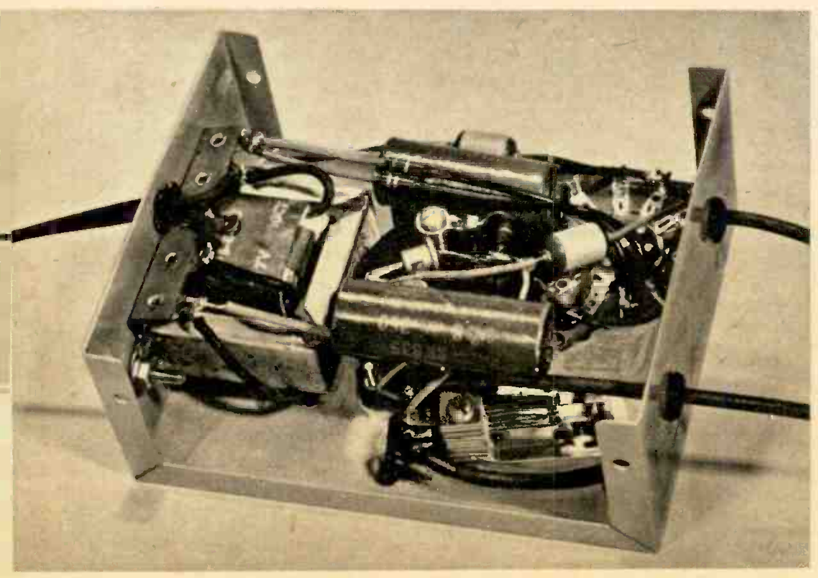
Here is a compact and inexpensive addition to your test equipment designed specifically to locate opens, shorts and leakage in electrolytic capacitors. It's simple to build, easy to use and should cost about ten dollars if all the components are purchased new. A quick look at the schematic shows that it's merely a three-level polarizing voltage supply with a milliammeter in the test capacitor circuit to indicate the presence and amount of current flow or leakage.

A transformer (T1) is provided for power line isolation. Three silicon rectifiers (SR1, SR2, SR3) and three capacitors (C1, C2, S3) can be switched by SW1 in a rather unique arrangement to provide an output of 150 volts through a half-wave rectifier, 300 volts via a doubler and 450 volts from a tripler circuit. Resistor R1 reduces current surges which might damage the rectifiers. R2, R3 and R5, placed alternately in the circuit by SW1, levels the current flow for the three voltages.

Current through the capacitor under test is limited to 12-15 milliamperes even if shorted. The maximum current *through the meter,* however, is held to approximately five milliamperes by the silicon diode-resistor network across the meter (D1, R4). The non-linear conduction characteristic of the diode permits the meter to accurately record the

PARTS LIST

Resistors
20%, 1/2-watt unless otherwise noted
R1—22 ohm, 1 watt
R2, R5—5,600 ohms
R3—10,000 ohms
R4—120 ohms
R6—10,000 ohms, 1 watt
C1,C3—8 mfd, 250 volt electrolytic capacitor
C2—8 mfd, 350 volt electrolytic capacitor
SR1,2,3—silicon rectifiers (Sarkes-Tarzian K-200 or the equiv.)
D1—silicon diode (1N536)
T1—power transformer, 117 V primary; 125 V secondary (Stancor PS-8415 or equiv.)
M1—0-5 milliammeter (Lafayette TM-401) or any 0-5 ma. miniature panel meter
SW1—DP 3-position rotary switch (Centralab 1472 or equiv.)
SW2—DPDT pushbutton switch (Switchcraft 1006 or equiv.)
Case-aluminum 5"x4"x3" (Minibox CU-3005A)



Completed unit with cover removed. Component placement isn't critical and parts may be arranged to suit the dimensions of the cabinet.

current flow to a bit over 4 ma and, very abruptly, additional current is routed through the diode. This meter protection circuit, which has many applications, is fully explained in the March, 1959, issue of *Electronics Illustrated.* SW2 discharges the capacitor being tested through R6 at the conclusion of the test. When testing large high voltage capacitors, pause a moment for this energy to be discharged before grasping the leads.

Construction

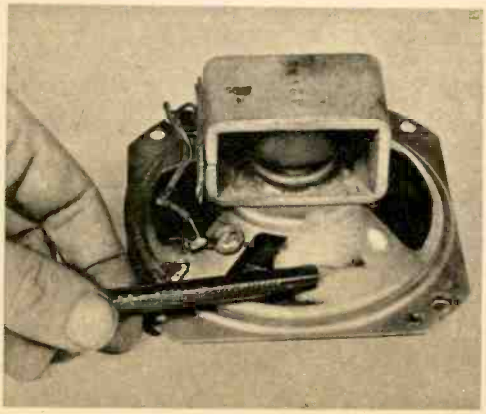
The choice of component values is subject to considerable leeway and many usable parts are probably on hand. The physical arrangement is completely non-critical and the unit may take any convenient form. The one illustrated was built into a 5"x4"x3" miniature cabinet and it could be even smaller with more efficient utilization of the space. Since significant voltages are present, use spaghetti on bare leads and make no connections directly to the metal cabinet. The test leads are terminated in insulated, color-coded alligator clips to indicate polarity—a very important item.

Open circuit voltages for the three positions of SW1 will be appreciably higher than the indicated 150-300-450. When a capacitor is connected, however, the voltage will fall to approximately the marked values.

Using The Leakage Tester

To test a capacitor in circuit it's usually necessary to disconnect one lead from the circuit to secure an accurate indication. Connect the test leads carefully, observing correct polarity, and push the test button (SW2). If the capacitor is open—the meter needle will not move; if shorted or leaking excessively, the needle will swing clear over and stay there. Thanks to the protective circuit the meter will not be harmed. If, however, the capacitor is good the needle will swing over and then gradually drop back as the electrolyte reforms and the capacitor charges. All electrolytics will have a certain amount of leakage. Some [*Continued on page* 108]

Small Speaker Repairs



IF a rattle or buzz in your AC-DC radio has been traced to an off-center voice coil in the speaker, it's a good idea to try a few repair tricks before replacing the speaker. Make sure that the buzz is not caused by the flexible wire voice coil leads resting against the speaker cone. Check to see if foreign materials may have lodged either in the voice coil gap or behind the speaker cone in the area around the corrugated voice coil centering support (spider). Try cleaning out the voice coil gap with a piece of Scotch tape.

If none of the above proves helpful, then it may be a straight case of voice coil rubbing due to a slight warp in the speaker frame or voice coil itself. In that case, try applying pressure from the rear of the cone with your fingers on one side or the other while the speaker is playing. Frequently you will find that the buzz can be eliminated with very little loss of quality. It then becomes a simple matter to stuff a small wad of cotton in between the speaker frame and cone at the point where the finger pressure cleared up the trouble. Do not put in so much cotton that the cone is excessively deformed.—*Dave Gordon*

Hi-Fi Clinic

Hi-Fi questions are all answered by mail. If of general interest they will appear in this column.

Output Tube Hum

I own a kit-built 20 watt amplifier with push-pull 6L6's in its output. After working satisfactorily for about a year, a problem has developed. The output tubes glow blue and a hum comes through the speaker even when the volume control is turned down. I have changed the filter capacitors, but that did not help. How can I cure my problem?

H. Svensen
Madison, Wisconsin

You will find two kinds of blue glow in output tubes. Sometimes minerals in the glass envelope of the tube fluoresce under the impact of stray electrons. Very high power tubes will also have a barely visible blue haze in between the elements. However, it is a good bet that one or both of your 6L6's is gassy. Frequently tube checkers will not show this fault, and I would suggest that you try substituting a known good tube or tubes. You might also check to see whether these tubes are balanced. An ordinary tube tester should indicate the same approximate scale reading for both of your output tubes.

Series or Parallel Speakers

I intend to mount two full-range 8-ohm speakers in one cabinet. Should I parallel the connections for a total of 4 ohms or would it be best to connect the speakers in series and have a 16-ohm input impedance? My amplifier has both a 4-ohm and a 16-ohm output.

Michael Koleman
Binghamton, New York

In general, it's best to parallel the connections in a setup such as yours. Speakers connected in parallel tend to damp out each other's resonant points and produce a smoother over-all sound. Series connected speakers tend to emphasize resonant peaks. However, if the speakers are a little bit bass shy or your room acoustics are not all they could be, you may find that the bass boost obtained is desirable. I would suggest that you mount the speakers and run the leads from *both* outside the cabinet. Now you can place the cabinet in the desired position and try both series and parallel connections without having to unseal the cabinet to switch the connections of the wires.

Stereo Speaker Matching

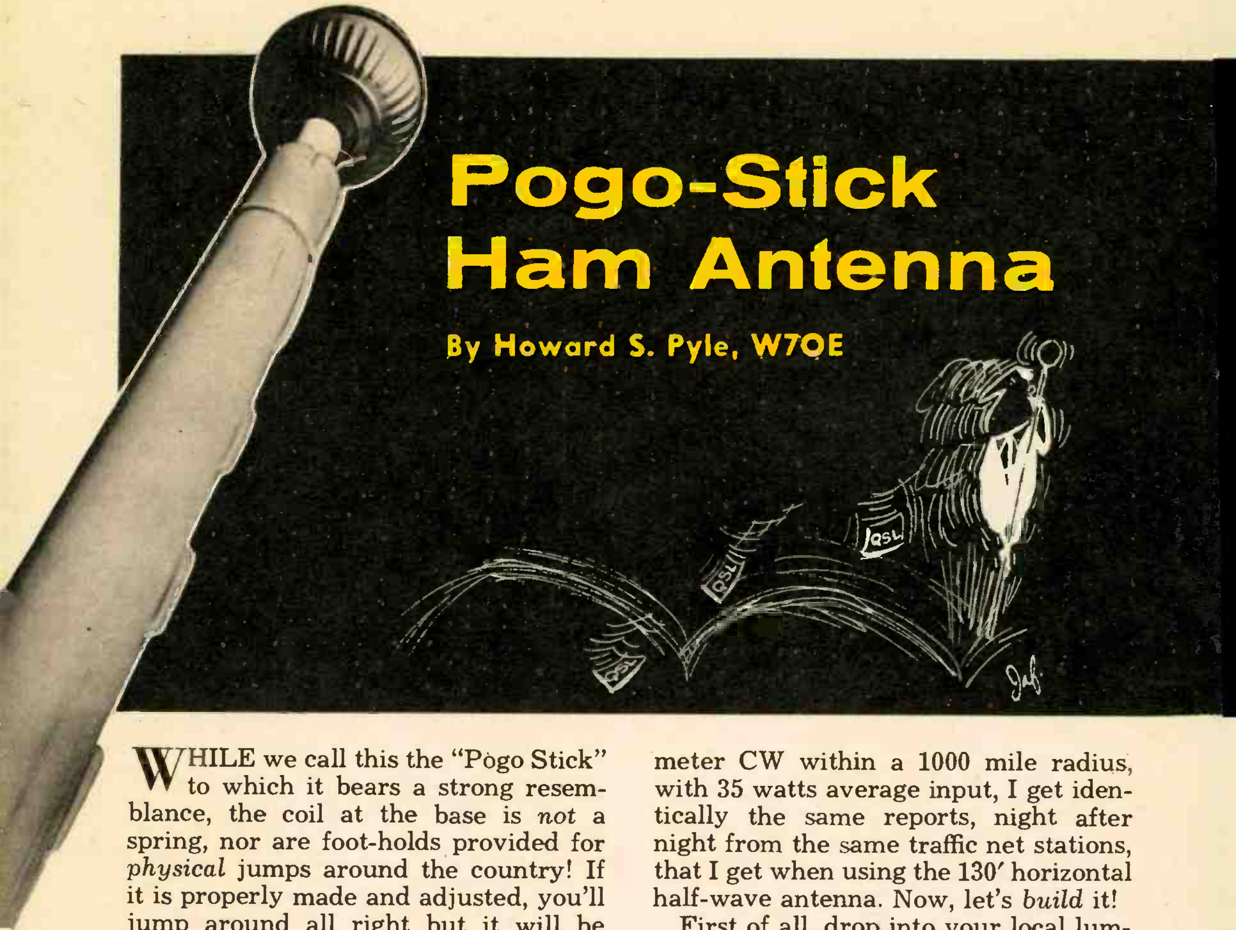
I have a large corner horn speaker system and wish to convert it to a stereo system. Space and expense problems make it impossible for me to duplicate my mono speaker. What would be the correct speaker to match it without detracting from the excellent sound I get from my present set-up?

Thomas W. Comstock
San Francisco, Calif.

In stereo, speakers should be matched. Naturally, the easiest way to accomplish this is to buy two identical systems. But when this isn't possible, they should be matched as to coloration; that is the frequency response and sound characteristics of the midrange and tweeters should be identical.

The reason for this is in the nature of stereo. The stereo effect largely resides in the mid and high frequencies. Therefore, if one speaker were to peak at 4,000 cps, and other at 5,500 cps, the sound would seem to jump from one speaker to another. If this drifting back and forth was not annoying to you, it would, at least, be very tiring after prolonged listening. You would tend to focus back and forth from speaker to speaker and succumb to listening fatigue.

It is impossible to suggest a speaker specifically for you. Try listening to other speakers as much and as carefully as possible.



Pogo-Stick Ham Antenna

By Howard S. Pyle, W7OE

WHILE we call this the "Pogo Stick" to which it bears a strong resemblance, the coil at the base is *not* a spring, nor are foot-holds provided for *physical* jumps around the country! If it is properly made and adjusted, you'll jump around all right but it will be through the medium of Hertzian wave radiation!

Much has been written and still appears, on the subject of "restricted space antennas." The apartment dweller, the owner of a small city lot and others who do not have room for a conventional half-wave horizontal wire antenna, face frustration. What to do? Vertical radiators of many types have been tried; some have been successful, others have been cast aside with disappointment.

We will not attempt to theorize on POGO's characteristics, preferring to leave that for the long-bearded gentry, but if you have need for a light weight, easily built and readily erected antenna for 20, 40 or 80 meters, for use at home in a restricted space area or, if you want something you can toss on top of your car and take with you on a Field Day jamboree, POGO is your answer! Maybe you can even hang up DX records on it; I don't know. Working on 80 meter CW within a 1000 mile radius, with 35 watts average input, I get identically the same reports, night after night from the same traffic net stations, that I get when using the 130′ horizontal half-wave antenna. Now, let's *build* it!

First of all, drop into your local lumber yard and pick up a 10′-12′ length of warp-free and knot-free 2″ x 2″. Then clamp the pole in a vise and draw a pencil line centered on one side down the entire pole. Make a pencil mark crossing this line three inches from the top, or what *will* be the top of your mast. Your 2″ x 2″, in finish grade lumber, will actually be 1⅝″ on each face. Now, for drill holes make pencil marks spaced every 1⅝″ until you are within a foot of the opposite end of the mast.

Drill a ⅛″ hole at every point where the pencil marks intersect for the length of the mast. Drill all the way through but be sure and hold the drill as nearly vertical as you can so that the holes come through on the opposite side in a reasonably straight line.

When you have finished drilling (I came up with 72 holes in a ten-foot length of wood mast), turn the mast 180 degrees and use a bit of sandpaper to smooth off any splintering which occurred where your drill broke through. (If you back up the mast with scrap lumber while drilling, splintering can be minimized.

Your last hole should be about a foot up from the bottom of the pole. If the lowest frequency you want to use will be in the 75/80 meter band, you'll need about 80 feet of wire on hand. Formulas for half-wave horizontal wire antennas are valueless here as you need appreciably less wire length to reach the half wave point. The wire we used was spun-glass insulated, stranded, size 18. Type "TW," No. 14, plastic covered, stranded house wire is also excellent, if you can get it; it's a bit on the rare side though. The *solid* No. 14 "TW" is readily available from any electrical dealer, but may be a little harder to weave through the holes in your mast. Again, let's not be fussy; use what you choose.

If you have a power driven table saw, you can cut two saw kerfs to a depth equal to the outside diameter of the wire you use for the full length of the mast, 180 degrees apart as shown in Fig. 2. This will enable you to flush the wire right into the pole and even fill in the kerf with a mastic compound before you paint it, if you want to go that far in an effort to convince the dubious landlord and the frowning neighbors that you are only a patriotic citizen who has erected a flagpole from which to fly the national emblem when the occasion warrants! If you can't manage a saw groove, don't worry about it.

Start one end of the wire through the last hole at the *bottom* of the mast. Pull enough wire through to insure reaching the other end with about a foot to spare, after weaving through the mast for its entire length. You can easily calculate

Fig. 1. Detail of Pogo's capacity ball at top of mast. Standoff insulator is porcelain type.

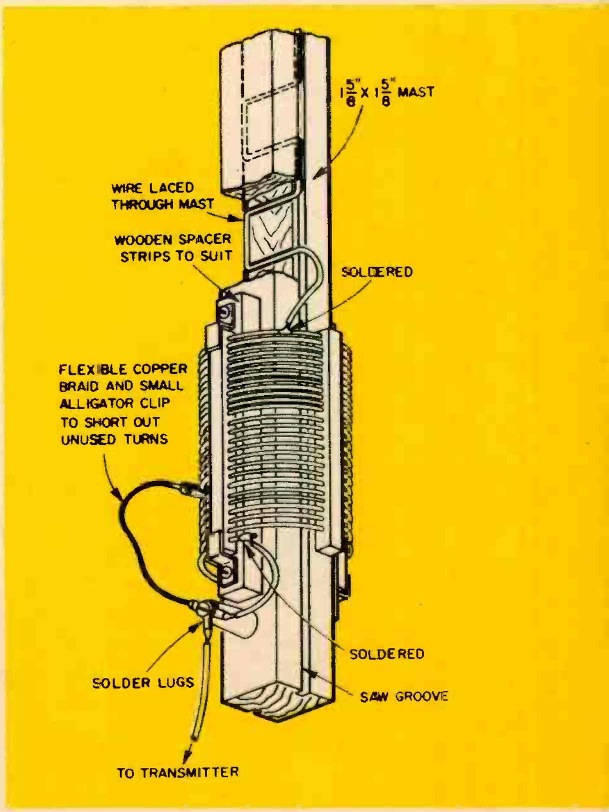


Fig. 2. Cutaway view of mast above loading coil shows lacing which goes up to top ball.

that; if you use a 1½″ thick pole, you'll need 4½″ of wire for each 1½″ you progress toward the top.

Now you have a 'laced' configuration through the entire length of your pole (less 3″ at the top and about a foot at the bottom). See Fig. 1. At the top end, mount a stand-off insulator on the *end* of the pole. A short, sturdy, porcelain glazed type was used. This was 2″ long and 1″ in diameter with a tapped hole in each end for a standard ¼ x 20 machine screw. A $\frac{3}{16}$″ hole drilled about 1½″ deep in the end of the mast, allowed a 2″ long brass machine screw (¼ x 20) with its head sawed off, to be self-threaded into the mast, leaving about a half inch protruding. Smear plenty of glue on the threads before screwing into the mast and the screw will stay put. Now, the copper toilet float ball (standard thread for these is also ¼ x 20) is screwed on to the protruding screw after slipping a suitably sized solder lug over the threads, and then the ball is drawn up tight. Solder the top end of the wire which you laced through the pole to the lug under the ball and then move to the other end of the mast. Mount coil about 1′ from the bottom. See Fig. 2.

Actually, that's all there is to it. Many refinements will no doubt occur to you as you progress. Paint the copper ball with gilt or aluminum paint if you like; leave it natural copper or make it red, white and blue to suit your fancy! The entire mast itself should receive a coat of clear shellac followed by two coats of spar varnish or, if you prefer, exterior paint of any color of your choice. Just be sure that you use a *rubber* base or similar non-metallic paint on the mast. Lead base paints *could* foul up the radiation pattern!

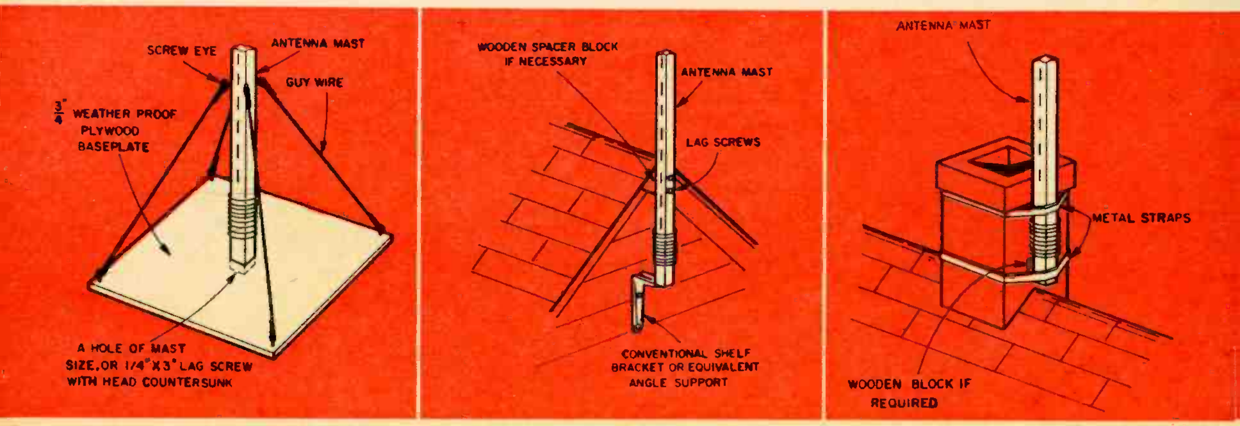
Adjusting POGO to resonance isn't at all difficult either. Use a grid-dip meter to find the resonant frequency. By clipping onto the coil at various points, the loading can be adjusted to the frequency you desire. I work mainly between 3520 and 3565 kc, I chose the desired point of resonance as 14,140 kc which would land me right on my chosen main traffic net frequency of 3535 kcs when working 80 meters.

There you have it. Let the theorists screech their heads off and tell us "it won't work" while we practical guys do all right and then some with a simple, cheap and effective little "Pogo Stick." Maybe it won't "bounce" but it *does* push a lot of signal here, there and everywhere. *You* take it from there!

PARTS LIST

- Base antenna coil, HY Q C75 (Master Mobile Mounts, Inc.)
- Copper toilet tank float ball
- 2 Ceramic stand-off insulators
- No. 18 spun glass hook-up wire, approx. 80 ft. required
- 2″x2″ pole, length 10 ft. or more
- Misc.—Screws, clamps, insulating sleeving, paint or varnish

Fig. 3. Three methods are shown for mounting the Pogo Stick mast. The high Q base coil permits mounting at various heights with excellent results.



Heinrich Hertz (1857-94) was a German physicist who, in 1886, proved the existence of electromagnetic waves, measured their length and speed and showed that they could be reflected, refracted and polarized like light.

Edwin Armstrong (1890-1954) was an American electrical engineer whose inventions include the regenerative circuit (1912), the superheterodyne circuit (1918), the super-regenerative circuit (1920), FM broadcasting.

Pioneers on Postage

Experimenters who hit paydirt: Czechoslovakia is spreading their fame far and wide through the mails.

Edouard Branly (1846-1940) was a French physicist who experimented in early reception equipment for wireless telegraphy. Among his inventions was Branly Coherer (1890) which made communication by radio practicable.

Nikola Tesla (1857-1943) was born in Austria-Hungary, but later became an American citizen. He applied the principle of a rotating magnetic field to evolve an induction motor. He also worked on arc lighting, high voltage.

Alexander Popov (1859-1905), Russian inventor, made a "filing coherer" for detecting hertzian waves in 1895. He was also the first person on record to place a wire high in the air as an antenna to trap the hertzian waves.

Guglielmo Marconi (1874-1937) sent the first radio signals across the Atlantic between Poldhu, England and St. Johns, Newfoundland in 1901. His radio inventions include a magnetic detector, horizontal directional antenna.

milt kiver on

Transistor Testing-3

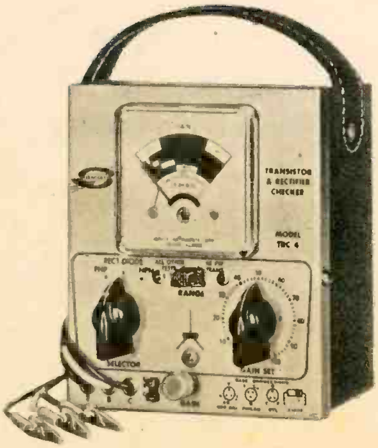
Completing our series—a review of various commercial checkers.

THIS final article in this series continues the discussion of commercial transistor checkers. Space limitations have not permitted the inclusion of every make and model now on the market. For further information write directly to the manufacturers.

Sencore Tester

The Sencore transistor tester, Model TRC4, utilizes the same basic circuitry as the General Electric or Knight-Kit units. However, the approach to gain measurement differs in the way the circuit controls are set up for the test. Consider the simplified circuit shown in Fig. 1. A 6-volt battery and a 3 ma meter are series connected with the emitter-collector elements of the transistor under test. At the same time, R_1 and R_2 provide a suitable current input for the base. This current can be varied by R_1.

For any given transistor, R_1 should be set so that 1.5 ma of current flows in the collector circuit and, hence, deflects the meter halfway across the scale. In order to reach this objective, Sencore furnishes a chart which indicates the proper setting of R_1 for each transistor type. On the meter scale itself, there is a broad green area on either side of the center point and if a given transistor produces a reading within this green area, it can be considered acceptable, provided it has successfully passed the previous I_{CEO} leakage test. If the needle rests on the low side, the beta value of this transistor is too low. A reading above center, of course, indicates a high beta and



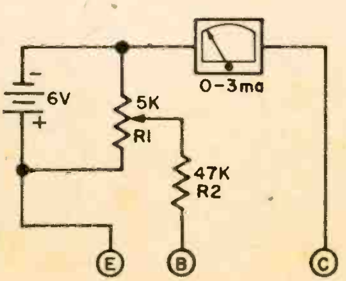


Fig. 1. Sencore varies (R1) to set 1.5 ma in collector circuit.

for most circuits, the higher the better.

The test chart is kept up-to-date by periodic revision by Sencore. In addition, instructions are also furnished for calculating settings for new transistors as they become available.

EICO Model 666

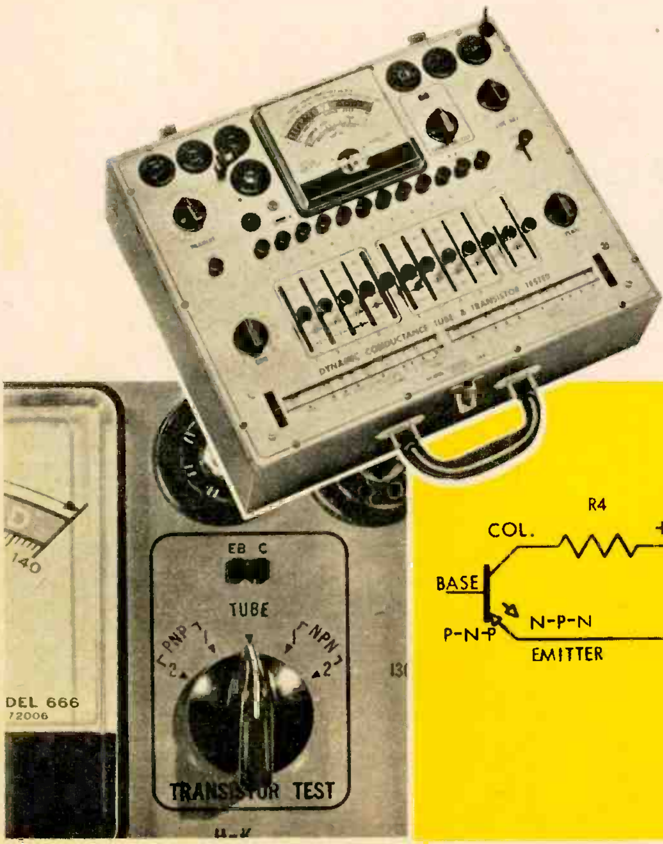
The Electronic Instrument Company's transistor tester is a part of the model 666 tube checker. See Fig. 2.

Seco Transistor Checker

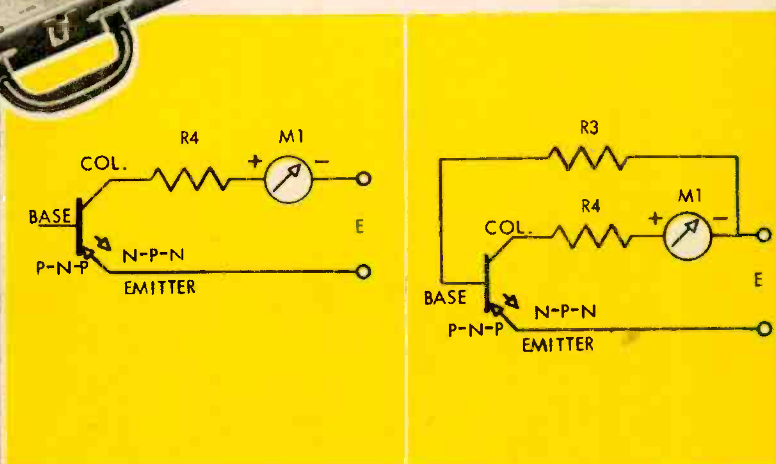
The Seco Transistor Checker, Model 100, tests gain by using a regenerative pulse oscillator in which the transistor under test is the active element. See Fig. 3. In operation, the transistor is inserted into the instrument and the feedback control of the oscillator is set to its maximum position. A neon lamp, transformer-coupled to the oscillator, fires if the oscillations have sufficient amplitude, indicating satisfactory operation of the transistor. The feedback control is then backed off until the neon lamp goes out. The dial setting at which the bulb extinguishes indicates transistor gain. The indication is only qualitative, but it is precise enough for matching transistors.

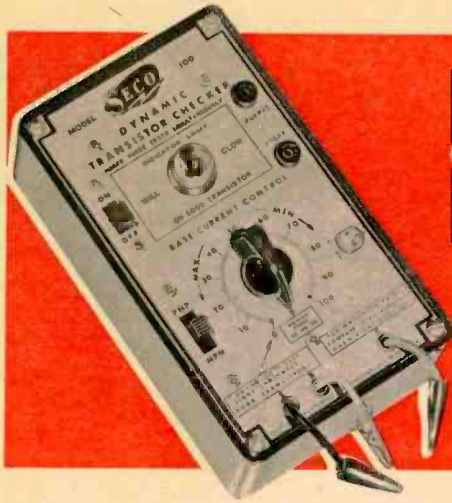
If the neon lamp fails to fire with the feedback control set for maximum feedback, either the transistor is defective or the wrong polarity is being used. Moving the NPN-PNP switch to the opposite position reverses the battery polarity. Firing of the neon bulb after the switch is moved indicates that the original position was wrong. The instrument is thus an identifier of the type (NPN or PNP) of transistor under test. (The low DC voltage in the circuit causes no harm if the wrong polarity is chosen.)

The unit tests all transistors, including power types. Many experiments have established that the relatively low



Transistor testing facilities are incorporated in the EICO model 666 tube checker. Fig. 2. Five position switch at upper right applies a DC bias voltage (E) between collector and emitter to test leakage current (Iceo), see below. To measure current gain, Beta circuit, right below, notes collector current change caused by change in base current.





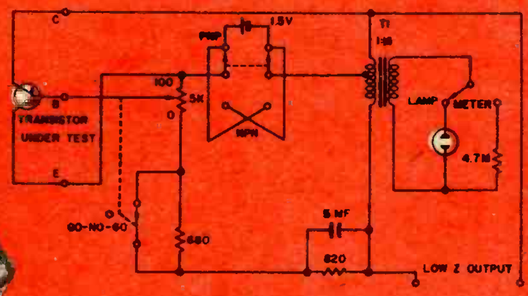


Fig. 3. Seco sets up the transistor under test in a regenerative-type pulse oscillator circuit.

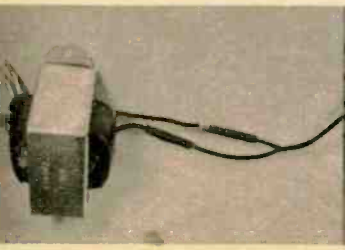
input currents used in the tester produce the same gain indication on power types as higher currents. However, should it be desirable to increase the loading of the power types, a low resistance may be bridged across the output jacks.

The neon bulb fires when circuit current exceeds 3.5 ma. In some small signal types, enough current may not be drawn to fire the bulb, even though the circuit is operating. A VTVM or an oscilloscope is then used as an indicator. Alternatively, another battery in series with the collector lead may be used to increase current.

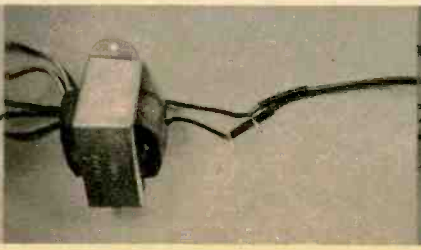
Wire Connections Made Easy

YOUR splicing can rival that of the experienced electronics man if you use some of his techniques. Here's a neat splicing trick that requires nothing more than a length of ¼" spaghetti (insulated tubing) and a little know-how. One problem, that of splicing a line cord onto the primary leads of a transformer, is duck soup when approached properly with this technique.

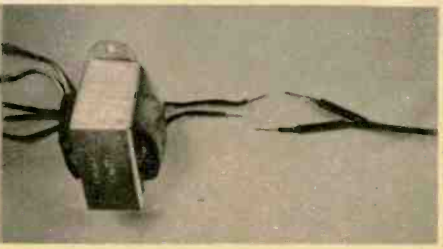
—*Dave Gordon*



1. Cut one lead of the transformer and one lead of line cord ¾" longer. Strip ½" of lead, slip 1½" tubing over wires.



2. Twist the stripped ends of wire tightly together; long line cord lead to short transformer lead, this avoids shorts.



3. Bend the pigtails of wire back against the transformer leads, away from direction tubing will be slid over the wire.

Electronic Brain

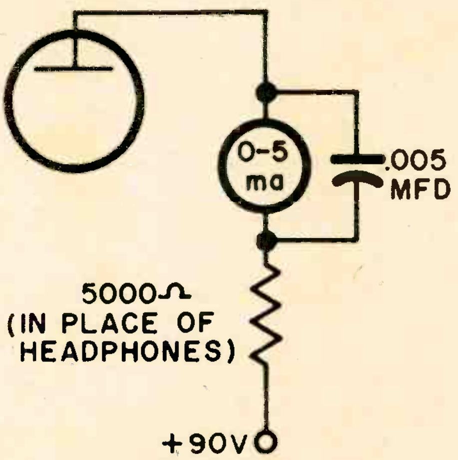
Have you any question on electronics? Send it in and the Electronic Brain will provide the answer.

Underwater Metal Locator

What modifications would have to be made in the metal locator described in the September 1959 issue of E.I. to permit me to use it under water?

Wilbur Anderson
Plattsburgh, N. Y.

As the first step, of course, you would have to enclose the entire unit, including the search coil, in a completely water-proof housing of some non-metallic material such as polystyrene or lucite.



The coil would have to be wound right against the front face of the plastic case so that it can be placed close to objects being tested for metallic content.

You would then have to modify the circuit to accept a meter rather than the headphones. The jack (J1) would be removed and replaced by a 5000 ohm, ½ watt resistor in series with the B+ line to the plate of the 1U4. In the same series line, a 0-5 ma meter would be connected as shown in the accompanying diagram. Using a .005 mfd bypass capacitor across the meter helps to shunt the high audio beat frequencies around the meter coil, thus providing a much sharper change in the meter reading as zero-beat is approached. The meter provides indications of average value of plate current; this value is quite different for zero-signal conditions as compared with strong-signal conditions.

Need a Power Transformer?

I recently acquired an audio amplifier consisting of a 6SJ7, two 6V6's in push-pull, and a 5Y3 rectifier. The power transformer is missing, however. What kind of transformer should I use?

H. D. Brown
Butler, Virginia

The power transformer you need will have four windings: (a) a 6.3 volt filament winding rated at a minimum of 2 amperes. Actually, the tubes will consume a total of 1.2 amperes, but it is best to allow a small margin of safety; (b) a 5.0 volt filament winding for the rectifier tube rated at 2.0 amperes or more; (c) a 120 volt primary winding, normally identified by black leads. The 6.3 volt winding has green leads, and the 5.0 volt coil terminates in yellow leads; (d) a high-voltage secondary winding in the vicinity of 500 volts at 90 milliamperes. This winding should be center-tapped to permit the use of a full-wave rectifier system using the 5Y3 rectifier. A transformer with a higher or lower voltage rating than this—confined to the limits of 20% more or less—can also be used. For example, if the transformer has a rating of 600 volts center-tapped, the voltages applied to the tubes will still not be excessive. If it is found that the 6V6's tend to run too hot, a 500 ohm 10 watt resistor can be connected in series with the present filter resistor or choke to reduce the voltage somewhat. A 400 volt transformer will also operate the amplifier satisfactorily, with slightly less output.

It is important when dealing with hi-fi amplifiers to have the proper B-plus voltage or the wattage output of the amplifier will suffer.

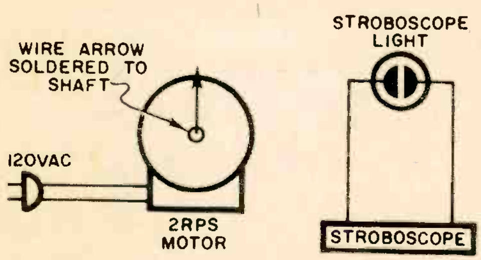
Strobe Calibration

I intend to build a stroboscope in the near future. I shall want to adjust the pulse repetition rate to a known frequency between 10 and 20 pulses per second. Can I make this adjustment by observing a rotating shaft with four, six, or eight sides by means of the stroboscope? The shaft will turn at a known speed.

Fred F. Davis, Vancouver, Canada

It would be very difficult to calibrate the stroboscope using a symmetrical shaft of four, six, or eight sides since you could not tell the difference between the sides when the shaft's motion is "frozen" by the stroboscope light.

There is a much easier way to do this. Using a Hurst motor, or something similar, make up a wire arrow as shown in the sketch to rotate at a rate two revolutions per second. Thus, the period of



rotation will be ½ second per revolution.

Now illuminate the wire arrow with the stroboscope adjusted to give a very slow repetition rate. With an adjustment that makes the arrow visible in the same spot each time the strobe flashes, you then know that the repetition rate is 2 per second; if the arrow is seen at "12 o'clock" and "6 o'clock," the repetition rate is 4 per second; thus, the repetition rate is always twice the number of arrows clearly seen in the same spot each time. This will enable you to calibrate the stroboscope from a few cycles per second up to 10 or 30 cycles per second, in steps of 2 cps. For single cycle variations, it would be quite safe to assume that the halfway mark on your control knob between any two "steps-of-two" calibrations would be sufficiently correct. For example, when you have marked off 12 pulses per second and 14 pulses per second, the 13 pulse per second adjustment would be very close to half-way between these two.

Dry Cell Rejuvenation

Can ordinary zinc-carbon dry cells be rejuvenated or recharged? If so, how long do they last after rejuvenation?

Gerhard Hees, Milwaukee, Wis.

This is a very common question to which many conflicting and incorrect answers have appeared in print. The zinc-carbon cell is a primary cell; as such, its chemistry makes no provision for recharging in the same sense as a lead-acid or nickel-cadmium cell may be recharged. A dry cell may go dead for a variety of reasons and, under certain conditions, may be rejuvenated to extend its life. For example, excessive current drawn through the cell may cause it to polarize and become temporarily inactive. In this case, if it is allowed to stand idle for several days, its own de-polarizing agent (usually manganese dioxide) will restore it to activity once again. In some types of cells, it is possible for the electrolyte (ammonium chloride) to dry out by evaporation; such cells can be given extended life by punching a nail hole in the bottom of the zinc case and sitting the cell in a shallow bath of saturated ammonium chloride for a few days. The hole may then be sealed with wax.

The life of a dry cell may be extended by 20 to 30% by passing a very tiny direct current through it in the reverse direction. That is, a low voltage DC power supply is connected to the cell with the + of the supply going to the + of the cell, and the voltage adjusted so that a few milliamperes flow. Just why this increases the life of the cell is still not well understood since, as mentioned previously, the chemistry of the dry cell does not explain the effect.

In any case, dry cell rejuvenation methods are far from satisfactory. We often wonder whether the results justify the means. A rejuvenated dry cell is apt to give out when least expected since its action is completely unpredictable. Hence, we suggest replacement rather than attempted recharging.

Fathometer gets checked out before being installed in yacht, background, by George Butcher, a retired naval officer now in business for himself.

EI's money making careers in electronics

There's Boodle in Boats!

By James Joseph

Selling, installing, repairing marine electronic gear, from fish-finders to radar, is now big business.

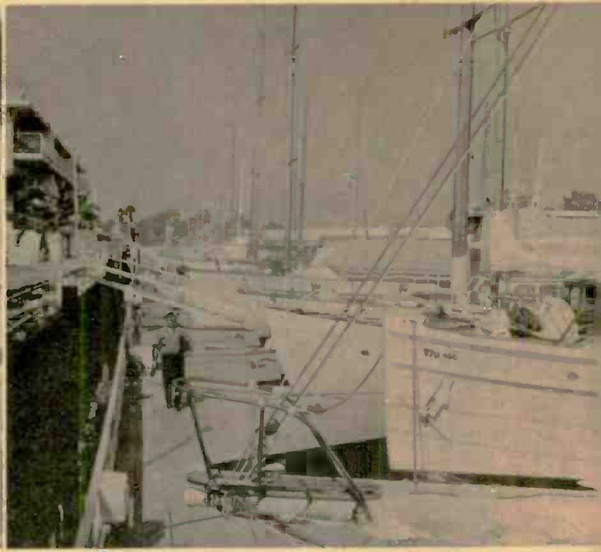
NOT square-knots but square waves can put you at the helm of a career as profitably charted as George E. Butcher's. His Electronics Marine Service, berthed in Newport Beach, Calif., is running full-sail before the greatest boat boom in history.

Boats and electronics can earn you a five-figured annual income . . . and more.

"The 'more,' " grins 50-year-old Butcher, as he adjusts a yacht's fathometer, "might not make dollars or sense to your accountant, but it makes sense aplenty to you."

He means the tang of freshly-caulked oakum, the cant of sea-wet decks underfoot.

Butcher, who retired a lieutenant commander after 28 years in the U. S. Navy, is profitably launched on a second career. Dawn finds him atop a yawl's mast, installing a radar's waveguide antenna (radar's cost: $3000-$5000, [*Continued on page* 107]



At left, Butcher tunes up installation on bridge of luxury yacht. Some privately owned ships head seaward rigged with upwards of $10,000 worth of electronic gear—from transistorized megaphones to radiotelephone. Small craft and their volume business are even more lucrative for the marine electronics specialist. Right, Butcher can walk from shop to berthing slips.

This deep-sounding fathometer is due for maintenance and adjustment. Butcher charges a minimum fee of $6 per hour. In background is Newport Harbor, Calif.

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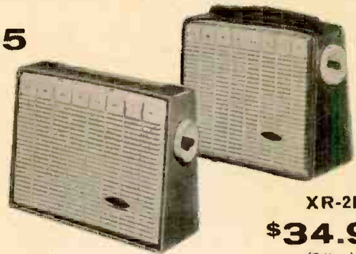

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Skyways of the Future

Continued from page 43

enters the data into the computer via the FLIDEN (Flight Data Entry) console. If the plan comes over the teletype, it is automatically coded and entered into the central computer. The computer stores the data on its file drums, makes all necessary calculations, then activates punch-print units at various consoles to print out "hard copy" flight strips for controllers' use.

The flight strips are placed in holders in a rack at each console position. As the flight moves along and the aircraft makes position reports, the new data is fed into the computer by means of a keyboard device at a sector controller's console. This new information updates the appropriate flight strips throughout the entire system. In the course of a flight, a controller at the "Conflict Display" can tell whether the progress of the flight will lead to a position-conflict with another aircraft and can then make suggested alterations in the flight plan according to information obtained from the computer. Any such change in the flight plan causes another up-dating in all flight strips at all console positions.

At the terminal point of the flight, control is routed to the Local Control Console, where flight strips are displayed via the high-resolution TV system. Upon touch-down, control is turned over to the Ground Control Console and the flight plan terminated and erased from the computer's memory file.

Communications

If automation of the air traffic control system is a vital need today, the same holds true for airways communications. "Clutter" on aircraft voice communications channels can be catastrophic.

In an attempt to ease the situation, the FAA awarded a study contract to RCA, the result being an experimental rapid Automatic Ground-Air Communications System (AGACS, pronounced "Ajax"). Currently under evaluation at NAFEC, AGACS uses a solid-state multiplexer to modulate UHF or VHF signals. Information from aircraft-to-ground and ground-to-aircraft can be exchanged through pre-determined message units supplemented by 4-digit numerals.

Here's how AGACS works: Routine flight instructions and advisory information from the air traffic controller are translated into pulse trains and transmitted sequentially to a particular aircraft where the pulses are converted into a direct-reading display for the pilot. When the aircraft is interrogated from the ground by other pulses, pilot-initiated routine information is similarly translated into pulses and transmitted to the ground where the data is also converted to a direct-reading display for the ground-bound controller.

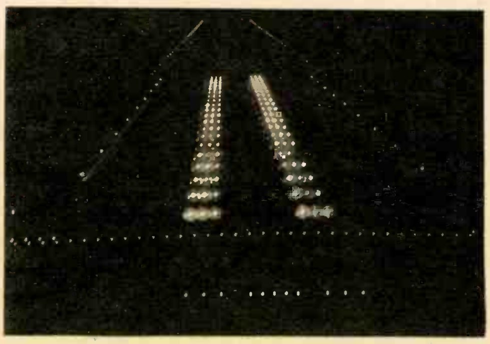
The present system has a capacity of 500 aircraft. With a basic message-handling capacity of 750 "bits" of information per second, all 500 aircraft may be interrogated and processed within two minutes.

Emergency messages can get through by a voice over-ride capability, but most significant, all automatic transmissions are accomplished over a single-frequency channel. It is obvious that, with its 500-aircraft capacity using only one channel, AGACS bids fair to greatly simplify air-ground communications.

The theory behind AGACS is "don't call us; we'll call you." That is, the controller initiates all routine communications. With a system based on the AGACS concept, the entire United States could be serviced by about nine channels, whereas it now takes about 25 channels to handle the New York area alone.

Test flights have been made at NAFEC using AGACS as the communications link. In one such flight, a 45-minute flight plan was followed during which a Grumman Gulfstream was kept on a pre-determined flight pattern solely by means of AGACS. No voice communications were used.

AGACS could be tied into the Data Processing Central. The automatically-transmitted routine messages coming from pilot to controller would be directly tied into the DPC computer and used to update an aircraft's flight progress strips throughout the DPC system.



Runway light systems under tests by FAA.

Dynamic ATC Simulators

One of the difficulties related to solving ATC problems is recreating the complexities and constantly changing patterns of dense air traffic in order to study bottlenecks and devise solutions.

Aircraft Armaments, Inc., under contract to FAA, has solved this problem with an electronic ATC simulator, recently installed and commissioned at NAFEC. The simulator has four basic elements: air target generators, radar simulators, communications, and data collection and reduction elements. The 48 target generators are operated by "pilots" who manipulate their "aircraft" (spots of light projected against airways charts on a small screen) in accordance with a pre-arranged flight plan, which is altered by a controller's instructions. The outputs of the target generators feed the radar simulators which transform the target position-data into a radar-type information which is fed to the controllers' displays.

Radar

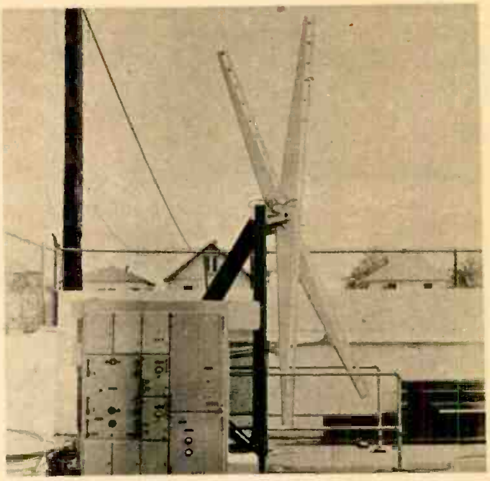
Since the end of World War II, radar in many forms has become one of the major tools of air traffic control. In its current efforts to modernize our ATC system, the FAA is installing increasing numbers of long-range en route radars and terminal radars throughout the country.

One sophisticated radar system under test at NAFEC is the Air Height Surveillance Radar, which is designed to provide a three dimensional display of aircraft in terminal areas, for use in conjunction with sequencing and other display aspects of the Data Processing Central.

Another, the FPN-34, has a range of about 120 miles on small targets—nearly double that of current terminal radar systems. Moving target indication (MTI) circuitry enables moving targets, even those returning a weak signal, to be clearly seen, while ground clutter disappears. Because the FPN-34 operates in a relatively low frequency (1280 to 1350 mc; L-band), weather clutter that normally obscures targets is greatly reduced.

Automatic Landing Systems

In poor weather and low visibility, an airport's ability to accept planes for landing is seriously impaired. Aircraft are "stacked" in holding patterns above terminal area . . . a situation very wasteful of time and fuel and somewhat dangerous to boot. With jets, which consume fuel at fantastic rates, the stacking problem becomes acute.



Narrow beam radar for automatic landing.

There are two basic philosophies that can be applied to an all-weather automatic landing system (ALS). One states that a ground-based system should, at a given point, take complete control of a particular aircraft and bring it automatically down to the ground. Such a system could handle a limited number of planes at a time.

The other philosophy is to develop a system which would create a "path" in space, a guided road down which any plane could be taken safely and surely, at its pilot's discretion, either by the pilot or by an autopilot. At NAFEC, tests are being run on systems based on both philosophies.

The first-mentioned approach used precision radar to track an airplane while radio transmits control instructions to the plane's autopilot. With a dual-radar setup, the system (Bell GSN-5) can handle two aircraft per minute.

A conical-scan radar locks onto an inbound plane and passes position data to a ground-based computer. The computer has been programmed with the *best landing path* of each type of aircraft. During the approach, the radar transmits position data to the computer, the computer seeks any deviations from the programmed "best" flight path, and sends corrective impulses back to the aircraft's autopilot by radio. The pilot keeps hands off the controls right down to the ground.

The Bell system offers certain obvious advantages. No special gear need be installed in the aircraft, since it functions with the standard ILS and autopilot. Also, as a built-in safety factor, the system can give a plane an automatic "wave-off" if a second plane is in danger of overtaking the first in a landing sequence.

The other design philosophy for an ALS is currently represented at NAFEC by a system known as REGAL (Range, Elevation Guidance, Approach, Landing). This is a strictly experimental system developed by Gilfillan, Los Angeles.

REGAL allows each plane to independently derive its own position information based on a ground reference signal source. The system uses a narrow beam radar which scans from a 20-degree vertical angle down to the horizon about five times each second. Every one-tenth of a degree, the beam elevation angle is transmitted to a special transceiver in the aircraft. The airborne unit, in turn, sends a pair of pulses which cause the ground transmitter to reply. By measuring the time interval between transmissions and reception of the ground reply, the airborne unit can determine the distance to the runway by converting time and speed into distance.

The REGAL system lets the pilot choose his own approach angle, flareout path, etc., or gives him the option of hooking into the autopilot and letting it take him down. Its airborne electronic unit occupies less than one-half cu. ft. and weighs less than 15 pounds.

Airborne Electronic Navigation

For the past few years, a nationwide network of VOR's (VHF Omnidirectional Ranges) has been supplanting an older system of low-frequency ranges that had been the country's air-navigational standby for decades. The International Civil Aviation Organization (ICAO) recently selected a VOR-based system known as VORTAC to be the worldwide navigation standard. VORTACs are now being phased into the civil airways system throughout the U. S.

A problem that has always plagued the VOR systems is that of finding suitable transmitter sites. For navigational purposes, it is desirable that the transmitter be as close as possible to a main terminal airport. However, it often occurs that natural or man-made obstacles (trees, hills, buildings, etc.) cause reflection problems at the most desirable locations. Reflections cause "bends" and scalloping of the VOR signals, creating significant problems of accuracy in navigation.

The recent development of a doppler VOR system appears to be the most promising solution to the problem. The doppler VOR creates an effect in the received signal similar to the doppler effect normally associated with sound. The VOR's doppler effect is the result of relative motion of one of two sources of radiation coming from a ground station and is accomplished by successively feeding each of 50 VHF horizontal loop antennas located at the ground station on the periphery of a circle 45 feet in diameter.

With doppler VOR, "scalloping" errors due to reflection were reduced *seven*-fold. The doppler system is completely compatible with present airborne receiving equipment and no modifications would be necessary to receivers.

Collision Avoidance Systems

So far, no single in-flight collision avoidance system (CAS) has emerged capable of doing the job. Some have been based on radar, others on infrared detectors. Some attempt a relatively complete solution while others try merely to give simple proximity warning indication. Bendix has been working for some time on a CAS using a ground-reflection technique. Sperry is working on a proximity warning device, but neither has been thoroughly evaluated as yet at NAFEC.

Bomb Detection

The phrase "mad bomber" has come to have a particularly ominous ring to the flying public. In recent months, a number of United States air accidents have been attributed to bombs brought aboard airlines by passengers with a suicidal bent. In the total aviation picture, these bombing incidents have been negligible, but in the public's mind, the need for bomb detection looms dramatically large.

The FAA has adopted a surprisingly close-mouthed attitude about any work being pursued in this direction. However, the Air Transport Association (representing the nation's schedule air carriers) has undertaken its own study program in this field. Discovering that no one person or agency has the vast range of knowledge to deal with every type of explosive or bomb that might be used, the ATA has hired the Standard Research Institute to carry out an exhaustive study of the subject. The FAA is maintaining close liaison with the ATA's Working Group on Bomb Detection.

As our air traffic control system evolves from its present inadequate status to a more sophisticated system, and as more and faster aircraft fill our nation's skies, NAFEC's job will increase in scope and importance. It promises to be one of our most valuable tools in the complex job of making air travel more efficient, economical, and above all, safer.

A Lie Detector

Continued from page 35

complicated, but it pays off in results.

Calibration

Before using the lie detector you must calibrate it so that indicator (PL1) does not react until there is a 5% decrease in resistance between electrode terminals J1, J2. To do this connect a 100,000-ohm, 5% resistor between J1 and J2. Turn the detector on and adjust balance pot R3 to the point where relay RY1 just closes and turns the lamp on. Without disturbing the setting of R3, switch the instrument off and connect a 5000-ohm, 5% resistor in series with the 100,000-ohm resistor between J1 and J2. Now switch on and note the meter reading, for this is the calibration point to which you must balance out the subject's normal skin resistance. Once the balance is set at this reading, a 5% decrease in the G.S.R. will turn on the lamp.

To use the lie detector, simply clamp the electrodes to each palm of the subject as

How a Lie Detector Works

When a conscious attempt at deception is made, you create within yourself an emotional or tension state; which shows up as an increased activation level of the autonomic nervous system. That sounds like quite a complicated mouthful. Well, let's break it down and simplify it so that those of us who are not psychologists will know what it is all about.

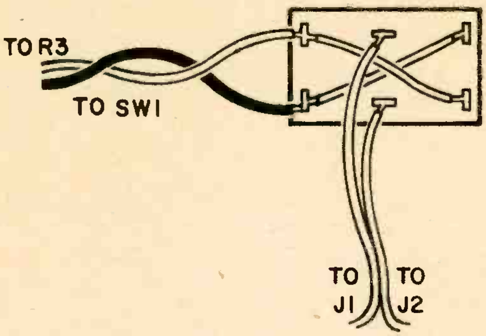
The autonomic nervous system is that part of our nervous system over which we have no voluntary control. It operates like a large complex self-regulating computer; its sole purpose is to keep us alive. Completely without direction from our conscious mind, it coordinates, regulates and controls the heart, breathing, body temperature, perspiration, skin resistance, digestion and about fifty other body functions which are necessary for our normal, healthy well-being. It is obvious that this system must always be operating at least at a minimum level—or minimum activation level, as the scientist would call it—or we would stop functioning.

The operating level of this system depends upon the stimuli or data which are continuously pouring in at the autonomic control center in the brain. This data originates not only from various areas inside the body, but also from the external environment. For example, when we are confronted by a situation which threatens our well-being, we experience a set of psychological and physiological changes which are called "fear." If you can stop and analyze the various sensations, such as pounding heart, extreme alertness, increase in perspiration—to mention a few—you'll see that your body has, in effect, shifted into high gear. You are prepared to react instantly and strongly to any threatening factors in the environment. In a similar fashion, all emotions and tensions are protective mechanisms resulting from increased activation of the autonomic nervous system.

This brings us back to the case in point, lie detection. As has been mentioned previously, conscious deception results in internal tension or increased autonomic activation resulting in physiological changes. In this case, the changes are usually very subtle and not readily apparent to the observer. The lie detector is a sensitive device for detecting these minute changes.

The Keeler polygraph is the lie detector used by most of our law enforcement agencies today. It is essentially an ink-writing instrument which records breathing, fluctuations in blood pressure and associative reaction time. These changes in physiological response are all written out side by side on a long chart. Of course, the device won't ring a bell or laugh sardonically when the person being quizzed strays from the straight and narrow, but the polygraph will, in the hands of a trained person, provide a real indication whenever the subject feels he is faced with a "hot potato" question.

shown. It is of the greatest importance that the subject's hands be clean and dry. Adjust R3 until the calibration reading is indicated by the meter. Ask the subject to keep his hands as motionless as possible. After a little practice you will be able to keep the meter adjusted to the calibration point despite the constant small variations.



Shown is an additional switch for reversing the electrical polarity of the electrodes.

The normal variations of G.S.R. are relatively slow when compared to the rapid decrease which occurs when telling a lie. With a little experience you will instantly recognize the difference.

If the detector seems to become unreliable, or suddenly lacks sensitivity, try exchanging the terminal connections of the hand electrodes. Put the electrode wire going to J1 to J2 and vice-versa. If desired, a polarity reversing switch (SW2) may be installed as shown between J1 and SW1 and between J2 and R3.

Your questioning technique can mean success or failure in detecting deception. First tell your subject to relax, as a matter of fact, let it slip that he may fool the detector if he is relaxed as possible when telling a lie. This little trick of negative psychology usually causes the subject to try so hard not to react to telling a lie that he actually reacts far more strongly. Build up tension by asking all sorts of unimportant questions and then spring the important ones.

All About Strain Gages

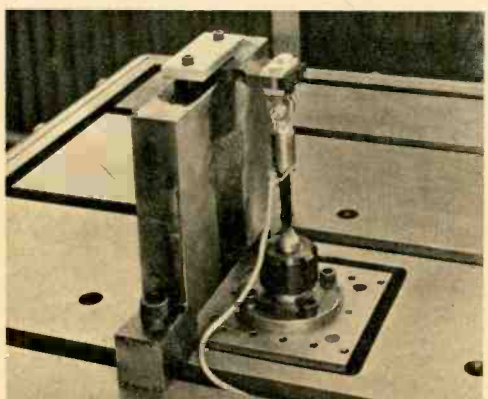
Continued from page 63

the gage member goes up or down with respect to R_2.

After initial null balancing, a circuit of this kind is extremely sensitive and tiny changes in gage resistance can be detected. A problem in design of a strain gage enters when you consider that resistance changes not only as a result of mechanical strains, but also as a result of temperature changes. When a strain gage is used to test the dimensional stability of a turbine rotor, it might undergo a resistance change as a result of a temperature increase rather than the result of a dimensional instability.

In order to overcome the temperature sensitivity of a strain gage, a variation of the Wheatstone bridge is used in which two strain gages are employed, one in each leg of the bridge circuit. One of the gages is mounted on the material to be tested, while the other gage is mounted on another unstressed piece of the same material. The two gages are located in identical environments so that both are subjected to essentially the same temperature. If both gages feel the same temperature changes, they will reflect the same resistance changes as a result of temperature and the Wheatstone bridge remains balanced. As soon as the material being tested exhibits any stress, the first gage will indicate a corresponding change in resistance while the dummy gage will not. The bridge becomes unbalanced and a reading can be taken.

With the ever-increasing use of devices operating at fantastic speeds in extremely severe environments—such as a rocket reentering the earth's atmosphere the simple, yet sophisticated strain gage will be a valuable ally.



Fatigue test on metal part; gage is under tape.

There's Boodle in Boats!

Continued from page 97

20% of it Butcher's profit). By noon, he's under sail on a shakedown cruise calculated to test a fathometer (any of a dozen models priced $125-$3500). By late afternoon he's beached, so to speak, in his one-man seaside shop (its 800 square feet crammed with electronic test gear).

As a career skipper, Butcher knows the electronic "Rules of the Road": the right radio direction finder for the neophyte skipper who seldom cruises more than 50 miles offshore; the fathometer (a recorder-graph model) suited for commercial tuna clippers; the radiotelephone calculated to keep a yachting corporate executive in contact with his shore-based business.

Though Butcher, electronically speaking, has been at the helm only five years (he set up business in 1955 with a few thousand dollars), he's seen plenty of changes.

"Big and fancy boats used to be your only electronic clients," he muses. "Nowadays, a fellow is liable to tow his little outboard skiff to your shop and tell you to install one of those new, low-cost fish-finding fathometers."

Electronic marine gear, once price-tagged beyond reach of the little-boat owner, now fits almost any boat and its skipper's budget.

"Way I figure it," says Butcher, "every one of the U. S.' more than 7,800,000 boats, berthed in salt water and fresh, are electronic potentials."

Butcher, an authorized Raytheon marine-electronics dealer, serves them all, installing spanking new navigational gear and repairing the old. His service charge is a minimum of $6 hourly.

For the weekend angler he stocks a compact, transistorized, battery-powered fish-finder whose ultrasonic beam ranges down to 120 feet and carries a budget price-tag: $125.

For $299.50 he'll outfit a sailboat (whether a 15-footer or a class racer) with a "Ranger" radio direction finder, its battery-run receiver and loop antenna pinpointing shore stations and showing the way through the thickest of fogs.

"And there's not a gas-engined boat afloat," enthuses Butcher, "that's not a prospect for a low-cost life-saver—a solar-celled fume detector that's priced less than $100, yet sniffs out dangerous gasoline fumes, then flashes an alarm to alert the skipper."

Butcher, an old-hand to brine but a relative newcomer to business, last year racked up better than $80,000 in sales and service (sales represented 80% of his gross), and netted himself about $12,000.

He stood, moreover, single-handedly at the helm of his own career, backed only by some $750-worth of electronic shipmates, among them an RF signal generator (9.5 kc to 50 mc) for trouble-shooting marine radios (cost: about $175 surplus); a frequency meter (125 kc to 20,000 kc), also purchased surplus for $60-$70; a Heathkit Q-meter, essential for measuring the Q of coils subjected to moisture.

Butcher—as can you—launched his seaside career with about $3000. Initially, he invested $500 in test gear (much of it shop-built or picked up from government surplus). Most of the remainder went to stock his small but busy retail sales room, which displays a dozen types of electronic gear, from fathometers to transistorized megaphones.

Even though boats are booming everywhere along salt water and fresh, economic barometer-watchers predict an even more explosive boom to come. Butcher's shop is nestled among the 8000 boats berthed in bustling Newport harbor, but opportunity lurks everywhere along our waterways. You can, in fact, all but name your career beachhead. There are more than 1100 yacht clubs and some 3900 marinas and boatyards spread from Maine to Alaska, plus more than 5000 small craft launching sites, many of them catering to fresh water skippers.

Nowadays marine electronics is a year-around business, bustling in winter when boatmen gird electronically for the summer sailing season.

To cash in on boats, you've got to know your electronics. Butcher learned his in the Navy and through correspondence courses. Also, you need at least a 2nd FCC Class Radiotelephone license. Then, too, you've got to speak the lingo of boatmen.

The FCC license permits you to install and tune marine transmitters, radiotelephones. Your license must have a ship's radar endorsement to work on radar.

As for the lingo? "Boatmen," says Butcher, "expect you, the electronic skipper, to have a feel for their problems, and it helps if you've helmed your own boat."

Ironically, Butcher owns no boat. Sheepishly, too, he admits that even after 28 years in the Navy, he still gets seasick. With it all, his seaside cash register has been ringing up an astounding gross. Recently, he installed a 70′ luxury cruiser with no less than $10,000 worth of electronics (and pocketed about $3000 as profit). Typically, the yacht's owner ordered a 32-mile range radar (cost: $5000); a $2500 high-seas radiotelephone (150 watt input, 11 crystal-controlled channels, range up to 3000 miles); an extended-depth fathometer (cost: about $560); a transistorized direction finder (price: $300); and a dozen other navigational aids.

"Before I was through," says Butcher, "I'd even rigged the yacht's life boats with radiotelephones and with radar targets—reflectors which help radar locate small boats."

Such big installations don't come overnight, neither for you nor for marine old-hands like George Butcher. Nor are they essential to career success.

"Small jobs—$125-$300 installations—are the ones that add up to a year-end bonanza from boats," says one marine expert.

Electrolytic Capacitor Checker

Continued from page 84

types, such as those designed for photo-flash use, may leak only 1 ma or less at rated voltage. Most electros, for conventional use, will leak 2 or 3 ma and still perform satisfactorily.

If the capacitor has been long unused, or if it is of high capacitance, it make take a minute or more for the leakage current to stabilize. When trouble-shooting recently used equipment, however, a reliable reading is quickly secured.

The application will determine the amount of leakage which can be tolerated. A power supply filter capacitor may leak 3.5 to 4 ma and still not overheat or significantly pull down the output voltage although this high a value usually signifies trouble ahead. A bypass capacitor, with this leakage, would show up in poor performance. Most good capacitors will fall in the 2-3 ma range.

Always make the test at the rated voltage of the capacitor or at the operating voltage if this is smaller. Watch the meter to be sure that after easing back to two or three ma it doesn't suddenly swing full scale—an indication of electrolyte breakdown. Remember that while the test is being conducted there is quite a bit of voltage on the capacitor and give it time to discharge after the test button is released.

This tester can be used for the larger non-electrolytics but, since the meter is incapable of measuring very small leakage, it will only identify opens and shorts.

Weather at Sea

Continued from page 50

gize the power for all circuits for a three-minute period once each six hours.

The program timer and element selector consists of a group of circular switches driven by a constant speed motor. When power is first applied the selector connects a precision resistance (the identification and reference element), into a self-balancing bridge amplifier. The bridge automatically matches the reference resistance with a helical potentiometer at the bridge balance point. Physically connected to the potentiometer's shaft are the code selector and code generator switches.

The code generator is a hollow cylinder consisting of eight metal rings insulated from each other, each with a code character machined in relief on the inner circumference. A rotating contact sweeps the inside of the cylinder, touching the raised portion of each ring. The three rings selected by the code selector key the transmitter with a three-letter code group. Transmitted on 6 mc, the signals are received on standard communications receivers and decoded with a special table. The same code group is repeated several times during the 20 seconds each of the five weather variables is on the air. This allows even inexperienced operators sufficient time to copy the signal.

Local surface weather conditions are converted into resistance values which can be matched by the self-balancing bridge amplifier. Air and water temperatures are measured by thermistors, semiconductors whose resistance varies with its temperature. To code air and water temperatures each thermistor is independently connected in the self-balancing bridge amplifier and the correct three-letter code group is automatically selected for transmission.

Surface wind speed is measured by a rugged three-cup anemometer. A small magnetic generator connected to the rotor shaft provides an electrical voltage proportional to the wind speed. To convert voltage changes to resistance changes, the output of the generator is coupled to the grid of a vacuum tube. Changes in grid voltage vary the plate resistance of the tube, thus the plate resistance of the tube is proportional to the wind speed and can be measured in the bridge amplifier.

To measure wind direction accurately when the orientation of the buoy is uncontrollable and convert this measurement into a resistance value required a bit more

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ingenuity on the part of the National Bureau of Standards, who developed the buoy. A synchro-type wind vane is used to transmit the vane shaft angle to a servo system located within one of the waterproof wells in the buoy. The servo rotates the body of a gimbal-mounted magnetic compass accordingly. The compass has a slave pointer which rotates above a circular resistance strip. The result is resistance values corresponding to wind direction relative to magnetic north. A rugged, aneroid-type barometer with a slave pointer and resistance strip similar to that on the compass provides accurate measurement of air pressure.

One of these buoys, located in the Gulf of Mexico, 300 miles south of the mouth of the Mississippi River, transmitted the first warning reports of tropical storm Irene on October 7, 1959. Another was successfully anchored off the George V Coast of the Antarctic ice cap.—*James R. Spencer*

EI Echo Chamber

Continued from page 57

as long as it has sufficient gain. That means that the amplifier must have a 12AT6, 12SQ7, or a 12AV6 in addition to the output tube and rectifier.

Connection of the echo unit is simple enough, although there are several variations you can use. The simplest hookup requires connecting a pair of leads in parallel with the speaker leads from your amplifier to terminal TS2 on the echo unit. The shielded lead from the phono cartridge (Xtal) is connected to the input of the built-in AC/DC amplifier. This small amplifier in turn feeds an external speaker. Since both the small amplifier and external speaker will be handling only the echo signal, they need not be of particularly high quality. Make sure that the external speaker is not placed too close to the spring unit or it will agitate it acoustically and cause a sustained howl or ringing noise.

A more complicated setup, but one which does not require a second external speaker and amplifier, uses a mixer to combine the output of the crystal with the original signal source. A suitable transistorized mixer will be presented in an early issue.

As can be seen in the photos the reverb unit and the AC/DC amplifier are housed in a wooden cabinet. The exact housing is not critical, but since the amplifier does present some shock hazard, it is a good idea to recess it in an insulated cabinet as shown.

In use, the complete reverb machine can be mounted near the main hi-fi amplifier and the inexpensive external speaker is mounted near your main hi-fi speaker. Control R6 is adjusted for minimum distortion of the echo signal; its setting will depend on the volume of the main speaker. Potentiometer R1 sets the volume of the echo signal and it is adjusted by ear for the most pleasing echo balance. You'll find that program material with a continuous high level of sound will hardly show the effect of added echo. Small combos and solo instruments, however, will have an extra certain something added which will be well worth the modest investment represented by this simple echo device.

Loudhailer Intercom

Continued from page 39

Since the unit is basically a high-powered intercom, there is no reason why the landlubber can't use it for other applications. It will operate from power supplied by dry cells or simply plugged into the cigar lighter receptacle of your car. Always be sure that polarity of the power source is correct, especially since some of the older cars have the positive battery lead grounded.

Transistorized Theremin

Continued from page 46

will result if the instrument is modulated by oscillating your hand around the point of desired pitch (a certain distance from an antenna). Volume changes can be made by shielding the antenna loop of the receiver with one hand, while varying the pitch with the other. The battery should last many hours in normal operation.

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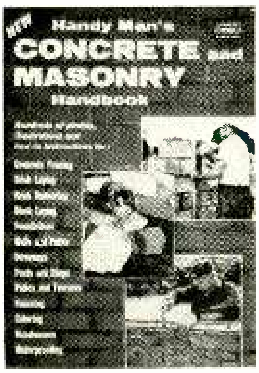

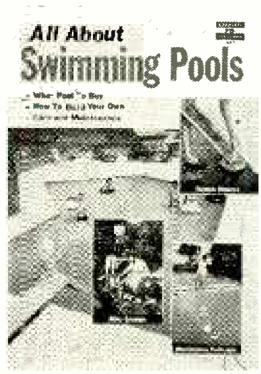

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