The Lowdown on Tape Playback Equalization

NOVEMBER 1958

Radio-Electronics

TELEVISION · SERVICING · HIGH FIDELITY

HUGO GERNSBACK, Editor

Power Transistor Tester

■

Installing Community and Commercial Antennas

■

Simple Low-Frequency Oscillator

■

Relay Adjustments

■

Servicing Pleasure-Boat Radio Installations

(See page 44)

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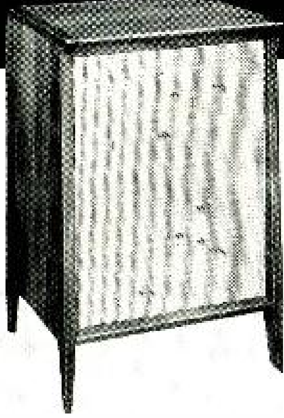
U.S. and Canada

For superb hi-fi listening . . . **Jensen** presents . . . in modest space . . . at new low costs . . . performance challenging comparison with speakers of any size at any price!

Featuring the new Flexair* woofer and Bass-Superflex* enclosure principle that establish completely new standards of bass reproduction.

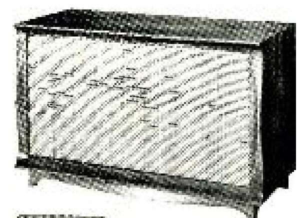


NEW JENSEN CN-100 3-WAY SYSTEM

A new 12" 3-way system, the CN-100 reproducer gives a new small-scaled fine furniture look to the hi-fi speaker, ideally suited to small living spaces. The 12" Flexair superlow resonance woofer in Bass-Superflex enclosure gives full bass response to a low 20 cycles. Special 8-inch mid-channel and RP-103 h-f unit assure smooth clean response to 15,000 cycles. Crossover frequencies 600 and 4000 cycles. 32" H., 21" W., 18¼" D. Available in Walnut, Tawny Ash, and Mahogany. **Net Price........149.50**

BF-100 ENCLOSURE FOR 12" SYSTEMS

In up-to-the-minute "Flair Line" styling, the BF-100 cabinet is ideal for all 12" speakers, and system kits including those with Flexair 12" woofers. Incorporates new acoustical design with tube-loaded port for unusual extension of the l-f range. Available in Walnut. Tawny Ash and Mahogany. **Net Price.........69.50**



JENSEN'S AMAZING TR-10 TRI-ETTE • Big Speaker Bass in Smallest Space
Sophisticate's Choice in 3-Way Components

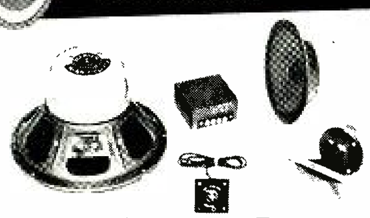
Heart of the Tri-ette is the new Flexair 12" woofer with its superlow free-air resonance of 20 cycles and high damping. In conjunction with the new Bass-Superflex enclosure, useful response down to 25 cycles is attained with the lowest distortion ever measured on such a small reproducer. Cabinet is extra rigid with Fiberglass lining. Special 8-inch midchannel handles the range from 600 to 4,000 cycles, through L-C crossover network. RP-103 Tweeter carries the response from 4,000 to 15,000 cycles. 13⅞" H., 25" W., 11⅜" D. Choice of Walnut, Tawny Ash and Mahogany. **Net Price....114.50**

ST-944 Stand . For floor use. Places top of cabinet 28" above floor. **Net Price......12.95**

ST-945 Base . For table or shelf. **Net Price...... 5.45**

ABOUT JENSEN'S NEW FLEXAIR WOOFER

The new Jensen Flexair Woofers are designed to extend bass response down to very low frequencies. They have highly-damped superlow resonance at the very bottom of the audio range—16 to 20 cycles. They have an exceptional degree of linearity and are capable of a total movement of 1". In even a relatively small Bass-Superflex enclosure, they deliver their extreme low-frequency performance with a new low in distortion.

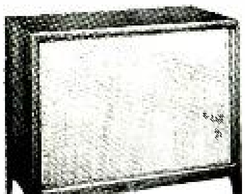


KT-33 3-WAY SYSTEM KIT

Includes basic speaker components for 3-way system identical in performance with Jensen CN-100 and TR-10 reproducers. Includes Flexair 12-inch woofer, special 8 inch m-f unit, and RP-103 compression h-f unit. Complete with control, crossover network, wiring cable, and full instructions for building enclosure and installing speaker system. **Net Price $80.00**

KT-34 TRI-PLEX II SPEAKER KIT

Components used in the TP-250 Tri-Plex II reproducer. 15-inch Flexair woofer, new compression driver m-f unit, and new phase correcting supertweeter. Response from 16 cycles to upper limits of audibility in Jensen Bass-Superflex enclosure (Jensen BF-200 suggested). Complete with 400 and 4,000 cycle networks, wiring cables and instructions for building enclosure. Impedance 16 ohms. **Net Price $179.50**



NEW TP-250 TRI-PLEX II 3-WAY SYSTEM

This latest version of the Jensen Tri-Plex reproducer incorporates the extreme bass capability of the 15" Flexair woofer, in combination with advances in midchannel and supertweeter design. This beautiful unit outperforms any speaker system of comparable size or cost. Excellent for superb monophonic reproduction or as one side of a stereo system. Response range, 16 cycles to beyond audibility. Components available also in kit form (see KT-34). 30½" H., 34½" W., 18¾" D. **Net Price........294.50**

BF-200 Cabinet only for 15" Systems, net price 129.75

Send for Bulletin JH-1

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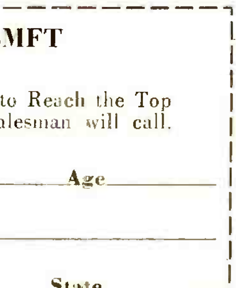

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NOVEMBER, 1958

Radio-Electronics

Formerly RADIO-CRAFT ■ Incorporating SHORT WAVE CRAFT ■ TELEVISION NEWS ■ RADIO & TELEVISION

EDITORIAL

ELECTRONICS

RADIO

TEST INSTRUMENTS

AUDIO—HIGH FIDELITY

TELEVISION

ON THE COVER

(See story on page 44)

Shooting trouble in a typical small-craft radio transmitter is James Lafferty of Charles Rogers & Sons, Manasquan, N.J., a leading marine radio service shop in what some call the small-boat capital of the country.

Color original by Hans Knopf

Average Paid Circulation Over 199,000

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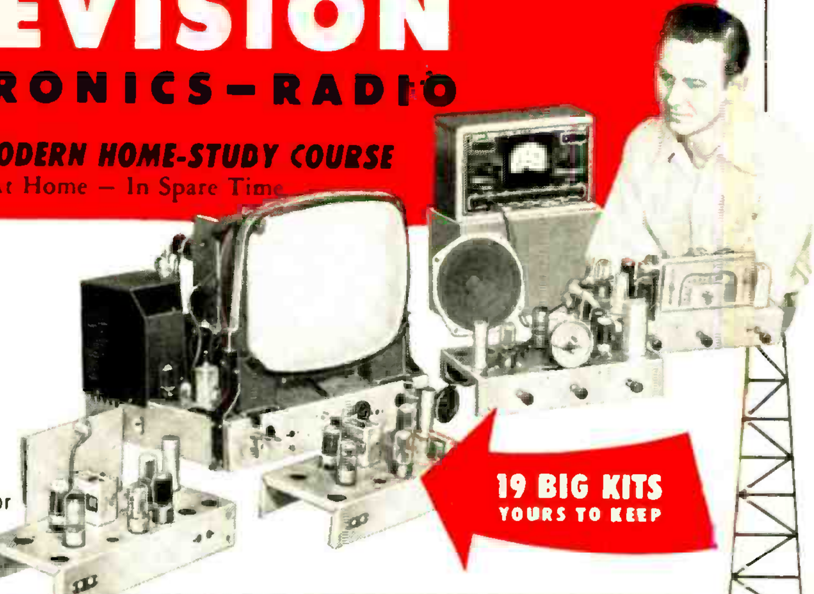

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STEREO MULTIPLEX adapters have been put on the market by several manufacturers, although the FCC hasn't yet decided which system of stereo multiplexing it will authorize.

The possibility of nationwide stereo FM broadcasting received a big boost when the National Broadcasting Co. asked the FCC for permission to broadcast stereo experimentally using a multiplexing system on WRCA-FM, New York. NBC is expected to test the so-called "compatible" or sum-and-difference system of stereo multiplexing developed by Crosby Laboratories, Syosset, N. Y.

In this method of multiplexing, the main FM channel carries the complete program (or sum of "left" and "right" signals). The multiplex subchannel contains the "difference" signals. A filter network in the receiver or converter separates the "left" and "right" signals and distributes them to the proper amplifiers. An FM receiver without a converter will receive only the main channel—or sum of both the "left" and "right"—providing monophonic reproduction of the full program.

Several FM stations are on the air with experimental multiplexed stereo. WBAI and WFUV, New York, are transmitting "compatible" stereocasts. WGHF, Brookfield, Conn., and others are using a "straight" multiplexing system in which one channel of the sound is carried on the main FM channel, the second on the multiplex subchannel.

ELECTRONICS will play a major role in the generation of atomic power by the fusion method—as much as 50% of the required equipment being electronic. A "test track" for nuclear fusion research will be built at Princeton University by the Allis-Chalmers Manufacturing Co. and RCA (model shown was displayed at the international conference on atomic energy in Geneva).

In the fusion method of generating power, a low-pressure gas or "plasma" (derived from deuterium) is heated to 100,000,000°F—10 times hotter than the sun—in a high vacuum. In the Princeton fusion installation, twenty 500-kw electron tubes, at frequencies near 100 mc, will do the heating. Dc power generators for the project will deliver about 200 megawatts peak power.

"MOON BOUNCE" SIGNALS have been received by at least 30 people, and possibly 60 or more, according to the US Army Signal Engineering Laboratory at Fort Monmouth, N.J., which is aiming radar signals at the moon with 1.2 megawatts of radiated power (RADIO-ELECTRONICS, August, 1958, page 6).

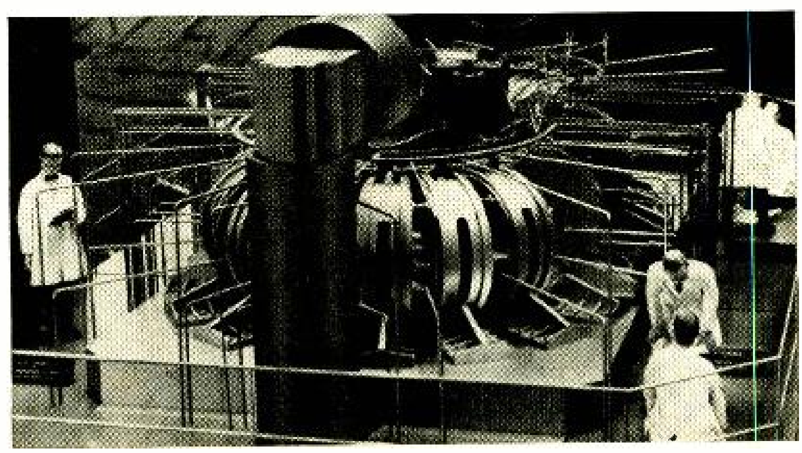
Responses to its Diana project have come from the US, Europe and Latin America, a laboratory spokesman said. The moon radar has been operating on frequencies of 108 and 151.11 mc, and the laboratory has been sending QSL cards to amateurs who report the conditions under which they have received the signal.

During November and December, the moon radar pulses will be on 413.25 mc. Readers who pick up the signals may send a listener's card to Diana, c/o RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N. Y. The information will be forwarded to the Signal Corps and will be acknowledged with a moon radar QSL card.

TWO ELECTRONIC DEVICES to help solve the problem of headlight glare are being offered as extra equipment on all 1959 Chrysler-built cars.

A self-dimming inside rear-view mirror (see diagram page 10) automatically flips upward to deflect the glare of headlights from a car following closely behind. A small opening in

(*Continued on page* 10)



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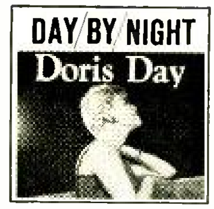


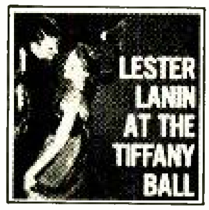
2 Moonglow, The Lamp is Low, 10 more

4 Original and best recording of this hit

16 Jealousy, High Noon, 10 more songs

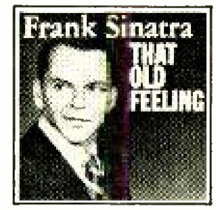
7 Where or When, Be My Love, 10 more

9 Six thrilling overtures and marches

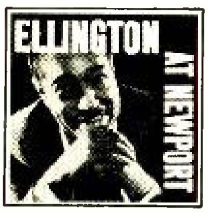


19 Almost one hour of dance music

14 Complete score includes 16 numbers

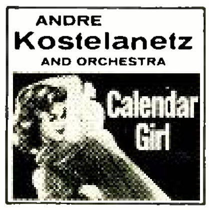


5 Mean to Me, Blue Skies, 10 more

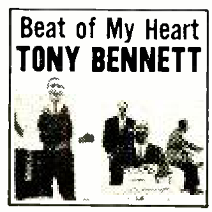


10 The Duke reaches new heights

17 Classic portrayal of the 4 seasons



12 Laura, Stella by Starlight, 10 more



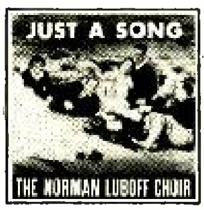
22 Tony with a wonderful beat

15 Two truly virtuoso performances

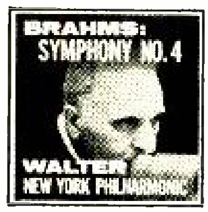
13 2 lovely works—superbly performed

21 Four melodic works for strings

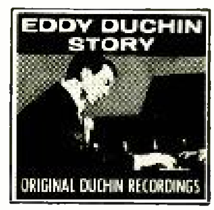
20 Suave arrangements of 14 numbers



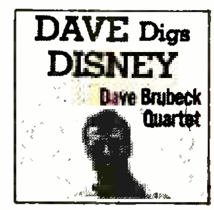
11 Whiffenpoof Song, Aura Lee, etc.



23 A great work—a grand performance



18 Duchin's 15 finest performances



24 Dave works over six Disney tunes

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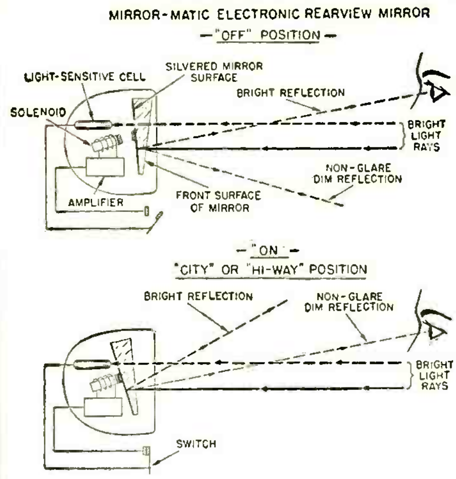
4. South Pacific—Orig. Broadway Cast
5. Frank Sinatra—That Old Feeling
6. Dvorak: New World Symphony
7. 'S Marvelous—Ray Conniff
8. Erroll Garner—Other Voices
9. Rossini: William Tell Overture, etc.
10. Ellington at Newport
11. Norman Luboff Choir—Just A Song
12. Andre Kostelanetz—Calendar Girl
13. Schubert: "Unfinished" Symphony; Mendelssohn: Midsummer Night's Dream
14. My Fair Lady—Orig. Broadway Cast
15. Paganini & Saint-Saens Violin Concertos
16. Frankie Laine—Command Performance
17. Vivaldi: The Seasons
18. Eddy Duchin Story
19. Lester Lanin at the Tiffany Ball
20. Percy Faith—Gershwin Hits
21. Strings of Philadelphia Orchestra
22. Tony Bennett—Beat of My Heart
23. Brahms: Symphony No. 4
24. Dave Brubeck Digs Disney

L-20

NEWS BRIEFS (Continued from p. 6)



the surface of the mirror admits lights to a photo-cell mounted in the rear of the mirror housing. When light intensity reaches an objectionable level, current from the cell activates an amplifier tube which energizes a solenoid, pulling the mirror prism a few degrees upward to give a secondary dim image.

The mirror is wired through the headlight system so it works only while the lights are on. A two-way "city-highway" switch adjusts the sensitivity of the circuit so that the mirror won't dip in response to street lights in city driving.

The second anti-glare device is an improved headlight dimmer using a circuit of 2 transistors and one 12-volt tube. The principal innovation is a "red-sensitivity" circuit which dims the headlights in response to the taillights of a car being followed.

The dimmer's sensitivity is adjustable by a driver to a range of 900-1,200 feet for headlights of approaching cars and 200-500 feet for taillights. The dimmer may be overridden at any time by a foot switch.

SPUTNIK TV RELAY may now be under construction in Russia to extend Soviet television to 2.2 billion people in Europe, Asia, Africa and Australia. An article in the Soviet magazine *Knowledge Is Strength* states that the principle has been officially endorsed by the Government and that "this launching can be readied and carried out now."

The article says the relay satellite would be placed in orbit 22,350 miles high, where it would move at the same speed as the earth—in effect staying in one spot with relation to the ground beneath it. The authors say a 2-kw relay transmitter would be adequate, getting its power from solar batteries at first, and later from small nuclear reactors.

The cost would be far less than building thousands of TV transmitters and relay stations, even if each relay satellite lasted only a year.

FUNDAMENTAL ELECTRONICS course for hams will be broadcast weekly over the First US Army Military Affiliate Radio System (MARS) network. Beginning Wednesday, Nov. 5, the 25-week

(*Continued on page* 14)

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NEWS BRIEFS *(Continued from p. 10)*

series will be heard every Wednesday, 8–9 p.m., EST, on 4.03 mc.

The course is sponsored by the US Army Signal School at Fort Monmouth, N. J. A complete schedule may be obtained by writing Chief Warrant Officer Herbert M. Huffman, MARS Director, Signal Section Headquarters, First US Army, Governors Island, New York 4, N. Y.

Calendar of Events

Hi-Fi Show, Oct. 29–Nov. 1, Windsor Hotel, Montreal, Canada.
Electron Devices Meeting, Oct. 30–Nov. 1, Shoreham Hotel, Washington, D. C.
International Hi-Fi Show, Nov. 7–9, Detroit Leland Hotel, Detroit, Mich.
Hi-Fi Musical Show, Nov. 7–9, Hotel Paxton, Omaha, Neb.
Conference on Electrical Techniques in Medicine and Biology, Nov. 12–14, Nicollet Hotel, Minneapolis, Minn.
Hi-Fi Fair—Nov. 14–16, Hotel Carter, Cleveland, Ohio.
Northeast Electronics Research and Engineering Meetings, Nov. 19–20, Mechanics Hall, Boston, Mass.
Hi-Fi Show, Nov. 21–23, New Washington Hotel, Seattle, Wash.
Electronic Computer Exhibition, Nov. 28–Dec. 4, Olympia, London, England.
1958 Mid-America IRE Electronics Convention, Dec. 9–11, Kansas City Municipal Auditorium, Kansas City, Mo.
2nd National Symposium on Global Communications, Dec. 3–5, Colonial Inn, St. Petersburg, Fla.

FIVE NEW TV STATIONS have begun telecasting since we last reported:

WFPK-TV, Louisville, Ky. 5
WJCT, Jacksonville, Fla. 7
KAYS-TV, Hays, Kans. 2
WTAE, Pittsburgh, Pa. 4
KWGB-TV, Goodland, Kans. 10

The same number went off the air:

WBLN, Bloomington, Ill. 15
KFSA-TV, Fort Smith, Ark. 22
WNOW-TV, York, Pa. 49
WVUE, Philadelphia, Pa. 12
WILK-TV, Wilkes-Barre, Pa.....34

The following call letters changed:

WJXT, Jacksonville, Fla. 4
(formerly WMBR-TV)
WMTW-TV, Poland Springs, Me. 8
(formerly WMTW)
KXMC-TV, Minot, N. D. 13
(formerly KCBJ-TV)
WNEW-TV, New York, N. Y..... 5
(formerly WABD)

Although the count remains the same for the US, 538, there are now 451 vhf and 87 uhf stations, including 32 noncommercial.

With the addition of:

CKBL-TV, Matane, Que. 9

Canada has increased its total to 54.

DR. ERNEST O. LAWRENCE, Nobel Prize-winning developer of the cyclotron and the inventor of the Lawrence one-gun color TV picture tube, died in Palo Alto, Calif., following surgery. He was 57. At the time of his death he was director of the University of California Radiation Laboratory. His color tube, which promised a less expensive approach to color television, has never been produced in quantity, but Allen B. DuMont Laboratories currently is doing further development work on the Lawrence tube and an associated color receiver. END

Correspondence

HARMONIC CANCELLATION

Dear Editor:

In his article "Special Amplifier Circuits" (August, page 40), Herbert Ravenswood states that "curvature in the 12AU7 . . . introduces second-harmonic distortion, which will ultimately cancel in the output stage."

Doesn't a push-pull amplifier cancel only even-order harmonics generated within that stage? A distorted input should still give a distorted output.

Mr. Ravenswood is further concerned with second harmonics of second harmonics. Since these are also even-order harmonics, why would they not also be canceled?

GEORGE REIS

Milwaukee, Wis.

(Mr. Reis' letter was referred to Mr. Ravenswood for comment.—*Editor*)

Dear Editor:

Mr. Reis is not the only one to question these points, so I am glad of this opportunity to set things straight for the record.

The first statement he questions depends to some extent on the way the push-pull amplifier functions. In its simplest form, each "side" of the amplifier operates as a separate amplifier unit, using a common power supply. The signal paths are almost completely separate from the phase inverter through to the output transformer, where they are recombined. In this arrangement, my original statement stands true: recombination will cancel equal quantities of second harmonic, wherever along each amplifier they are generated.

In some amplifiers, larger-than-usual common impedances are included in the coupling, along with deliberate large amounts of feedback for the spurious in-phase components. This arrangement helps maintain balance very closely at all stages and does, to some extent, reduce second-harmonic components being generated along the way. But recombination at the output will still cancel any second-harmonic components, so long as they are equal and opposite in phase.

So curvature introducing second-harmonic distortion anywhere along a push-pull amplifier will ultimately cancel at the output. But other distortions may creep in which do not cancel.

On this second point a little further elaboration seems necessary. Curvature can be expressed in terms of a power law. A curve that will add simple second harmonic could be written

$$y = A(x + ax^2)$$

where x is input, y output, A amplification of the stage, and a is the second-harmonic distortion coefficient.

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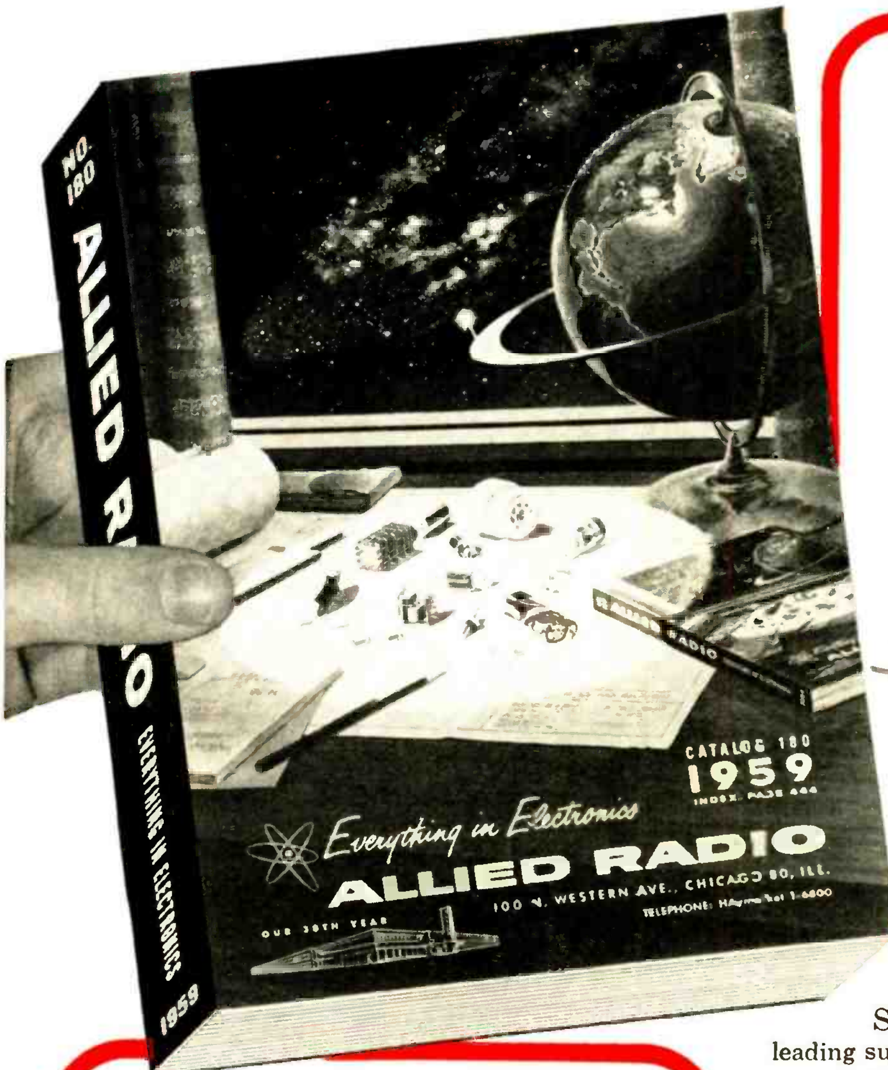

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Passing this through a second stage, also producing second-harmonic distortion in opposite phase, can be written

$$z = B(y - by^2)$$

where z is the final output and B, b have similar significance to A, a in the first expression.

Now, writing the final output in terms of the original input, we get by substitution:

$$z = AB\ (x + ax^2) - ABb\ (x + ax^2)^2$$
$$= AB[x + (a - b)x^2 - 2abx^3 - a^2bx^4]$$

Notice that this has terms *up to* the fourth. The term in x^2 will produce the usual dc and second harmonic. The term in x^3 produces a fundamental component and third harmonic. The term in x^4 produces dc, second and fourth harmonics. For small orders of distortion, the second harmonic disappears when a = b. This leaves the major component as *third*, with a smaller component of fourth.

Consequently, my original statement would better read that second harmonics of second harmonics will produce components *up to* the fourth. While fourth may be canceled in the output recombination, the third definitely cannot be.

To illustrate with numbers: if a and b are both 5%, the analysis works out as follows: second, .00625%; third, 0.125%; fourth, .0015625%. Thus third is quite obviously the most serious remaining component.

A further interesting point is that compounding curvatures in this way, using terms in x^3 that yield third harmonic individually, produces an expression with terms *up to ninth*, including only odd orders.

HERBERT RAVENSWOOD
New York, N. Y.

STAND UP AND BE COUNTED

Dear Editor:

The TV service industry is a paradox:

On the one hand you have many individuals who are dedicated to their profession, studying to keep abreast of latest developments in their field, always striving to have the latest and most up-to-date equipment, maintaining the highest standards of integrity, and occasionally losing money on "tough dogs" for the personal satisfaction of a job well done.

On the other hand you have some nontechnical shop owners, some appliance store owners and (so-called) cut-rate service operators whose only purpose is to peddle their wares or services without assuming the responsibility of maintaining a high-quality and high-integrity service operation.

The latter TV shop gives the entire service industry a black eye because of its inability to fix a set in the shortest possible time and without using unnecessary parts (or its dishonest practices). Many sets are not fixed properly, but still the customer invariably winds up with a large repair bill.

Now you may say that this type of operation drives service business to the better shops; well, to a small degree you are correct. But since the layman is not able to distinguish a qualified shop from a makeshift one, he is not in a position to switch to a better shop.

Therefore, what usually happens is this: People are scared away from service shops in general because of the incompetence of a few. Good service potential is lost as the incompetent shop informs its customer that the set cannot be fixed, or that it is cheaper to buy a new one.

Since my article, "The Facts About the Cost of TV Repairs," appeared in the June 28 *TV Guide*, I have been swamped with mail from TV owners. The majority of the letters were concerned with the problem of how to tell a qualified shop from a makeshift one. This avalanche of mail drove home to me the point that the real backbone of our industry, the dedicated technician, can never obtain the respect and economic standing that he so sorely deserves—unless we make a concentrated effort to accredit all qualified shops on a national basis.

Now that we are in the era of color TV, I think it is a fitting time for a national fellowship of qualified technicians to work toward this objective. I shall be most happy to cooperate with sincere service organizations and individuals willing to work for this objective. Stand up and be counted!

We should also work with state and municipal law enforcement agencies to help expose known dishonest operators.

As individuals we must bring the Ten Commandments into the marketplace for world peace—yes, world peace starts at home. We must not be satisfied with just what is legally right, but must insist on what is *morally* right.

Hudson Falls, N. Y. MELVIN COHEN

TV SERVICE BLUES

Dear Editor:

When I broke the vhf fine tuner dial cord on my 1957 RCA 21D744, I called a "basement repair man" who put on a new one. It lasted long enough for me to tune in two stations. A recall resulted in a second repair which lasted about the same length of time. Charge: $3.

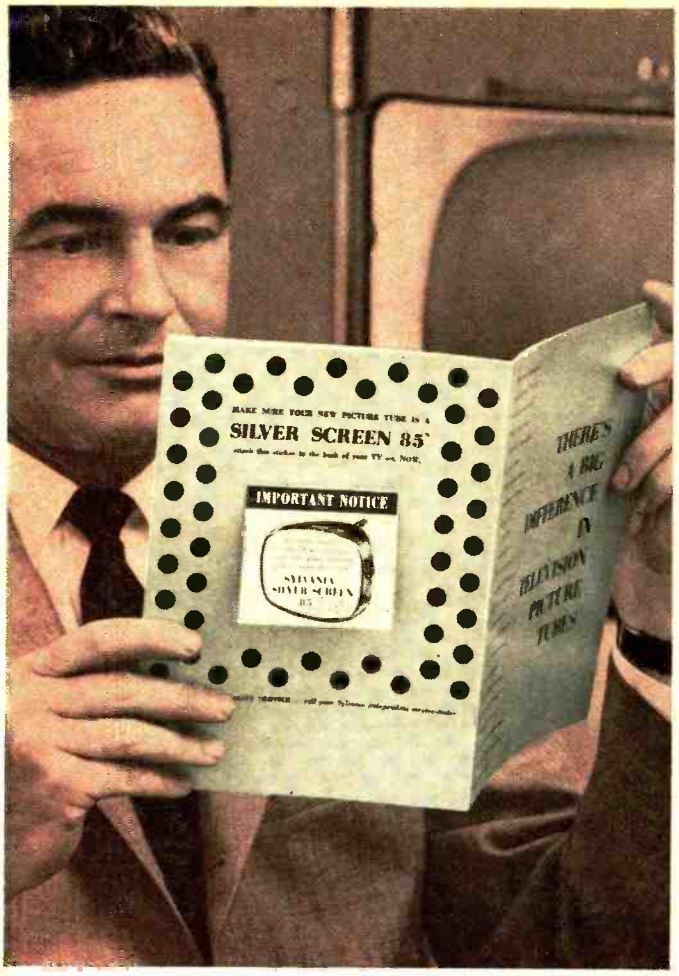
I then called on my dealer. He pulled the set into the shop and installed a new cord. It slipped from the time I touched the dial. After a heated session, he returned the set to the shop and soldered a bronze cable in. It broke the first evening. Charge: $15.

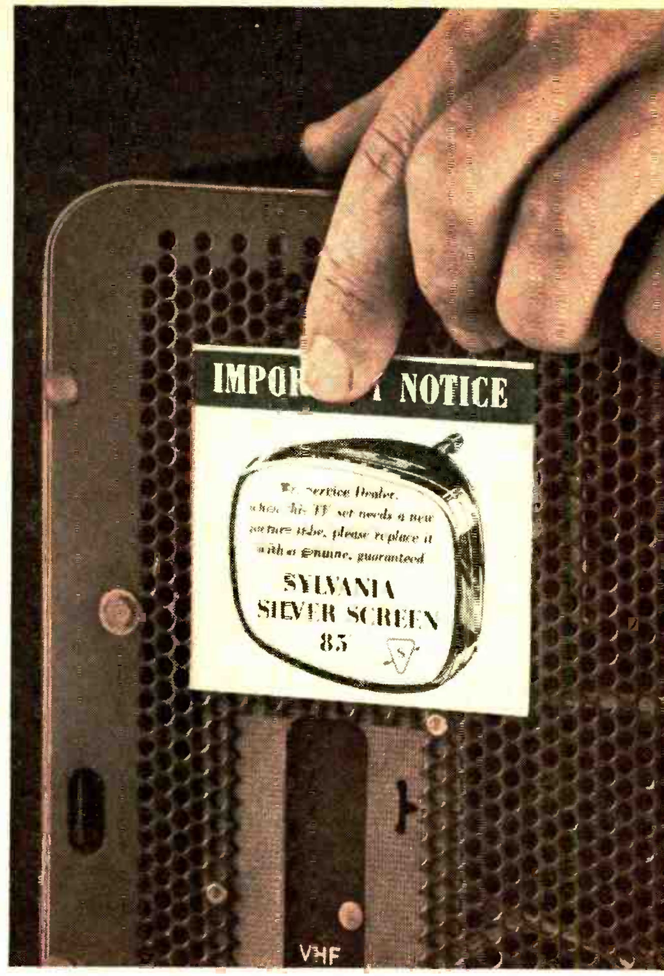
I then called in a second dealer. He took the set in and cleaned off the solder and added an idler pulley—the cloth type—which lasted an evening. After a recall he put some "gook" on the belt and gave it more tension. Charge: $16.

It is still slipping. I will have to put one on myself to get it right. Thirty-four dollars and six service calls is just a little too much for me!

Rochester, N.Y. ROBERT Z. BARNEY

END





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In layman's language, this booklet details the difference between Silver Screen 85 and cut-rate off-brand tubes. It's chock-full of facts as they were revealed in Sylvania's recent test of a nationwide sample. What's more, there's a handy sticker on the back of each booklet for the customer to attach to the back of his TV set. This is your signal that he's *presold up* to Silver Screen 85.

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OPPORTUNITIES IN ELECTRONICS

... Enterprise and Imagination the Keys to Electronics Fortune ...

READERS frequently query the editor on opportunities in electronics today. They wish to go into the electronics business but do not know how to proceed. It is always difficult for an outsider to advise young men who wish to embark on a new undertaking in a new field. There are many requirements: education, ingenuity, enterprise and imagination, not to forget what is known in the vernacular as "guts." Even more important is the requirement of a nucleus—a *central idea*. Upon this a plan of action can then be evolved readily. Incidentally, no two persons will proceed exactly alike—the final how-to-do-it changes with each individual.

What about capital? Many successful beginners had little or none, but they were able to convince others of their integrity and ability and usually had little difficulty securing the money required. It is felt that rather than editorialize further on the subject, we should give some concrete examples of how others embarked into electronic enterprises. The factual thumbnail sketches of several outstanding men who made good might serve as a valuable guide to those who are seriously thinking of entering on an electronic business career.

MILTON JERROLD SHAPP, of Philadelphia, Pa., was a 34-year-old manufacturers' representative and a graduate engineer. At a "bull session" between technical discussions at the 1947 IRE show, Shapp conceived the Jerrold Electronics Corp., a firm which now does a business of over $5,000,000 a year. He discussed the idea of building a master antenna for use with a number of TV sets. After a year of discussion and study, Shapp formed the Jerrold Corp. with $500 in capital, and then designed and developed a multiset coupler. Today, he probably sells more master antenna systems than all other companies combined. Not only did he build master antennas—Shapp and his group proceeded to build community TV antennas to bring television to those in "shadowed" towns, in a similar manner that people receive telephone and power service. Today, more that 2,000,000 viewers in more than 600 communities receive their television service via community antennas, and Shapp claims that more than 85% of these systems use Jerrold Electronics Corp. equipment.

ALEXANDER M. PONIATOFF, of Redwood City, Calif., was a Russian political emigré who lived in Shanghai until 1927. A veteran of the Imperial Russian Navy, he emigrated to San Francisco where he became a General Electric development engineer and later worked for Dalmo Victor. He founded the Ampex Corp. in 1944 and manufactured precision electric motors for the Armed Forces. The first three letters in the name Ampex are his initials.

At the end of World War II, his concern was left without customers, and Poniatoff looked around for a new civilian product. He knew of the German successes with tape recording and, after scientific study, he turned his scientists and engineers to tape development. While his tape recorder was not the first in the US, it was one of the first to achieve the necessary fidelity for radio broadcasting. Bing Crosby tried it and decided to tape his shows prior to broadcasting. Thus began the tape revolution that changed radio broadcasting and phonograph recording methods almost overnight. Next, Ampex, despite its success and growth in the audio field, under Poniatoff's guidance determined to apply the same techniques to TV. They developed the first video tape recorder to be put to practical use. It was announced in 1956. Today, over 100 of these $45,000 machines are in use, yet Poniatoff looks to still further uses of these wide-band magnetic recorders in TV, motion pictures, instrumentation, the military and space. Ampex today is a $19,000,000 company.

BEN ADLER, of New Rochelle, N.Y., having worked with RCA and risen to manager of its test and measuring department, founded Adler Communications Laboratory in small rented headquarters in an unused shipyard in 1947. Convinced there was a need for a low-powered TV repeater for sparsely settled areas, he coined the word "translator," subsequently adopted by the FCC in its standards. To date he has produced 160 uhf and vhf translators now in use in the US, Canada, Mexico, Cuba, Brazil and Guam. His company is still the sole manufacturer of TV translators.

Adler Communications Laboratory now occupies a modern 4-acre research and development and manufacturing facility and has produced such diverse items as missile testers for the Navy, a complete 50-kw broadcast station on wheels for Radio Free Europe, a mobile communications system for use by the Atomic Energy Commission at the Nevada Proving Grounds. The company's willingness to attack tough problems has resulted in the addition of a half-dozen new products to the company's line in the past year.

MARTIN M. DECKER, Philadelphia, Pa., had no formal scientific training, but his experience in the Air Force convinced him there was going to be "unlimited opportunity for the development of electronics in many different directions." In 1951, in a small room in Philadelphia, he founded the Decker Aviation Corp., now the Decker Corp. which occupies a 9-acre site at Bala-Cynwyd, Pa., with more than 100 employees. The company's first business was modifying aircraft instruments for the US and Canadian Air Forces. In 1956, Decker refused a $5,000,000 offer for his company.

Among the devices developed by the Decker Corp. is the T-42 ionization transducer, a tiny glass tube which converts a mechanical change into a proportional electrical signal which can be recorded or used to open or close circuits. Then the company developed instruments utilizing the transducer for use in the Navy's IGY Aerobee-Hi rocket for measurements of outer-space atmospheric pressure, and for use in a rocket-borne capsule to record cosmic-ray data, 2,000 miles out in space. It is the heart of a flight simulator for intercontinental ballistic missiles, and, in medical electronics, it is used in the Decker Cardiodynameter, for body measurements in diagnosing heart and circulatory ailments. In addition to this, the CAA is considering equipping planes with a Decker system to help prevent mid-air collisions. Decker's work is in research and development only; manufacturing is done by others under subcontract. Last year's sales were more than $1,500,000.

DAVID F. SANDERS, of Plainfield, N.J., was one of three former Western Electric engineers who, shortly after World War II, founded Stavid Engineering Co. with a small research project for the Navy, which subsequently developed into a $200,000 design contract. Starting with a total of $10,000, which represented the savings of all three this year the company, specializing in military electronics is expected to realize $14,000,000 in sales. Stavid, under the leadership of Sanders, pioneered the "team system" of military contracting, and last year the Air Force's first major contract awarded on a team bid went to a group

(*Continued on page* 144)

Measuring cloud cover makes long-range weather reports possible, but it takes a lot of electronic gear crammed into a 20-inch sphere to do it

SATELLITE MEASURES CLOUD COVER

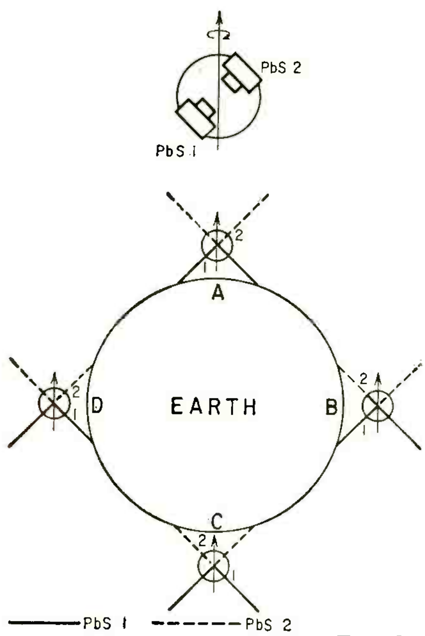


Fig. 1 — Photocell orientation at various points of the satellite's orbit.

By EDWARD RICH, JR.*

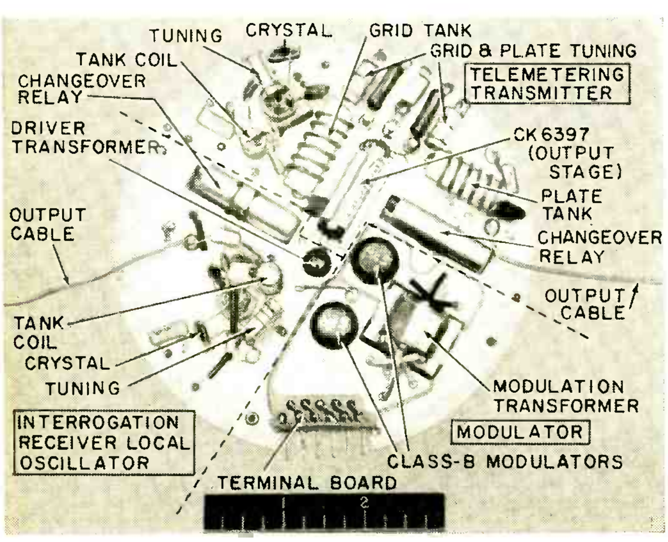
MANY contributions to the field of meteorology are being made in the IGY program. With the rapid advances of civilization, the need for reliable long-range weather predictions has increased. It is extremely important to know of impending major storms, hurricanes and typhoons, and their origin, speed and direction.

An electronic package has been designed at the US Army Signal Engineering Laboratory, Fort Monmouth, N. J., which will furnish sufficient cloud structure detail to enable meteorologists to plot the formation and movement of such storms. The package will be installed in a 20-inch sphere weighing 21 pounds. This *cloud-cover satellite* is designed to be launched in a Vanguard rocket.

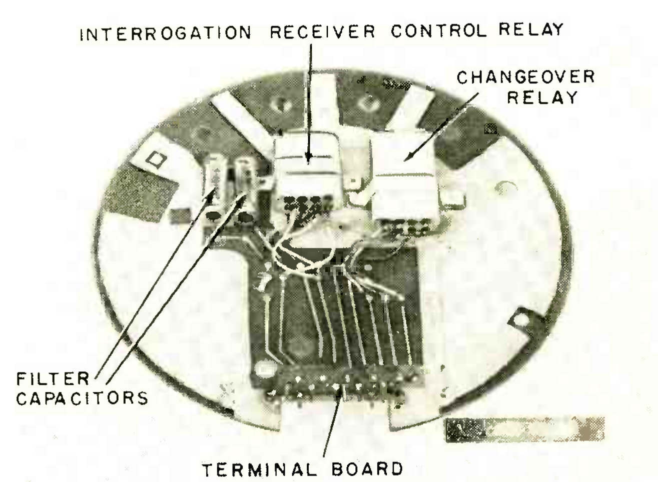
The sphere is gold-plated both inside and out to reduce heat radiation losses from the internal package. But if the finish were 100% reflective, instrument temperatures would be too low for reliable operation. To adjust the amount of solar heat absorbed by the sphere, keeping instruments at operating temperatures, a dull film of silicon monoxide is deposited on the outside.

The basic operation of the cloud-cover instrumentation is not complicated. Light-sensitive lead sulphide cells in

* US Army Signal Research & Development Laboratory, Fort Monmouth, N. J.



The transmitter deck.



The relay control deck.

Ready to launch, the polished satellite is handled with soft gloves to avoid marring its finish.

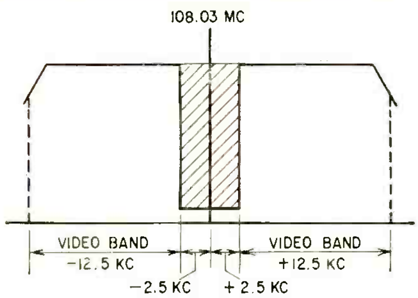


Fig. 2 — Transmitted signal response showing CW portion used for tracking.

the optical system convert the reflected light from the earth's cloud cover into electrical signals. The optical system consists of a pair of photosensitive detecting elements, which rotate around the sphere's axis (the vertical arrow running through the sphere) as it orbits. When the satellite is in position A, PbS 1 (1 in Fig. 1) scans the earth while PbS 2 (represented at 2) scans space. In position B, PbS 1 and 2 alternately scan the earth and space. When the satellite reaches C, PbS 2 scans the earth and PbS 1 space. At D, both cells again alternately scan the earth and space. So each of the detecting elements scans the earth, space, or earth and space, depending on the satellite's orbital position. The reflectivity, or *video* as it is called, of the surface scanned is translated into electrical signals. These can be interpreted in terms of the amount of cloud coverage over the area scanned. The signals are recorded on magnetic tape. When the satellite passes over a ground receiving station, the tape is played back and the information telemetered to the ground. A record–playback ratio of 1 to 50 compresses 50 minutes of daylight recording into the 1-minute period when the satellite is within receiving distance of a ground station.

Tracking and telemetering

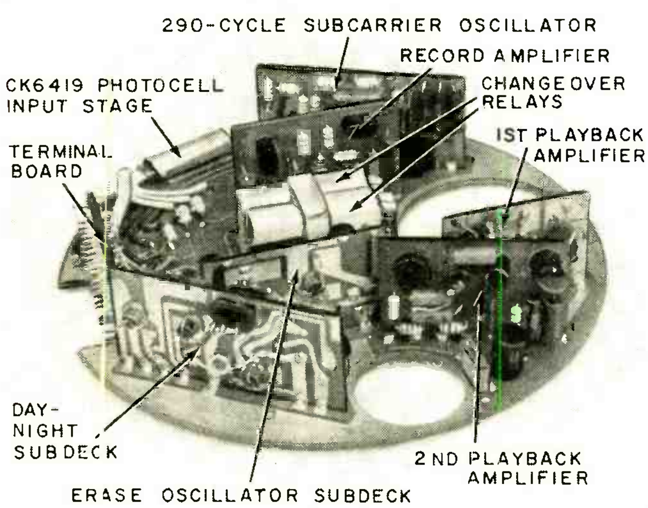
The Minitrack system has been described before (see "Electronics and the IGY, Part II," RADIO-ELECTRONICS, March, 1958, page 82). The satellite is tracked by the interferometer method of measuring the phase angles of arrival at two separate antennas. To facilitate accurate fixes, a CW carrier must be used (see Fig. 2). This carrier, within a spread of ±2,500 cycles, must be free of modulation. Since the signal-to-noise ratio for a given power determines the usable bandwidth, the power available limits the bandwidth to 15 kc. Thus, for data transmission the net bandwidth is limited to 12.5 kc.

Because of the 1-to-50 speed ratio in the tape recorder, the actual frequency deviation allowed in the recording process can vary only between 50 and 290 cycles to satisfy the conditions of modulation. For this reason a subcarrier (290 cycles) is introduced and amplitude-modulated so the 50–290-cycle signal band will be recorded. This is done by modulating the 290-cycle subcarrier with the 0–240-cycle signal band available at the photocell. The variation in amplitude becomes proportional to the amount of reflected light gathered. Essentially, only one of the subcarrier sidebands is transmitted on the upper and lower side of the carrier frequency since attenuation is high above 15 kc.

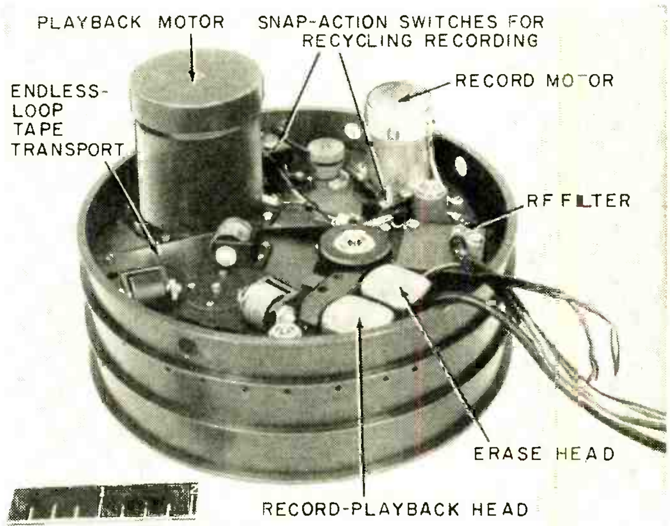
Recording (see Fig. 3): The 290-cycle subcarrier is modulated by lead sulphide cells PbS 1 and PbS 2. The resulting video information is fed through the recording amplifier and is recorded directly on magnetic tape. The recording head is also used for playback purposes as in many conventional tape recorders. A 5-kc erase oscillator presents a clean tape to the record head for each recording cycle. The tape is an endless loop and is used over and over.

The last portion of the recording system is called a day–night switch. This is an all-important power-saving circuit that switches off all unneeded circuitry while the satellite is on the dark side of the earth. This cuts power consumption almost in half and effectively doubles the life of the battery supply. The day–night switch is triggered by a bias voltage supplied by a series of solar cells mounted in the optical system. When reflected light is available, recording takes place. In its absence, the recorder and associated circuitry are on standby.

Playback (see Fig. 4): Playback is started when the satellite receives a coded pulse from a ground-station transmitter. This pulse, picked up by the interrogation receiver, triggers a relay which energizes all the control-



The main electronics deck.



The miniature tape-recorder deck.

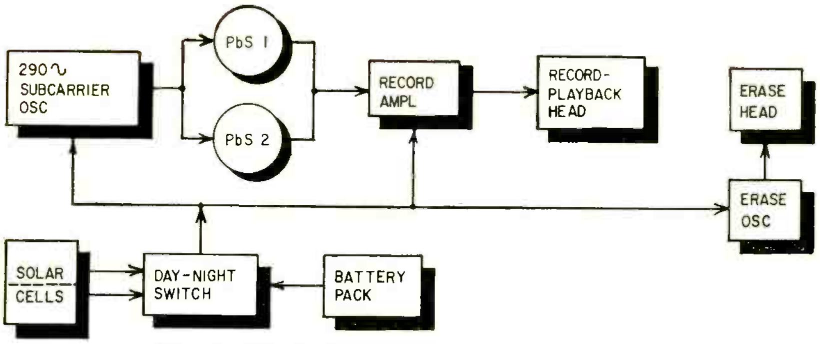


Fig. 3—Block diagram—recording operation.

ling relays. In this fashion the package is switched from record or standby to playback. The signal produced in the playback head is fed to a high-gain amplifier at the 50× speed and frequency ratio. The audio amplifier in turn excites the class-B modulator stage which produces over 1 watt of audio power. Combination plate and screen modulation is applied to the high-power telemetry transmitter. The transmitter's output, ranging from 1.0 to 1.25 watts, is capacitance-coupled to the special antenna phasing system, required to feed the four quarter-wave antenna stubs 90° out of phase with respect to each other. This results in two circularly polarized signals.

Deck assembly and function

Most of the satellite experiments being conducted for the IGY have certain features in common. Modular construction has become an accepted method of "building" the package. For this application a series of 5½-inch-diameter discs containing electronic circuitry is stacked, drawn together with bolts, and fitted to the instrumentation cylinder. Several of the satellites also carry an independent deck complete with battery supply containing a 10-mw tracking oscillator, commonly called Minitrack.

The assembled package is shown in Fig. 5. The decks are described below and illustrated in the photos.

Transmitter deck: This deck contains the high-power telemetry transmitter, push-pull class-B modulator, local oscillator for the interrogation receiver, and the relays that turn the transmitter on. The actual telemetry transmitter is a tube–transistor hybrid. A low-power transistor crystal oscillator drives two tubes (6397's) in parallel.

Interrogation receiver and relay deck: The interrogation receiver is an all-transistor, crystal-controlled, dual-conversion superhet. Local-oscillator injection is furnished by the transmitter deck. A relay deck is interfitted so relays mounted on the underside of a disc occupy waste space in the receiver deck. In this manner a set of relays is added to the package, yet its length is extended only 1/16 inch.

Main electronics deck: The main deck contains most of the electronics necessary for the experiment. Miniature subdecks are mounted vertically. Each contains a block of circuitry—the subcarrier oscillator, recording amplifiers, playback amplifiers, day–night switch and erase oscillator. The subdecks are arranged on the main deck to provide clearance holes for the tape recorder's recording and playback motors. When the two units are fitted together, the thickness of the main deck is included in the overall height of the tape recorder.

Tape recorder deck: The magnetic tape recorder was designed specifically for the instrumentation. It is one of the smallest recorders ever developed in regard to weight, size, frequency response and power consumption. On this deck is a 1-hour recorder—an endless loop, 75 feet of ¼-inch instrumentation-quality tape is used. Mechanical provisions have been made to record and erase with separate heads, record and playback with separate governor-controlled motors and automatically reset the relay system for recording at the end of a playback cycle.

Minitrack transmitter: This deck provides a 10-mw signal for tracking. Circuitry is very similar to the local oscillator and driver oscillator on the transmitter deck.

Battery deck: The last and bottom section of the instrumentation holds a number of mercury cells arranged in series and parallel combinations to supply the necessary power to operate the instrumentation for approximately 2 weeks.

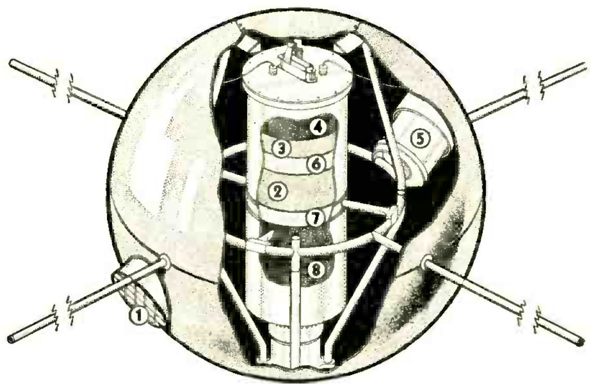


Fig. 5 — Component layout inside the cloud-cover satellite: 1. optic light baffle; 2. magnetic tape recorder; 3. interrogation receiver; 4. data transmitter; 5. photocell; 6. main deck; 7. tracking transmitter; 8. battery pack.

Construction details

All wiring, with the exception of interconnecting cables, is printed. The discs are glass-fiber epoxy laminate, copper-clad with a .00135-inch foil. A photographic process preserves the copper lines and areas needed for construction while the remainder of the material is etched away with ferric chloride. Printed lines, rf coils, tube shields and copper areas are silver-plated. The completed decks are coated with silicon lacquer prior to potting.

Damage to the foil-to-laminate bond by excessive soldering heat was eliminated by using silver-base solder with a low melting point. Dip soldering could not be used since components are mounted on both sides of the printed-circuit boards in almost every instance.

Heat distribution is an ever-present problem in all fields of electronics. It is a serious problem for builders of subminiature instruments. To dissipate and

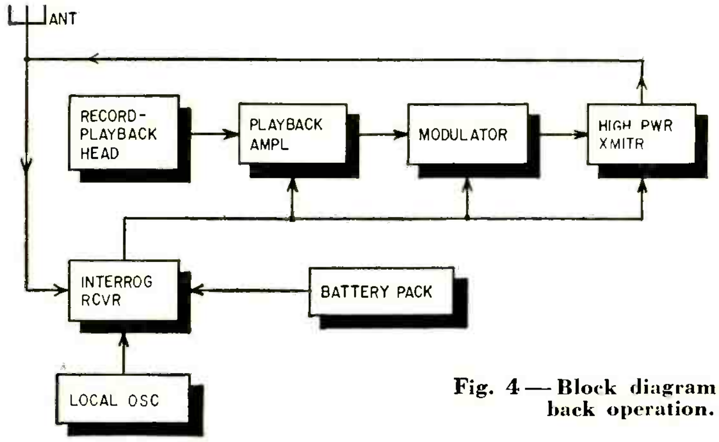


Fig. 4 — Block diagram — playback operation.

distribute the heat generated in the cloud-cover package, two basic methods were used. The first and more conventional is straight conduction from the hot element, the tape recorder, to the cylinder by multiple conduction paths. The second method, described below, is new and may find favor in other applications.

Normally, in power transistors the collector is connected to the case to facilitate good heat conduction. For this reason a metallic heat-conduction path to ground is not feasible. All the transistors, however, that generate an appreciable amount of heat do so during the 1-minute transmission period. Therefore a heat-storage system was devised. Heat sinks with sufficient thermal capacity and relatively long time constants are installed on each of the hot units. During playback, the sinks absorb the heat and slowly dissipate it into the foam potting material over the 90-minute cooling period. Using this system, temperature rise is limited to 5°C.

The potting material mentioned is technically known as "foamed-in-place plastic." Each of the decks, with the exception of the tape recorder, is potted in this material. It has a density of 12 to 15 pounds per cubic foot. Potting is performed in molds that are carefully polished and waxed to obtain a high dimensional stability along with a glazed skin finish. This potting process is fairly common in the missile field, although the potting material may differ. It eliminates failures of components due to shock, vibration and acceleration. In the 1-watt transmitter, however, the high-density material lowered the Q of the tank circuits to such an extent that output power was reduced some 20%. This loss was cut down to 1% by forming glass fiber inside the coils and prepotting the sensitive areas with 2-pound-per-cubic-foot material.

Aluminum rods hold the individual decks to the can cover. Terminal boards on each of the decks are arranged to form an intercabling channel down the side of the package. Two output connections are provided on the can cover to feed the low-power 108.00-mc and high-power 108.03-mc outputs to the antenna system. The input signal for the interrogation receiver picked up by the antenna is fed through proper filters, which are part of the Minitrack deck, to the receiver input.

A multipin connector is located in the center of the can cover to provide a way of disconnecting the batteries from the system and to allow for applying external power during a check of the instrumentation. A shorting plug is inserted into this connector and secured before launching, connecting the internal battery to the electronic circuits.

The overall package is 5½ inches in diameter, approximately 11 inches long, and weighs approximately 12 pounds. As a system it must operate over a temperature range of 0° to 60°C, and voltage variations of ±20% nominal. END

The Backward Diode

By ED BUKSTEIN

Zener diodes have applications in voltage regulation and wave clipping

MOST technicians have resigned themselves to the fact that the arrowlike symbol used to represent nonthermionic diodes does not point in the direction of electron flow. Now, to augment the confusion caused by this unfortunate choice of symbol, comes a new application for the silicon diode. In this application, the diode is intentionally connected with reverse polarity in a dc circuit.

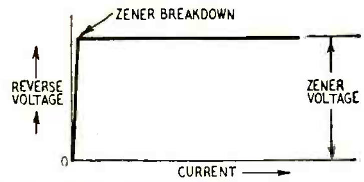


Fig. 1—Characteristic of a Zener diode when a reverse voltage is applied.

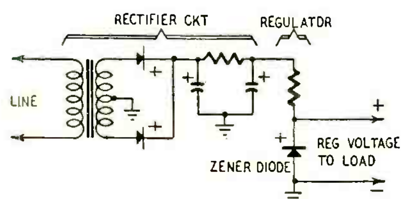


Fig. 2—Voltage drop across Zener diode remains constant even though current may vary over wide limits.

It is well known that a silicon diode has a low forward resistance and a high back resistance. Not so well known is that the back resistance suddenly decreases at a certain value of reverse voltage. The voltage required to produce this breakdown of back resistance is known as the Zener voltage. As shown by the characteristic curve in Fig. 1, the current is practically zero for all values of reverse voltage up to the Zener value. When the Zener breakdown occurs, the reverse current suddenly increases. As the characteristic curve shows, in this region the voltage across the diode is nearly independent of the current flow through it. This ability of the diode to maintain a constant voltage makes it useful in voltage reference and regulating circuits.

Fig. 2 shows how the Zener diode is connected to maintain a constant voltage across a load. Although current flow through the diode may vary, due to line voltage or load changes, the voltage across the diode remains constant. The Zener diode offers many advantages over other voltage regulating elements such as gas-filled tubes. It is smaller, lighter, mechanically rugged and has a long life. The Zener diode can be manufactured for any value of regulated voltage from a few volts to several hundred and for operating currents from a few milliamperes to over an ampere.

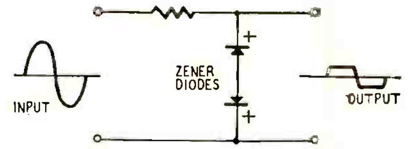
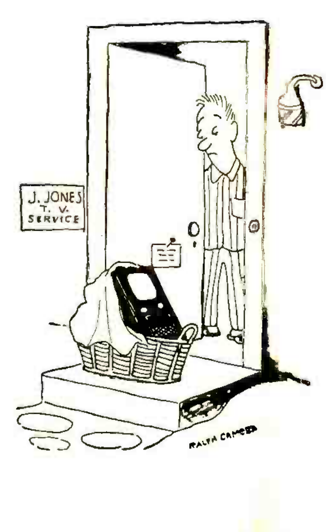


Fig. 3—Connected in opposite directions, Zener diodes clip extremes of input waveform.

In general, it is better to use several low-voltage diodes connected in series rather than a single diode of higher Zener voltage. The advantage of the series arrangement is that the total power dissipation is divided among several diodes. For this reason, temperature change in each diode is relatively small and stability is improved.

Fig. 3 illustrates the possibility of using two Zener diodes in a squaring or clipping circuit. The two diodes are connected in opposing directions so that they break down on opposite alternations and prevent the output from rising above the Zener value. The Zener diode is a relatively recent development and many other uses for it will be forthcoming.

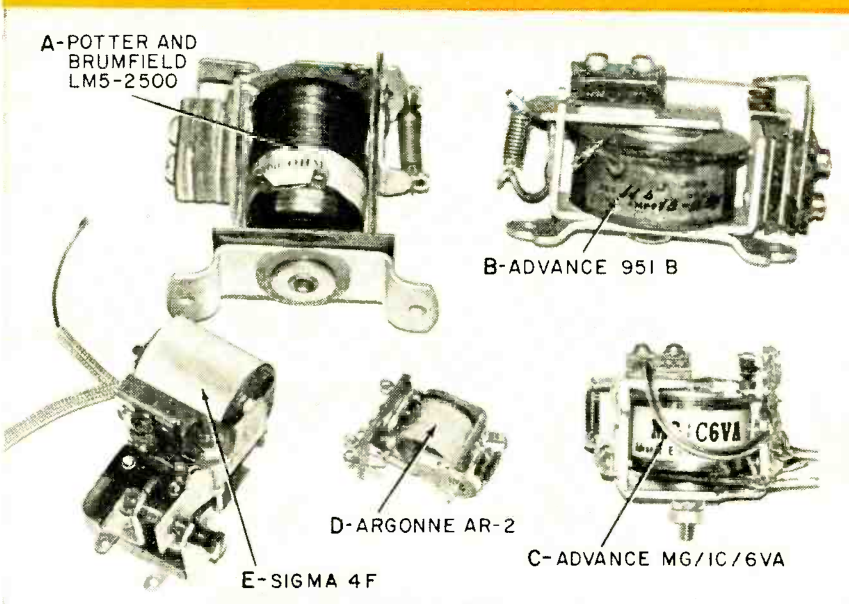
[Numerous Zener (voltage-reference) silicon diodes are made by National Semiconductor Products, Raytheon, Texas Instruments and other manufacturers of semiconductor products and sold through distributors and mail-order radio and electronic parts supply houses. Among the silicon diodes listed specifically for voltage-regulator and reference applications are the Raytheon 1N437 and 1N438, and Texas Instruments 650C-653C and 650C0-653C9.—*Editor*] END



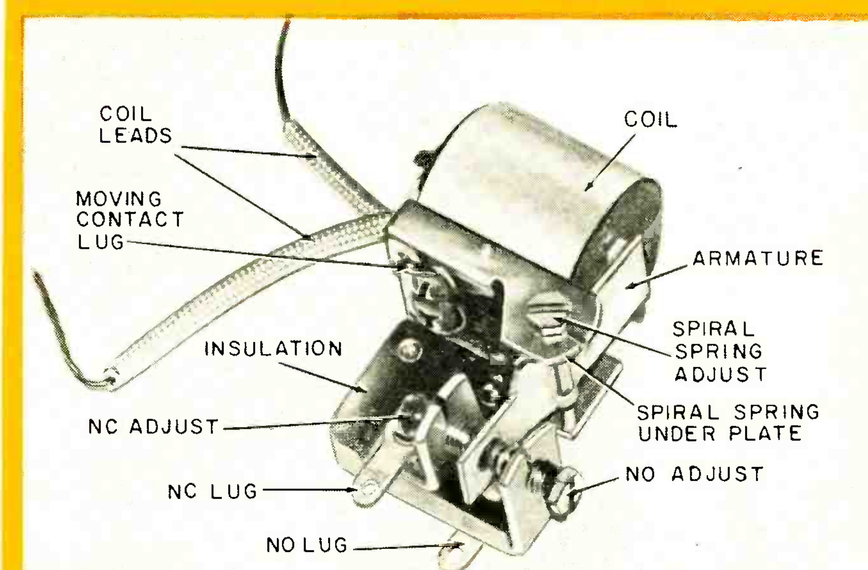
Get the MOST out of your relays

By JAMES A. McROBERTS

There are many ways of adjusting relays. The best methods and their effects are detailed for the technician and experimenter



A group of five typical relays.



A spiral spring is used in this relay.

RELAYS were once confined to control and automation but now you can find them in auto radios and TV sets. Although relatively rugged and troublefree, occasionally they do need adjusting. Considerable know-how is necessary despite the apparent simplicity of the device and its circuit (see Fig. 1). Even new units should be checked for proper pull-in and dropout points.

Relay theory

Some knowledge of relay theory is needed if you are to adjust them properly. The why of adjustments becomes understandable. All relays reduce to the basic model of Fig. 1 no matter what shape or size they may take. For example, some relays have a spiral spring supplanting the helical spring found in others. The theory remains the same even when multiple contacts or complicated stops are used.

Let's start with the relay at rest in its unenergized position. Fig. 2-a shows the relay at rest and Fig. 2-b is a force diagram of this condition. We are concerned with the spring force F_S and force F_{NC} at the normally closed contact or rather the *moments* of these forces. (The *moment* is the force times the distance from the pivot or hinge.) Con-

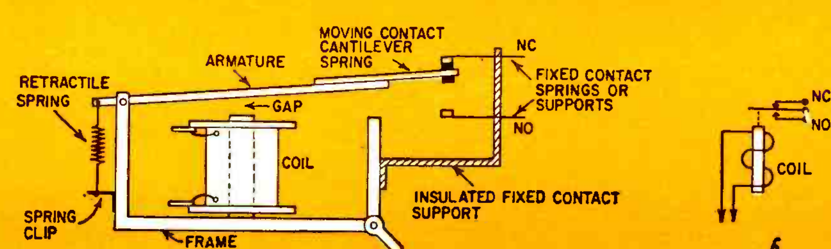
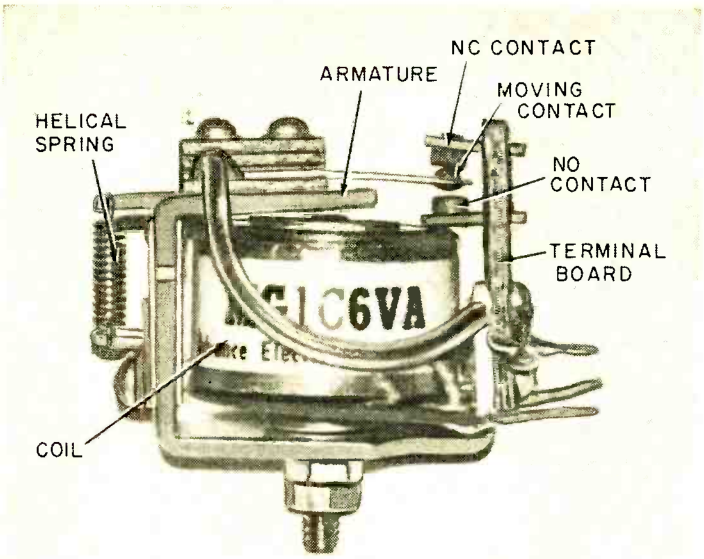


Fig. 1—Sketch of typical relay shows principal mechanical components.



Closeup shows the helical spring usually used in relays.

tact (NC) moment counterbalances the spring (F_S) moment—disregard the equal and opposite forces on the fulcrum hinge or pivot and the residual core magnetism force F_M for now.

Current flowing through the relay coil applies a magnetizing force to the magnetic structure. It tries to force a magnetic flux through the core, armature and gap (sometimes several gaps, but always including one at the hinge). The flux across the armature gap produces a mechanical pull (F_A) at the same point as F_M (see Figs. 2-c, 2-d). The moment of this force tends to rotate the armature. When force F_A is large enough (due to increasing current) to overcome F_S with the aid of F_{NC} (contact pressure) the armature starts to move. Stage 1 of the operate cycle now ends.

Armature motion narrows the gap and the flux increases, producing a greater mechanical pull (F_A). (Total reluctance decreases because of narrowing gap.) Pull increases even if current remains constant. This is stage 2.

Stage 3 of operate is a buildup of contact pressure against the NO (normally open) contact as F_A continues to increase. Some force may be expended in flexing contact springs if the contacts are so mounted. Force of spring F_S has increased during both stage 2 and stage 3.

Stage 1 of the release cycle begins with a decrease of coil current. Force F_A and its moment decrease, too. When the other forces are overcome, the armature starts moving toward the rest position. This ends stage 1.

Note that if F_M is appreciable because of a small gap or residual magnetization, the armature may not release. The armature touching the pole piece can also keep it from releasing. This causes sticking, which is covered later.

Stage 2 is motion with the gap widening. Decrease in flux for dropping coil current lessens F_A.

Stage 3 is the buildup of contact pressure against the NC contact or flexing of its springs. Stage 3 ends with current at a minimum or zero, which is back where we started.

Testing a relay

Relays, both old and new, should be tested for the pull-in and dropout points. To do this use either of the two methods shown in Fig. 3. In dc relays the current is proportional to the voltage since coil resistance is fixed. Hence, wattage is often specified for pull-in and dropout (stage 2 current in operate and release cycles). Either method can be used to test the relay in its circuit (ammeter in series or voltmeter in shunt). For accuracy, use an ammeter whose resistance is less than 5% of the coil resistance or a voltmeter with an input impedance 20 times the coil resistance.

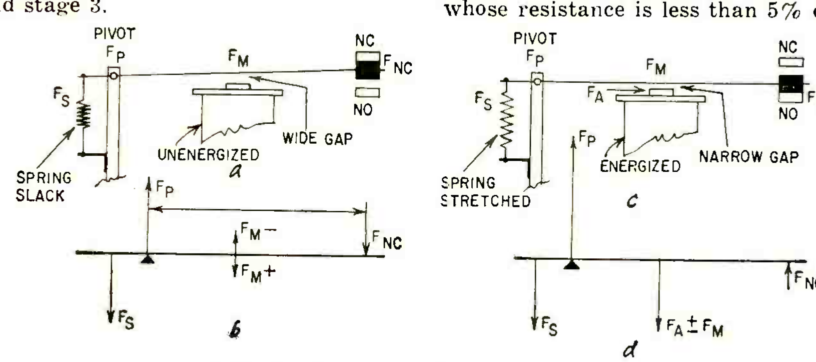


Fig. 2-a—Mechanical position of contacts and armature in rest position. b—Force diagram for Fig. 2-a. c—Contacts and armature in operate position. d—Force diagram for Fig. 2-c.

Using Ohm's law you can convert opening and closing currents to voltages across the coil or to wattage input.

The battery used in Fig. 3 should have more than twice the anticipated pull-in voltage. The rheostat (R) drops battery voltage to coil voltage—use about double the coil resistance for R. Finally, equip the working circuit with some sort of visual indicator like the lamp and battery shown or an ohmmeter to indicate relay action, either pull-in or dropout.

Range adjustment

Spring tension controls the range of the relay's critical points. Operate and release points may be doubled or halved in most relays by adjusting the spring tension. A Sigma 4F relay can be made to pull in at 3.0 ma and release at 1.5 ma or at an operate of 0.75 and dropout of about 0.3 (not exactly half due to residual magnetism).

Helical spring types may have the spring-tension adjusting nut sealed with wax. Unseal, adjust slightly, and test.

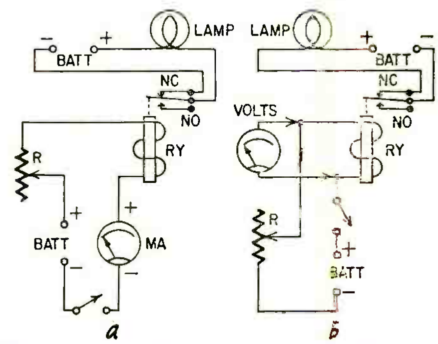


Fig. 3—Test circuits for dc relays: a—ammeter method; b—voltmeter method.

Continue to adjust and test until you are satisfied, then reseal. Spiral spring types have a similar adjustment.

Sometimes, the spring clip holding the spring to the frame may have to be bent—use a pair of needle-nose pliers. Adjust a little at a time, testing after each adjustment. Some flat springs have adjusting screws and locknuts. Others have to be formed (bent) to increase or decrease spring tension.

If spring tension is increased, more armature pull and coil current are needed to start the operate cycle. With the relay energized—armature pulled in—a high coil current is needed to hold it in at the start of stage 2 in the release cycle. Conversely, with less spring tension, pull-in and dropout occur at lower coil currents. If too little spring tension is used, the armature may not drop out at all and will stick, assuming that the armature is touching the coil core.

Fig. 4-a shows another range adjustment found on some units. A screw with locknut is provided to alter the gap between armature and pole piece. Narrowing the gap increases the flux and the pull by decreasing total reluctance

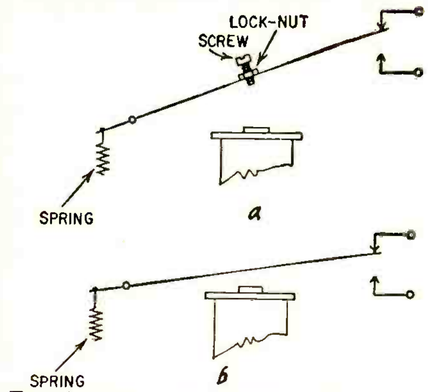


Fig. 4—Two armature-gap adjustments. See text for details.

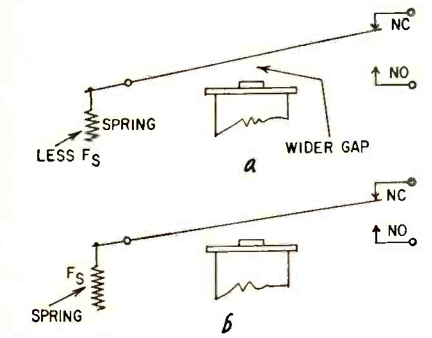


Fig. 5—How varying the position of the NC contact affects the operate point.

due to any fixed value of coil current. (Action is like decreasing resistance in an electrical circuit.) So, dropout occurs at lower current values if the gap is narrowed. Widening the gap has the opposite effect and makes this critical point higher.

Spring tension can be adjusted to supplement this action when making range adjustments. A test as indicated in Fig. 3 or in the operating circuit should always be made to define the operating points.

Fig. 4-b is still another kind of range adjustment. It can be used with or in place of preceding methods. Both fixed contacts are shifted relative to the frame while maintaining their original separation. The effect is a shift in the width of the armature to core gap as just described.

Changing the pull-in point

You may want to shift only the pull-in point. Fig. 5 gives you the general idea. In Fig. 5-a the fixed NC contact has been moved away from the NO contact. The NC contacts on some relays —such as Sigma 4F—can be adjusted with a screwdriver. To make the same adjustment on other relays, such as Potter & Brumfield LM5, the NC contact arm must be re-formed to move the stationary contact (use needle-nose pliers). The armature gap is widened for the operate cycle only, since the NO contact is not moved—compare with Fig. 5-b, the original adjustment.

When this is done, be sure that the NC contacts mate with the required pressure if they are part of the controlled circuit. Some adjustment of spring tension may be needed if a great increase in pull-in current value is desired. (The spring tension is lessened when the NC contact is moved away from the NO contact.) A readjustment of the NO contact may then be needed to maintain the same dropout value.

Moving the NC fixed contact closer to the NO contact narrows the gap, reducing pull-in current. A limit is imposed because the moving contact must be able to move sufficiently to create a contact gap large enough to break the circuit controlled by the relay. In the Sigma 4F example, the pull-in can be decreased from a factory adjustment of 1.5 ma to 0.9 ma without altering the dropout at 0.75 ma as a case in point. This adjustment, however, causes a decrease in the contact gap and to see that the contact gap is not reduced below the minimum requirement for breaking the circuit being controlled.

Dropout variation

Fig. 6 shows the effect of changing the position of the NO contact or a stop, if provided. Moving this contact (the NO one) away from the NC contact or stop lowers the dropout current value. The armature pull (relay energized) is increased, so a lower current holds the armature in position against the NO contact. A limit is reached due to armature sticking, although this may be desirable in some instances (in burglar alarms, for instance, where you may want to cut off the power to unlatch the relay or reset it without triggering the alarm).

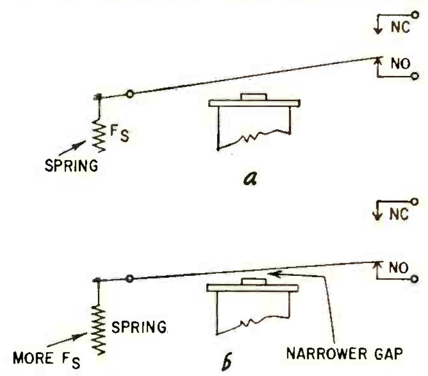


Fig. 6—Changing the position of the NO contact points varies the dropout point

Some rise in the release point is obtained by moving the NO contact closer to the NC contact. As a result, dropout occurs at a higher current.

Differential adjustment

Relay differential is the current or voltage range between the pull-in and the dropout points. In the Sigma 4F example we have the differential as the difference between 0.75 and 1.5 ma or 0.75 ma for the factory settings.

Spreading the fixed contacts apart increases the differential or the spread between operate and release values. Pushing them together narrows this range. A similar action is obtained by setting the pull-in to one current value and the dropout to another. The range adjustment may have been made previously or performed simultaneously with a change of the differential. Usually the range adjustment is made before setting the fixed contacts for a different range of values.

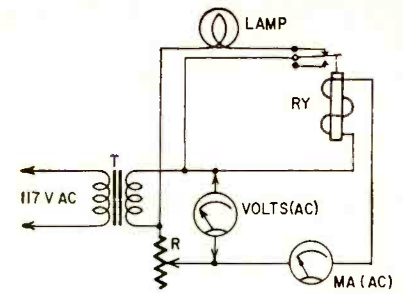


Fig. 7—Circuit for testing and adjusting ac relays.

Ac relays

Test ac relays like the dc variety. Use an ac voltmeter and ammeter with a transformer as in Fig. 7. The transformer can power the indicating lamp or device if one is not provided by the circuit.

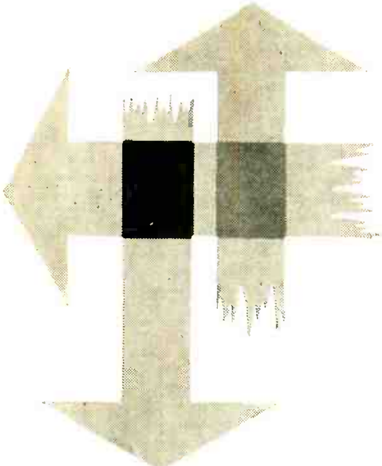
Ac relays are often specified in terms of coil voltage at pull-in such as 6, 12 or 110 volts. This means rms values. Or the coil pull-in volt-amperes may be specified with a given value of coil resistance. (Inductance is often neglected.) Allowable safe dissipation is often specified in volt-amperes, hence any calculation is similar to the dc relay. Thus a coil may operate at 6 volts with 1 ampere or 6 volt-amperes and have a safe dissipation of 9 va. So, 9 volts at 1 ampere is the maximum that should be applied.

New relays

New relays may exhibit a rather high range of critical points. Check to see that the helical spring seats in the grooves in the clip and the armature end. It may have shifted out of one or both grooves with a consequent increase in tension and range of operating values. Put the spring ends back in the slots or grooves and check again!

If a new relay has a high differential, it may be due to friction. Some friction is always present at the hinge or pivot of most relays. (The Advance type in the photo does not have a hinge, but a spring that flexes. Exclude such designs from this treatment.) If pivot or hinge friction is large, it will tend to prevent the relay from operating or releasing at the points (current values) it should. Correct by loosening the pivot bearings' adjustment screws slightly, where possible. Or apply a minute amount of penetrating and non-gumming oil to the hinge or pivot.

One word of warning, any bending or forming of contacts should be followed by a visual check for mating. Moving contact points must make parallel (flat) contact with both sets of fixed contacts. Otherwise you end up with rapid wear and a faulty adjustment. END



THREE-WAY TIMER

Agitation timer, conventional timer and counter circuits are built into this photographer's electronic right hand

By E. H. LEFTWICH

THIS versatile unit is definitely *not* just another phototimer. It was designed to take the guesswork and headaches out of agitation timing for both color and monochrome photographic film processing. It is also an excellent conventional timer for enlarging and printing and has several other useful functions. It has definitely proved to be the most useful of the electronic controls in my darkroom.

The block diagram (Fig. 1) gives a good overall idea of the timer's operation. In agitation timing, it:

1. Accurately indicates a 1-minute interval.
2. Signals with a warning buzzer or pilot light the instant the 1-minute interval is reached.
3. Immediately following the signal,

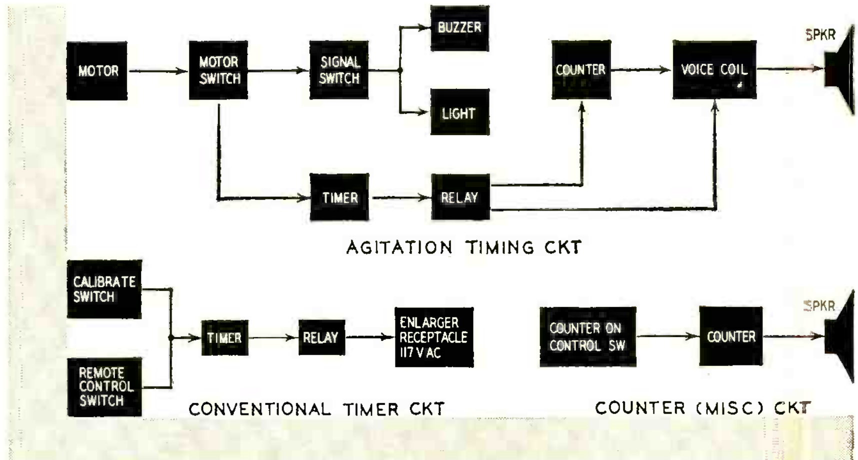
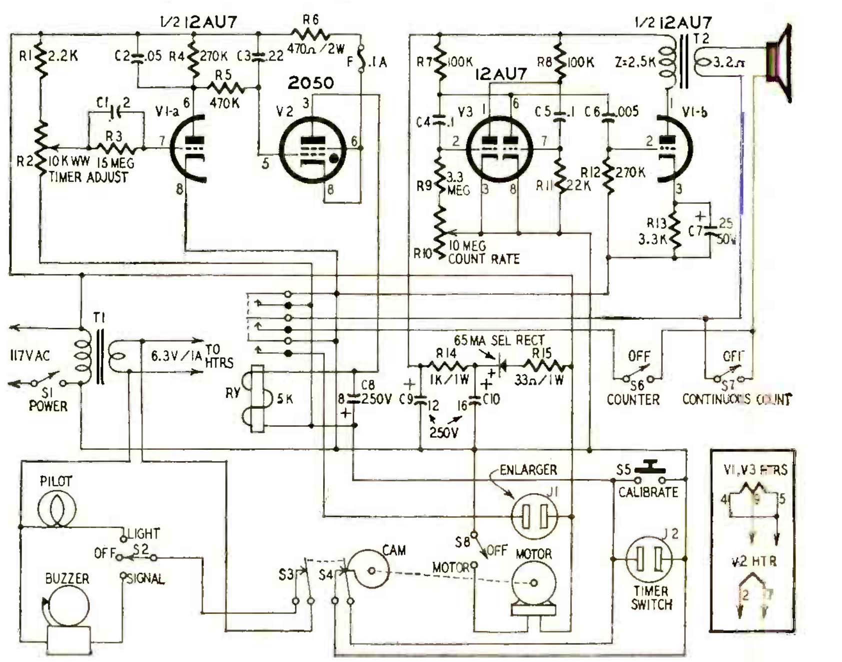


Fig. 1—Block diagram of the three-way timer.

R1—2,200 ohms
R2—pot, 10,000 ohms, wirewound
R3—15 megohms
R4, 12—270,000 ohms
R5—470,000 ohms
R6—470 ohms, 2 watts, wirewound
R7, 8—100,000 ohms
R9—3.3 megohms
R10—pot, 10 megohms
R11—22,000 ohms
R13—3,300 ohms
R14—1,000 ohms, 1 watt
R15—33 ohms, 1 watt
All fixed resistors 1/2 watt 10% unless noted, see text.
C1—2 μf, paper, 400 volts
C2—.05 μf, 400 volts
C3—0.22 μf, 400 volts
C4, 5—0.1 μf, 400 volts
C6—.005 μf, 600 volts
C7—25 μf, 50 volts, electrolytic
C8—8 μf, 250 volts, electrolytic
C9—12 μf, 250 volts, electrolytic
C10—16 μf, 250 volts, electrolytic
F—0.1 amp, 8AG
J1, 2—sockets, female (Amphenol 61-F1 or equivalent)
RECT—selenium 130 volts, 5 ma
RY—3-pole double-throw, 5000-ohm coil (Guardian 200-5000D) with contact assembly (Guardian 200-1) and contact switch parts (Guardian 200-3)
S1, 6, 7—spst, toggle
S2—spdt, center off, toggle (Cutler-Hammer 8816-K5 or equivalent)
S3, 4—switch contacts (see text)
S5—spst, momentary contact, pushbutton
T1—filament transformer: primary, 117 volts; secondary, 6.3 volts, 1 amp (Knight 62G030 or equivalent)
T2—output transformer: primary, 2,500 ohms; secondary, 3.2 ohms (Knight 62G063 or equivalent)
V1, 3—12AU7
V2—2050
Buzzer, high-frequency (Johnson 114-400 or equivalent)
Fuse holder for 8AG fuse
Motor, Telechron clock
Sockets, 9-pin miniature (2)
Socket, octal
Pilot-light assembly, with 6-volt pilot lamp
Loudspeaker, 3-inch, PM
Terminal strips, 4 lugs (4)
Cabinet, 6 x 9 x 5 inches
Chassis, 1 x 6 x 4 inches
Dial plates, 1-24 (Mallory 394 or equivalent)
Miscellaneous hardware



Note: Since the ac line connects to several points in the circuit all wiring must be insulated and all components mounted so they cannot contact the chassis.

Fig. 2—Circuit of the versatile unit.

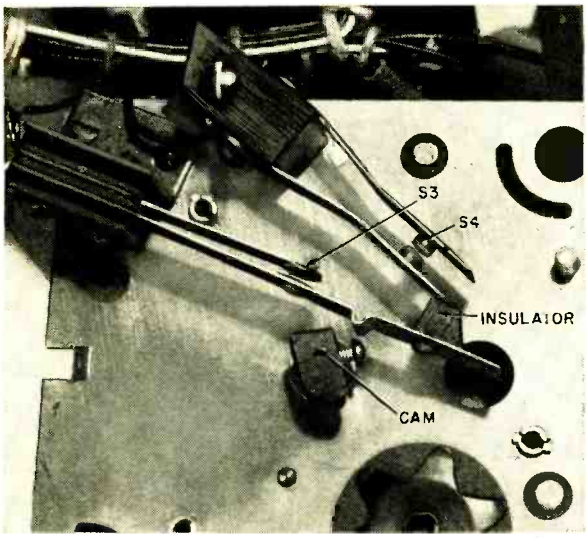


Fig. 3—Detailed look at switches S3 and S4.

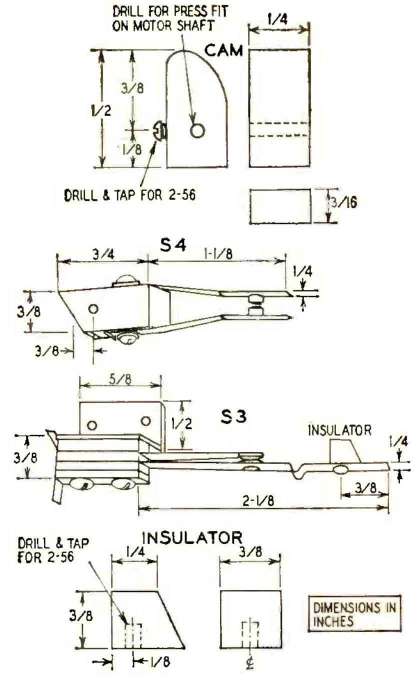


Fig. 5—Construction details for S3 and S4.

it automatically begins to count off 15 seconds audibly at the rate of 1 pulse a second. The counter then cuts off. The timer motor, which remains on, automatically *repeats* this cycle for as long as desired.

4. Triggers manually (tests) and adjusts counter rate through a range of 10 pulses per second to 1 pulse every 2 seconds.

In conventional timing it:

1. Switches enlarger or printer lamp on and off at preset intervals of 1–80 seconds.

2. Provides remote control or panel triggering of timer circuit.

3. Contains timer circuit calibration adjustment.

In counter (miscellaneous timing):

1. Counts audibly, by seconds, for checking elapsed time of enlarger exposures. The operator can check remaining time for a particular exposure and dodge, burn in, etc.

Three circuits

Fig. 2 shows the unit's circuitry. There are actually three circuits. These are standard types with some slight modifications.

1. Timer circuit: Uses V1-a, half of a 12AU7 twin triode, with V2, a 2050 thyratron, to actuate relay RY and supply plate voltage. Potentiometer R2, in V1's grid circuit, regulates the length of time that RY stays closed after S4 is closed. The switch circuit may also be closed manually with CALIBRATE switch S5 or by a remote switch plugged into TIMER SWITCH receptacle J2. There is a 1-second delay in the relay's operation, so all switches in the timer circuit must be held closed momentarily to start the timer. A 0.1-amp fuse protects V2's cathode against possible line surges.

2. Counter (multivibrator) circuit: The counter circuits uses both triode sections of V3, another 12AU7. It is normally on when the unit is in operation with S6 closed. Its pulses become audible when one pair of RY's contacts is closed to complete the voice coil circuit. A continuous count is obtained when switch S7 is closed. MOTOR switch S8 is opened only when a continuous count is desired or when the unit is not being used for agitation.

Frequency of counter pulses is varied by adjusting COUNT RATE potentiometer R10. Counter output is coupled to the grid of V1-b, thus providing an audio stage.

3. Motor–switch circuit: The motor–switch circuit consists of a standard Telechron electric-clock motor assembly and two sets of spst cam-actuated contacts. (S3 and S4 in Fig. 3) This assembly, which is the heart of the unit, provides the 1-minute *continuous* timing for agitation. This is how it works:

The cam mounted on the motor's second-hand shaft closes the two sets of contacts (S3 and S4) once each minute. The contacts remain closed for 1 second. S4 triggers the timer circuit and closes the counter voice coil circuit (through contacts of relay RY). At the same time S3 momentarily closes the signal circuit to the buzzer or light.

All parts are standard except for the motor-contact assemblies, spacers and clock motor. (I used 5% resistors but 10% units should be satisfactory.) *Even though all wiring is insulated from the chassis, it is suspended in the cabinet on insulating spacers to minimize shock hazard if a short circuit should occur (see Fig. 4).*

Fig. 3 is an enlarged view of the clock's front plate and Fig. 5 shows details of the cam and contact assemblies. Contacts with springs and fiber-block mountings can generally be found in surplus stores. As the motor has little power, contact springs must be made from thin stock and should be about the same length as those shown in Fig. 5.

Make the cam and insulator from small fiber blocks. Saw out and cut to shape. Drill the cam to fit the center (second-hand) shaft of motor. Drill and tap a 2-56 hole in the side of the cam

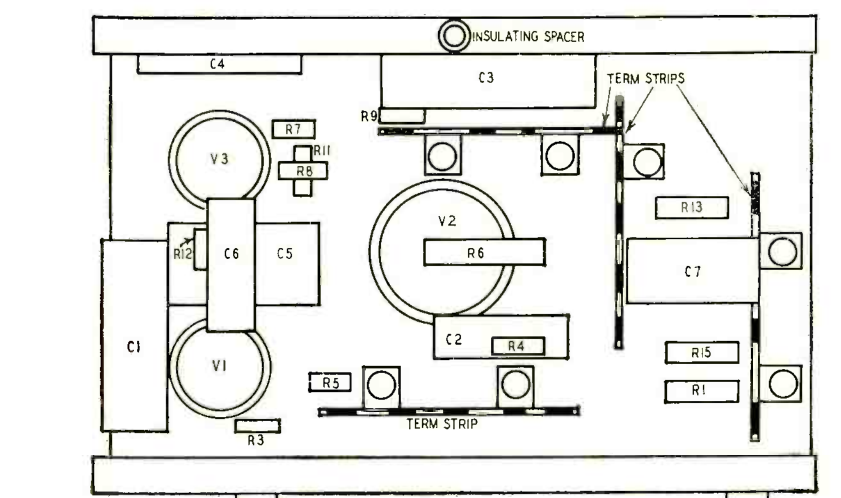
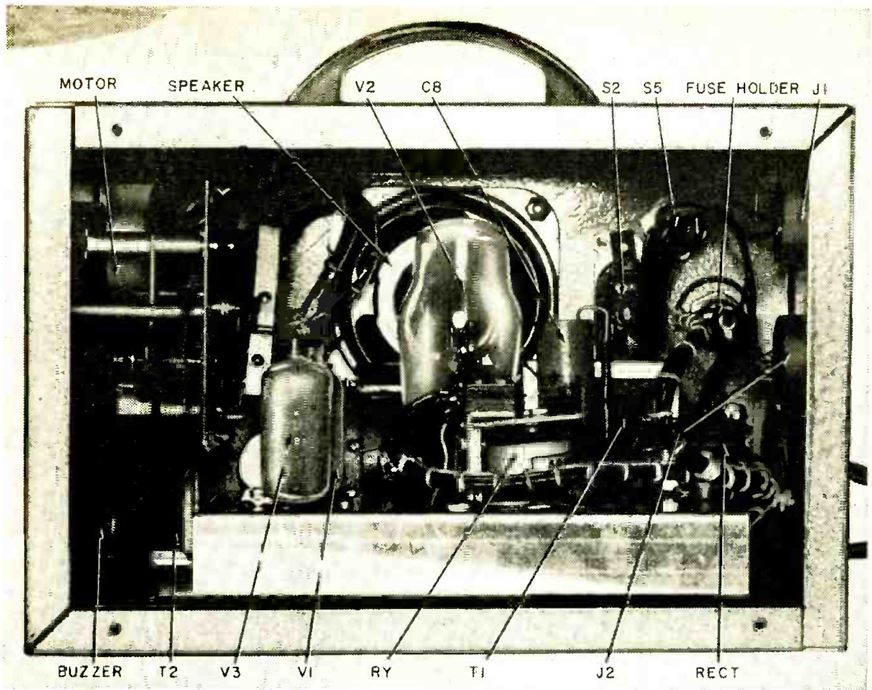
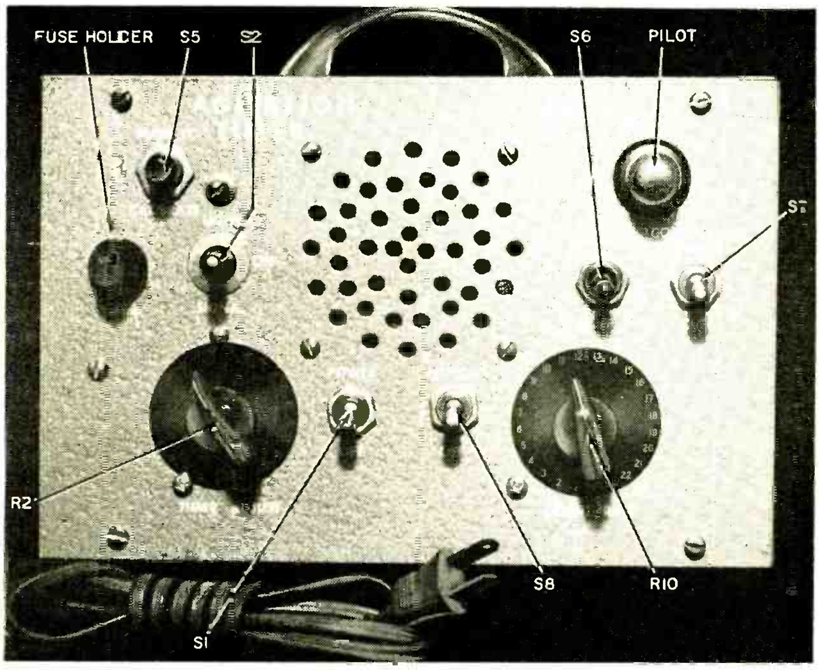


Fig. 4—Component layout under the chassis.



A look inside the case. Note the motor and buzzer mounted on the left.



Front view of the completed timer. Jacks J1 and J2 are mounted on the left side of the case.

block, to take a 2-56 setscrew. To gain enough length to mount the cam on the shaft, carefully file off part of the flanges on which the minute and hour hands were originally mounted. Drill and tap the insulator for 2-56 and mount on the spring as shown in Fig. 3.

Adjust the contact springs (made from .012–.015-inch spring brass stock) so that the cam holds contact assembly S3 closed for at least 1 second and at the same time momentarily closes contact assembly S4. (Location of the contact assemblies will vary, depending on length and type of contact springs used.

Operating instructions

To use as an agitation timer: Place all switches in OFF position. Turn POWER switch on and allow 3 minutes for tubes to warm up. Set the TIMER ADJUST knob to about half of full clockwise position. Now push CALIBRATE switch and hold down for 1 second. Relay will close with an audible click and remain closed for the desired agitation time (usually 15 seconds) determined by the setting of the TIMER ADJUST switch. When the relay opens, a second click is heard. Use the second hand of your watch or an electric clock to check for 15 seconds.

Turn the COUNTER and CONTINUOUS COUNT switches on. With COUNT RATE knob at full counterclockwise position, counter pulses will start and are audible. Check the timing of pulses and slowly advance the COUNT RATE knob until a 1-pulse-per-second rate is obtained. Then turn off the CONTINUOUS COUNT switch and turn the SIGNAL-LIGHT switch on. Next turn the MOTOR switch on.

Hold a finger on the lever of the MOTOR switch and turn it off as soon as signal (buzzer or light) stops. When ready to start agitation, turn MOTOR switch on. Counter will audibly tick off 15 seconds and stop. After 45 seconds, light or buzzer will again signal and 15-second count will be repeated. The entire cycle repeats until POWER switch is turned off.

Enlarging or printing timer: Turn all switches off. Turn POWER switch on and wait 3 minutes for tubes to warm up. Calibrate the TIMER ADJUST control and make up a calibration chart.

To do this set the TIMER ADJUST control at its extreme counterclockwise position. Push the CALIBRATE switch and hold closed for 1 second. RY will close with an audible click and quickly open with a second click. Check the elapsed time between each click (in seconds) and note the dial setting on your chart. Slowly advance the TIMER ADJUST knob, one division at a time and note elapsed time (in seconds) for each setting. Continue until full clockwise position is reached. Your complete chart will give you a timing range of 1–80 seconds.

Use of an external timer (remote) switch is optional but is provided for by ENLARGER receptacle J1. The timer is normally triggered by pushing the CALIBRATE switch on the panel.

Set TIMER ADJUST control for the desired exposure. Plug the enlarger or printer ac line cord into receptacle J1 and, if remote control is desired, plus a spst pushbutton switch into J2. Push the CALIBRATE or remote switch and hold down for 1 second. The enlarger or printer light will come on and remain on for the interval selected. The cycle repeats only when the CALIBRATE or remote switch is again closed.

In addition, the COUNTER switch may be turned on and the counter will operate, counting off the seconds while the enlarger or printer lamp is on.

The CONTINUOUS COUNT switch may be turned on any time the power switch is on. This provides a continuous count of seconds.

For ventilation, use a perforated Masonite sheet for the back cover unit. If the timer is carefully wired and checked, there is little possibility of trouble. However, a few items may require minor correction.

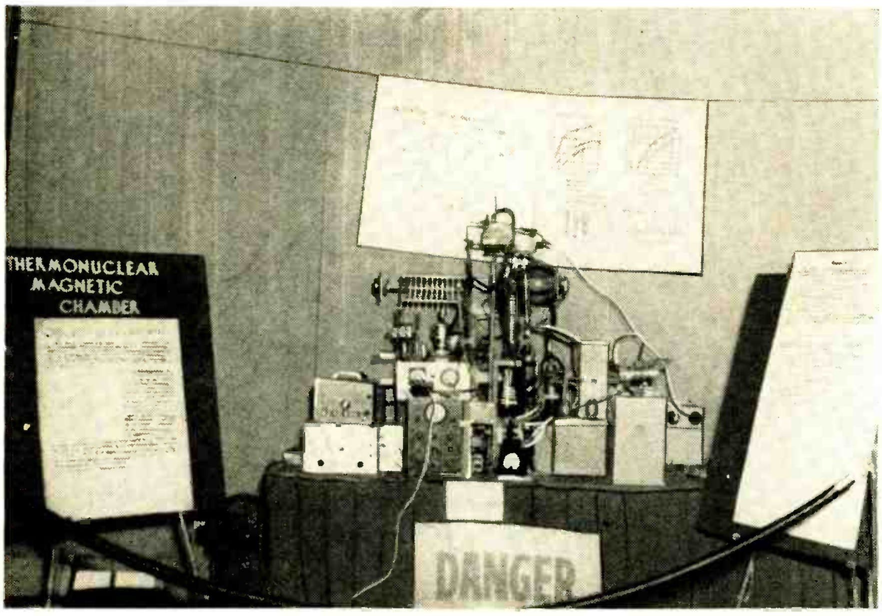
POSSIBLE TROUBLE:	*REMEDY:*
Excessive (ac) hum.	Reverse leads to primary of output transformer.
TIMER ADJUST control operates backward.	Reverse outside leads on R2.
COUNT RATE control operates backward.	Reverse leads in R10

END

WESCON VISIT

Touring the 1958 West Coast electronics show

By TOM JASKI



Teen-ager Allan Hill's demonstration of the pinch effect for containment of thermonuclear reactions.

THE annual WESCON show, held in the Pan Pacific building in Hollywood, Calif., in late August, displayed 900 exhibits of electronic equipment for the trade and engineers attending the conference and lectures organized by the IRE. In contrast with last year's show, when many displays were consumer-oriented, this year's presentations were aimed primarily at industry.

Another outstanding aspect of the show was the limited budget, evidenced by the holdover of last year's display decorations and a number of booths with only mockups, slides and charts or a tape-recorded sales pitch. Not marked by outstanding discoveries or new devices, the show nevertheless drew a capacity audience and had many points of interest for the technician, ham, and student as well as the professional engineer.

Most thought-provoking were the displays of the Future Engineers—equipment built by high-school students, some highly original, some very professional-looking. Besides the usual Tesla coils and ultrasonic cleaning and homogenizing apparatus, there was the setup of high-school student Allan Hill of Durango, Colo., demonstrating a new method of confining thermoneuclear reactions away from vessel walls. Allan built for pennies apparatus which would cost thousands if done in the nation's laboratories.

Of particular interest

For the technician: Multicore solder by *Multicore Corp.* containing a special alloy which tends to plate the soldering-iron tip and reduce tip wear.

A printed-circuit desoldering kit by *Ungar* with tips designed especially for the removal of parts from circuit boards without the usual point-by-point prying loose of one connection at a time. For those dealing with TV sets and radios using printed-circuit boards, this can be a tremendous time saver.

New scopes by *Waterman* and a British firm called *The Scopes*. *Waterman* has come out with a portable unit measuring only 4¾ inches high, 5½ inches wide and 10 inches deep. Dc to 250-kc response, 10-mv/cm sensitivity, using a full 1½ x 3-inch flat cathode-ray tube. Waterman also showed the prototype of a slightly larger scope with a specially developed short 5-inch CR tube only 12 inches long.

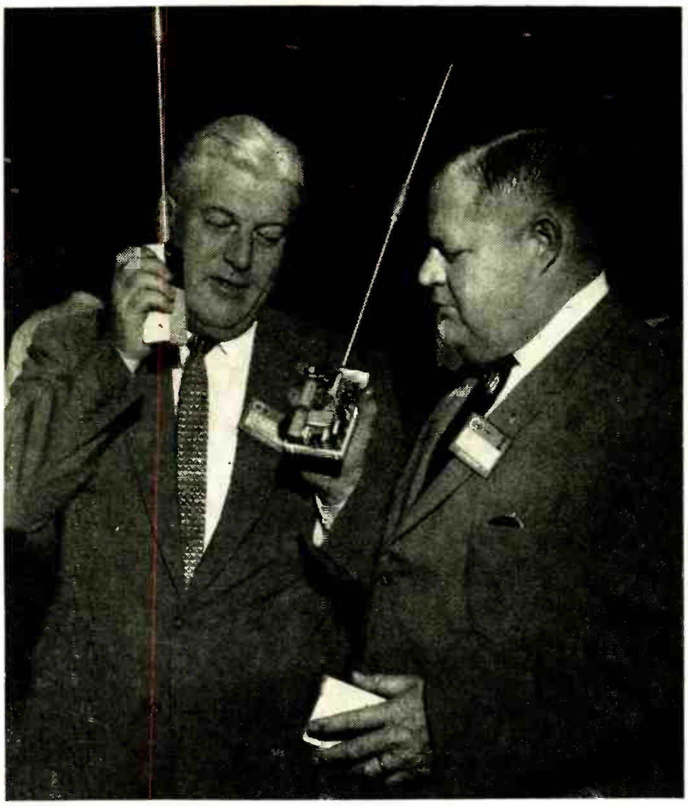
The Scopes instrument is a conventional-looking 3-inch model with an unconventional dc to 6-mc bandwidth, 60-mμsec rise time and 100 mv/cm sensitivity. Also in evidence was the *Heath* professional scope which has unusual sweep generator capabilities for a kit type oscilloscope.

For the ham: *Heath* showed two new receiver–transmitter combinations and a single-sideband adapter. Particulars appear in *Heath's* new catalog.

Texas Instruments demonstrated a palm-sized transistor transceiver with a ½-mile range. It operates in the 27-mc band, requiring a special permit from the FCC, but can be adapted for the ham bands.

Knight (Allied Radio Corp.) had on hand their new four-band shortwave receiver, the "Spanmaster," and their Deluxe amateur receiver using printed-circuit switches and printed-wiring boards throughout.

For the engineer: Since this show was oriented toward industry many items appealed to almost any classification of engineer. Of general interest were the enormous Klystron displayed by *Eimac*, ceramic tubes by *Sylvania*, the CK 1053 time-measuring tube by *Raytheon*, the *Amperex* indicator for transistor circuits and a host of new transistors introduced by all major firms. TI has new power transistors, G-E commercially available tetrodes (3N36 and 3N37) and Sylvania a new



Deak Atkinson (left) and W. E. Trantham of Texas Instruments demonstrate an all-transistor 27-mc transceiver. Special FCC license was required.

Helmet transceiver developed for carrier jet-landing instructions by Dr. Webster and Mr. Gibson of the Naval Electronics Laboratory in San Diego, Calif.

1-watt 70-mc unit. Worth owning is the new G-E *Transistor Handbook* listing all the latest data with circuit applications.

The *Naval Electronic Laboratory* in San Diego showed a "Man from Mars" Trojan helmet, containing a newly developed vhf communication system for carrier landings of jet aircraft. The unit is entirely self-contained, uses rechargeable nickel-cadmium batteries, is entirely transistorized and is designed to take advantage of the physiology of the head. Supports for the unit are designed to press on the areas of the head containing very few nerves and blood vessels, assuring wearer comfort. Special noise-attenuating mouthpiece and earphones are attached.

A new approach to tape recording of telemetered data was shown by *Precision Instrument Engineering* with their typewriter-sized case containing all-transistor data-recording equipment usually requiring one full-size relay rack. The seven-channel recorder requires only 1.54 cubic feet of space, weighs less than 50 pounds and uses all standard tape speeds from 3¾ to 30 inches per second.

For everyone

Westinghouse showed their models of electronic refrigeration, employing semiconductor thermocouples and the well known Peltier effect to produce an electronic baby-bottle cooler—heater which can be set for various combinations of cooling and heating cycles automatically.

Allied Radio demonstrated their new stereo and stereo adapter kits and an interesting new inexpensive tube checker.

Triplett showed their new line of "Unimeters," a series of basic meter movements and separate scales which can be combined in many combinations to provide for easy scale changes.

Missing: Conspicuous by their absence were devices like the flat picture tube, the flat, wall-hung electroluminescent CR screen; all-transistor hi-fi amplifiers; stereo discs and cartridges (none were present in the show); small and lightweight portable tape recorders; portable all-transistor TV sets (the *Texas Instruments* prototype was not demonstrated at the show proper) and many other advances we have been conditioned to expect from our electronic technology. END

a new service for our readers . . .

When you see this emblem on a constructional article in RADIO-ELECTRONICS, build with confidence. It is your assurance that the equipment has been actually bench-tested, either by the editors or by a reputable outside testing facility, and that the schematic has been carefully checked against the equipment. A short test report will be published with each article. The only construction articles not included in this plan will be (1) equipment whose performance can be accurately predicted by study of the schematic and (2) articles which were purchased before this policy went into effect.

BENCH R-E TESTED

COVER FEATURE

Part I—Opportunities are increasing in the small-boat radio installation and service field. What's it all about and what do you need to go into the marine radio business?

RADIO for WEEKEND SAILORS

By LEO G. SANDS

THE pleasure-boat industry found 1958 to be its best year yet, according to reports from many engaged in the manufacture and sale of boats and boating equipment. Estimated sales in 1958 are running 10% above 1957, when more than 35,000,000 people took part in recreational boating activities. Attendance at the boat shows in 1958 was reported to be better than 10% above 1957 figures and one marine radio equipment manufacturer reported a complete sellout of a new model it introduced this year.

The latest available figures published in a joint report of the National Association of Engine and Boat Manufacturers and the Outboard Boating Club of America show that more than 7,000,000 pleasure boats are in use in the United States, compared to only 1,500,000 two decades ago. And the number is growing rapidly.

The latest annual report of the Federal Communications Commission notes that only 65,000 vessels are licensed to use radio. These FCC figures include fishing boats, cargo vessels, passenger liners and other commercial vessels as well as a very small percentage of the more than 7,000,000 pleasure boats.

Sales of marine radio equipment have climbed sharply as will be evidenced when the next FCC annual report is published. The public is getting extremely safety conscious and because of the widespread use of mobile radio on land, the weekend sailor also is becoming extremely cognizant of the conveniences of modern communications. The big spurt in marine radio sales this year was caused by the introduction of lower-priced radiotelephones especially designed for use on outboard motorboats which heretofore had to do without radio.

Marine radio sales also spurted in 1958 when operators of party boats and passenger vessels carrying six or more persons for hire bought radio equipment to comply with an FCC requirement that such vessels have radiotelephones. Approximately 5,000 vessels were affected by this FCC mandate. Passenger-carrying vessels over 65 feet in length operated on the Great Lakes are also required to carry radio. There is a move in Congress at present to waive the requirement for radio on vessels operating within 1,000 yards from shore. However, for safety as well as convenience, a radiotelephone should be required on all passenger-carrying vessels.

Two-way radio can be used in pleasure craft as well as commercial vessels. Most common is the radiotelephone operating in the 2–3-mc band, which lies between the 80-meter and 160-meter ham bands. Many vessels also have vhf radiotelephones on marine frequencies in the 152- to 162-megacycle band.

Vhf–uhf radio

Boats used in a commercial enterprise may be equipped with LPI (low-power industrial) or Citizens radiotelephones for private ship-to-ship or ship-to-shore communications. When operating in these radio services, licensees can also communicate from boats to similarly equipped automobiles and other vehicles on shore. LPI or Citizens systems are most frequently used by yacht clubs and organizations which service other vessels. The LPI communicating range (25–50-mc or 152–162-mc band) is relatively short (1 to 5 miles) due to limitations on antenna height and transmitter power.

Any US citizen over 18 years of age may operate his own private ship-to-shore radio communications system in the 460–470-mc Citizens band. Standard 450-mc mobile radio equipment is available from a variety of manufacturers and is of the same type as used in automobiles and trucks. Range depends upon the height of the base-station antenna above surrounding terrain and varies from 10 to 20 miles and more.

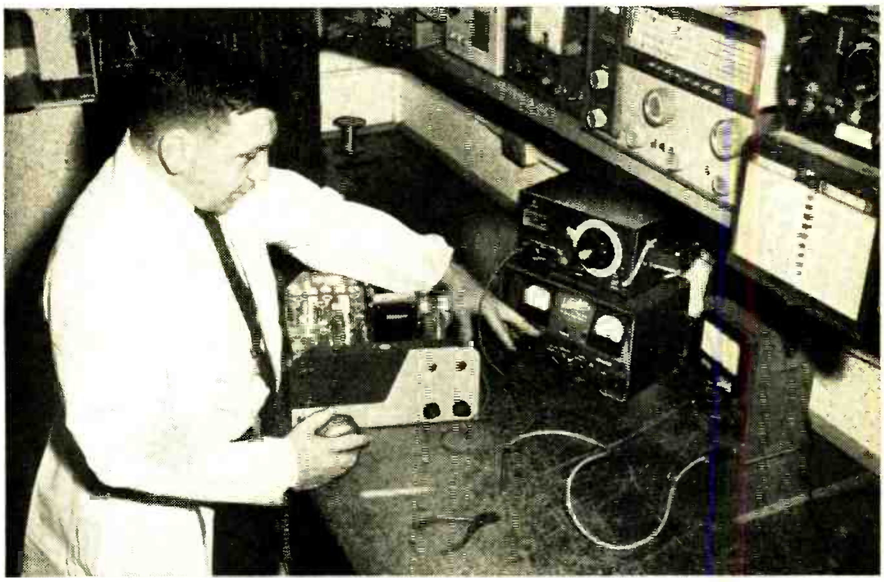
Railroads and other industrial users who are eligible for licensing in the 152–162-mc band sometimes operate private vhf ship-to-shore communications systems to cover marine extensions of their land operations. Generally the equipment is conventional vehicular mobile radio equipment or heavy-duty railroad radio equipment, often housed in special enclosures to prevent damage by salt water. Range from a private shore station to tugboats and other commercial vessels at sea may be as long as 30 miles.

Low-power industrial or Citizens band radiotelephones can be used for private ship-to-shore communications.

Medium-frequency radio

The vast majority of marine radios are licensed in the Marine radio service and operate in the 2–3-mc band. Ships and pleasure boats thus equipped can communicate with other boats, with the Coast Guard and with public shore stations operated by common carriers such as the telephone companies. Private shore stations are not permitted. However, there is no prohibition against a moored boat communicating with another boat off shore.

There are 48 public coast stations in the United States which pleasure boat owners may contact. The Pacific Telephone & Telegraph Co., for example, maintains coastal harbor radiotelephone stations in Seattle, Wash.; Portland and Astoria, Ore.; Eureka, San Francisco and San Pedro, Calif. All these stations operate on a 24-hour basis. They are interconnected with the telephone system. A boat owner can contact the nearest coastal harbor radiotelephone station by radio and then via wire line any telephone in the United States, or in almost every part of the world. Furthermore, calls between boats may be routed via one of the telephone company stations. A minimum toll of $1 is charged for this kind of service. The toll varies with the distance.

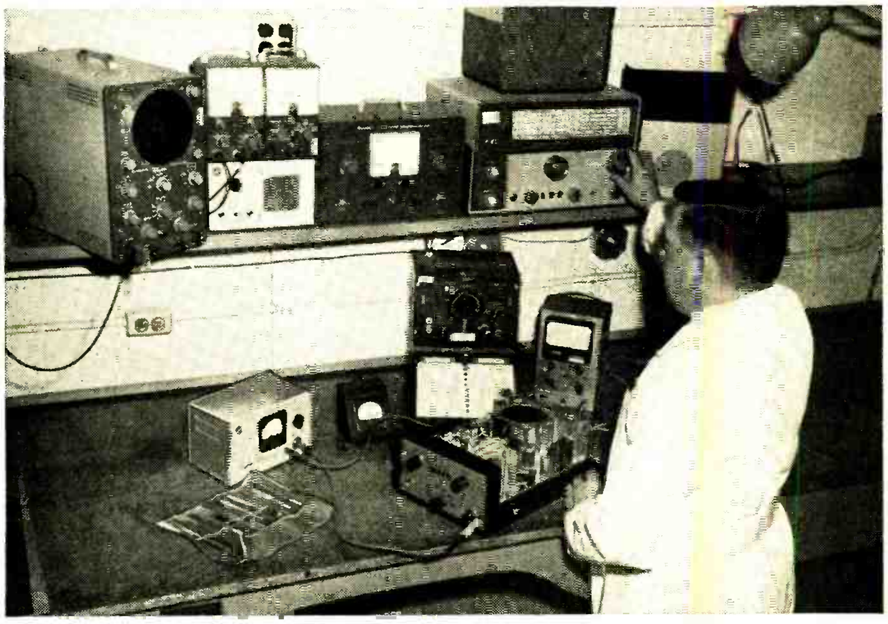


Measuring frequency and deviation of a 450-mc mobile unit.

The range of a marine radiotelephone depends upon the antenna system and transmitter power. There is a rough rule-of-thumb which states that communicating range is 1 watt per mile. However, this is not considered accurate. Transmitter power is usually spoken of in terms of power input to the final rf stage. Using this barometer, the over-water daytime communicating range of a 20-watt (output) transmitter when fed to an efficient antenna system is 50 miles. Increasing power to 30 watts produces slight increase in range. A 150-watt transmitter generally is capable of providing a 100–125-mile range during the day. Nighttime range may be considerably greater because of skip transmission. However, dependence should be placed only on the rated daytime range.

Various frequencies in the 2–3-mc band are assigned to marine radio services. The international calling and distress frequency is 2182 kc. Ordinarily, boat radios are left tuned in on 2182 kc so calls may be intercepted, except when monitoring one of the coastal harbor or inland telephone stations in anticipation of a telephone call.

After calling another boat or intercepting a call from another boat, both stations shift to another frequency for carrying on a conversation. On the Great Lakes, 2003 kc is the ship-to-ship



Marine radio channels can be monitored and spurious radiation from a transmitter being checked can be noted with a professional communications receiver.

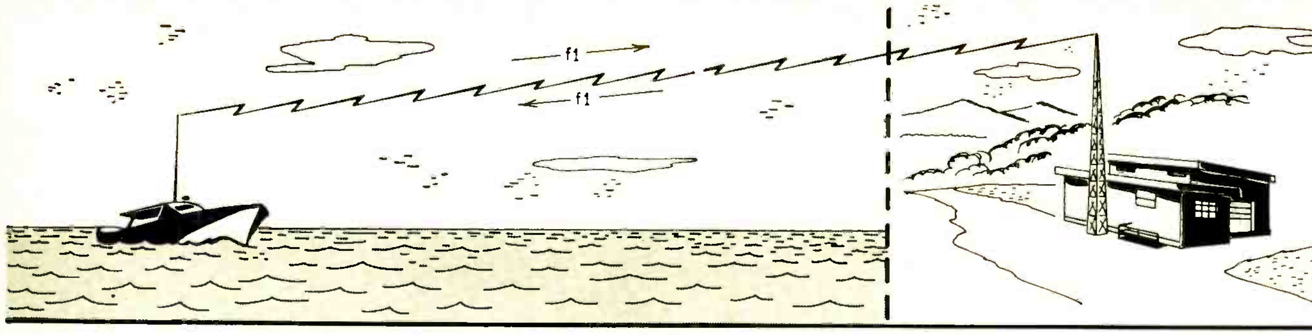


Fig. 1—Simplex transmission uses the same frequency for transmitting and receiving.

frequency. On the Gulf of Mexico the frequency is 2830 kc, and 2738 kc may be used anywhere, except in the Great Lakes and the Gulf of Mexico. The frequency 2638 kc is used for ship-to-ship communication at sea, in tidewaters, inland lakes, canals and rivers.

Marine radiotelephone transmitters are crystal-controlled to meet FCC frequency-stability requirements. Receivers also tend to be crystal-controlled so the user does not have to fiddle with tuning knobs.

A boat which normally operates along the Pacific Coast near the Golden Gate, in San Francisco and San Pablo bays and up the Carquinez straits and the Sacramento and San Joaquin rivers would have its transmitter and receiver set up as follows:

Frequency in Kc		
Transmitter	*Receiver*	*Function*
2182	2182	calling and distress
2003	2430	telephone
2406	2506	telephone
2638	2638	ship-to-ship
2738	2738	ship-to-ship

One channel is set to a 24-hour telephone channel and another channel is set to a daytime-only telephone channel, both for contacting the coastal harbor station at San Francisco.

In other areas, other telephone channels would be used. Sometimes the same telephone frequencies are used in more than one area. For example, the pair 2598–2206 kc is common to the coastal harbor stations at San Pedro, Calif., and Astoria and Portland, Ore.

Marine radiotelephones are intended for *safety*, *operational* and *business* purposes, with priorities in that order. The calling frequency, 2182 kc, may not be used for extensive conversations as improper use could interfere with distress calls.

The *operational* function is for the exchange of information pertaining to navigation, movement and management of vessels. The *business* function permits boat crews and passengers to transact business between vessels and—via a commercial shore station—with points on land. The purpose of the *safety* function is obvious.

Boats operating on inland rivers, particularly those which have locks, communicate with stations at these locks and with other ships on 2738 kc.

When calling another boat, the radio is set to transmit and receive on 2182 kc. The call is made by reciting the name of the desired boat followed by the name and radio-station call letters of the calling vessel. After contact is established, both boats shift to ship-to-ship frequency.

Telephone calls

To call a land-based telephone, the radio is set to one of the coastal harbor telephone channels. If the channel is busy, a conversation or conventional *busy* signal is heard. When the channel is clear, the calling vessel announces the station being called, followed by the name of the ship and its call letters. This call is repeated slowly at least three times.

When the marine operator replies, the calling vessel gives the city telephone number and, if required, the name of the desired person as well as the boat's position. The operator then gives instructions on how to proceed. At the end of the conversation, the boat's name and call letters are repeated followed by the words "signing off."

To place a call from a land-based telephone, the caller dials the long-distance operator and gives the name, call sign and location (if known) of the desired ship.

The call is intercepted by the desired boat if the radio receiver is turned on and set to the appropriate telephone channel and if someone is listening. Obviously, the boat must be within radio range of the shore station through which the call is routed.

Some ships, particularly passenger liners, are equipped with selective-calling devices, obviating the need for continuous aural monitoring. A receiver, whose output is muted, is tuned to a shore station and connected to the selective-calling device. When the tone-pulse code which matches the setting of that specific decoder is received, a bell or other alarm is sounded.

Simplex–duplex

A typical marine radiotelephone consists of a multichannel AM transmitter and a multichannel AM receiver, packaged as a single unit. Frequencies are selected with a switch that controls transmitter and receiver simultaneously.

For calling and ship-to-ship communication, single-frequency simplex operation is used. This means that transmission and reception take place on the same frequency (see Fig. 1) and that transmission takes place in one direction at a time only. To transmit, the push-to-talk button on the microphone or handset is operated. To listen, the push-to-talk button is released.

When communicating with a coastal or Great Lakes shore station to place or receive telephone calls, transmission takes place on one frequency, reception on another (see Fig. 2). The boat operator uses the press-to-talk technique but the shore station transmits and receives at the same time. By using this technique, communication with ordinary telephones, which are not equipped with push-to-talk buttons, can be maintained.

Since the transmitter and receiver can be tuned separately, each channel can be set for transmission and reception on the same or differing frequencies as required.

Marine radio servicing

Marine radio equipment is sold by dealers who are technically competent to install and service it. It is seldom feasible for a dealer to sell equipment and farm out the installation and service work to an independent technician.

The marine dealer sells "systems" which fit the requirements of specific boats. Sometimes a short-range radio will do. In other cases, a more powerful radio which needs a more efficient antenna system and a more adequate power source is required. The dealer must be able to specify the required equipment, the modifications that must be made on the boat and the estimated cost.

Most marine electronics shops are located on or near the water. One dealer in Portland, Ore., has a floating shop on the giant Columbia river. His customers can tie their boats alongside or sail into a sheltered berth where the radio can be serviced on the boat even in bad weather.

Shop test equipment, in addition to the usual vtvm's and hand tools, should include a frequency meter which meets FCC requirements for accuracy, an instrument for measuring percentage of modulation, an rf signal generator and a dummy antenna.

Transmitter frequency can be measured with a direct-reading electronic

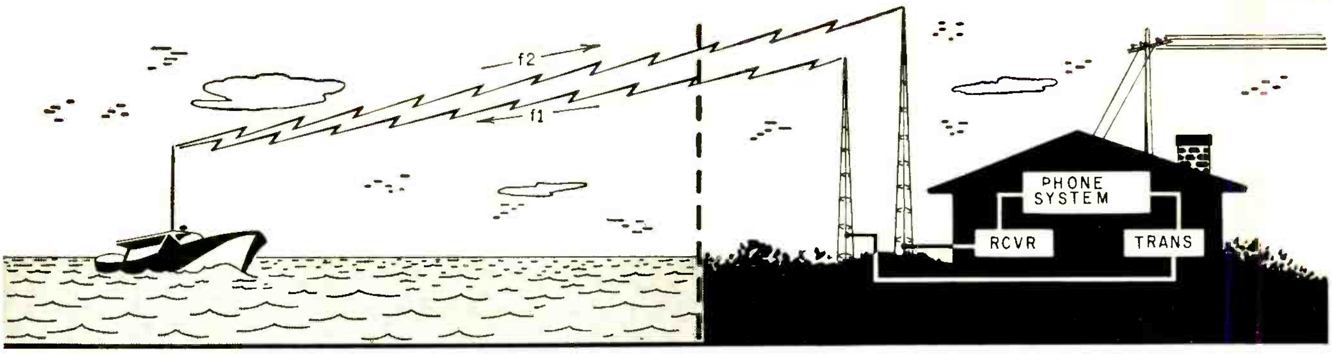


Fig. 2—Duplex transmission uses one frequency for transmitting and another for receiving.

counter or a surplus BC-221 (or equivalent) frequency meter. A direct-reading modulation meter or an oscilloscope is used to determine a transmitter's modulation capability.

While most rf signal generators used for servicing home radio receivers also cover the marine band, a professional-grade rf signal generator will help the technician do a better job. A BC-221-M frequency meter which produces a modulated signal may also be used as an rf signal source for receiver alignment.

Unfortunately, direct-reading, laboratory type rf wattmeters are designed for measurements at a 50-ohm impedance and serve as a 50-ohm dummy load. While impedance-matching networks can be used, an rf ammeter in series with a 10-ohm (typical marine antenna) dummy load is generally used for measuring transmitter output.

Tube failures and erratic operation are minimized by checking tubes on a really critical tube tester which measures dynamic mutual conductance. In addition, tubes should be checked for grid emission with grid-circuit testers or general-purpose tube testers equipped for grid-emission tests. A tube which checks out OK on an ordinary tube tester may have grid emission that can cause erratic receiver performance.

Another useful shop tool is a high-grade communications receiver for monitoring marine radio channels as well as for checking transmitters for spurious radiation.

Field servicing

A boat owner can remove his radiotelephone from his boat and bring it to a shop for servicing by a licensed technician. He can also reinstall it himself. But he may adjust only the front-panel controls, leaving all other adjustments to a licensed technician.

For optimum results the radiotelephone should be tuned up on the boat, at least initially. This must be done by a licensed technician.

Among his chores is determining the transmitter frequencies. This is done with a portable frequency meter such as a surplus BC-221 which was recently checked for accuracy. He measures the transmitting frequency of each channel, noting in the log the exact frequency measured, not just "OK."

He can also align the receiver, using the BC-221 as a signal generator. (The BC-221-M produces a modulated signal.) Or he can bring along a portable rf signal generator. It should be a battery-operated type unless he also wants to bring along a dc-to-ac converter.

When extensive transmitter adjustments have to be made, a dummy antenna is used to avoid interfering with others on the same channel.

With the radiotelephone connected to the boat's antenna and ground, the transmitter is tuned for maximum output. An antenna current indicator is a built-in feature on most sets, and generally consists of a shunted pilot lamp in series with the antenna. When the transmitter is adjusted properly, the antenna indicator lamp increases in brilliance when the transmitter is modulated.

Sometimes it is convenient to know if the transmitter is putting out its rated power. This is determined by using a dummy antenna load equipped with a series rf ammeter as shown in Fig. 3.

Transmitter power output is calculated by multiplying the square of the antenna current in amperes by the load resistance in ohms ($W = I^2R$). If the current is 0.5 ampere and the load is 10 ohms, the power output is 2.5 watts. If the current is 1 ampere, the output is 10 watts since $1 \times 1 \times 10 = 10$.

Some technicians like to use an rf ammeter for tuning a transmitter to its antenna. This may create problems. Inserting the meter into the antenna circuit, especially if it is mounted in a metal box, can add capacitance to the circuit which will not be there when the meter is removed. It is best to tune the transmitter to its own antenna, using the built-in antenna current indicator only.

Personnel requirements

Technicians who service transmitters must either have a suitable license or work under the direct supervision of another person who holds the proper license. For servicing radiotelephone equipment, a first- or second-class radiotelephone operator's license is required.

This license may be obtained by any citizen of the United States who can pass the written test. The test covers basic electronics theory, radio transmitters and FCC regulations. No code test is required. The test for the first-class license is the same as for a second-class license except that additional questions on advanced electronic theory are included.

The test may be taken at any of the FCC field offices which are located in most of the nation's key cities. Information about operator licenses and location of field offices may be obtained by writing to the Federal Communications Commission, Washington 25, D.C.

Hams have an advantage in the marine radio field since they are already familiar with tuning of transmitters. However, a ham ticket won't do for servicing commercial marine transmitters. You must also have a commercial ticket.

FCC licenses

A radio station license, available without cost from the FCC, is required for all marine radio equipment. The license covers a specific boat only and permits the use of a specific transmitter. Hence, a radiotelephone may not be used except on the specified boat without the express authority of the FCC.

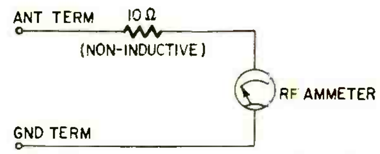


Fig. 3—Dummy antenna equipped with an rf ammeter measures transmitter output.

FCC form 501-A-1 is used for applying for a ship radiotelephone license. These forms are available from the Federal Communications Commission, Washington 25, D.C., or any of its field offices as well as from manufacturers of marine radio equipment and their dealers.

Only US citizens are eligible for FCC ship and operator's licenses. The ship radio can be operated only by a licensed operator or under his supervision. A restricted radiotelephone operator permit, obtained by filing FCC form 753-1, will suffice.

So far we have seen what a tremendous business marine radio is and we have gone over the procedures of radiotelephone operation and what it takes to run a marine radio repair shop. Next month we will take a look at a typical radiotelephone's construction and go over a few hints leading to more effective use of marine radio by the weekend sailor. TO BE CONTINUED

TWO MULTIBAND TRANSISTOR SETS

Philco Trans-World

Motorola Weatherama

By ROBERT F. SCOTT
TECHNICAL EDITOR

ONLY a few years ago transistor receivers were insensitive novelties that picked up a few local broadcast stations. Now, there are literally hundreds of transistor models whose sensitivity, selectivity and output equal or surpass many tube type portables. Also, the transistor has made possible multiband portables whose tube versions were often impractical because of bulk, weight, cost and frequent unavailability of special batteries. Transistor portables are less expensive to operate, are generally smaller and lighter, and use standard flashlight batteries that can be obtained almost anywhere in the world.

In the August, 1958, issue of RADIO ELECTRONICS we discussed the Magnavox and Zenith all-wave transistor portables. Now we will describe the Philco model T-9 Trans-World and Motorola 6X39 Weatherama receivers.

Philco model T-9

This is a nine-transistor model covering from the bottom of the broadcast band to 18.2 mc in seven ranges: 540–1620 kc and 2.0–4.0, 4.0–8.0, 9.4–9.9, 11.4–12.0, 14.8–15.6 and 17.2–18.2 mc. A logging scale is directly coupled to the wave-band switch and always comes to rest under the band in use.

The set uses six standard flashlight cells—two as a stabilized 3-volt supply for the oscillator and four as a 6-volt supply for the rf amplifier, mixer, detector and if and af amplifiers. The circuit of the T-9 is shown in Fig. 1. Partial schematics of rf, mixer and oscillator circuits are shown in Figs. 2 and 3.

The rf amplifier is a Philco T1010 transistor similar to the SB103/2N346 surface-barrier type designed for rf and video amplifier service and for oscillators working up into the 60–75-mc range. The rf amplifier is connected in a common-base circuit—equivalent to a grounded-grid vacuum-tube amplifier. Collector and emitter currents are common to the base circuit, providing 100% negative current feedback. This results in a current gain of less than unity and good isolation between the input and output circuits.

Although current gain is less than 1, the common-base circuit provides approximately the same voltage gain you would get with this transistor in a common-emitter arrangement.

On the broadcast band the receiver uses a built-in ferrite-rod (Magnecore) antenna or an optional external antenna coupled to the set through a 7.5-μμf capacitor. The incoming signal is developed across a parallel-tuned circuit consisting of the primary of the ferrite-rod antenna tuned by a 442-μμf capacitor.

The developed signal is transformer-coupled to the emitter of the rf amplifier through a secondary winding which matches the comparatively low impedance of the transistor's input circuit. Emitter bias is provided by a well-filtered and decoupled voltage divider consisting of R5, R8, R14 and R15 and dropping resistors R1 and R9. This bias is stabilized by the comparatively heavy bleeder current through R14 and R15. The base is grounded for rf by a .04-μf capacitor and is returned to the avc line.

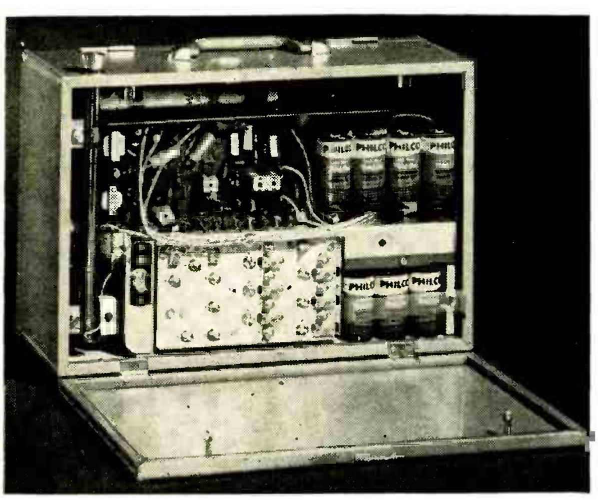
The rf amplifier's output is developed across the primary of an rf transformer tuned by the second 442-μμf section of the six-section tuning capacitor. The small amount of neutralization that may be required to offset feedback through stray coupling is provided by feeding some collector signal voltage back to the emitter through C6, the secondary of the antenna coil and the 3.3-μh rf choke.

The oscillator uses a Hartley circuit with feedback between collector and emitter. The oscillator coil is tuned by the remaining 442-μμf section of the tuning gang in series with a 560-μμf padder. Oscillator operating conditions are critical for optimum performance, so separate flashlight cells are used to stabilize oscillator voltage and current.

The mixer is a common-base arrangement with the signal voltage fed into the base circuit through the secondary of the rf transformer. Oscillator voltage is injected into the emitter circuit from a tap on the oscillator coil. The mixer's emitter bias and the oscillation injection are adjusted for maximum conversion gain for the band in use. The 455-kc if signal is taken from the collector and fed to the if amplifiers.

Fig. 2 shows the T-9's front-end circuitry for the broadcast band. A similar arrangement is used on shortwave bands 1 and 2, covering 2–8 mc. On the 2–4-mc band, antenna transformer T1 and its trimmer replace ferrite-rod antenna and trimmer VC10; rf transformer T8 and its associated trimmer replace T7 and its trimmer, and oscillator transformer T15 with trimmers and padders replaces T14 and allied components. Similar substitutions are made when switching to the 4–8-mc range. Note well that the three 442-μμf sections of the tuning capacitor are used on the three lower frequency bands.

On the 31-, 25-, 19- and 16-meter bands the circuit is as shown in Fig. 3 with the oscillator operating *below* the



Inside the Trans-World's case. Storage space for four extra batteries is provided.

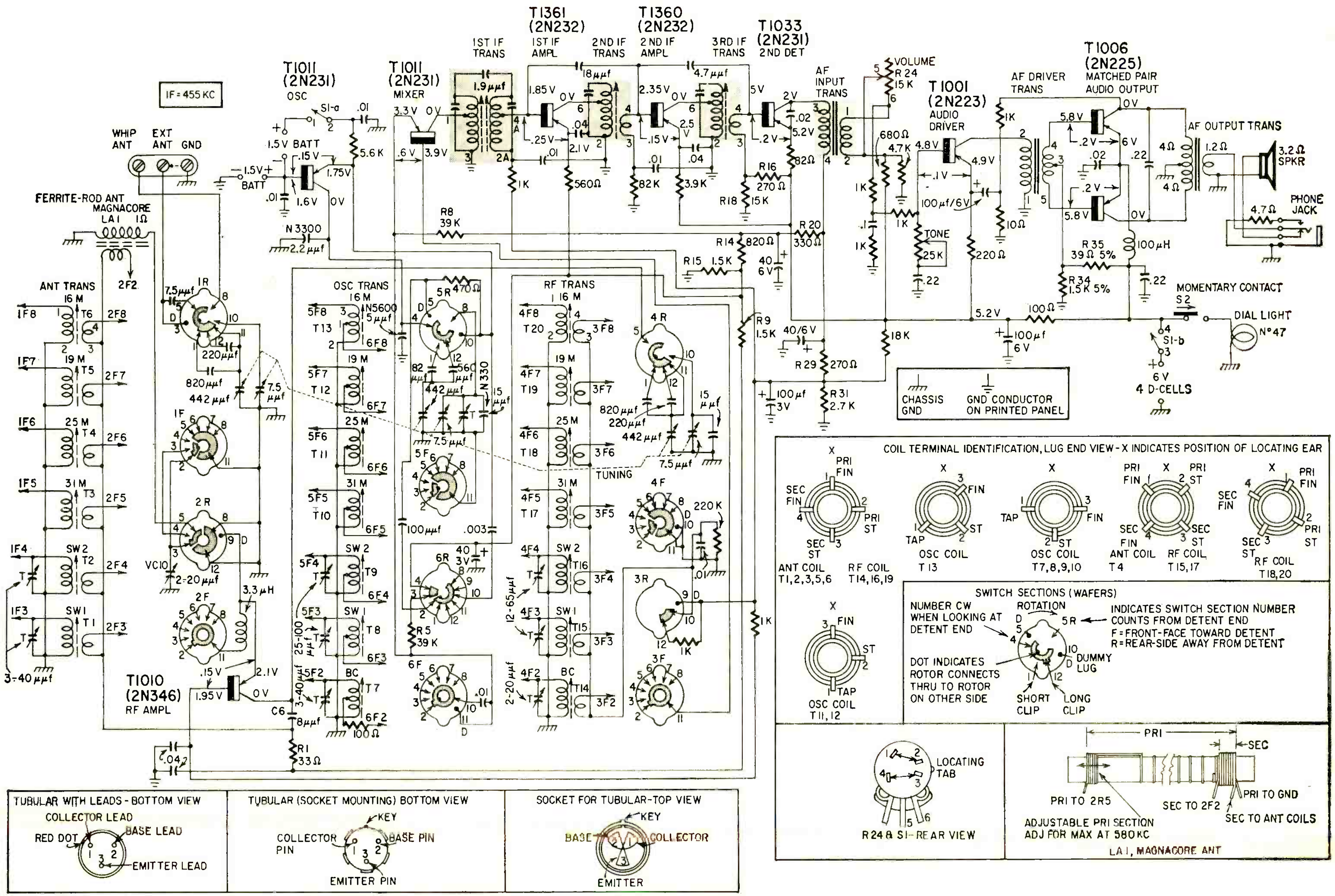


Fig. 1—Circuit of the T-9 portable. The bandswitch is in the broadcast position.

signal frequency. Here the circuits are tuned by the 7.5-$\mu\mu$f sections of the tuning capacitor. The emitter bias for the mixer is varied by altering the values of the biasing resistors to maintain optimum conversion gain.

The 455-kc if amplifier uses high-gain p-n-p surface-barrier transistors in common-emitter circuits. Some early sets use T1012's as if amplifiers, and later sets have T1360 and T1361 transistors in the first and second stages, respectively. In emergencies, either can be replaced by a 2N232. The base-collector capacitance is high enough to develop considerable positive feedback from collector to base. To counteract this feedback and reduce the tendency to oscillate, the stages are neutralized by a negative feedback voltage from the collector to the input circuit.

This voltage is taken from the secondary of the if transformer and applied to the base through an 18-$\mu\mu$f capacitor in the first if stage and a 4.7-$\mu\mu$f unit in the second. The voltage available for neutralization varies inversely as the stepdown ratio of the if transformer, so larger neutralizing capacitors are needed on stages with the greatest stepdown ratio on the output transformer.

The detector is biased class B by current flowing through a voltage divider consisting of R16 and R18 in series between the 5.2-volt line and ground. The voltage across R16 is very low and the bias current through the base is almost zero. Thus the detector transistor is almost cut off and very little current flows in its collector circuit.

Collector current flows through two parallel dropping networks. One consists of R15, R14 and R20, and the other is formed by R29 and R31. When no signal is being received, little or no collector current flows through the networks.

However, when a signal is tuned in, collector current increases and the collector becomes more positive in proportion to signal strength. The variable dc voltage developed across the load networks is tapped and used for avc. The voltage across R31 is applied to the rf and first if amplifiers on all bands and to the mixer on the broadcast band only.

The detector is transformer-coupled to the audio amplifier through the collector circuit. The first audio stage (driver) is a common-emitter type with the volume and tone controls in its base circuit. The driver is transformer-coupled to the 0.25-watt class-B push-pull output stage using 2N225's. The output stage uses a common-emitter circuit with base bias provided and stabilized by a voltage divider consisting of R34 and R35. The phone jack is arranged to cut out the speaker when

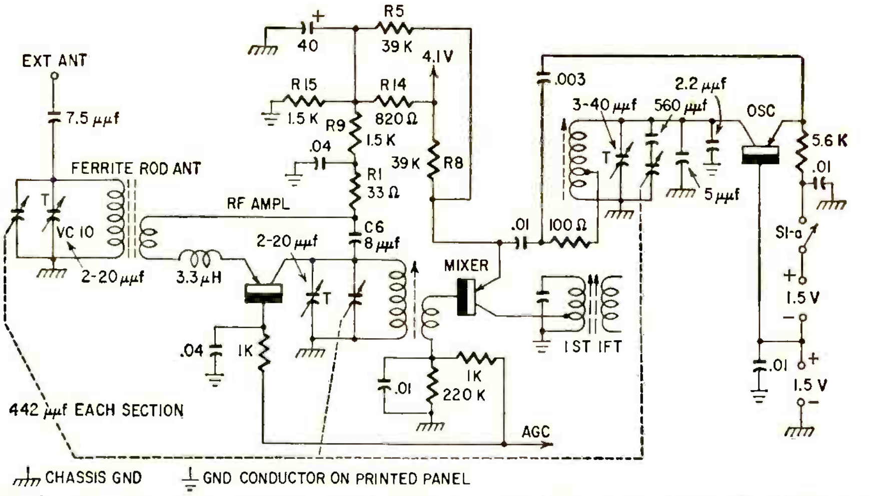


Fig. 2—Partial schematic shows the T-9's broadcast-band antenna, rf, oscillator and mixer circuits. Except for coils and trimmers, SW1 and SW2 bands are similar.

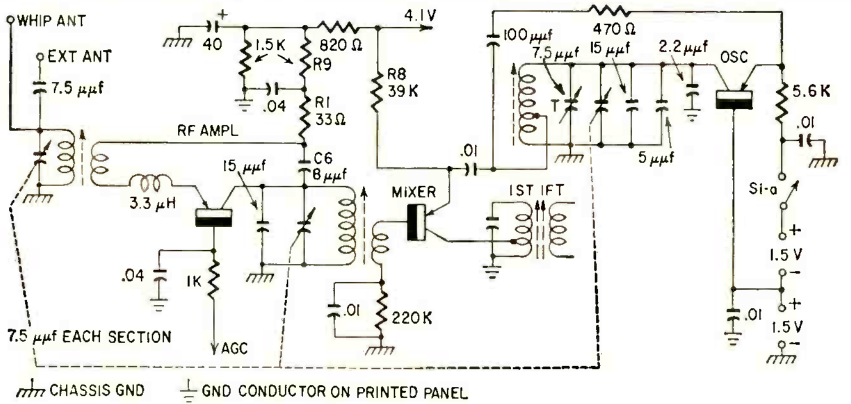


Fig. 3—This time the antenna, rf, oscillator and mixer circuits of the T-9 are shown for the 16-meter band.

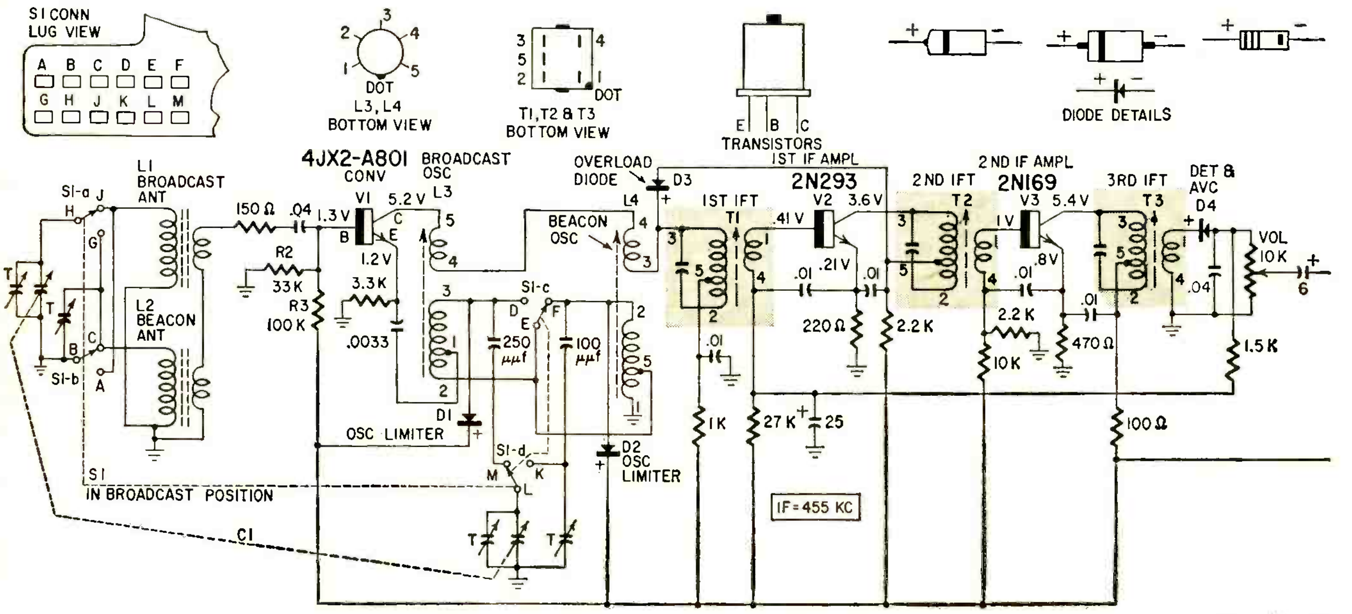


Fig. 4—The

phones are used.

Motorola Weatherama

The little Motorola model 6X39 is a compact, pocket-size transistor portable covering the standard broadcast and the 200–420-kc weather and aircraft beacon bands. It will probably be very popular with private pilots, boat owners, hunters and others whose hobbies or vocations depend on frequent accurate weather reports. The set is 6½ inches wide, 4⅞ inches high (with handle down) and 2½ inches deep. Weight is only 2¼ pounds.

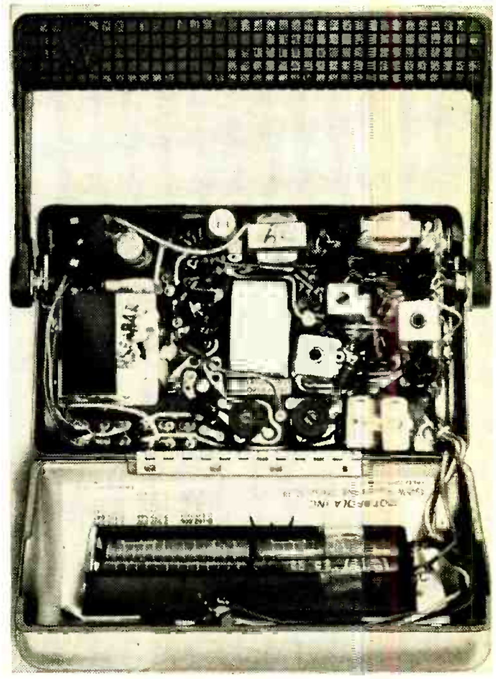
The Weatherama uses six transistors and four germanium diodes. It runs for about 200 hours on four penlight cells and considerably longer on type ZM-9 or equivalent mercury cells. It has two ferrite-rod antennas built into the handle.

The circuit of the 6X39 is shown in Fig. 4. Bandswitch S1 is a four-pole double-throw slide type located just below the tuning dial. The antenna is selected by S1-a and the unused loop is shorted out by S1-b. The secondaries of the loop are in series and capacitance-coupled to the shunt-fed base of the converter. This is a special n-p-n transistor (Motorola 4JX2-A801) with its base biased slightly positive with respect to the emitter for detection. Base bias is provided by voltage divider R2–R3.

Oscillation is provided by regenerative coupling between the collector and emitter. This is a tickler–feedback oscillator similar to its vacuum-tube equivalent. The emitter connection is tapped down on the tuned winding to provide optimum matching and to reduce damping. The ticklers are close-coupled to the tuned windings and are in series with the collector circuit. S1-c short-circuits the unused oscillator coil and S1-d connects the tuning capacitor across the coil for the band being used.

The converter uses an interesting innovation to insure uniform operation on both bands without using factory-selected or hand-picked transistors. Characteristics of transistors vary considerably—even in identical types—so performance as a converter may vary over wide ranges. If the oscillator supplies too much signal, the set will have birdies, spurious oscillations and other troubles. D1 and D2 are amplitude limiters and prevent these troubles when an over-active transistor is used.

These diodes are connected between the hot ends of the oscillator-coil primaries and the positive side of the battery. They are back-biased so they do not conduct under normal conditions. A transistor that is too active on either or both bands develops an rf voltage that overrides the blocking bias and lets the diode conduct on positive half-cycles. This damps the tuned oscillator coil and reduces the oscillator output.



The Weatherama with back open for battery replacement.

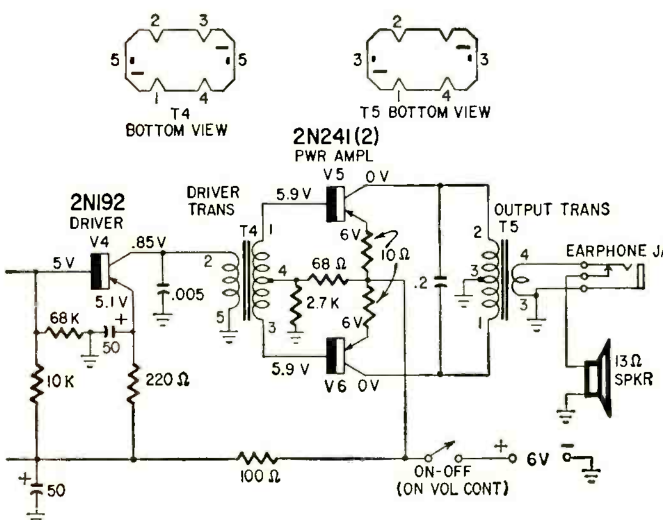
The first and second if amplifiers are common-emitter types using high-gain n-p-n type 2N293 and 2N169 transistors, respectively. The circuit design and wiring layout combine with comparatively low operating voltages to make neutralization unnecessary. Avc voltage is applied to V2's base.

In addition, diode D3 is used to help prevent overloading on signals too strong for the avc circuit to handle. The diode is biased by dc with its cathode approximately 0.9 volt positive with respect to its anode, so it cannot conduct on signals of average strength. Incoming signals exceeding a specific level develop enough rf voltage across the diode to cause it to conduct. During conduction, D3 reduces the gain of the first if stage by damping and reducing the effective Q of the tank circuit of the first if transformer.

The detector diode is connected to T3's low-impedance secondary. The cathode returns to ground through the transformer. The ac signal output from the anode has a dc component that is filtered and applied to the first if transistor for avc. The stronger the incoming signal, the more negative the dc voltage, so the if gain is reduced in proportion.

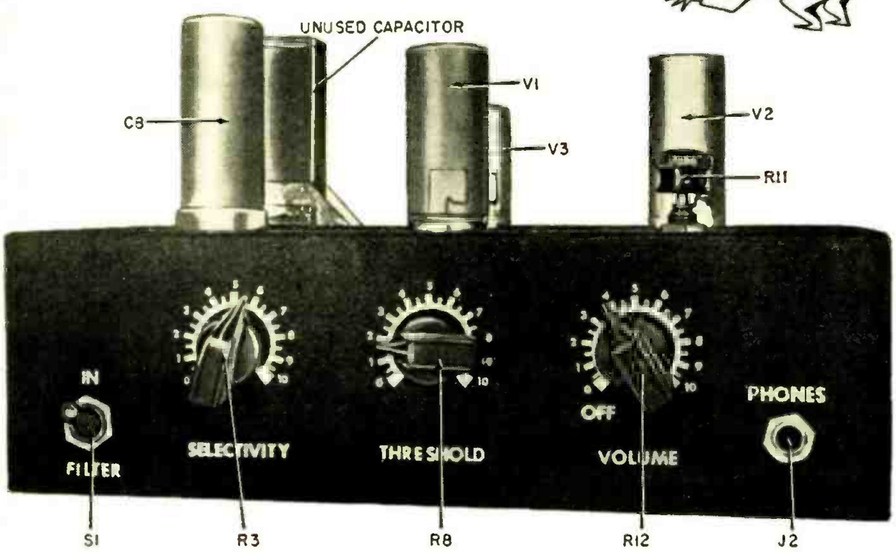
The detector's ac output is R-C-coupled to the 2N192 p-n-p driver. This stage is stabilized by tying its base to a voltage divider and by the 220-ohm resistor in its emitter return.

The 2N241 power amplifiers are operated class B and are biased to cutoff by the drop across the 2,700-ohm resistor in the common base return. Temperature stability is provided by the 10-ohm resistors in the emitter returns. The speaker has a 13-ohm voice-coil impedance. It is disconnected when phones are plugged into the jack on the rear of the case. A 15-ohm earphone is available as an accessory. END



2-band Weatherama's circuit.

THE QRM DODGER



By DON M. WHERRY, W6EUM

Three-tube circuit ends background noise, fading and ringing. Passes a clear, clean CW signal to your phones

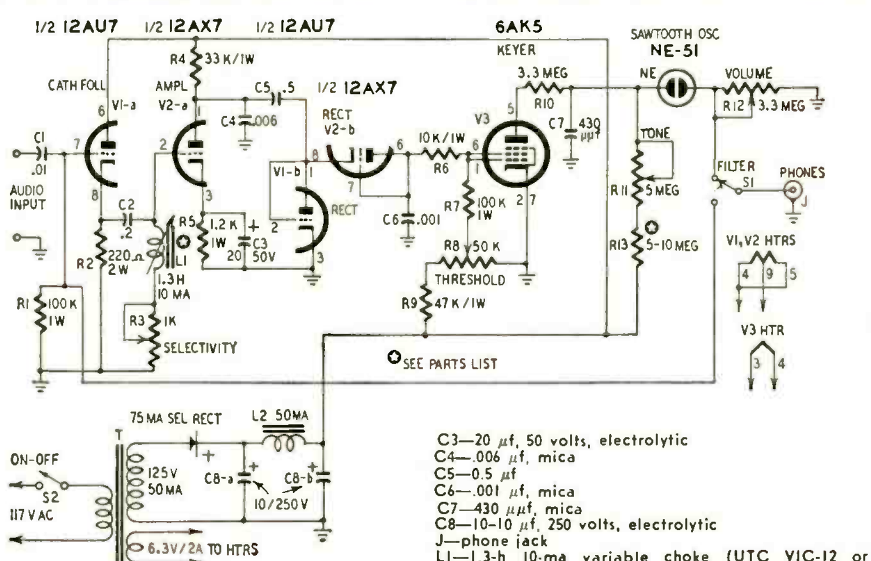
HOW would you like to sit down to your schedule tonight and copy that CW traffic with absolutely no QRM or background noise, complete silence between characters, an S8 signal 200 cycles away completely inaudible, no fading, ignition noise or racket from the XYL's vacuum cleaner, none of the ringing so common to highly selective circuits—just a pleasant tone of your own choosing? Impossible? Not at all.

It has long been my objective to develop an auxiliary unit to go with a standard amateur receiver which would increase the readability of code signals. The limiting factor has always been the ringing when sharply peaked circuits are used, especially at audio frequencies. There are low-frequency and magnetostrictive if circuits which give remarkable results but they are costly enough to be beyond most of us. Therefore the unit shown in Fig. 1 was developed. It consists of a 12AU7 cathode-follower input, an audio filter, amplifier, rectifier, keyer tube and neon-lamp sawtooth oscillator.

The input, which may come from the phone jack or any other convenient audio takeoff point, is fed into the grid of the cathode-follower input tube. This type of input circuit is used for two reasons: to isolate the unit from the signal source and to furnish a low-impedance input of approximately 125 ohms to the tone filter.

The filter is a series-resonant circuit consisting of a choke (L1) and a series capacitor (C2) which, with the SELECTIVITY control (R3) and cathode resistor (R2), form a resonant circuit. The resonant frequency of the circuit is approximately 550 cycles. This may seem low, but remember that selectivity is a percentage proposition, so the lower the frequency, the higher the selectivity.

A lower frequency than specified here may be used, provided it doesn't present tuning problems to the operator. I have used experimental circuits of about 180 to 200 cycles with astonishing results, getting tremendous selectivity before ringing became objectionable. However,



R1, 7—100,000 ohms
R2—220 ohms, 2 watts
R3—pot, 1,000 ohms, wirewound
R4—33,000 ohms
R5—1,200 ohms
R6—10,000 ohms
R8—pot, 50,000 ohms
R9—47,000 ohms
R10—3.3 megohms
R11—pot, 5 megohms
R12—pot, 3.3 megohms, with spst switch S2
R13—5-10 megohms, adjust for proper range of tone on R11
All resistors 1 watt unless noted
C1—.01 μf
C2—0.2 μf, mica if possible
C3—20 μf, 50 volts, electrolytic
C4—.006 μf, mica
C5—0.5 μf
C6—.001 μf, mica
C7—430 μμf, mica
C8—10-10 μf, 250 volts, electrolytic
J—phone jack
L1—1.3-h 10-ma variable choke (UTC VIC-12 or equivalent); varies +85% to —45% of listed value
L2—50 ma, ac-dc choke
RECT—selenium, 130 volts, 75 ma
S1—spdt toggle
S2—spst on R12
T—power transformer: primary, 117 volts; secondary, 125 volts, 50 ma; 6.3 volts, 2 amp
V1—12AU7
V2—12AX7
V3—6AK5
NE-51, neon bulb
Chassis, 10 x 5 x 3 inches
Tube sockets, 9-pin miniature (2)
Tube socket, 7-pin miniature
Tube shields, for 9-pin miniatures (2)
Tube shield, for 7-pin miniature
Miscellaneous hardware

Fig. 1—Circuit of the QRM dodger.

There's no crowding under this chassis.

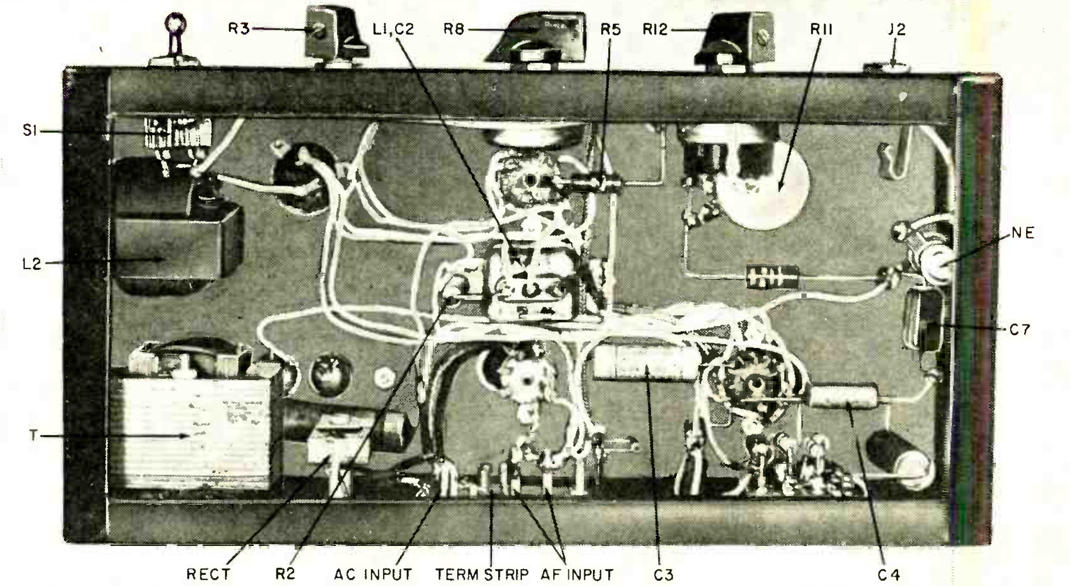
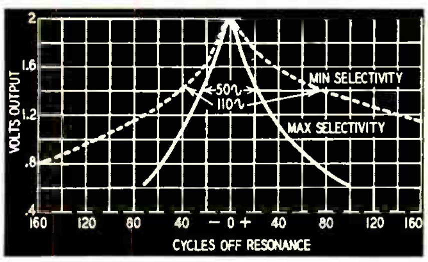


Fig. 2—Minimum and maximum filter characteristics afforded by the simple unit.



such low frequencies may present an impossible tuning situation unless the receiver has a wide bandpass.

Returning to the circuit, the SELECTIVITY control (R3) operates on the principle that, as the series resistance of a tuned circuit increases, the Q decreases and bandpass increases. Actually overall bandpass is not appreciably increased but rather the gain of the resonant circuit is decreased, which moves the nose down, giving an apparent increase. However, the results are the same.

L1 is an audio choke, which may seem to have a low inductance for the frequency used but was chosen deliberately. If the circuit is to resonate at the desired frequency, a rather large capacitor C2 is necessary. Resistor R2 in the cathode circuit of V1-a, which sets the current through that tube, also limits the selectivity.

The two selectivity curves (Fig. 2) show "cycles off resonance vs. volts output." The value of the output voltage is chosen arbitrarily for explanation purposes only. The half-power point is approximately 50 cycles wide at the maximum selectivity position, and approximately 110 cycles at the minimum.

A different value of resistance for the SELECTIVITY control, or a different resonant frequency, gives a different curve. It would seem possible that by simply adding more filter sections the amount of selectivity would be unlimited in a device of this sort. But with an excessive amount of filter the high Q of the circuit causes ringing. This appears as tails to the code characters and also excessive softness at the beginning. The ringing normally permissible in this unit far exceeds that which would be objectionable for ordinary use. This is partly due to the ear being a very poor audio-level indicator and also that this unit uses only a small portion of the code character envelope.

The use of a variable inductance for L1 is desirable but not necessary. Any good audio choke can be substituted if the proper value capacitor, for the frequency desired, is used in series. In fact a common filter choke can be used but with reduced selectivity due to the low Q of such reactance.

The output from the audio filter is fed to the grid of a 12AX7 triode amplifier. The plate of this tube is bypassed quite heavily to attenuate the higher frequencies which get by the tone filter.

The output of this tube is then fed, through capacitor C5, to a voltage-doubler rectifier circuit made up of the remaining halves of V1 and V2. These triodes operate satisfactorily as rectifiers when they are diode-connected.

The rectifier's output is then filtered and applied to the 6AK5 keyer or trigger tube, which is connected as a high-mu triode. This keyer tube has a neon sawtooth oscillator in its plate circuit. The keyer turns the neon oscillator on and off to correspond to the code characters received. It does this by drawing, with no signal present, such a large current through resistors R13 and R11, that the voltage at the neon lamp is insufficient to allow it to ionize, hence no oscillation and no output. In use, receiver noise, etc., puts a dc voltage at the keyer's input, sufficient to cut off plate current and allow the neon oscillator to run continuously. The THRESHOLD control (R8) removes this noise voltage by applying a small positive potential to the keyer tube's grid, which holds it at a value that permits the tube to conduct at all times, when no signal is present. It, in effect, cancels out the small negative noise voltage present. The negative voltage developed by a signal then overrides the bias or threshold voltage, allowing the neon to oscillate. Potentiometer R11 controls the oscillator frequency. The output voltage is taken from across the VOLUME control (R12) which is inserted in the ground lead of the neon lamp.

In setting up this unit for operation, the audio input is connected to the receiver. The receiver's gain is set at approximately the normal operating position. Then with the power on and the filter in, adjust the THRESHOLD control until, with no signal tuned in, background noise just fails to trigger the neon bulb. Now, as signals are tuned, the voltage rises, cutting off the trigger tube and keying the neon oscillator. A signal of 0.25 to 0.5 volt to the keyer grid will key the neon oscillator.

With the proper adjustment of the THRESHOLD, the keying voltage level can be set above any interfering signal. Suppose a signal is placing 1.5 volt at the keyer's grid. The THRESHOLD could be set at 1.5 volts bias and no trigger action will occur. Now, if the signal we wish to copy places 2 volts at the keyer's grid, we have a differential of 0.5 volt available for keying. We are now copying a signal only 0.5 volt stronger than another on the same frequency.

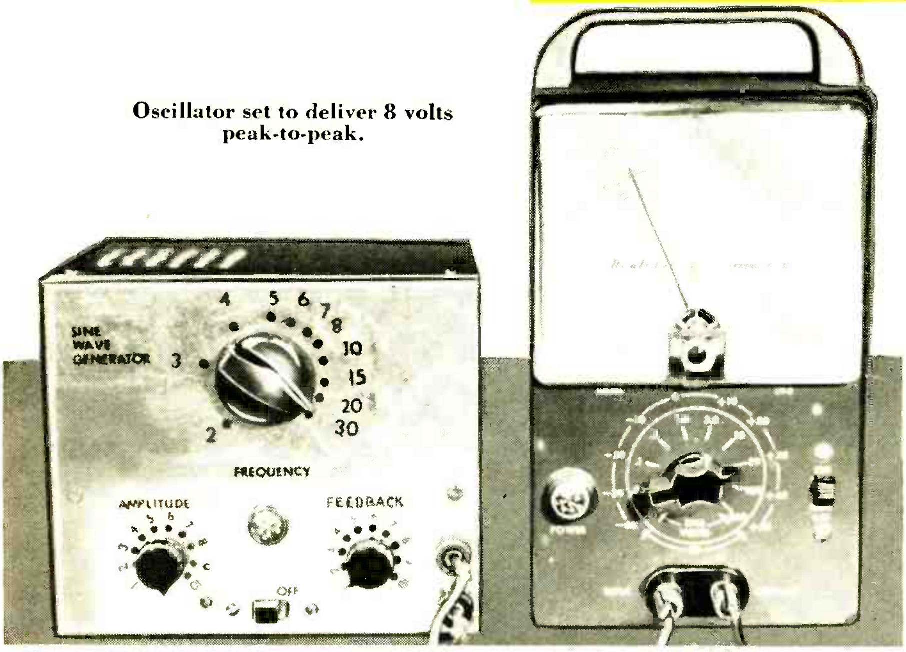
This unit opens a large field of applications for highly selective audio circuits as a simple, reliable way to obtain and use high audio selectivity without the effects of prohibitive ringing. It opens the possibility of multiple code channels on one rf frequency, each using a different audio tone. (This would not apply to amateurs of course.) One transmitter could carry a number of simultaneous code transmissions into the ultrasonic region; ultrasonic code on voice channels and a means of QRM–QRN - free communication for amateurs. END

2–30-cycle very-low-distortion sine waves, for testing amplifiers, oscilloscopes and speakers are delivered by this handy instrument

BENCH R-E TESTED

By TOM JASKI

DOWN LOW with an AUDIO OSCILLATOR



Oscillator set to deliver 8 volts peak-to-peak.

MOST kit type audio oscillators produce a good sine wave down to about 20 cycles. But if you should want to test anything below 18 or even 10 cycles, not much is available as a sine-wave source.

Why might you want to go down that low? Well, most oscilloscope amplifiers are rated down to 2 or 3 cycles per second, many speakers and some amplifiers down as low as 10 cycles. To test their performance at these low ranges, you'll need a signal source. If you are interested in developing or building an electronic organ, and need a source for 32-foot low C, you need an oscillator that can produce 16 cycles. And again, you might want to use a temporary tremolo or vibrato setup requiring frequencies as low as 4 cycles.

For all such uses, the little inexpensive oscillator described here is useful. It produces a very good sine wave from 2 to 40 cycles, supplementing the low range of your present equipment. Generating pure 2-cycle sine waves is difficult, unless you are willing to use a beat oscillator actually containing two oscillators and producing the low-frequency sine wave by beating one against the other. A beat oscillator has the disadvantage that it is difficult to stabilize—any instability in the basic oscillators may be added to produce annoying drift.

This little oscillator does not produce an absolutely pure sine wave, but it does not have more than a few percent distortion, and we will explain how you can get rid of even that with some extra parts. It has turned out to be remarkably stable. The one critical part for stability is the Wien-bridge dual potentiometer (R1), which should be rated at 2 watts for satisfactory stability.

Fig. 1 shows the complete circuit diagram. As you can see, it is a conventional Wien-bridge oscillator, but with very large capacitive values and more than usual number of filament lamps. (Thermistors have been used in some low-frequency units in place of the lamps to get greater stability.) The extra lamps are in the cathode of the 6AQ5 feedback tube and help to clean up the waveform. V3 is a simple cathode follower which prevents oscillator circuit loading which would result in a frequency change.

With R5 at minimum resistance the oscillator just oscillates, but the waveform is purest at this point. Figs. 2-a and 2-b show actual oscillograms made with this oscillator at 4 and 20 cycles, respectively. Some distortion of the sine wave is visible at the lower peaks but, as you can see, it is not a very serious amount.

Construction and circuit details

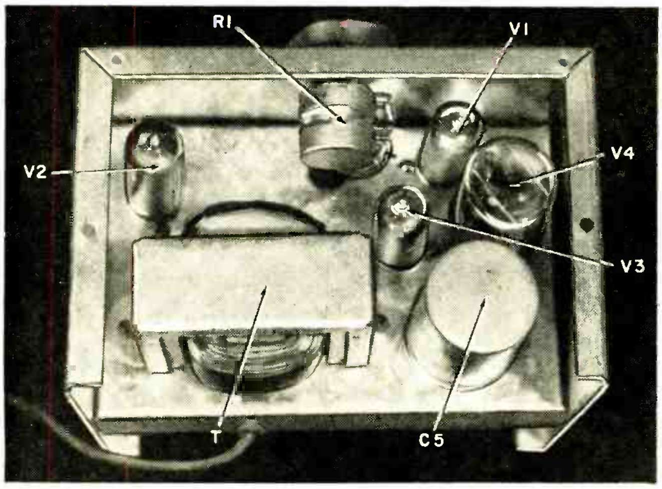
Parts placement is not at all critical. If you like a different arrangement, there is no reason why you shouldn't use it. The underchassis photo makes things look very crowded, but underneath the large capacitors, C3 and C4, there is plenty of room.

If you need a very pure sine wave at these low frequencies, the simplest solution is to include a low-pass filter network at the oscillator's output. This works because, no matter how distortion is originally created on the sine wave, most of it represents the creation and inclusion of higher harmonics. Eliminating the higher harmonics will clean up the wave. Fig. 3 shows a typical low-pass filter which will do a creditable job at all the frequencies produced by this oscillator, but it will, of course, result in some attenuation at the upper end of the range. Attentuation is not a serious problem; the oscillator puts out (for most purposes) a large signal anyway. Incidentally, the oscillograms in Fig. 2 were taken without any filter.

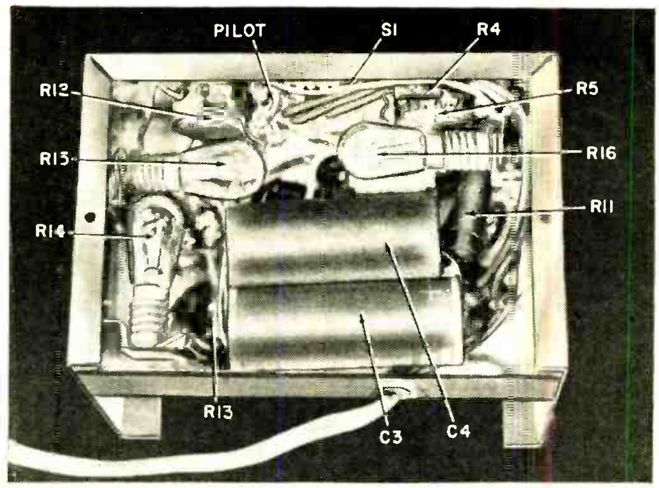
Tested by a member of the staff of RADIO-ELECTRONICS, the oscillator's lowest frequency was 2.93 cycles and the maximum frequency above 30 cycles. No-load maximum output was 30 volts. Oscilloscope traces agreed with those of Fig. 2 of the article.

Output *(volts peak-to-peak)*	Load *(ohms)*
30	none
20	1,000
15	470
3	82
2	52

Overall operation is highly satisfactory but the compactness of the unit results in a large amount of heat given off by the unit (the case measured 100°F after 2 hours operation). A slightly larger case will eliminate this problem.



Top inside view of the oscillator.



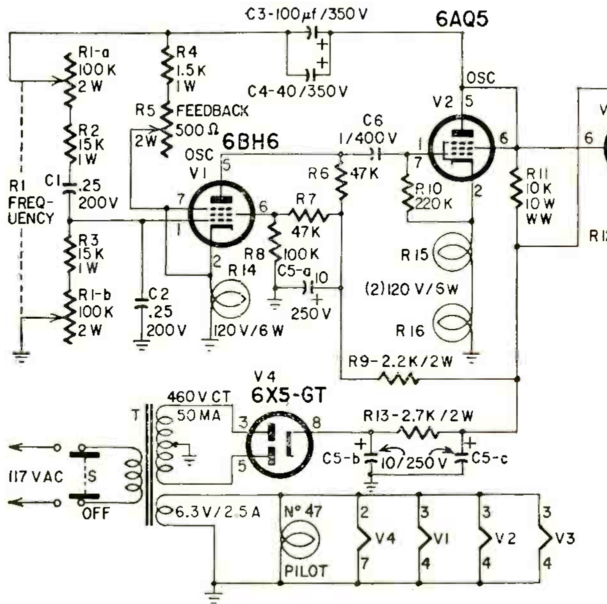
The three lamps are mounted under the chassis.

With the filter shown, no distortion could be detected visually.

Other than testing amplifiers, scopes and speakers, what are some uses for this little oscillator? Well, you could use it to determine rumble frequency of a turntable by making Lissajous figures on a scope, using the oscillator for horizontal deflection. You could amplify the signal with a very simple power amplifier and apply it to a solenoid to rock a photographic tray or tank slowly. You can apply the signal to a reactance tube to frequency-modulate another oscillator, giving a vibrato effect for electronic organs or other musical instruments. Vibrato and tremolo usually require 4 to 6 cycles per second. Originally designed to provide a subsonic signal for psychophysiological tests, there are many other uses for it. An important use is in checking modern feedback amplifiers whose response below 15 cycles is important in determining stability.

Calibration is a simple process. The 30-, 20-, 15-, 10- and 5-cycle points, and even 3 cycles, can easily be checked with Lissajous figures on an oscilloscope, using 60-cycle line voltage for comparison. Below 5 cycles, a stopwatch and counting will work.

[J1 is positive to ground, so use a blocking capacitor when feeding an amplifier that does not have one in its input circuit. Also, V3's bias may be upset when driving a low-resistance load. To avoid these difficulties, connect the positive side of a 250-volt, 100-µf (or higher) electrolytic to the arm of R12 and the negative side to J1. Connect a 1-megohm resistor between J1 and J2.—*Editor*] END



Note: If necessary to get down to 2 cycles, shunt C1 and C2 with extra capacitors. Standard capacitors may be as much as 20% low.

R1—dual pot, 100,000 ohms, 2 watts, linear taper (Ohmite CCU1041 or equivalent)
R2, 3—15,000 ohms, 1 watt
R4—1,500 ohms, 1 watt
R5—pot, 500 ohms, 2 watts, linear taper
R6, 7—47,000 ohms, ½ watt
R8—100,000 ohms, ½ watt
R9—2,200 ohms, 2 watts
R10—220,000 ohms, ½ watt
R11—10,000 ohms, 10 watts, wirewound
R12—pot, 50,000 ohms, 2 watts, log taper
R13—2,700 ohms, 2 watts
R14, 15, 16—6 watts, 120 volts, candelabra lamps
C1, 2—0.25 µf, 200 volts
C3—100 µf, 350 volts
C4—40 µf, 350 volts
C5—10-10-10 µf, 250 volts, electrolytic
C6—1 µf, 400 volts
J1, 2—3-way binding posts
S—dpst slide
T—power transformer: primary, 117 volts; secondary, 460 volts, 50 ma; 6.3 volts, 2.5 amps (Stancor PC-8418 or equivalent)
V1—6BH6
V2—6AQ5
V3—6C4
V4—6X5-GT
Case, 4 x 5 x 6 inches
Chassis, 1½ x 4⅞ x 5¾
Lamp sockets, candelabra (3)
Pilot-light assembly with No. 47 bulb
Miscellaneous hardware

Fig. 1—Circuit of the 4-tube unit.

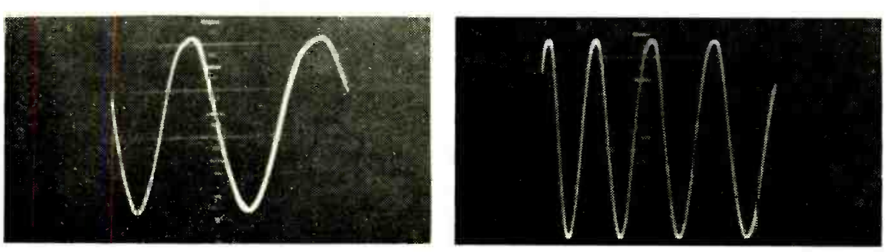


Fig. 2—Oscillograms of the sine wave turned out by the oscillator: a—4 cycles; b—20 cycles.

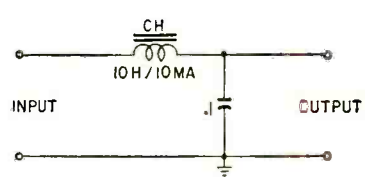


Fig. 3—Low-pass filter to reduce further the slight amount of distortion present in the sine-wave output.

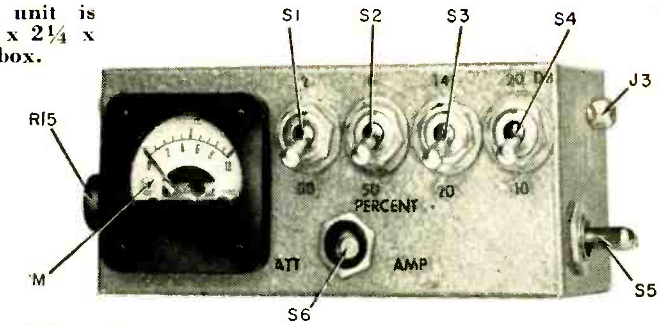
DC AC

ATTENUATOR has many uses...

A handful of valuable instrument that can be used for meter and oscilloscope calibration, as a db and output meter and for measuring voltage gain

By I. QUEEN
EDITORIAL ASSOCIATE

The compact unit is housed in a 5 x 2¼ x 2¼-inch box.



THIS compact device makes little voltages out of big ones. It works on ac (line frequency and af) as well as dc, and is conveniently controlled by switches. Among its applications are: meter and oscilloscope calibration; db and output meter; measurement of voltage gain.

By flicking switches you can insert 2-, 6-, 14-, 20-db losses or any combination thereof. Loss maximum is 42 db, when all switches are up. When all are down (or out as shown in Fig. 1), the loss is zero—output equals input.

The complete circuit (Fig. 2) has four T-networks in series. Each requires three resistors to attain the desired loss and maintain correct impedance match. Attenuation values selected for this particular instrument are listed in the table. This also shows the *exact* resistance needed for the network plus the nearest *preferred* value.

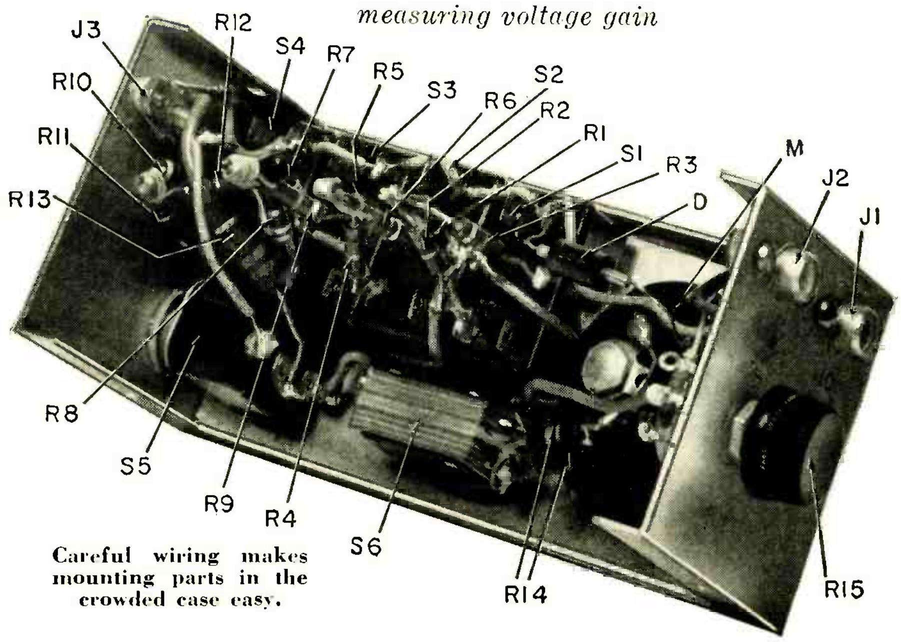
From available resistors select those closest to the required values, using either an ohmmeter or bridge. If you plan to incorporate other attenuation values in addition to or instead of those given here, see page 98 of *Basic Audio Course** for resistors required.

The following table lists attenuation in db, corresponding percentage and switches to flip to obtain the desired values:

Loss db	*Loss %*	*Output— % of Input*	*Switches Thrown*
2	20	80	S1
6	50	50	S2
8	60	40	S1–S2
14	80	20	S3
16	84	16	S1–S3
20	90	10	S4
22	92	8	S1–S4
26	95	5	S2–S4
28	96	4	S1–S2–S4
34	98	2	S3–S4
36	98.4	1.6	S1–S3–S4
40	99	1.0	S2–S3–S4
42	99.2	0.8	S1–S2–S3–S4

Thus, if we want to attenuate a signal by 26 db, the table shows that we must flip S2 and S4. The loss will be 95% and the output will fall to 5% of the input. The third column is convenient because if it is multiplied by 10 it gives the *output in mv* when the input is exactly 1 volt. For example, if we need 40 mv for a certain test, we have it by switching to 28 db.

*No. 66, Gernsback Library.



Careful wiring makes mounting parts in the crowded case easy.

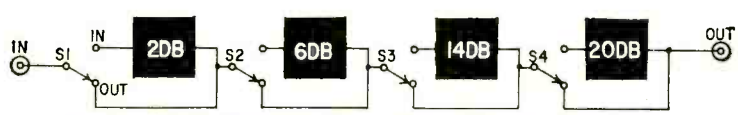
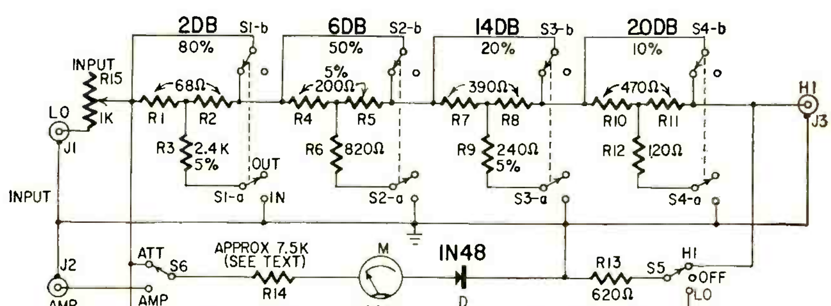


Fig. 1—Block diagram shows that with switches down—in out position—loss introduced by attenuator is zero.



R1, 2—68 ohms
R3—2,400 ohms, 5%
R4, 5—200 ohms, 5%
R6—820 ohms
R7, 8—390 ohms
R9—240 ohms, 5%
R10, 11—470 ohms
R12—120 ohms
R13—620 ohms
R14—7,500 ohms
R15—pot, 1,000 ohms, miniature
All resistors ½ watt 10% unless noted
D—1N48
J1, 2, 3—phono jacks
M—200 μa, dc meter
S1, 2, 3, 4—dpdt toggle
S5—spdt, center off, toggle
S6—spst toggle
Chassis, aluminum box, 5 x 2½ x 2¼ inches
Knob
Miscellaneous hardware

Fig. 2—Circuit of the simple unit. Four T-networks in series provide variable attenuation. See text and chart for nearest attenuator resistor values. The circuit shows nearest preferred values to select from.

Required Resistance Ohms		Nearest Preferred Value		Db Loss
Series	Shunt	Series	Shunt	
68.8	2,582	68	2,400*	2
199.3	803.4	200*	820	6
400.4	249.4	390	240*	14
490.4	121.2	470	120	20

* 5%

There are a few gaps in the db column, the maximum being 6 db (such as between 8 and 14). To interpolate within these spaces, note that each 0.1 volt change (from 1 volt) is equal to a change of approximately 1 db. Now suppose we wish to generate a signal that is 10 db below 1 volt dc. The number 10 does not appear in the chart, so we can proceed as follows: Adjust the input for a meter reading of 0.8 volt and switch to 8 db, or adjust the input for a meter reading of 1.4 volts and switch to 14 db. It is better to use *minimum* deviation from the midscale reading of 1 volt, so the first plan is better. Except when interpolating as above, the most convenient procedure is to set the meter to midscale.

If you are using ac instead of dc, note that a 0.2 volt change from the 2-volt midscale corresponds to 1 db. In any case each db is equal to a *10%* change from midscale or standard setting.

Circuit details

A sensitive meter mounted on the front panel indicates voltage. Resistor R14 is selected to provide mid-scale deflection with 1 volt dc. I found that 33,000 ohms across 10,000 ohms did the trick, so this pair became R14. This value will vary and must be determined by experimenting.

The meter circuit also accepts *ac*. Diode D simply chops off half of each ac cycle, leaving the other half to be read on the dc meter. On dc, the current flows through D into the meter.

Perhaps I was lucky, but tests show that my meter reads mid-scale with exactly 2 volts ac, so no calibration chart is needed. If the 2-volt ac point happens to be in some other spot, make a note of it so you can set the input to 2 volts ac at any time.

Each T-network is designed for 600 ohms. This means that when a 600-ohm load resistor is across its *output* terminals, the *input* will also measure 600 ohms. For example, consider the 6-db network shown in Fig. 3. Resistor values are approximate, and the dotted line shows the required load. Note that R_b is shunted by 800 ohms ($R_c + R_L$) to give an equivalent (between A and B) of 400 ohms, in series with R_a. Thus the input to this T-network is 600 ohms *when (and only when) the terminating load is 600 ohms.*

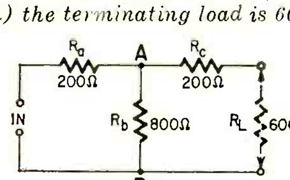


Fig. 3—This 6-db network delivers 50% of the input to the load.

It is also easy to show that the circuit of Fig. 3 delivers 50% of its input voltage to R_L. R_a is in series with an equivalent of 400 ohms. Thus one-third of the input is lost in R_a and *two-thirds* is transmitted. Of this fraction, one-fourth is lost in R_c and *three-fourths* is transmitted to R_L. The fraction appearing across the load is ¾ of ⅔, which is ½.

Whether one or more networks are used, only one load resistor is needed. It should always be across the last network. As shown for Fig. 3, when the output is 600 ohms (R_L) so is its input. Therefore any previous T-network (if used) is automatically terminated in 600 ohms, and so on.

In Fig. 2, R13 is the load resistor. It is selected from among low-reading 620-ohm resistors (5%). S5 is a spdt toggle switch with a center-off position. It switches R13 either across the HI (J3) or the LO (J1) terminals, whichever happens to be used as output. R13 is not needed when an external load across the attenuator is already terminated in 600 ohms. In that case, S5 is left in the off position.

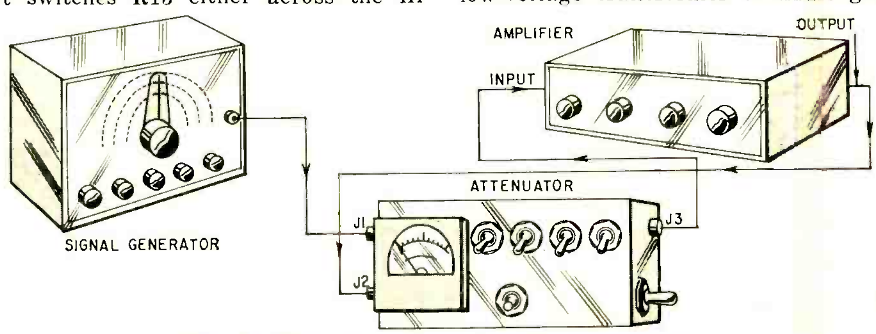


Fig. 4—This setup shows how to use attenuator to measure voltage gain of an amplifier.

The input potentiometer (R15) is normally left at zero resistance so that the device acts as a 600-ohm attenuator. The pot adjusts an input signal to a desired voltage and its use is described later.

All resistors in this device are ½-watt units, selected (as mentioned previously) from available preferred values.

After completing this instrument (and it shouldn't take long), be sure to test it. Switch in maximum attenuation and apply 20 volts dc at J3 (all switches up). The meter should hardly deflect. Switch off all but S4 (20 db), at which the deflection should read full scale (2 volts). In other words, the attenuator is set for 10% output or a 90% loss. Now add 2 db more (S1) and the needle should fall to 80% of full scale.

Switch off S1 and substitute S2 instead, leaving the needle at mid-scale. Switch S2 off and S3 on, at which the reading should drop to 20% of full scale. You may also test input resistance. Switch S5 to HI and measure the resistance across J1. It should be 600 ohms, no matter what combination of switches is left up.

If these readings are approximately correct (5% or better), your job is well done. For very high precision you will need careful selection of the resistors that go into these networks.

What will it do?

1. Meter calibration (dc)

Apply a known dc at J1. Adjust the INPUT potentiometer for a meter reading of exactly 1 volt. The output must be 600 ohms. Therefore, if the external circuit impedance is very high, switch in R13 across J3 the HI terminal.

You now have small fractions of a volt available. For example, if you need .08 volt, switch in 22 db. Note that accuracy is controlled by *resistors* and does not depend upon errors inherent in a meter or battery.

2. Ac calibration

The method is similar to dc calibration, except that the source may be a low-voltage transformer or audio generator. Either a meter or oscilloscope may be calibrated. To measure the amplitude of an unknown waveform on an oscilloscope, compare it with the known outputs from the attenuator. The resistive networks used here can be relied upon at all audio frequencies.

Calibration of ac meters is especially important. From time to time articles have described excellent meters for measuring weak ac voltages. The real problem is in how to *calibrate* the meters. Many ac meters have nonlinear scales, and the linearity becomes worse at lower ranges. This attenuator offers a very convenient means for accurate calibration.

3. Larger voltages

The setup used for ac calibration is limited by the meter's capability. Suppose you wish to measure in the range of 20 volts or more. Apply the unknown voltage at the HI terminals. This places the attenuator between signal and meter, and you can insert adequate loss to protect the meter. Suppose your meter reads 1 volt when S3 is the only switch in the circuit. This corresponds to 20% output, so your input is 5 volts. The 600-ohm termination must now be across J1. A maximum of about 25 volts is permissible across J3.

4. Db or output meter

Obviously this instrument can be used to measure or monitor the output of an amplifier, recorder or other device which has an output of about 1 volt or more. Just set the switches for a reading near mid-scale, so there will be room for increase or decrease. Changes in signal amplitude show up on the meter. If the rise is too great, insert additional attenuation as needed. Either dc or ac signals may be monitored.

5. Voltage-gain measurement

Although this is a variable-*loss* device, it can be used conveniently to measure *gain*. See Fig. 4. An amplifier is shown in series with the attenuator. By switching S6 between AMP and ATT, the meter compares outputs from the oscillator and the amplifier. When the readings are equal, attenuator loss must be the same as amplifier gain (in volts). Either value is read off the switch combination. To maintain accuracy, the attenuator output must be 600 ohms. Fortunately this is approximately the input to most common-emitter stages so additional termination (R13) is not needed. The amplifier should be terminated in its specified impedance load.

When equal readings are obtained (at both AMP and ATT positions of S5), note the setting of S1–S4 in db and convert to percentage. If, for example, the answer is 1%, the amplifier's voltage gain is 100.

Because of the gap in the db scale (such as between 8 and 14) it may not be possible to find the exact db gain of an amplifier. In other words, switching between ATT and AMP may not permit identical readings. When this happens, the meter itself is used to interpolate. Suppose, for example, that the switches are set to 8 db for closest comparison between AMP and ATT readings. When switched to AMP the meter deflects higher than midscale (which is convenient for the ATT setting).

As mentioned earlier in the article each 10% of change from a midscale reading means 1 db. If the meter shows 2.4 volts ac (as against 2 volts at midscale) the actual gain is 8 db plus 2 db or a total of 10 db. END

Notes on Soldering

By DARWIN H. HARRIS

When I became absorbed in electronics some 10 years ago, one of the first things I learned was that connections have to be secured by winding, wrapping or twisting the wire about the terminal before soldering. Being experimentally inclined, which implies making changes, I soon learned that these junctions are not easy to disassemble. This led to the obvious course of eliminating mechanical joints and depending entirely on the solder for strength. During the long period I have followed this practice, I have had *no joint failures* due to mechanical causes. The very few bad ones were plainly caused by the usual thing—sloppy soldering, resulting in cold joints. (Some of the soldering observed was subjected, without any trouble, to vibration in car radios.)

Therefore, my philosophy is simply that a properly soldered connection requires no provision to secure it other than the solder itself. This applies to all ordinary connections made in electronic hookups, where wires are soldered into lug holes. There are some obvious exceptions—places where unusual strength is required. For example, an antenna lead, where you naturally make a strong twisted splice before soldering. The admonitory adjective "properly soldered" should be kept in mind. More on this presently.

I have a notion that the wrapped-joint dictum might have come from three things: Certain manufacturing practices require that one person make the connection, another solder it. It must then be self-supporting between operations. The old electrical code required this type construction. Low-tin solder might make it advisable. Personally I believe no solder should be used that contains less than 50% tin. Best of all is eutectic solder (60% tin, 40% lead), which I now use almost exclusively.

When two metals are melted together in different proportions, some particular composition has the lowest melting point. This is the eutectic alloy. It has the important property of melting sharply—of passing from solid to liquid (or vice versa) at a constant temperature, as pure metals do. Mixtures on either side of the eutectic do not have a true melting point, but have instead a semisolid zone persisting through a certain range of temperature before becoming liquid. Within limits, the more the composition differs from the eutectic, the wider this semisolid range is, temperature wise.

The tin–lead eutectic contains 62% tin. The commercial 60% grade is so near the eutectic as to be practically equal to it. This solder not only melts most easily, but sets quickly and strongly on slight cooling. Low-analysis alloy (40% tin) requires a considerably higher temperature to become fluid and sets on slight cooling to a soft state which is brittle and weak until it cools far enough to be truly solid. (The semisolid characteristic of this grade is useful in the wiping-solder method of joining lead pipes.) Obviously, medium-analysis solder (50% tin) is intermediate in properties between the extremes discussed. It has enough good qualities to be satisfactory, although markedly inferior to the eutectic grade of solder.

Based on these facts, it is my opinion that a well-soldered wire connection requires solder containing at least 50% tin and preferably 60%. It is hardly necessary to mention the other ingredients of good soldering, cleanliness and sufficient heat, since these are matters that anyone trying to do good work soon learns. END

NEXT MONTH

ECONOMY TUBE CHECKER

An easily built tester that will obtain for you many of the results expected from much higher priced units.

RING RADIATOR

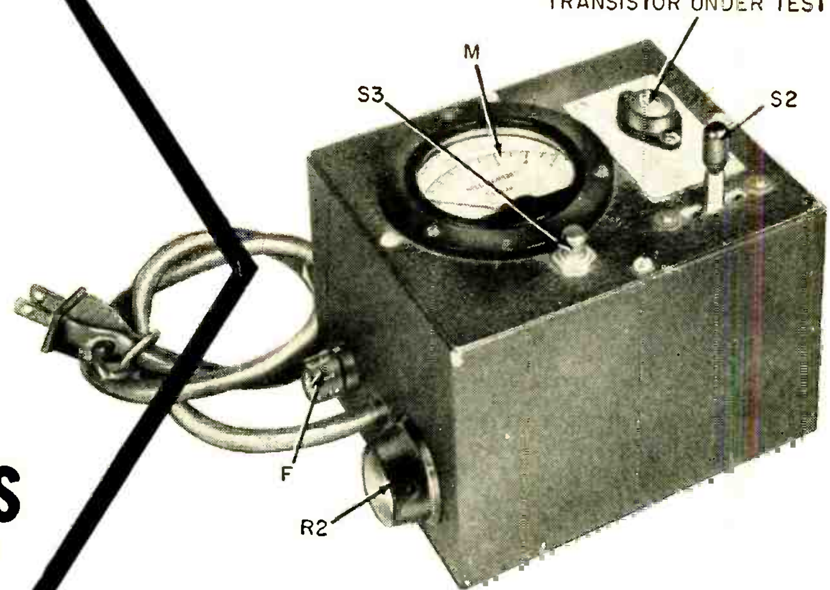
A complete description of the new Jim Lansing tweeter which uses a special principle to produce and radiate high audio frequencies.

SIMPLE SUPER TIME BASE

This generator supplies your scope's horizontal oscillator with a sweep that can be triggered to give a single trace at rates ranging from 0.2 second to 0.2 μsec per inch. Also operates free-running.

A checker that detects shorts, opens, leakage and low power gain in auto radio power transistors

This Tester Checks Power Transistors



The finished unit. This is the ac version.

By W. F. JORDAN and H. C. LIN *

SERVICE technicians and dealers need a simple and inexpensive device for checking the power transistors used in hybrid and all-transistor auto radios. The instrument described in this article accurately tests for power gain and any one of or combination of opens, shorts, leakage and voltage breakdown in the transistor.

To measure power gain you usually need bulky and expensive instruments, such as an audio signal generator and ac voltmeter. The tester makes ac power-gain measurements by using a dc test. This simplifies operation and reduces the tester's cost.

Power gain

Power gain in a transistor amplifier, as defined by most auto radio manufacturers, is the ratio (in decibels) of output power to the maximum power available from a generator of a specified impedance (R_{gen}). The equivalent input circuit of an amplifier can be represented by a *current* generator and shunt impedance R_{gen} as in Fig. 1.

Essentially, power gain depends on two quantities—collector-to-base current amplification (h_{fe}) and the input resistance. Measuring either alone does not measure power gain, since both vary over a wide range.

On the other hand, when output power and generator impedance are fixed, generator current I_g is proportional to the square root of the available power input:

Available input power $= I_g^2 R_{gen}/4$

(The equation is divided by 4 as auto radio manufacturers feel this represents actual available input power—it takes into account all receiver losses.)

Therefore, I_g is inversely proportional to the power gain in decibels because power gain in decibels equals

$$10 \log \frac{\text{Output power}}{\text{Available input power}}$$

In the tester, this generator current indicates power gain and is simulated with a dc source (the battery in Fig. 2). Using dc is justified because the ac signal amplification (h_{fe}) is very nearly proportional to the direct-current amplification (h_{FE}) for these transistors.

Dc output power is maintained constant by holding collector current constant. Since collector current is nearly equal to emitter current, consistency of collector current is handled by emitter degeneration (R2 and R3 in Fig. 2). The input circuit is represented by current source I_s (3-volt battery section) shunted by the specified source resistance. I_s is then a "straightline" function of power gain (in db). A graph comparing them is shown in Fig. 3 and using it you can calibrate the milliammeter dial in decibels.

Emitter current in the test circuit (Fig. 4) is essentially equal to the 3-volt supply divided by R2 plus R3. Any

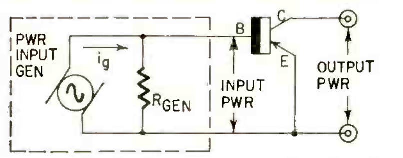


Fig. 1—Equivalent input circuit of a power transistor amplifier stage.

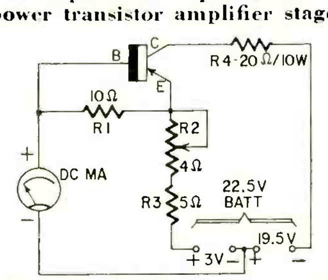


Fig. 2—This circuit tests for gain. R1 is the constant generator impedance and R4 is the constant load impedance.

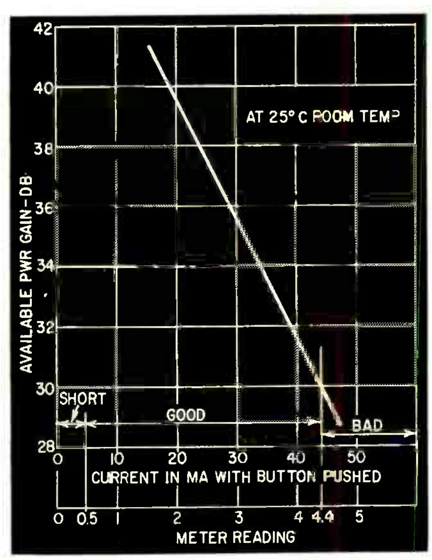


Fig. 3—Power gain vs meter reading for use on gain tests. Above 2.2 ma can be marked *bad* on the meter face and below 2.2 ma can be marked *good*.

*Semiconductor Operations, CBS-Hytron, Lowell, Mass.

TABLE I—OPERATING INSTRUCTIONS

Calibrate
(Do not push button)

Dc tester: Set to 2 (400 ma). If you can't, replace battery.
Ac tester: Set to 1.5 (300 ma).

Leakage

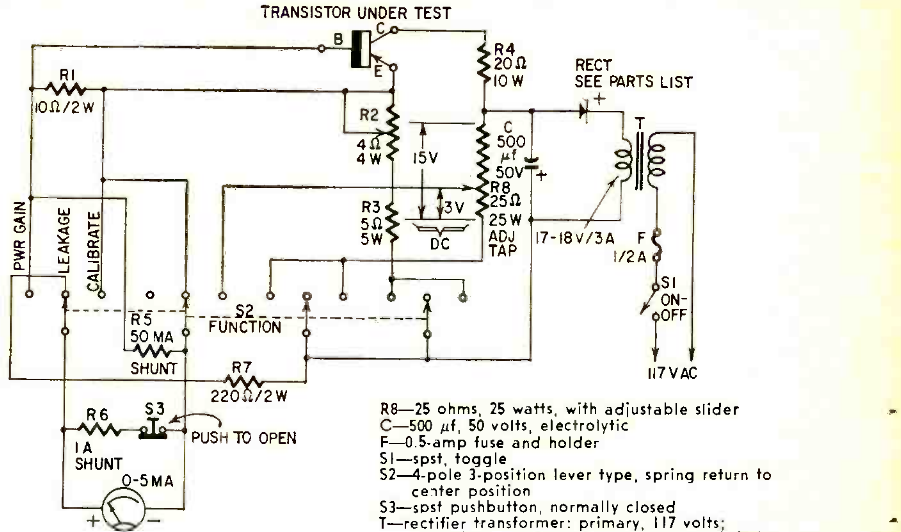
Greater than 0.1 meter reading (20 ma) is C–B, C–E or C–B–E short.

Less than 0.1 meter reading. Push button.
(1) Greater than 2 (2 ma) is excessive leakage.
(2) Upscale creeping is leakage.

Gain
(Good–bad based on 30-db gain point)

Greater than 0.5 (100 ma) is B–E short or any open.

Less than 0.5 meter reading. Push button.
(1) Less than 1.0 (10 ma) is C–B, C–E or C–B–E short.
(2) Greater than 4.4 (44 ma) is poor gain.



R1—10 ohms, 2 watts
R2—pot, 4 ohms, 4 watts
R3—5 ohms, 5 watts
R4—20 ohms, 10 watts
R5—50-ma shunt to suit meter
R6—amp shunt to suit meter
R7—220 ohms, 2 watts
R8—25 ohms, 25 watts, with adjustable slider
C—500 µf, 50 volts, electrolytic
F—0.5-amp fuse and holder
S1—spst, toggle
S2—4-pole 3-position lever type, spring return to center position
S3—spst pushbutton, normally closed
T—rectifier transformer: primary, 117 volts; secondary, 17–18 volts, 3 amps (Triad F-47U or equivalent)
Rectifier, 1 amp, 50 piv; collector–base junction of discarded power transistor is satisfactory
Socket, 9-pin miniature (to plug transistor into)
Meter, 5-ma full scale
Case, to suit
Miscellaneous hardware

Fig. 7—Ac version of the auto power-transistor checker.

change in the 3-volt supply is compensated for by adjusting R2 to maintain emitter current constant at the predetermined level.

Leakage and shorts

In the leakage test, the circuit is connected as in Fig. 5. The meter reads the collector reverse current with the base connected to the emitter through a 10-ohm resistor. If the collector is shorted or has excessive leakage to either the base or emitter, the meter will give a high reading. A base-to-emitter short is detected by the power-gain test.

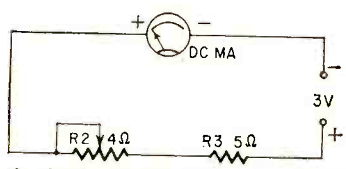


Fig. 4—To set a constant output current, adjust R2 in this calibrate circuit.

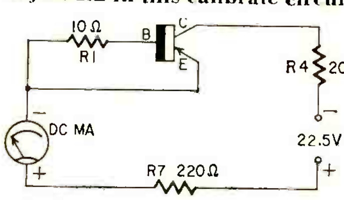


Fig. 5—Leakage test circuit checks the reverse biased diode current of the collector.

A pushbutton shunt and a series resistance protect the meter. Always test first without the pushbutton depressed. If the reading is high—over 0.1 on leakage or 0.5 on gain—the meter may be damaged if the pushbutton is depressed.

Checking for opens

During power-gain tests, open electrodes are detected. If the collector is open, emitter current is diverted to the base, resulting in a heavy current through the meter.

When the emitter is open, no emitter current flows through R2 and R3 and the voltage drop across these resistors is greatly reduced, voltage at the emitter rises and again current through the meter is high.

If the base lead is open, collector current is equal to h_{FE} times I_{CBO}, where h_{FE} is the collector-to-base current amplification and I_{CBO} is the open-emitter collector current. If h_{FE} times I_{CBO} is high, the meter reads high in the leakage test. If h_{FE} times I_{CBO} is low, the voltage drop across R2 and R3 in the power gain test is small and a high voltage appears across the meter, making the reading high. A base-to-emitter short is also detected during this test. Heavy base current flows through the meter due to zero power gain.

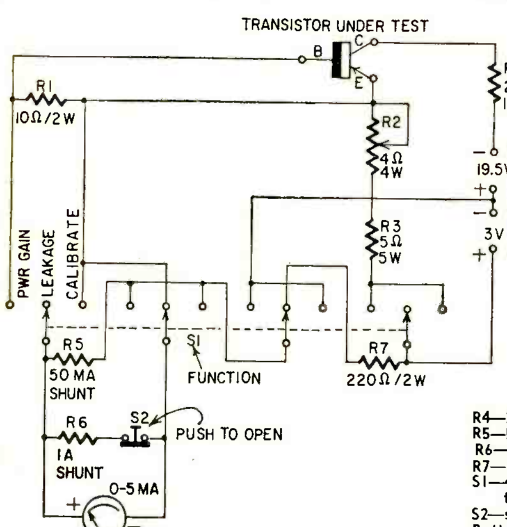


Fig. 6—Complete battery-powered transistor checker.

R1—10 ohms, 2 watts
R2—pot, 4 ohms, 4 watts
R3—5 ohms, 5 watts
R4—20 ohms, 10 watts
R5—50-ma shunt to suit meter
R6—amp shunt to suit meter
R7—220 ohms, 2 watts
S1—4-pole 3-position lever type, spring return to center position
S2—spst pushbutton, normally closed
Battery, 22.5 volts, tapped at 3 volts
Socket, 9-pin miniature (to plug transistor into)
Meter, 5-ma full scale
Case, to suit
Miscellaneous hardware

The complete tester

Two versions of the tester were constructed[1], one for dc operation (Fig. 6) and another for ac (Fig. 7). The dc tester uses a 22.5-volt battery as its power supply. The ac tester uses a stepdown transformer and a half-wave rectifier.

There are three test positions—LEAKAGE, POWER GAIN and CALIBRATE.

The normal operating position is LEAKAGE and a spring-return switch is used to insure that the switch returns to this position when released. In the leakage position, power consumption is low, while in the other positions it is high. If the tester were left in either of the high-consumption positions for an extended period, a larger transformer or battery would be needed. The spring-return switch makes this unnecessary.

Operation

Use the tester following the steps

[1]The designs shown are accurate for transistors rated up to 5 watts. Higher-power transistors may be tested, but operation at full power will not be indicated. The current level must be raised by redesigning the circuit to simulate higher-power operation.

Transistor Low-cost Frequency Standard

By PAUL S. LEDERER

A 100-kc frequency standard is an extremely useful item around the ham shack or experimenter's lab. Such a standard, using two inexpensive surplus crystals (type FT-241), is described here.

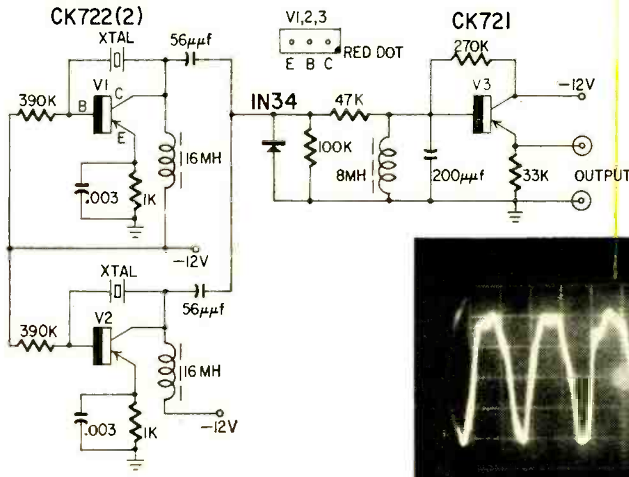
These surplus crystals were originally used for equipment operating on adjacent channels from 20.9 to 27.9 mc. The channels were 0.1 mc apart and the crystals' 54th harmonic was the desired channel frequency. The actual fundamental frequencies of the crystals range from 370,370 to 516,667 kc. Such odd frequency values are not very useful, but it is possible to obtain a useful frequency from *the difference in frequency of two selected crystals*. The choice of crystals is based on the following consideration: Since each channel is the 54th harmonic of the crystal's fundamental frequency, if the difference between two channel frequencies is *exactly* divisible by 54, then the difference between corresponding crystal fundamental frequencies is an even number without fractions.

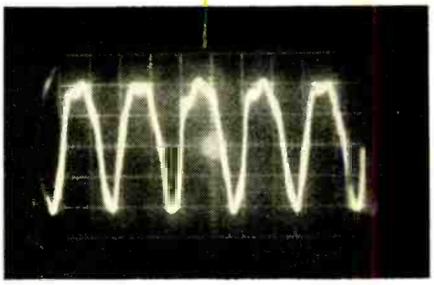
The transistor frequency standard uses one crystal marked channel 0, 20.0 mc, and one crystal marked channel 54, 25.4 mc. The difference between channel frequencies, 5.4 mc when divided by 54, is 0.1 mc or 100 kc.

The crystals are used in Pierce oscillators (see diagram). The oscillators' outputs are mixed in a germanium diode circuit. This is followed by a parallel-resonant filter circuit tuned to 100 kc, which feeds a grounded collector transistor amplifier acting as buffer and impedance matcher.

The circuit uses inexpensive, readily obtained components. The Pierce oscillators use CK722's, while the buffer uses a CK721. It is interesting to note that these transistors were not selected. The circuit was built with the first units received. Although these transistors are considered for use at only comparatively low frequencies, other [illegible]xperimenters have reported their suc[illegible]ful use in oscillators at radio fre[illegible]

[illegible]ce type of crystal oscillator [illegible]d reliable, and requires a [illegible]um of adjustment. In this circuit, [illegible]e crystals are connected directly between collector and base. Since the crystal has a low impedance near its series-resonant frequency, there is enough feedback at this frequency to maintain oscillation. With the low input impedance of the grounded-emitter circuit, a low value of voltage gain in the stage sustains oscillation. This may explain why these circuits oscillate near the transistor's alpha-cutoff frequency.





Schematic of transistor frequency standard and waveform of its 100-kc output.

Since the input impedance of the stage is capacitive, the crystal must appear inductive to give the proper phase shift between collector and base. At most, this phase shift is less than 180° and the required additional phase shift must be achieved by loading the plate circuit with a detuned resonant circuit whose resonant frequency is less than the crystal frequency. In this particular circuit a 16-mh ferrite-core choke is used with the collector-to-ground output capacitance. The output of these oscillators is combined in a mixer circuit consisting of a 1N34 germanium diode shunted by a 100,000-ohm resistor. A parallel-resonant circuit, tuned to 100 kc and consisting of a 8-mh ferrite-core choke and a 200-μμf mica capacitor, is coupled to the mixing circuit through a 47,000-ohm resistor and acts as a filter passing the 100-kc component on to the common-collector buffer circuit.

The common-collector circuit uses a CK721. Its fairly high input impedance does not load down the parallel-resonant circuit, preserving its filtering action. At the same time, the low output impedance (about 3,000 ohms) of the grounded-collector circuit is desirable for matching low-impedance rf circuits.

The frequency standard is powered by a 12-volt battery. Its total current drain is 2.6 ma. The output waveshape is shown in the photo. The output voltage depends on the amount of capacitance across the output. It varies from a maximum of about 1.5 volts peak to peak to about 0.6 volt peak to peak with 330 μμf across the output. The most important property of a frequency standard, of course, is its ability to deliver an accurately known frequency. This was checked by feeding the output of the standard into a Berkeley electronic frequency counter (with an accuracy of ±1 part in 10^5). Results showed the standard frequency to vary from 100,013 ±1 cycle to 100,008 ±1 cycle over a period of about 1 hour. Thus the absolute accuracy of the 100 kc standard is at least 14 parts in 100,000 or .014%. END

THIS TESTER CHECKS POWER TRANSISTORS (Continued)

shown in Table I. This chart also shows what the meter readings represent.

Any inaccuracy in power-gain measurements is caused by variations in the initial bias of the dc input characteristics for different transistors or under different temperatures and the variations in collector cutoff currents.

Initial bias may vary from transistor to transistor. However, for the same type of transistor the variation is usually quite small.[2] The initial bias value also goes down about 2.5 mv for every °C increase in temperature.[3] To correct for temperature, add 1 db to the power-gain reading for every 20° temperature increase.

The cutoff current (I_{CBO}) creates a forward bias when it flows through the base circuit resistances. This bias tends to offset the collector current's consistency. Making base circuit resistances small removes this objection.

If the temperature is within 10° of 27°C (80°F), power-gain measurements are accurate within 1 db.

Leakage current is a function of voltage and temperature. Therefore, the accuracy of this reading is good only if the supply voltage and temperature are held relatively constant. END

[2] L. J. Giacoletto, "Study of PNP Alloy-Junction Transistor from Dc through Medium Frequencies," *RCA Review*, 15, December, 1954.
[3] H. C. Lin and A. A. Barco, "Temperature Effects in Circuits Using Junction Transistors," *Transistor I*, RCA Labs, 1956.

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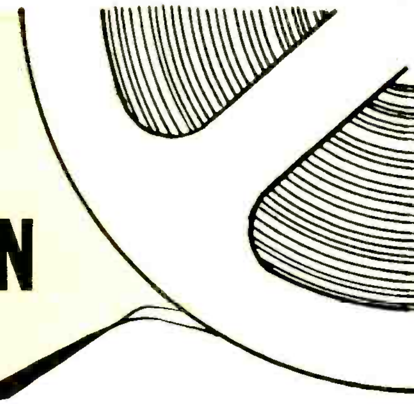
LOWDOWN ON TAPE PLAYBACK EQUALIZATION



For proper reproduction of prerecorded tapes, your tape playback amplifier should have NARTB equalization. Unfortunately, many tape recorders don't have it. Here's how it works, and some simple circuits to add the NARTB curve to your hi fi or tape recorder

By HERMAN BURSTEIN and HENRY C. POLLAK*

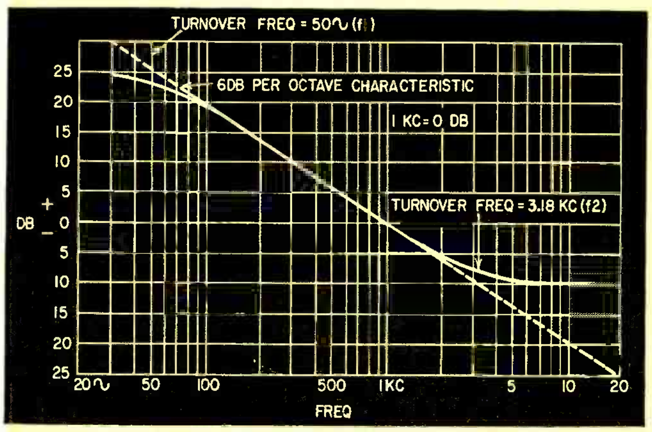


Fig. 1—The NARTB playback equalization curve.

COMMERCIAL prerecorded tapes generally use NARTB equalization at the 7.5-ips speed. For flat response when playing these tapes, the playback amplifier must provide NARTB playback compensation, mainly a lot of bass boost (see Fig. 1). However, many home tape recorders, particularly the older and less expensive ones, do not have NARTB playback equalization, but some other kind of bass-boost characteristic instead. Also, a number of control amplifiers that have a special input for a tape head fail to supply NARTB compensation. Such tape machines and control amplifiers generally provide a smaller amount of boost, starting at a lower frequency. Therefore, a prerecorded tape played on such a machine tends to sound thin in the bass region.

To get flat response when playing prerecorded tapes, you may have to change the playback equalization circuit of the tape machine or control amplifier to produce the curve of Fig. 1. If playback equalization of a tape recorder is changed, the machine's record equalization must be changed correspondingly to yield flat response when playing tapes recorded on this machine. Therefore, you may prefer to introduce NARTB playback equali-

*Authors of *Elements of Tape Recorder Circuits*. Gernsback Library, No. 67.

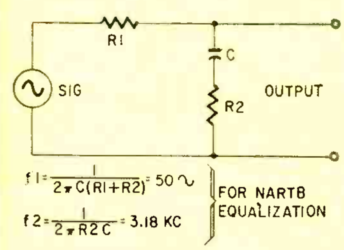


Fig. 2—Fundamental losser-type bass-boost circuit.

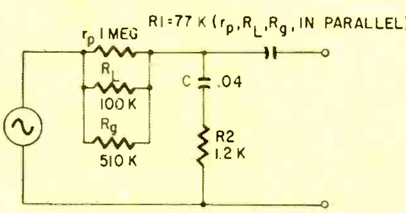


Fig. 4—Equivalent circuit of Fig. 3.

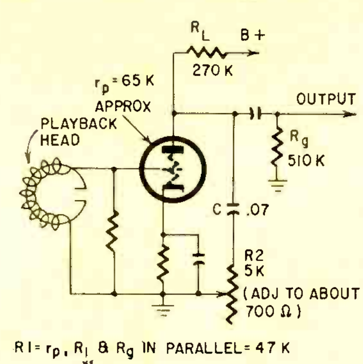


Fig. 5—Practical bass-boost circuit using a high-mu triode.

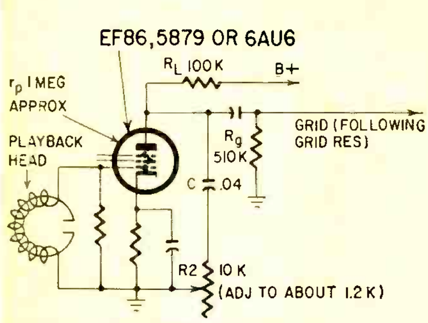


Fig. 3 — Practical bass-boost circuit using a pentode.

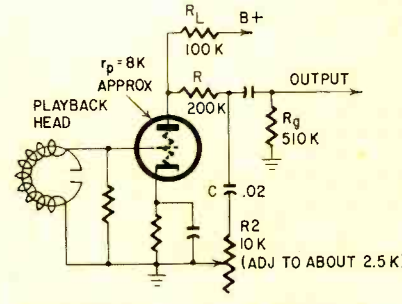


Fig. 6—A medium-mu triode in a practical bass-boost circuit for a tape playback amplifier.

zation using a switch. This lets you use the original equalization when playing tapes recorded on the modified machine and NARTB equalization when playing commercial tapes. As you will soon see, the components in the equalization circuit are so few that the problem of switching between the two circuits is not complicated. Generally, a simple double-throw switch will do the job.

So the technician or handy audiophile can incorporate the correct circuit values for NARTB equalization, we will analyze the most commonly used playback boost circuits. First, however, it would be helpful to explain *why* bass boost is required when playing a tape, and to state some general principles of playback equalization.

Bass boost in playback

The playback head is an inductive device — essentially a ferromagnetic material with a winding. Its output voltage is proportional to the rate at which the magnetic field on the tape changes—proportional to frequency. Thus the head's output decreases 6 db per octave as frequency declines, making a very substantial quantity of compensating bass boost necessary—up to 36 db of it for NARTB equalization. Where the NARTB curve is employed, bass boost starts (3-db rise) at 3,180 cycles and continues to rise with declining frequency, but eventually levels off so that at 50 cycles it is 3 db below the maximum bass boost eventually attained.

Since the declining output of the playback head follows a 6-db-per-octave slope, the bass-boost curve must do the same. Therefore, R-C circuits which have such a characteristic are used in playback bass-boost circuits, whether of the losser or feedback type. In feedback circuits, only voltage-feedback types are used. Use of current feedback—produced by a large cathode resistor—would necessitate bypassing the resistor with an inductor to boost the bass, a practice that is objectionable because of the disadvantages of inductors for such use—hum pickup, cost, lack of precise NARTB equalization.

Although the output of the playback head continually drops 6 db per octave with decreasing frequency, note that the curve of Fig. 1 does not continue upward throughout the bass range, but levels off instead. This moderates the problem of hum amplification, a severe one in all cases. The loss of bass response due to leveling off of the playback curve is made up in recording by supplying a slight amount of corresponding bass boost.

Playback losser circuits

Fig. 2 shows the fundamental losser type bass-boost circuit. The practical circuits discussed all refer to the elements of Fig. 2, whose roles may be explained as follows:

At very high frequencies, where capacitor C is a virtual short circuit, Fig. 2 is in effect a voltage divider made up of R1 and R2. This sets a limit to the maximum drop in response. The maximum drop is referred to as the insertion loss. The limit to which gain declines is called the *lower shelf*. The original signal level is referred to as the *upper shelf*.

As frequency decreases, the reactance X_c of capacitor C rises and approaches the resistance of R2. At the upper turnover frequency, f2 (3,180 cycles), R2 and X_c are equal and the output is 3 db above the lower shelf. As frequency declines further, X_c continues to increase and the output goes up until the value of X_c approaches that of R1 + R2. When X_c becomes equal to R1 + R2 (at f1, 50 cycles), the output voltage is within 3 db of the input voltage and a further rise is therefore very limited. In most cases R1 is much bigger than R2 (62 times as large for NARTB equalization), so the lower turnover frequency f1 is essentially determined by R1 and C. The upper turnover frequency, as already indicated, is determined by R2 and C.

Fig. 3 is a practical version of Fig. 2, employing an EF86, 5879 or 6AU6 pentode. R1 (thinking in terms of Fig. 2) consists of the 100,000-ohm load resistor R_L in parallel with the much larger plate resistance (r_p) of the tube, assumed to be about 1 megohm, and the following 510,000-ohm grid resistor R_g. For easier visualization see Fig. 4, the equivalent circuit. The 77,000-ohm parallel resistance R1 (r_p, R_L and R_g in parallel) and the .04-μf capacitor esesentially determine the lower turnover frequency of 50 cycles. R2, adjusted to about 1,200 ohms, and C determine the upper turnover frequency of 3,180 cycles.

Using triodes

Fig. 5 is essentially the same as Fig. 3, except that a triode is used instead of a pentode. The triode is assumed to have a plate resistance of 65,000 ohms, although this value differs according to tube type. R1, again made up of r_p, R_L and R_g in parallel, is 47,000 ohms. R1 is essentially determined by r_p, which is considerably smaller than R_L and R_g. R1 and C essentially produce the lower turnover of 50 cycles. R2 adjusts to about 700 ohms and C produces the 3,180-cycle turnover.

Sometimes triodes are considered preferable to pentodes as input tubes because, as a rule, they produce less hum and noise (although this rule has very definite exceptions). Therefore, on the grounds of hum and noise, the circuit of Fig. 5 might be preferred to that of Fig. 3. On the other hand, a pentode has an important advantage over a triode in possessing much lower input capacitance, preventing high-frequency loss. Thus it might seem that the equalization circuit using the triode is at a disadvantage.

This is not true of Fig. 5. Input capacitance consists mostly of that between plate and grid and in effect varies directly with gain, due to Miller effect. (For example, when the grid goes positive, the plate goes negative—the more tube gain, the greater the negative voltage on the plate. The signal source sends a charging current into the grid–plate capacitance, whose ability to absorb current from the input signal varies with the potential across this capacitance. Hence the greater the gain, the more signal current is absorbed by plate–grid capacitance and the greater are the signal losses. This effect is equivalent to that produced by a larger capacitance between plate and grid than the actual physical capacitance.) In Fig. 5, equalizer capacitor C approaches a short circuit at high frequencies and the load consists mainly of R2, a relatively small value. Since the load, principally R2, is in series with the plate resistance, by voltage-divider action there is very little output voltage across R2. In brief, the tube's gain is greatly reduced at high frequencies. Along with this reduction in gain, there is a decrease in Miller effect. In other words, the input capacitance becomes

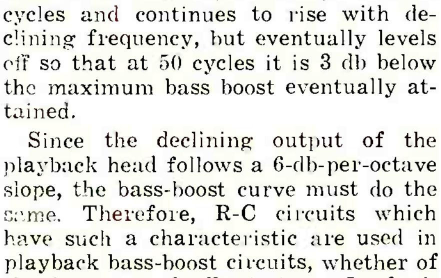


Fig. 7—Pentode bass-boost circuit designed to keep changes in plate resistance from affecting equalization.

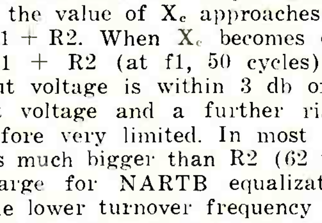


Fig. 8—Equivalent circuit of Fig. 7.

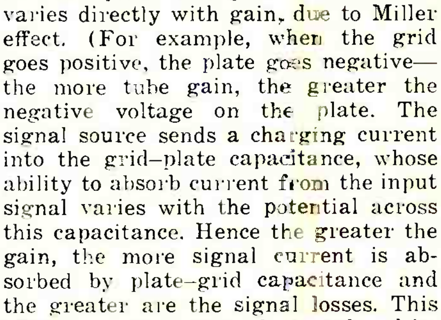


Fig. 9—Voltage feedback over two amplifier stages gives bass boost.

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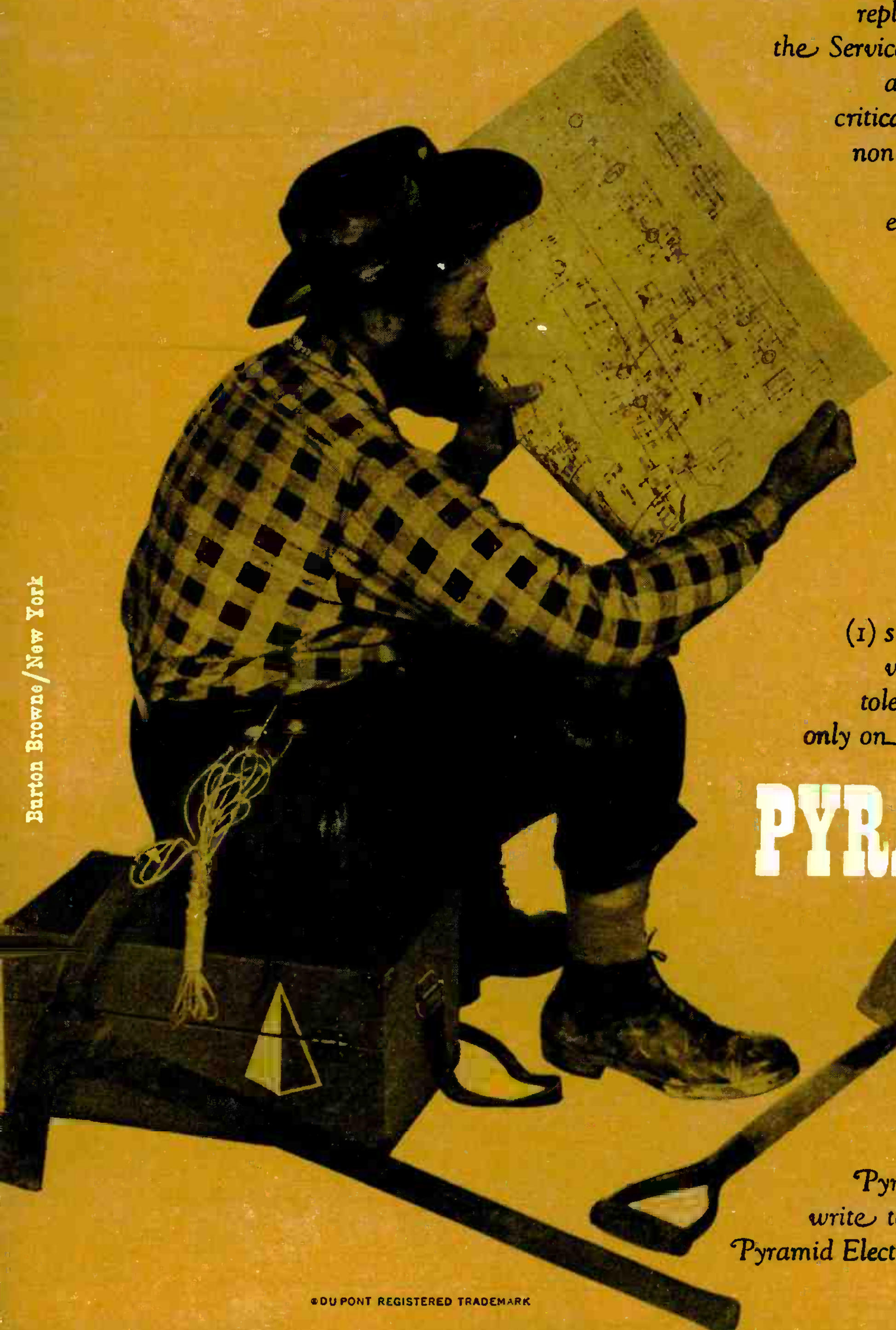

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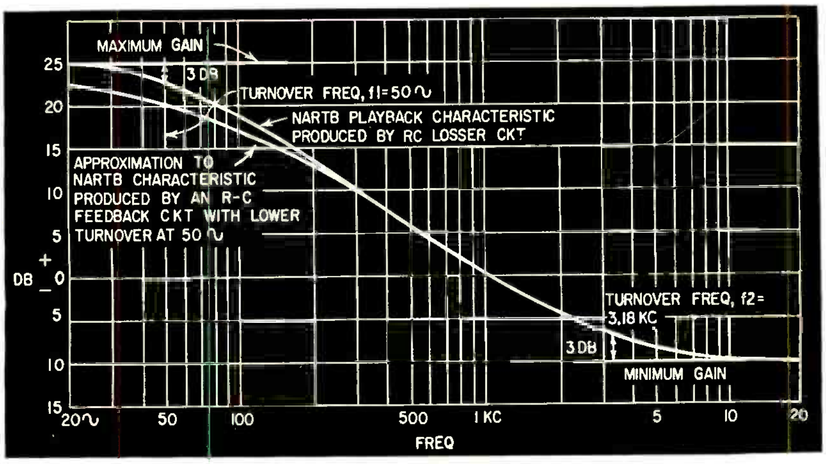


$$f1 = \frac{1}{2\pi R1C} = 50 \text{ cps}; \; f2 = \frac{1}{2\pi C\,(R2 + R_K)} = 3{,}180 \text{ cps}$$

Fig. 10—Comparison of bass-boost curves produced by R-C losser and feedback circuits.

very small and high-frequency response is not endangered.

Still, there is a slight disadvantage to the circuit of Fig. 5. To the extent that plate resistance departs from its nominal value due to voltage changes, age, or the individual tube used, the low turnover frequency of 50 cycles is affected. Therefore bass equalization will not be absolutely precise. However, this variation is usually small enough to be acceptable for practical operation.

Fig. 6 represents the use of a medium-mu triode, such as half of a 12AU7. Here the plate resistance, assumed to be 8,000 ohms, is too low to serve as the principal component of R1. That is, C would have to be quite substantial, about 0.4 μf, which is relatively expensive, space-consuming and subject to hum pickup because of size. Therefore, a 200,000-ohm resistor is used as the principal component of R1, which figures out to 147,000 ohms. This value, in conjunction with a .02-μf capacitor, produces a low turnover frequency of about 50 cycles. Potentiometer R2 is adjusted to about 2,500 ohms to produce a 3,180-cycle turnover frequency in conjunction with C.

Fig. 7 is similar to Fig. 6, except that a pentode is used. Although the load resistance in parallel with the tube's plate resistance and with the following grid resistor is high enough to serve as R1, the designer has sought to reduce the effect of changes in plate resistance upon equalization by inserting R, a 510,000-ohm resistor. Consequently R1 is determined to a substantial extent by R. The plate and load resistances are in parallel with each other (combined value about 330,000 ohms) and in series with R. All these are in parallel with the 510,000-ohm grid resistor, making a toal resistance for R1 of 313,000 ohms. R1 and the .01-μf capacitor produce a turnover frequency close to 50 cycles. R2 is adjusted to about 5,000 ohms to produce the 3,180-cycle turnover frequency.

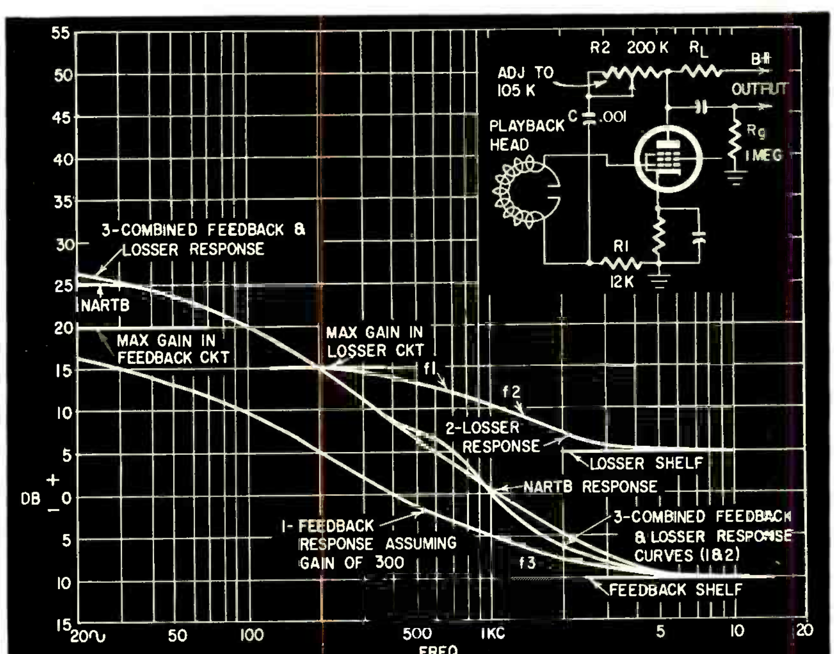
To help unravel the complications of Fig. 7, the equivalent circuit is shown in Fig. 8. Except for the values of the components, Fig. 8 is also the equivalent of Fig. 6.

Feedback circuits

Bass equalization circuits using voltage feedback have two worth-while advantages over losser circuits. Distortion is reduced particularly at the high frequencies where signal output of the tape head is greatest. The effective plate resistance of the tube is reduced and therefore its output impedance is also reduced. This makes it easier to maintain high-frequency response, since shunt capacitance (stray capacitance and capacitance of the following stage) produces less treble loss across a small resistance than a large one.

A typical feedback bass-boost circuit with good characteristics is shown in Fig. 9. R2 is relatively small, so at high frequencies—where C is a virtual short circuit—a large amount of negative feedback is applied to the cathode of the first stage. R2, R_k and C essentially determine the upper turnover frequency (3,180 cycles). As frequency decreases, the reactance of C becomes equal to R2 + R_k, feedback starts decreasing, and gain starts increasing. R1 and C essentially determine the lower turnover frequency (50 cycles). As frequency continues to decrease, the reactance of C becomes equal to R1, C no longer bypasses R1, feedback stops increasing and gain approaches a maximum. (At very low frequencies the value of coupling capacitors C1 and C2 must be properly selected to avoid subsonic peaking due to feedback.)

The roles of R1, R2 and C in Fig. 9 correspond to those of the same components in losser bass-boost circuits. However, the response curve may not be as precisely shaped by feedback as by losser networks. That is, the shift from flat response to a 6-db-per-octave characteristic tends to be considerably more gradual at the low end with a feedback equalizer. Fig. 10 compares the bass boost achieved by an R-C losser and an R-C feedback circuit. The turnover frequencies are nominally 50 and 3,180 cycles for both circuits. It can be readily seen that the feedback



$$\text{Feedback boost: } f3 = \frac{1}{2\pi R2C} = 1{,}500 \text{ cps; feedback factor, maximum} = 1 + A\beta = 1 + \left(\text{gain} \times \frac{R1}{R1 + R2}\right) = 1 + (300 \times 0.1) = 31 = 30 \text{ db; losser boost: } f1 = \frac{1}{2\pi R_L C} = 660 \text{ cps; } f2 = \frac{1}{2\pi (R1 + R2) C} = 1{,}350 \text{ cps; insertion loss} = \frac{R1 + R2}{R1 + R2 + R_L} = 10 \text{ db}$$

Fig. 11—Approximation of NARTB bass boost produced by plate-to-grid feedback combined with a losser circuit.

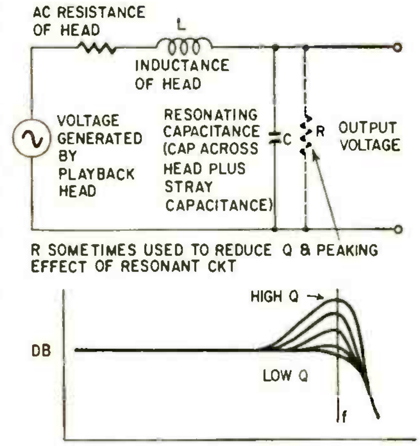
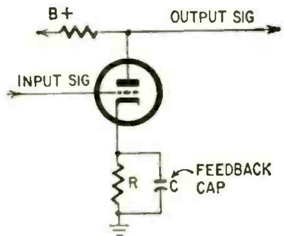


Fig. 12 — Playback treble boost produced by resonating the playback head.

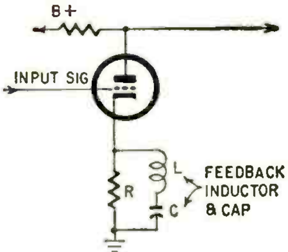


Lower turnover frequency (3 db rise in response $= \frac{1}{2\pi RC}$; treble boost tapers off when voltage across C becomes much smaller than input signal voltage.

Fig. 13—Treble boost through R-C current feedback.

circuit produces a more gradual transition from flat to 6-db-per-octave response at the low end, so bass response suffers a bit. From a practical aspect, however, this deficiency in bass response can be made up by designing for a lower turnover frequency than 50 cycles, say about 30 cycles. If approximately 30 cycles is taken as the design frequency, R2 in Fig. 9 would become about 1 megohm.

You can also get feedback equalization with a single tube, preferably a pentode for sufficient gain. Actually, a losser circuit is combined with the feedback network so that the corresponding curves add up to a characteristic closely approaching NARTB equalization. Fig. 11 is such a circuit. R1, R2 and C constitute the feedback network, with R1 and R2 forming a voltage divider. As frequency declines, the reactance of C becomes equal to R2 and the feedback voltage across R1 begins to decrease, with a resulting increase in gain at the low-frequency end. The feedback curve shown in Fig. 11 has a turnover frequency (f3) of 1,500 cycles. The losser circuit is made up of R1 and R2 in series, R_L and C. It operates in the same manner as Fig. 3, with R_L playing the same role and R1 + R2 in Fig. 11 playing the role of R2 in Fig. 3. The resulting curve has turnover points at 660 (f1) and 1,350 cycles (f2). Adding the feedback and losser curves produces a bass-boost characteristic close enough



Treble boost reaches maximum when reactance of L = reactance of C:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Fig. 14 — Treble boost through R-L-C current feedback.

to the NARTB for practical purposes.

The response curve can be adjusted in a number of the playback bass-boost circuits shown. This flexibility permits fairly precise equalization, at the same time allowing for the effects of other factors upon high frequencies. For example, if in playback there are treble losses due to cable capacitance, the upper turnover frequency, 3,180 cycles, can be reduced somewhat. This means that the equalization curve does not drop as much at the high end. Thus, in a specific situation a turnover of 2,000 instead of 3,180 cycles might approximately balance out high frequency losses elsewhere—in the playback amplifier, the head or connecting cable.

Playback treble boost

To correct for treble losses in playback, which are most likely to be caused by the gap of the playback head (the wider the gap, the greater the losses), tape amplifiers frequently provide high-frequency boost, particularly above 8,000 cycles or so.

The shape of the required treble-boost curve depends upon the factors primarily responsible for playback losses. If gap width is the principal factor, losses take place at a rapidly accelerating rate. Therefore a circuit with a sharply rising characteristic is needed. This may be obtained by an R-L-C circuit. Such a circuit can add a very important half-octave to the high-end response.

One way of achieving this effect is to shunt a suitable capacitor across the playback head, as shown in Fig. 12. The playback heads commonly employed in home tape machines typically have an inductance in the range of 0.5 henry. Therefore, capacitors of about 200–400 $\mu\mu f$ could be used to resonate the head in the region of 12,000 to 15,000 cycles. The capacitor and the inductance of the head form a tuned circuit. Voltage across the capacitor reaches a maximum approximately at resonance, and output voltage can therefore be appreciably increased, depending upon the Q of the tuned circuit.

Here it may be seen that although capacitance across the playback head (in the form of cable, interwinding or input tube) is usually viewed as a threat to high-frequency response because of its shunting effect, yet *properly controlled capacitance* can produce just the opposite result. If the head and the various capacitances resonate within the audio range, there are losses above resonance. But if resonance occurs slightly beyond the audio range, it can improve response at the upper end of the audio spectrum.

If the peaking effect due to the tuned circuit is too great, try a resistor across the head to reduce the Q of the circuit and thereby reduce the rise in response as shown in Fig. 12. If the recorder has a head with a very narrow gap or operates at high speed, say 15 ips, so that gap losses do not significantly enter the picture, and if there are no treble losses due to other factors, you may have a situation where rising output due to head resonance is undesirable. Then it is necessary to make sure that head resonance occurs well above 20,000 cycles or to use a resistor to reduce the Q of the resonant circuit. While the value of the resistor has to be experimentally determined, it should be in the region of 50,000 ohms.

You can also get treble boost by using current feedback. A moderate amount of boost is obtained, as in Fig. 13, by shunting the cathode resistor with a suitable capacitor. A more sharply rising curve can be obtained by shunting the cathode resistor with an inductor and capacitor in series as in Fig. 14. A sharp rise can also be achieved by repeating the circuit of Fig. 13 in several stages.

If a bass-boost circuit such as that of Fig. 6 or 7 is employed, it can also be used to provide treble boost if resistor R is shunted by a suitable capacitor. Thus in Fig. 6, where R is 200,000 ohms, you could get a rise of 3 db at 15,000 cycles by placing a 50-$\mu\mu f$ capacitor across R. END

STEREO PHONO CARTRIDGES

Part III—High-quality higher-priced magnetic cartridges are this month's targets—Audiogersh Stereotwin 200; Fairchild model 232; Grado stereo cartridge; London-Scott type 1000; and the Shure model M3D

By JULIAN D. HIRSCH

SEVERAL new cartridges and pickups have been announced since the previous article in this series was prepared. The units described this month are all relatively high-priced magnetic types.

Shure model M3D

The Shure Professional Dynetic stereo cartridge, model M3D, employs the same moving-magnet principle as the monophonic Dynetic cartridges.

The external appearance of the model M3D is similar to the standard M5D monophonic cartridge. It comes in a black bakelite case with standard ½-inch mounting centers. As with several magnetic stereo cartridges, each channel has separate output terminals so grounds for the two channels can be kept separate.

Frequency response is within 3 db from 20–15,000 cycles. The output voltage per channel is approximately 5 mv at 1,000 cycles. The recommended load impedance is 50,000 ohms and higher load resistances may be used to get a slight increase in high-frequency response.

The stylus is a 0.7-mil diamond, with lateral and vertical compliances of 3×10^{-6} cm/dyne. Recommended tracking force is 3–6 grams. The channel separation is said to be greater than 20 db at 1,000 cycles.

The price of the Shure Stereo Dynetic cartridge is $45.00. Shure has announced a novel plan that protects the consumer against financial loss due to obsolescense of his monophonic pickup. Anyone who now has a monophonic Dynetic cartridge or pickup will be given a trade-in allowance of 75% of its cost toward the purchase of a stereo pickup. The offer is good through Dec. 31, 1959, and covers all Shure Dynetic cartridges and pickups, no matter when they were purchased.

London-Scott type 1000

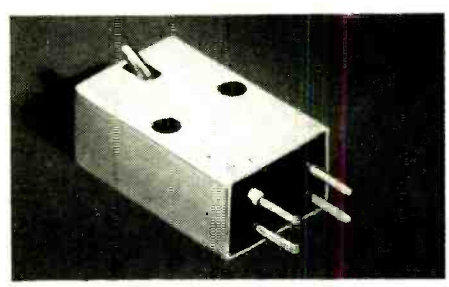
The London-Scott type 1000 is an integrated pickup design, sold only as a unit. It was developed in England by London Recording Laboratories and is marketed in the US by Hermon Hosmer Scott, Inc.

The London-Scott cartridge is a moving-iron or variable-reluctance type.

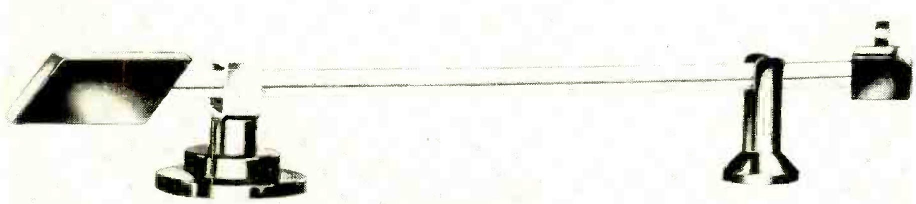
(*Continued on page* 88)

Stereo Dynetic model M3D, by Shure.

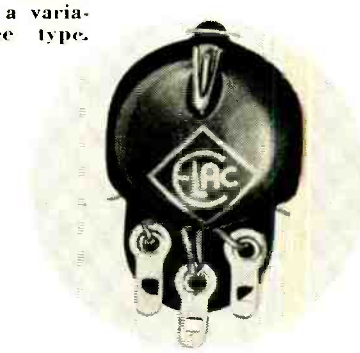
Fairchild model 232.



The Grado stereo cartridge is of the moving-coil type.



London-Scott type 1000 is a complete arm and cartridge assembly.



Audiogersh Stereotwin 200 is a variable-reluctance type.

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

★ NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES. Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

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The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

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SUPERIOR'S NEW MODEL TD-55

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★ FOR THE BUSY TV SERVICE ORGANIZATION, which needs extra Tube Testers for its field men.

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The Model TD-55 provides a super sensitive method of checking for shorts and leakages up to 5 Megohms between any and all of the terminals. Continuity between various sections is individually indicated. This is important, especially in the case of an element terminating at more than one pin. In such cases the element or internal connection often completes a circuit.

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The Model TD-55 incorporates a newly designed element selector switch system which reduces the possibility of obsolescence to an absolute minimum. Any pin may be used as a filament pin and the voltage applied between that pin and any other pin, or even the "top-cap."

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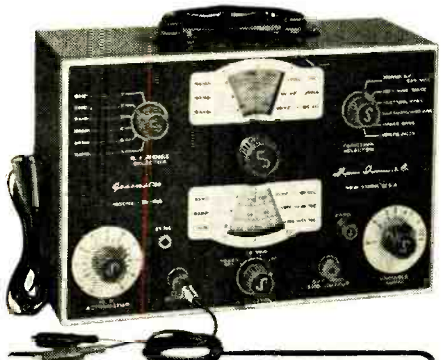

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Specifications

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The Model TV-50A comes complete with shielded leads and operating instructions. Only

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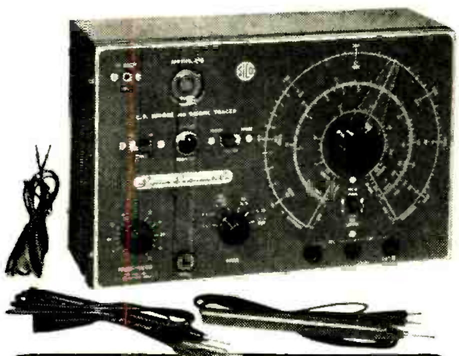

Model 76 . . . Total Price $26.95 — Terms: $6.95 after 10 day trial, then $5.00 monthly for 4 months.

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CONDENSER BRIDGE
with a range of .00001 Microfarad to 1000 Microfarads (Measures power factor and leakage too.)

IT'S A
RESISTANCE BRIDGE
with a range of 100 ohms to 5 megohms

IT'S A
SIGNAL TRACER
which will enable you to trace the signal from antenna to speaker of all receivers and to finally pinpoint the exact cause of trouble whether it be a part or circuit defect.

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The TV Antenna Tester section is used first to determine if a "break" exists in the TV antenna and if a break does exist the specific point (in feet from set) where it is.

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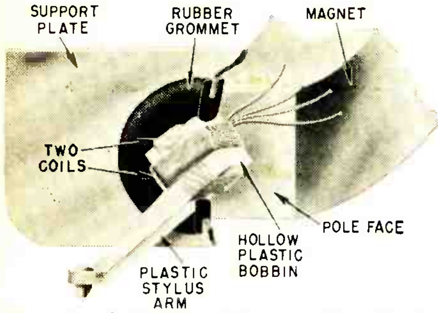

Fig. 1—Coil assembly in the Grado stereo cartridge.

(*Continued from page* 83)

The moving mass is exceptionally low, less than 1 milligram, which is conducive to wide frequency response and low record wear. The compliance is 3.5×10^{-6} cm/dyne. Frequency response is rated at 20–20,000 cycles, within 2 db.

The cartridge is fully shielded for low hum pickup. Its output per channel is 4 mv at a stylus velocity of 5 cm/sec. When both channels are paralleled for lateral response, the output is 3 mv.

The cartridge comes with a 0.5-mil diamond stylus. The recommended tracking force is 3.5 grams. Coil impedance is 4,000 ohms per channel at 400 cycles, and the recommended load resistance is 47,000 ohms. Channel separation is stated as better than 20 db.

The arm which forms an integral part of the London-Scott pickup has an overall length of 12.5 inches. Its height is adjustable from 1⅜ to 2½ inches. The arm pivots on frictionless roller bearings.

The price of the London-Scott type 1000 pickup is $89.95.

Audiogersh Stereotwin 200

The Audiogersh Stereotwin 200 is a variable-reluctance cartridge, housed in a rather unusual-looking cylindrical case which mounts on standard centers.

Frequency response of the Stereotwin 200 is within 2 db from 30 to 18,500 cycles. Its output voltage at 1,000 cycles is 25 mv for a stylus velocity of 10 cm/sec—relatively high for a magnetic cartridge.

The stylus is a 0.7-mil diamond, with a compliance of 4×10^{-6} cm/dyne. Recommended tracking force is 4–6 grams. Channel separation is better than 20 db.

Like other variable-reluctance cartridges, the Stereotwin 200 is rugged and immune to damage from ordinary handling. The stylus assembly is easily replaced by sliding out the stylus and the protective sheath which surrounds it and inserting the replacement.

The recommended load resistance is 37,000 ohms. The Stereotwin 200 has a negligible external magnetic field and will not exert any measurable pull on a steel turntable. The audiophile net price is $59.50.

Fairchild model 232

The Fairchild model 232 is a production version of the XP-4 stereo cartridge. It uses the same type of dual rotating-coil construction as the XP-4, (see RADIO ELECTRONICS, July, 1958, page 28) and has somewhat greater output.

The model 232 has standard ½- to 7/16-inch mounting centers and fits any standard arm. Its terminals are arranged so it can be plugged into the Fairchild 282 arm.

Rated frequency response of the model 232 is 10–20,000 cycles. Its output is 5 mv per channel for a 7-cm/sec stylus velocity. Like the XP-4, the model 232 has a 0.6-mil diamond stylus. The cartridge weighs 12 grams.

Both vertical and lateral compliance are 6×10^{-6} cm/dyne. Channel separation is rated as better than 25 db. The two channels are brought out to four terminals with complete electrical separation. Coil impedance is 600 ohms per channel. The price is $49.50.

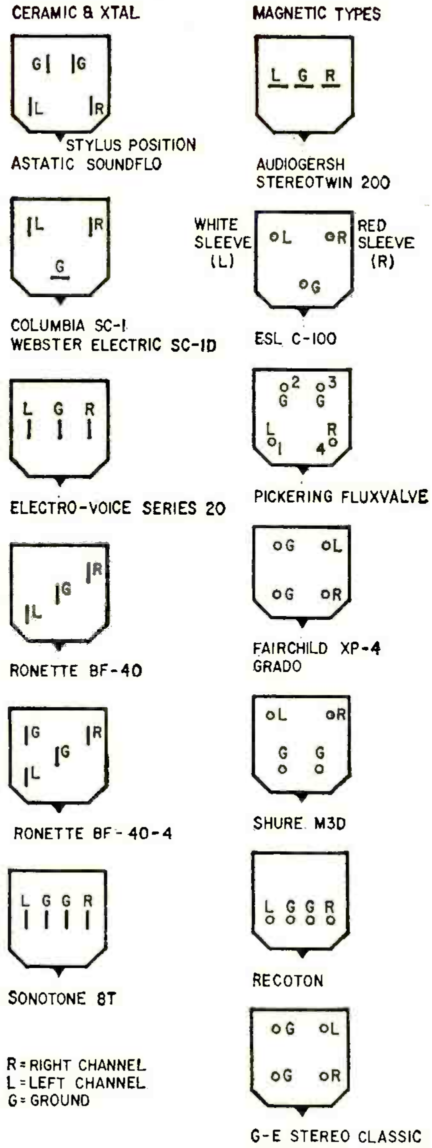

Fig. 2—These are some of the terminal arrangements you will run into on the stereo cartridges described in this series. Some of the markings shown actually appear on the cartridge, others don't.

Grado stereo cartridge

The Grado stereo cartridge is a moving-coil type, featuring very low moving mass and high compliance.

The coils are wound at right angles to each other on a hollow plastic cube about 1/16 inch on a side. Attached to this bobbin is a plastic stylus arm with the diamond stylus at its other end. The coil structure is mounted in the hole of a tiny rubber grommet, with the coils at a 45° angle to the record surface. The grommet in turn is mounted in a support plate which positions the coils in the gap of a powerful magnet (see Fig. 1).

The coil-and-magnet arrangement acts in the same way as the system Fairchild uses. Movement of the stylus in one channel produces an output only from the coil corresponding to that channel. It rotates like a d'Arsonval coil between the pole pieces, producing an output. At the same time, the coil for the other channel is rotating on its axis, does not cut any lines of force and therefore delivers no output.

Frequency response of the Grado cartridge is stated as 10–35,000 cycles. Its output is 5 mv per channel at a stylus velocity of 10 cm/sec. It weighs 16 grams.

Like the monophonic Grado cartridge, the stereo model has a very low moving mass and high compliance. The mass of the moving system referred to the stylus is 1 milligram, and the compliance is 8×10^{-6} cm/dyne. Because of the symmetrical mounting system, compliance is the same in any plane. Recommended tracking force is 2 grams.

Coil impedance is 600 ohms per channel, essentially resistive. The terminating resistance is not critical and may be any value over 5,000 ohms.

Grado Laboratories states that channel separation is greater than 25 db, and points out that the limitation is in the cutter heads used in making the stereo records. In other words, channel separation in the test records used to measure cartridge performance is not as good as the cartridge's inherent performance.

The coils in the Grado cartridge are electrically separate and are brought out to four terminals at its rear. The cartridge has standard mounting centers and may be installed in any standard arm.

For use with low-gain preamps, a stereo transformer to step up cartridge output voltage is available. The frequency response of the transformer is 10–30,000 cycles ±1 db. Channel output balance is ±0.2 db. Channel separation is 50 db and the hum level is −90 db. Distortion is said to be unmeasurable with a 40-mv input.

The Grado stereo cartridge is priced at $49.50 and the transformer costs $23.50.

Terminal configurations

Since monophonic cartridges have only two terminals, which are usually not polarized, there has been a certain degree of standardization among manufacturers as to contact spacing and dis-

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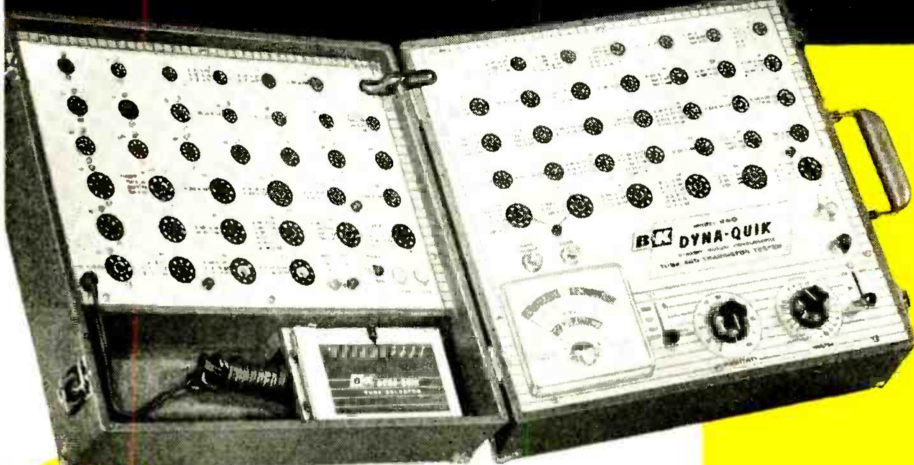

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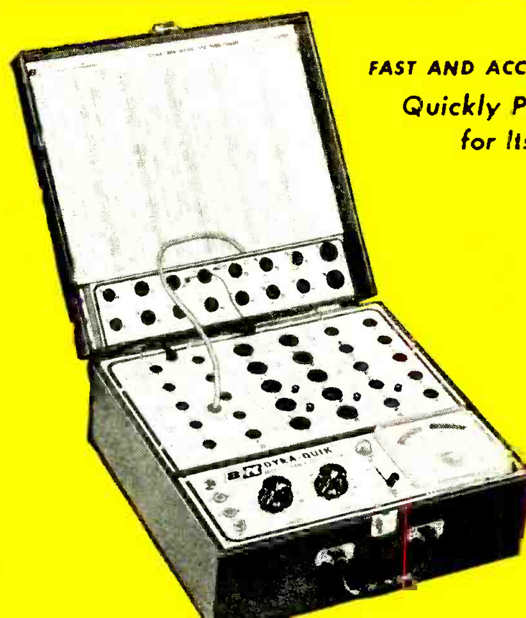

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tance of terminals from the mounting centers. Practically all cartridges have their terminals side by side in a horizontal plane. This has made it possible for at least one arm design (the Fairchild 280/281) to accommodate practically any magnetic cartridge and many ceramic types without any soldered connections. Nevertheless, there are wide differences between makes in such matters as terminal lead diameter, cross-section and length.

The situation is much more complicated with stereo cartridges. Here we have the possibility of either three- or four-terminal outputs, with a requirement for definite polarity (to identify the left and right channels).

These three or four terminals may be arranged in a variety of ways across the rear of the cartridge body. An examination of the various cartridges described in this series reveals several terminal configurations (see Fig. 2). In a few cases there appear to be similar terminal arrangements for two groups of cartridges, but as a general rule the ceramic types have thin, flat-lug terminals with very close spacing (less than ⅛ inch). On the other hand, magnetic cartridges usually have cylindrical wire terminals with relatively wide spacing in the order of 5/16 inch.

Of course, the same differences have always existed to some extent between monophonic cartridges, and it probably does not impose too great a hardship on the user to solder wires to clips which are pushed onto the cartridge terminals, wherever they may be located.

In stereo cartridges the possibility of error in connecting four clips in a small space is obviously much greater, and the desirability of a standardized terminal layout increases. Practically all stereo arms are designed so contact clips can be soldered to the ends of the lead wires and fitted to the cartridge terminals. So far, the only evidence of an attempt at standardization is the Fairchild model 282 stereo/monaural arm. This is designed along the same lines as the Fairchild 280 series of arms, with contact springs which make a solderless connection to the pins of any Fairchild stereo or monophonic cartridge. The Grado stereo cartridge appears to have the same terminal configuration and should also be usable in this arm.

Considering the many years required for the development of monophonic cartridges it is not too surprising to find that there is diversity of terminal shapes and dimensions. However, virtually all stereo cartridge development has taken place within the last year, and much more work will be done in years to come. In view of this, the standardization of stereo terminal configurations should be seriously considered in the near future, before too many types become widely used. In the meantime, the least that should be done is to mark each cartridge with the left and right channel designations near the corresponding terminals. END

new DISCS and TAPES

STEREO and MONO

Reviewed by
Chester Santon
Station WQXR
New York City

AT THE time of writing (September 1958), I am looking forward to the New York High Fidelity Music Show to clarify one phase of stereo's progress on discs. That is the performance of stereo cartridges released on that occasion. We'll know considerably more about the stereo medium when stereo versions of today's most highly refined monophonic pickups are unveiled and demonstrated at the show. In recent days, I have been sampling a prototype of a forthcoming stereo cartridge of ambitious design. With lower stylus pressure, reduced stylus mass and greater overall compliance, records played with earlier cartridges revealed less surface noise and better definition of sound. Once incorporated into production models, specifications formerly considered luxuries in monaural cartridges may well become everyday necessities in stereo. In the meantime, tape producers are not neglecting the luxury stereo market.

Stereo Mosaic
Stereo Age Recordings
(7-inch; playing time 12 min.)

This 600-foot sampler tape is available free of charge with the purchase of any $12.50 Stereo Age tape. A. Stewart Hegeman, whose loudspeaker was described in the September issue of RADIO-ELECTRONICS, was the recording engineer for six of the first seven releases represented on this sample reel. Only the very finest sound systems will reveal how far above average is the sound on these tapes. Fabulous presence and completely natural, wide-open response in the categories of solo voice, solo harp and solo piano. The jazz sample is also outstanding. If these releases do not surpass virtually all other tapes on your present rig, audition a better system with this sampler tape.

TCHAIKOVSKY: *Piano Concerto No. 1*
Van Cliburn, Pianist, and Orchestra conducted by Kiril Kondrashin
RCA Victor Stereo Tape ECS-187
(7-inch; playing time, 35 min. $14.95)

When a release assumes international importance, it deserves the best in sound. Stereo tape rises wonderfully to the occasion. In this eagerly awaited tape, emphasis quite naturally has been placed on the Cliburn piano in plotting out the pickup. Superior in sound to previous RCA piano concerto tapes, the range, depth and presence of the instrument as heard here surpass the LP version. In comparison, the piano's great moments sound tame on records.

Songs From Great Films
Herman Clebanoff and His Strings
Mercury Stereo Tape MDS 2-35
(7-inch; playing time, 36 min. $12.95)

This is the first Mercury tape I've heard with their new "sonic signal" between selections to aid cuing at fast wind or rewind speed. This beep was meant to be low enough in pitch to be inaudible at the 7.5-ips playing speed. To my pleased amazement, the tone overlaps the low-end response of my system at a shade above normal playback level. Many tape fans who discover this tone may favor its retention by Mercury. I can think of no easier check on a system's bass response. Excellent violin ensemble work topped with high, soft-tinkling percussion.

Dancing and Dreaming
Jay Norman Quintet
Concertapes (Stereo) 24-2
(7-inch; playing time, 32 min. $11.95)

Piano, vibes, guitar, drums and bass heard in vivid, completely straightforward sound. No tricks but simply the best that can be done with today's equipment to keep alive old favorites such as *Time on My Hands*, *Easy to Love*, etc. Worthy of the very best sound systems.

Music for Non-Thinkers
Guckenheimer Sour Kraut Band
RCA Victor Stereo Tape CPS-133
(7-inch; playing time, 27 min. $10.95)

While fracturing music for small German bands, the Guckenheimers toss our way some of the most technically alert sound in the Victor tape library. Response is as broad as the humor.

Top Percussion
Tito Puente
RCA Victor Stereo Tape APS-120
(7-inch; playing time, 16 min. $6.95)

Pandemonium by Tito Puente, the outstanding exponent of Latin percussion. With five wildly earnest colleagues at the assisting drums, Puente presides at the timbales (Cuban drums played with sticks). On a good system, he delivers wavefronts considerably steeper than those found on most drum recordings. Widely separated stereo expedites the delivery.

DVORAK: *Violin Concerto*
Nathan Milstein, violinist
William Steinberg conducting Pittsburgh Symphony Orchestra
Capitol Stereo Tape ZF-26
(7-inch; playing time, 29 min. $14.95)

From any standpoint, this is the best-sounding stereo tape recording of a violin concerto available at moment of review. No other tape in the catalog has the combination found here, the warm, rich tone contributed by Milstein and the flawless engineering and processing provided by Capitol. The solo violin goes out to the top of its range without a trace of peak anywhere. Unlike the Pittsburgh tape of the Beethoven Seventh Symphony, the orchestra is heard in relatively close pickup. Its colorful comments in the course of the concerto surround the soloist in completely natural stereo. If you have room for only one violin concerto in your tape collection, get this one.

STRAVINSKY: *Song of the Nightingale*
Fritz Reiner conducting Chicago Symphony Orchestra
RCA Victor Stereo Tape CCS-97
(7-inch; playing time, 22 min. $10.95)

In this fairy tale set to music, the Chicago Orchestra is heard in one of its better demonstration tapes to date. So minimal is the tape hiss, a new extension of dynamic range is possible here without marring the low-level passages. The flecks of ultra wide-range tonal color, in stereo, are easily spotted throughout the orchestra is Fritz Reiner depicts an Oriental setting with his customary attention to detail.

RAVEL: *Bolero and Ma Mère L'oye*
CHABRIER: *Bourrée Fantasque*
Paul Paray Conducting Detroit Symphony Orchestra
Mercury Stereo Record SR-90005

Mercury has tackled the *Bolero* in its first stereo disc release. The gain in technical yardage is a significant one. Although stereo records do not match the dynamics and aural impact now on tapes. distortion here is held to an impressive low. The added value of stereo puts this item ahead of the monaural disc version recorded some time ago. Effective stereo in the *Mother Goose* and *Bourrée.*

BARTOK: *Concerto for Orchestra*
Fritz Reiner Conducting Chicago Symphony Orchestra
RCA Victor Stereo Record LSC-1934

I have noticed that RCA's stereo pressings tend to vary according to cartridge output. coming over very well on a 25-mv magnetic job feeding RCA's favorite speaker in two enclosures. Under those circumstances. the comparatively flat response on the record rejuvenates this long-popular version of Bartok's challenging score.

BEETHOVEN: *Symphony No. 7 in A Minor*
Guido Cantelli Conducting Philharmonia Orchestra
Angel Stereo Record S-35620

Its second batch of stereo releases finds Angel still cautious in the dynamic range used on their records. Distortion is lower than that on a companion release (*Tchaikovsky Symphony No. 4*, S-35565). Apparently Beethoven's clearer tonal texture is easier to record at this juncture than Tchaikovsky's uninhibited sonorities. To sample Angel's best current sound, try the new monaural Rossini overtures led by Markevitch (35548) and the Berlioz album (35431).

Overtures in Hi-Fi
Albert Wolff Conducting Paris Conservatoire Orchestra
London Stereo Record CS-6015

London continues to set the pace in classical stereo discs. This record is the cleanest-sounding of their latest releases. Close-range stereo recording as practiced here offers fresh insight into dramatic effects used in these familiar overtures to three French and three German comic operas. A must for audiophiles familiar with Wolff's monaural *Overture* record of a few years ago (London FFRR LL-1157).

Gerry Mulligan Songbook, Vol. 1
Gerry Mulligan and Sax Section
World Pacific Stereo Record 1001

Is proximity to Westrex a factor explaining the exceptional cleanness of West Coast stereo discs? I've noticed that feature in other California products. This World Pacific jazz release ranks with the very best. Mulligan's imagination is converted to sound by carefully chosen personnel. Transparent texture of the stereo sound is particularly noticeable in the sweet "tsing" of drummer Dave Bailey's wire brushes. Don't miss this one.

Sea of Dreams
Nelson Riddle and His Orchestra
Capitol Stereo Record ST-915

The sweetest massed violin sound I've heard so far on stereo discs, stemming in part from the nature of the tunes used. With lower strings used to deepen the already excellent perspective, these warm arrangments by Nelson Riddle should sell stereo to persons unmoved by classical music in two-channel sound.

United States Air Force
Narrated by Arthur Godfrey
Vox Stereo Record ST-PL 10.520

Recorded at the Air Proving Ground Command, Eglin Air Force Base, the main attraction in the stereo disc version of this documentary is still the sonic boom. That is the sound created by an F-100 jet passing the sound barrier about 50 feet above the Astatic 988 dynamic mikes used in the recording. Strictly for the air-minded.

Breaking the Sound Barrier, Vol. 1
Paul Price Conducting American Percussion Society
Urania Stereo Record USD-1007

Already widely known in monaural disc and stereo tape versions, this percussion extravaganza arrives with quiet surfaces on this stereo record. This permits good volume levels when testing stereo cartridges. The Edgar Varese *Ionisation*, a famous test item in the early '50's enters upon a new career. separating this time the compliant from the reluctant in stereo pickups.

Sounds . . . Out of This World
Stereo Balance/Test/Demonstration disc
Omega OSD-1

This stereo test record arrived too late for full evaluation in this column. I'll report next month on its behavior under several cartridges. In the frequency response test. the two channels start at opposite ends of the spectrum and are said to contain. with no cross-modulation, 30 to 15,000 cycles. Cross-talk is stated to be 45 db.

COPLAND: *Billy the Kid*
Rodeo
Morton Gould and His Orchestra
RCA Victor Stereo Record LSC-2195

Room acoustics as heard on this disc deserve fresh examination in the light of stereo. New York's Manhattan Center, scene of this recording, is RCA Victor's most reverberant hall. In monaural days, a distant mike placement there lent a valuable illusion of depth. Now, on a space-revealing stereo record, the reverberation is excessive. There is greater range of dynamics on the monaural disc (LM-2195).

The King and I
Motion Picture Sound Track
Capitol Stereo Record SW-740

The latest appearance of this familiar Rodgers and Hammerstein score as heard in the movie. A single-track best seller now offered in the finest sound-stage acoustics I've heard so far on stereo disc.

VIVALDI: *The Four Seasons*
Antonio Janigro conducting I Soloist di Zagreb
Vanguard Stereolab Record BGS-5001

Vanguard, in company with many other firms, is getting better results on stereo discs with material that makes small demand on the medium. Slightly inferior technically to the monaural version, this splendid performance of Vivaldi's music offers adequate stereo realism.

MENDELSSOHN: *Quartet in E Flat*
GLINKA: *Quartet in F*
Westwood String Quartet
Stereo Records S-7006

First recordings of quartets uncovered by the Society for Forgotten Music. The monaural version (SFM-1001) has a dry, too-close sound. On stereo disc, that effect is gone yet the four strands of music are easier to follow. Excellent signal-to-noise ratio.

Note: Records below are 12-inch LP and play back with RIAA curve unless otherwise indicated.

BERLIOZ: *Symphonie Fantastique*
Ataulfo Argenta conducting Paris Conservatoire Orchestra
London FFRR LL-3016

Seldom before has the wild imagination of Hector Berlioz been translated into such recorded sound. The fourth movement, *March to the Scaffold*, punctuated by blood-curdling percussion, gives way to a seething caldron of sound in the last movement. Greater miking distance than that in *The Rite of Spring* above sharpens the bite in the sound. Very clean at the top level of the best systems.

MENDELSSOHN: *A Midsummer Night's Dream*
SCHUBERT: *Rosamunde*
George Szell conducting Concertgebouw Orchestra
Epic LC-3433

Is there today an active conductor more fortunate than George Szell? An audiophile of some years standing, his recording assignments for Epic take him to two of the more exhilarating halls in use today, Severance Hall in Cleveland and the Concertgebouw Hall in Amsterdam. Conductor, orchestra and hall are in rare form in this exceptional disc.

Beauty and the Brute Force
Dot Evans and Brute Force Steelband of Antigua
Cook 1049

The oil-drum steelbands of the West Indies were brought into prominence by Cook Labs some years ago. Here they are given a new lease on popularity with the addition of the lazy, torchy voice of Dot Evans. An unlikely combination proves to be a likable one.

Josef Hofmann plays Chopin
Rondo 1002

In the year 1888, pianist Josef Hofmann, at the age of 12, was the first name artist to engrave a wax record for Thomas Edison. Although his career was legendary, he made very few records. These three Chopin works, transferred from player-piano rolls, have far better sound than the only other Hofmann record in general circulation, Columbia KL-4929. Dynamics indicated in later years by the performer have been recently added electronically, restoring the dynamic range unobtainable on piano rolls. Each phrase was processed on tape run at half-speed. On a broadcast VU meter, the performance now behaves like a modern record, peaking zero from −20 db with total freedom.

MAHLER: *Symphony No. 2 in C Minor*
Bruno Walter Conducting New York Philharmonic and Westminster Choir
Columbia M2L-256

The recording sessions devoted to this gigantic work were interrupted for a year by the illness of Bruno Walter. Recording director David Oppenheim, drawing upon his years of work in Carnegie Hall, has matched the various takes with unfailing skill. Here's the first recording with string lows rich enough to give meaning to this dark-hued symphony. Anticipating the very low noise level on the finished disc, gain was properly left low in the quiet choral passages. Breathtaking effect on a pair of truly flat speaker systems.

BARTOK: *Concerto for Violin*
Issac Stern, Violinist
Leonard Bernstein conducting New York Philharmonic
Columbia ML-5283

The finest recording of this music currently available. The transparent, ultra-clean recording reveals the true bite in Bartok's orchestration. Stern's great performance forces one to forget that this concerto is supposed to be difficult to follow.

The ABC's of Hi-Fi
Cook 5022

Some audio old wives' tales are disposed of and a few new ones are started in this salty two-record discourse by Emory Cook on the acquisition and practice of high fidelity. A few opinions expressed are already going out of date at the end of August. The practical tips on handling records and tapes have durable value and the aural illustrations are very helpful. Sure to stimulate many happy hours of argument in the months ahead.

Sylvia Zaremba Plays Brahms
Unicorn UNLP-1058

A major Brahms solo piano work, *The Variations and Fugue on a Theme of Handel*, and three Brahms rhapsodies are played with seasoned style in Miss Zaremba's first recording. Recording engineer Peter Bartok and the fine acoustics of New York's Town Hall give us an outstanding concert-hall piano sound.

Sound Ideas
Les and Larry Elgart Orchestra
Columbia CL-1123

The Elgarts' keen interest in top-notch sound pays off handsomely at the loudspeaker with popular music of durable appeal. Try their latest arrangements when experimenting for maximum monaural depth from two speakers.

GRIEG: *Piano Concerto in A Minor*
RACHMANINOFF: *Rhapsody on a Theme of Paganini*
Phillipe Entremont, Pianist
Eugene Ormandy conducting Philadelphia Orchestra
Columbia ML-5282

Your ear will inform you to keep an eye on this rising young French pianist (Columbia's answer to Van Cliburn?) Stunningly captured is the uniquely confident tonal production of an already seasoned artist. Very highly recommended. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14 St., New York 11, N.Y.*

READY FOR STEREO?

Part II—Add a second channel to your monophonic system in easy steps

By DONALD C. HOEFLER

GETTING ready for stereo should be a logical building-block process, at a rate determined by the availability of components and funds. For, while the effect of stereo on the hearer is revolutionary, the equipment which produces it is not.

This means that you have to throw away very little, if any, of your present system. Some pieces must be modified and you must add some equipment for the second channel. But converting to stereo is a process of building up, not tearing down.

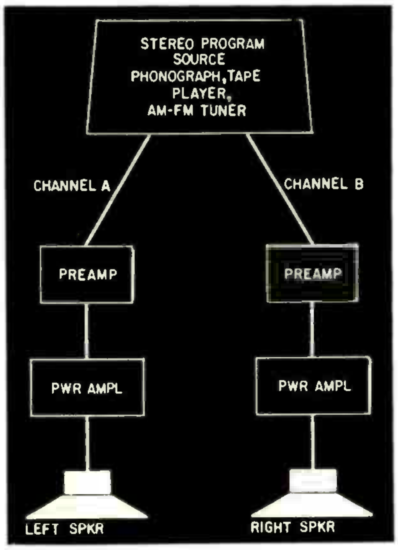


Fig. 1 — Fundamental stereo arrangement. Converting existing equipment involves modifying the source components and adding a second audio channel.

The basic elements of any two-channel stereo system are shown in Fig. 1.

This arrangement differs from conventional monophonic systems on two fundamental points. First, the *program source* is *stereo*. Second, an additional channel has been introduced.

Each component in the stereo system will be taken up in turn in this series, beginning with stereo phonos next month. But for those thinking about buying equipment now, here are a few general suggestions.

Sources and equipment

Even if you don't want to go into stereo right now, any new phono pickup you buy should be a stereo unit. Remember, that stereo discs cannot be played with monophonic cartridges without damaging the record severely. On the other hand, both sides of a stereo cartridge can be paralleled to reproduce both types of discs, through a monophonic system. As soon as you have a stereo cartridge you can begin building your library of stereo records, playing them monophonically until your stereo system is complete.

Stereo tapes aren't damaged when played on a monophonic machine, but only one track is heard and the sound is rather anemic. However, you can temporarily parallel the outputs of a stereo machine into a single channel for monophonic reproduction. An existing tape recorder can easily be modified for stereo. This will be described in a future article. But if you don't already have tape equipment and are intending to buy some, by all means go stereo.

If you plan to purchase new tape apparatus, you must decide on the ultimate form of your own setup, to adapt to your own equipment and available stereo tape facilities. These range from the stereo tape deck—simply a bare transport mechanism equipped with stereo heads, but without tape preamps or amplifiers—to the complete stereo tape system, including dual power amplifiers and speakers.

In between are systems which include equalized tape preamps. These must be coupled to external power amplifiers. This is the best arrangement for those who already have a hi-fi system.

When it comes to stereo tuners, there are only two things to remember. If separate AM and FM tuners are not used, the AM-FM tuner must be able to receive and detect AM and FM *simultaneously*, so both channels of the AM-FM stereocast can be reproduced. Further, the FM tuner should provide for the future addition of a multiplex adapter, as this single-carrier type of stereocast is destined to be important.

A step on the path

While rearranging your source devices takes you a few steps closer to

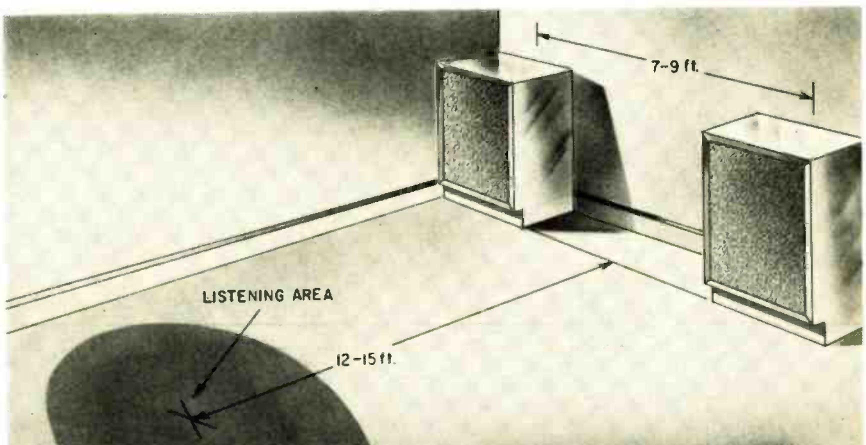


Fig. 2—Recommended relation between speakers and listener for 2-channel stereo. This may also be used for spread sound.

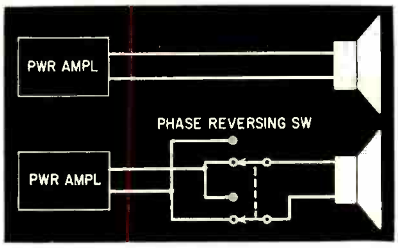


Fig. 3—A dpdt phase-reversing switch in one channel makes it easy to phase speakers properly.

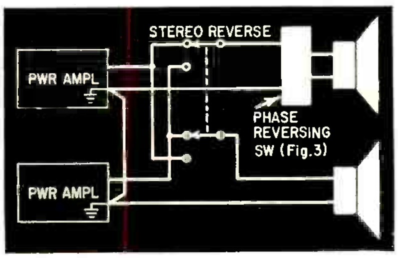


Fig. 4—A stereo reverse switch lets you reverse channels when necessary, without changing speaker leads around.

total stereo, the effect on your ears at this point has not changed. Lest you lose patience and get discouraged in midstream, there is one step on the way to stereo which has immediate and tangible results. Add the second speaker!

Two speakers, connected to a single amplifier and properly placed in the same room, provide a spread-sound effect which for most types of music is definitely superior to the point-source single speaker. Of course, it's not stereo. Preferably, the two speakers should be identical, as should all components in the two stereo channels. Otherwise the proper acoustic balance is more difficult to get and the effect on the ear can be fatiguing.

The speaker arrangement depends on room acoustics, listening level and personal taste. The general arrangement of Fig. 2 provides a good starting point, assuming an average listening distance of 12 to 15 feet. This puts the ideal listener position at the apex of a triangle whose sides form an angle of 30° to 40°. In a monophonic setup these factors are not highly critical, but you might as well start with them, experimenting with spread sound while building the balance of the s[illegible] system.

Connecting the addit[illegible]peaker to the single amplifier is [illegible] Connect the two speakers in par[illegible]oss the secondary of the outpu[illegible]former, but remember you have [illegible]e impedance in half.

Each speaker's output [illegible] be less than before for a given v[illegible] setting, but the combination's tota[illegible]put will remain about the same.

Two speakers working i[illegible]onfined area must be in phase. T[illegible]s, both cones must move forward [illegible]e same instant, and must also mo[illegible]back together. This is one place wh[illegible]re "push-pull" is no good. In a monophonic spread-sound setup, the speakers are phased once when installed, and that's that. But when you get into stereo, the phase relationships between channels may vary with the sources, particularly on FM–AM stereo broadcasts, and a phasing switch will become a necessity.

This is simply a double-pole double-throw switch, connected as in Fig. 3. One switch is used as you have to swing only one of the channels into phase with the other. The switch may be connected anywhere in the chain, but if you are installing your own the best place is probably at the amplifier's output.

Phase cancellation is most noticeable in the bass region, so the correct setting of the phasing switch can be easily determined by ear, once your stereo system is operating. Simply adjust the system for equal loudness from each speaker, then stand at a spot about midway between them and flip the switch back and forth a few times. The correct position gives full bass, while the out-of-phase condition presents a very thin sound.

Having a second speaker and stereo program sources, all that remains is to add a second amplifying channel to complete the arrangement of Fig. 1. Existing equipment should be duplicated if possible, but any second amplifier will work in a pinch.

There is also the possibility of the channel-A part of the program appearing out of the right speaker, instead of the left where it belongs. This can be controlled with a stereo reverse switch, a two-pole double-throw arrangement shown in Fig. 4. The reverse switch actually swaps channels between left and right.

Even with these switches in place, the basic arrangement of Fig. 1 leaves something to be desired. One important factor is the volume setting. It takes some experimenting to get the correct balance between the two channels, and this is almost impossible to maintain if separate volume controls in each amplifier must be adjusted each time the level is set. A much better arrangement is a ganged control (like that found on many stereo preamps), which works equally on both channels.

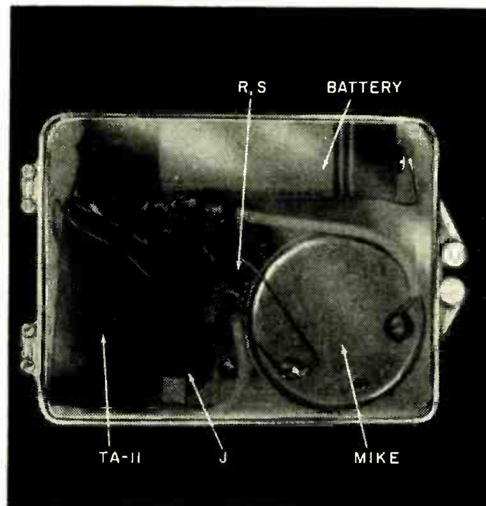
Such a control is included in the stereo adapter described in RADIO-ELECTRONICS, July, 1958, page 36. This completely passive unit is connected between the preamps and the power amplifiers.

A dual 500,000-ohm potentiometer acts as the volume or loudness control for both channels—the loudness function is switched in. The selector switch includes a stereo reverse position and combines outputs from the stereo pickup when playing monophonic records. It also permits playing any other monophonic source from either channel through both amplifiers simultaneously. All these modes of operation can be handled through haywire connections or by slinging a lot of patch cords around, but a stereo adapter can save a lot of time and trouble.

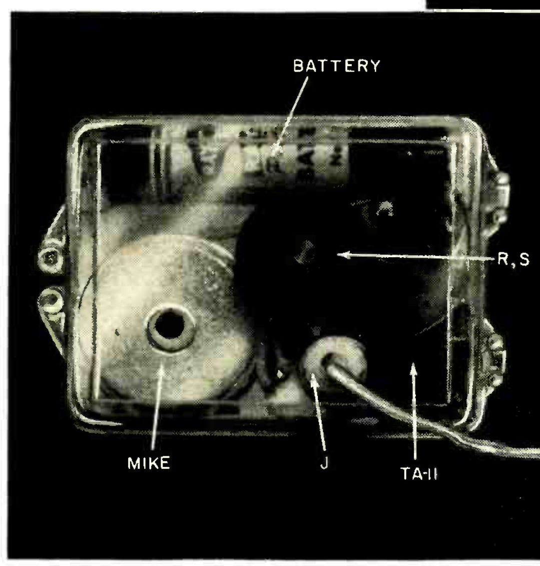
Next month we'll see how you can modify monophonic phono equipment to play stereo discs. TO BE CONTINUED

Low-Cost TRANSISTOR HEARING AID

A 4-stage amplifier with a gain of 1,000 forms the heart of this tiny aid for the hard of hearing



Despite its small size, there is no cramming in the case.

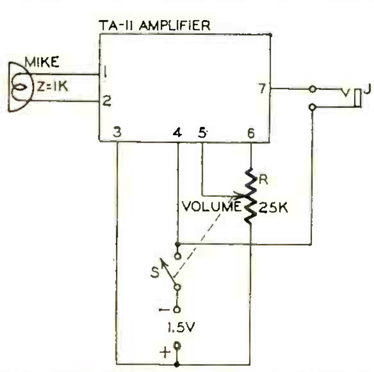


A look at the front side of the midget unit.

By FORREST H. FRANTZ, SR.

EVERY day large numbers of hard-of-hearing people in the United States purchase new transistor hearing aids to replace the older, bulkier, battery-hungry vacuum-tube variety. These people already own a headphone with a custom ear mold. Many others would purchase new hearing aids if the cost were not so high. And, of course, there are many potential hearing-aid buyers who have never purchased one.

Up to now, most hearing aids that have been described in the literature have been gadgets which illustrated an application for transistors. As practical hearing aids, they have been unattractive and bulky. From a business standpoint, the labor required to build one of these was prohibitive. The relatively new Centralab printed-circuit TA-11 four-stage transistor amplifier changes the picture. Now the service technician and electronic hobbyist are in a position to enter the profitable hearing-aid business with a unit that is attractive in size, appearance and cost. At the same time he can enjoy the satisfaction of performing a valuable service for his fellow-men.



R—pot. 25,000 ohms, with spst switch S (Centralab B16-217)
S—spst on R
TA-11, transistor amplifier (Centralab)
Earpiece, 2,000 ohms (Lafayette MS-368 or equivalent)
Battery, 1.5 volts penlight or mercury
Microphone, 1,000 ohms (Shure MC-11 or equivalent)
Case, 1¾ x 2¼ x ½ inches
Miscellaneous hardware

Circuit of the finished transistor hearing aid.

Let's take a look at the hearing-aid business aspects. One general-merchandise mail-order house sells four-transistor hearing aids for prices ranging from about $100 to $135 without the earphone. The custom-brand hearing aids sold through dealers cost more. The hearing aid described in this article requires less than $40 worth of parts and can be built in 30 minutes to 2 hours, depending on the packaging arrangement you resort to and the quantity in which you produce them. You can easily meet competition and still enjoy a good profit.

The hearing aid shown here was built into a plastic case 1¾ x 2¼ x ½ inches—about the size of a book of matches. These cases are available in most hobby shops. I left the plastic clear for illustrative purposes. A unit you intend to sell can be made more attractive by spraying the inside of the case with enamel.

The amplifier connections are shown in the diagram. The numbers on the TA-11 in the diagram correspond to the numbers on the actual unit. I soldered the leads to the battery, but a unit to be marketed should have spring clips or a battery holder for easy battery replacement. Ray-O-Vac 400, RCA VSO 74 or Burgess No. 7 penlight cells may be used. You might wish to give some consideration to using a longer-life mercury cell. The penlight cells are attractive because they can be purchased almost anywhere.

Another suggested change for a commercial unit is locating the earphone jack on the side of the unit rather than on the front, to avoid pocket bulge. Since most anticipated sales will be to persons who already have earphones, you'll want to use an output jack to fit the plug on the user's earphone. For some, you'll need a small bracket to mount the jack.

I used a hot ice pick to cut the large hole for the volume control and a 3/32-inch drill for all other holes. The phone-jack and microphone openings were enlarged with a taper reamer. This reduces the risk of cracking the plastic. The microphone is cemented to the front of the plastic case. END

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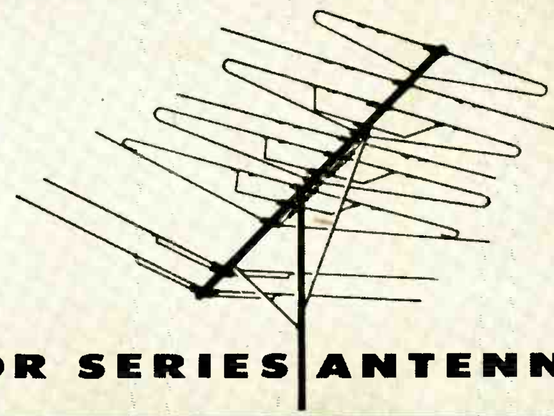

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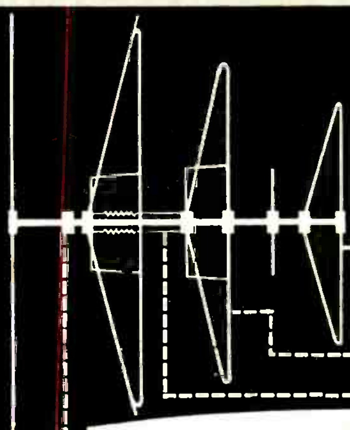

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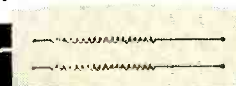

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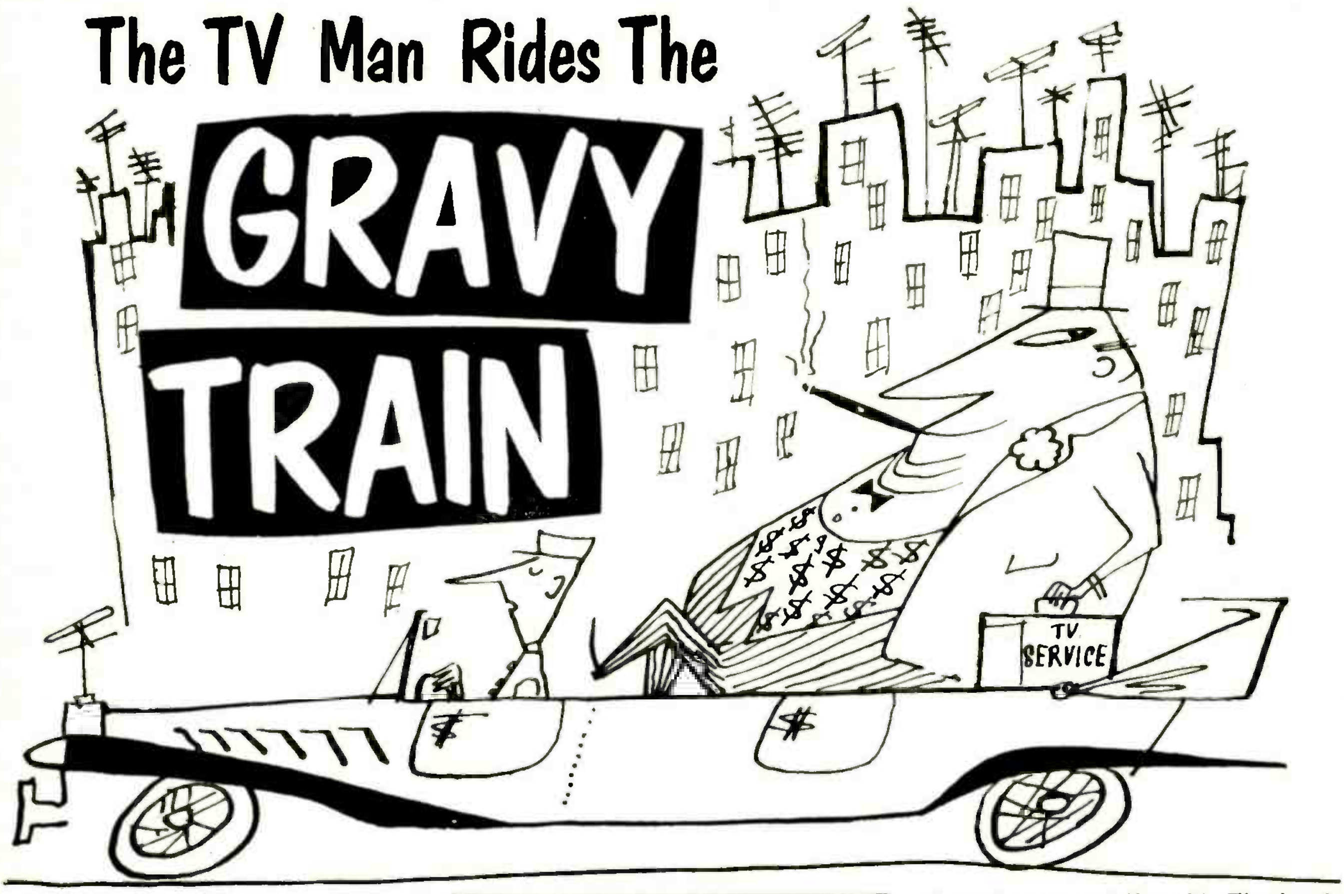

By E. H. LEFTWICH

> We would have been more than a bit dubious about this article, had we not remembered Mr. Leftwich as that old-time service technician and author who wrote the famous article "Watch Out, Mr. Serviceman, or the Set-Owner Will Gyp You," in the April, 1942, issue of RADIO-CRAFT. The practices he describes can hardly be called typical, but may be widespread enough to indicate that the night-crawler and cut-rater are not the only ones who are giving the honest TV technician a black eye.

BECAUSE I'm an old-time ex-radio technician and knew very little about TV, in the past I was smart enough to lay off my 21-inch Magnavox combination (hi fi and TV) and call in some local TV man when I had trouble. I sometimes felt that I was getting rather high repair bills, but succeeded in keeping my big mouth shut—until this time. I felt that "live and let live" was a good rule to follow, and I was actually glad to see the TV man riding the gravy train, his ancestor (the radio man) having come up by the starvation route.

But when I read the headline, "Prices Too Low," in *Technicians' News* in RADIO-ELECTRONICS some months ago, my grids went positive and I shorted the bias on my output tubes! In this article, Mr. Russell Hansen of RCA Service Co. stated that the prices charged by TV repair firms were too low and that the gross income from a shop should total 2½ times payroll expenses.

On first thought, I felt that such a figure would jack up prices still more than they already are—and I was "all shook up." I now realize that this markup is quite reasonable. I only wish that the shops I dealt with had been satisfied with such a fair profit! The true experience which follows will show just what kind of a gravy train the TV men are riding in this area—at more than *twice* the figure Mr. Hansen recommended!

Regardless of what my TV trouble has been, the bill was always $24, plus or minus a dollar or so. The extent of such troubles was a couple of tubular capacitors in one case, two tubes in another; and finally an oscillator coil and a couple of tubes. Now, I'm sure there are many honest dependable TV men in this area and elsewhere. It's unfortunate that I've had only the other kind do my work.

For example, the last time my TV conked out, I noticed that the plate of the horizontal amplifier tube (6BQ6-GTB) was running red hot. By wiggling the adjustment screw on the horizontal oscillator coil, I was able to clear the short intermittently and the picture would come back in sync on the picture tube. All tubes had checked OK on my tube tester. Having read about an electrocution in RADIO-ELECTRONICS and horrified by the thought of "harmful X-rays" emanating from the 1B3 tube (reference *RCA Tube Handbook*, 1957), I was more "chicken" than ever. Because I knew right where the trouble was, I decided to let an experienced TV man take *his* chances with the high voltage and the X-rays. It should take only a few minutes to clear the short, I thought. That's what I *thought!*

Having had past experiences with fantastic charges, I never called the same TV man twice, everlastingly living in the hope that I would eventually find a reliable and reasonable technician. So, I looked in the Yellow Pages of the phone book.

"Trustworthy TV" sounded good, and had the biggest ad in the section! Trustworthy promised to send a man out right away and warned me that there would be a $5 charge for the service call. Nothing, I thought, could be more reasonable than that. Again, that's what I thought!

In a couple of hours, a neatly uniformed young fellow drove up in a sedan. He looked "trustworthy." I explained the trouble, which he verified. I also told him that the tubes were okay. He started to make out his bill.

"Just a minute," I said. "There's no need for you to take the set to your shop. I'll help you carry the chassis to my bench in the garage. I have a vtvm. You can clear up the short in a couple of minutes. I'll still have time to see the Alfred Hitchcock show."

He laughed as he continued to make out his bill. "Sorry," he said, "but we don't operate that way. I don't repair sets at all, except to replace tubes. I just diagnose the case and turn in a report. Tomorrow they'll send out and pick up your set."

"But look, bud," I protested, "it'll take only 15 minutes to do the job. Why not do it now and get it over with?"

But he shook his head and tore off

my copy of the bill (diagnosis, that is). "Look, mister," he said, "I wish all my customers were like you. It would make the job easy. We'll pick up your set and take it in to the shop, put in a new oscillator coil, and tune it up."

I examined the "preliminary" bill. On it, in addition to the $5 service charge, was the diagnosis, "Replace Hor. Osc. Coil and tune up." "How much will the whole job run?" I asked apprehensively.

"It will be $14 to take the set in and bring it back, plus the cost of the coil—about $1.75."

"Does the $14 include the $5 service call?"

"Yes, it does," he said.

Oh, well, I figured, having shot five bucks on the service call, I might as well shoot another $9. "Okay," I said, "I'll help you shack the chassis to your car."

This time, he laughed out loud. "Sorry, mister," he said, "I don't pick up sets, I just——"

"I know," I interrupted, "you just replace tubes and diagnose the case."

Before he left, I gave the TV man a cold Pepsi for the road, and we became quite congenial. He confided that he made about 25 service calls per day (six days per week) and told me that I should take a part-time job in his shop. "But I know nothing about TV," I argued, "I'm just an ex-radio-man."

"You found the trouble with this one," he said, "and TV's are easier to fix than radios—you've got a built-in scope."

I couldn't argue with that—the built-in scope, that is. Next morning at nine, I called Trustworthy and spoke to the service manager. After some 15 minutes, he located my ticket and said he'd get the pickup men out that night. Three nights later, a couple of husky country lads (the kind they had before the war) arrived in a station wagon. They looked like they were fresh from the hills. They came into the house. They took one look at the TV combination (as large as an upright piano and almost as heavy) and groaned. They started to lift the cabinet.

"Hold on," I protested. "Don't take the whole thing in, just the chassis—it's loose in the cabinet." Their jaws dropped and they stared at me.

"But, mister," one said, "We only pick up cabinets and all. We don't know nothin' about no chassis. We'd be afeared we'd break somethin'."

At this point, I could have been forced to admit that I had become a trifle impatient with the entire deal. Last time transfer men had moved "cabinet and all" they'd broken three legs (of the cabinet). "Either you take only the chassis," I said, "or you don't take anything."

They took the chassis, handling it as though it were a bushel basket of eggs.

Receipts		Day	Year
6 service diagnosticans, avg. 15 calls each per day	90 calls @ $5	$ 450	
2 crews, pickup & delivery, avg. 15 jobs each per day (includes labor charge)	30 jobs @ $14	420	
Avg. parts & tube sales per day	30 jobs @ $10	300	
Daily total		$1,170	
$1,170 per day, 6-day week, total $7,020 × 50 weeks			$351,000
Additional tubes & parts sold in shop $185 × 50 weeks			9,250
Total yearly receipts			**$360,250**

Expenses		Week	Year
Salaries			
6 service diagnosticians	@ $100 week	$ 600	
3 shop technicians	@ 100 week	300	
1 service manager	@ 130 week	130	
1 clerk-typist	@ 60 week	60	
4 pickup & delivery men	@ 40 week	160	
Weekly Payroll		$1,250	$62,500
Executive's (owner's) salary, pro-rated			6,000
Total yearly salaries			**$68,500**

Operating Expenses—Yearly	
Merchandise cost	$ 13,500
Mileage, depreciation, insurance, operating costs, 8 cars	39,600
Depreciation, shop & office equipment	2,000
Rent (pro-rated for 1/3 total store area)	3,600
Utilities	900
Insurance	600
Advertising (Yellow Pages, phone book, principally)	1,300
Office supplies	300
F.I.C.A. (social security)	1,185
Workman's compensation	1,107
Bookkeeping service	1,200
Attorney—retainer fees	500
Miscellaneous expenses	5,000
	$ 70,792
Plus yearly salaries	68,500
Total yearly expenses	**$139,292**

Gross receipts	**$360,250**
Less total expenses	139,292
	$220,958
Less California State Income Tax	11,758
Net Profit before Federal Income Tax	**$209,200**

NOTE: Gross receipts of $360,250 are more than 5.2 times payroll expense of $68,500.

One week later

After repeated hassles with the service manager (on the phone), I finally got Trustworthy to return the chassis. Meantime, I was a bit fretful, having missed a week of my favorite TV programs.

This time a different man appeared. He was alone, in a small sedan. I had to help him carry the chassis into the house and get it into the cabinet. The set worked, but the picture was out of focus just enough to be annoying to watch. "How about tuning it up a little?" I asked.

"Sorry," he said, "But I only deliver sets and turn 'em on. I'll turn in a report and there will be a man out to tune it up."

With these familiar words, he threw his bill in my face. Sure enough, there was the $14 pickup and delivery charge, plus $5 for the first service call, plus $2.75 for the coil, and plus $2.60 for two tubes—as usual, a total of $24.35! I, who had trusted Trustworthy, was disillusioned. I squawked. I explained that the $5 service call was to be included in the $14 pickup charge, and added that I didn't need any tubes.

"Don't blame me, mister," the man said, "I only deliver sets. They make out the bills at the office."

"I know," I said wearily, "But just for the sake of my own morbid curiosity, suppose you had to deliver a big chassis to a little old crippled lady who lived out in the country. And suppose, because of a forest, you couldn't drive in closer than half a mile from the house. What would you do then?"

His eyes bulged out and his jaw slackened, while he hung his head. "I just don't know, mister," he admitted.

Well anyhow, I thought, I'll get to see the weekly rerun of *The Honeymooners* tonight, even though the picture distortion makes me bug-eyed. That was something else I *thought!*

I paid the man and watched him, fascinated, while he jerked the line cord from the chassis. "Hey, wait!" I yelled. "What's the idea?"

"Why, that's *my* cord, mister. It's

the one I have to try out sets with—when I deliver them."

"Then, where's *my* cord?"

"I don't know. It should have been fastened to the back."

It appeared, then, that the pickup men had taken my cord when they took the chassis, and that the delivery man would not leave his cord. This was the last straw! I threw on my jacket, fired up the Chev and took off for the home office of Trustworthy TV.

The Sales Department was large and impressive—so was the shop. On the wall, prominently displayed, was a bronze plaque which read "Member—Better Business Bureau." This forestalled any ideas I may have had about reporting Trustworthy as a gyp outfit. After a wait of 30 minutes, I got in to see the general manager. I introduced myself, shook hands and explained that I was an electronics engineering writer and ex-radio service technician. I reviewed the entire deal, complaining bitterly about the $5 overcharge, the poor performance of the set and the loss of the cord without which I could not operate the set after waiting for a week to get it back.

The manager seemed concerned, but not enough to refund the $5 overcharge, which, he explained, resulted from an error on the part of the technician. He was generous enough, however, to give me a brand-new cheater cord. Then, using master sales techniques, he launched into a hard-luck story that was calculated to bring tears to my eyes—and almost did. He wailed and moaned about "overhead," emphasizing the point that it cost $4 to make a $5 service call and that if his service department would only just *break even*, he would be a happy man. He added that he was truly sorry that the TV was out of alignment and that he would send a man out right away to tune it up at "no charge." If it took several more trips to accomplish the tuneup, there would still be no further charge.

As I left, I patted his shoulder consolingly. Poor guy, I thought, what a burden he has to bear. That was two months ago, and Trustworthy has yet to send the man out to tune up my TV. Meantime, being free from the hypnotic influence of the manager's super salesmanship, I have done a bit of figuring. In the estimated figures for Trustworthy's business (see chart page 99) I feel I have been quite conservative. I have piled on the expenses as much as I could. I have discounted the diagnostician's statement that he averaged 25 calls per day, which in an 8-hour day would allow only 20 minutes per call. I have allowed 15 calls per day. Of course, the TV service business is seasonal, but since this was in the summer, I presume the year-round average would be better rather than worse than my figures would show.

"Okay," you may very well say, "so there is a net profit of $209,200 before Federal income tax—and *after* income tax, what does the owner have?" I'll tell you. This business is a "proprietorship" owned by one man. He would, therefore, pay income tax on his individual income, which is that of the shop. Figuring none except business deductions (total expenses), Uncle's cut would be $142,828 and so our store owner would *take home* a mere $66,372.

Although my estimated figures have been checked by two accountants and one business administrator, and have been judged "realistic," there may still be some who might question them. I want to please everyone, so for the benefit of doubters, let's cut the profits in half and come out with only $104,600 net profit before Federal income tax. On this amount, Uncle's cut would be $57,090, and the shop owner's "take-home pay" would be $47,510.

Definitely, this isn't hay! No, I never did call Trustworthy back on the tuneup job. Frankly, I don't trust Trustworthy and I wouldn't let them touch my TV with a 60-foot antenna mast. For self-preservation (and until I can find a fair TV man) I have done some studying, and am now repairing my own TV—no one else's, just my own.

TV repair charges too low? Maybe, in some areas—but *not* in mine! END

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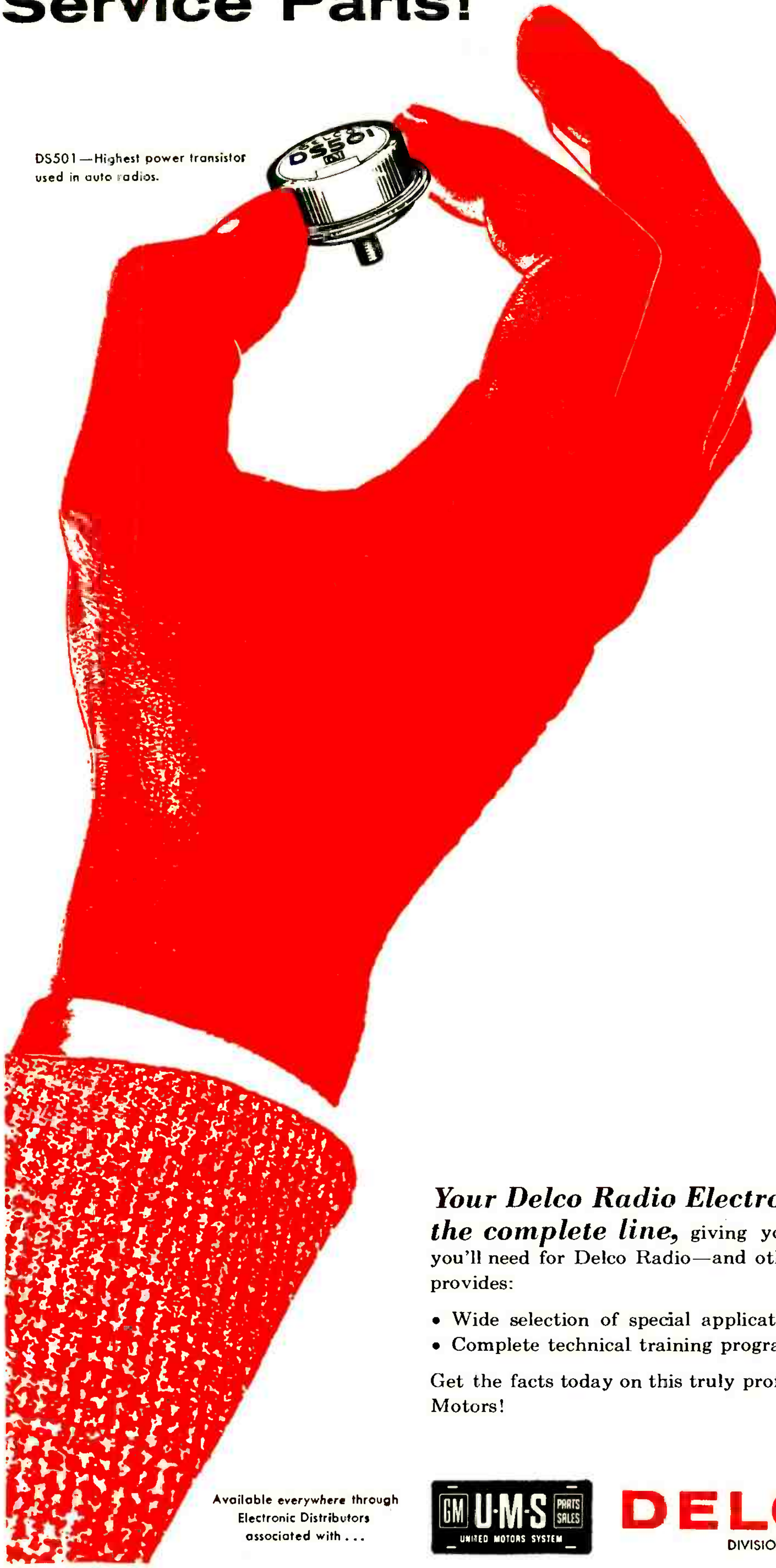

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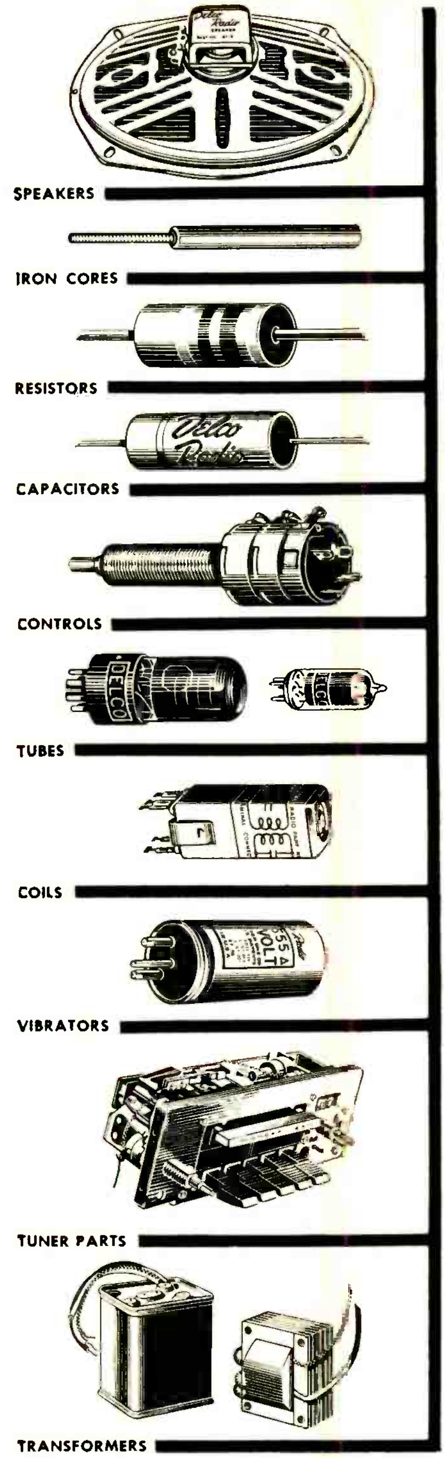

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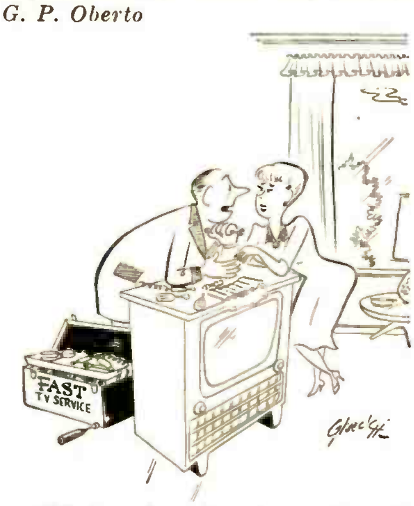
My most unusual service job was on an RCA model T-120. The complaint was an intermittent picture. Close observation showed poor sync stability in the horizontal oscillator and arcover in the horizontal output transformer and 1B3. The picture and raster would intermittently cut out with a loud click. When a picture was on the screen, the top part of the picture would bend and weave a little.

After probing around with a scope, I noticed that the peak-to-peak voltage at the grid of the 6BG6-G horizontal amplifier was greater than normal; the peak-to-peak voltage at the plate of the 6BG6-G would decrease as the brightness control was advanced, and the high voltage would drop to 8,650. The efficiency of the circuit was improved by replacing the horizontal output transformer, tubes, and some components. However the trouble was still there.

Reducing the horizontal drive cured the instability problem. But now the picture lacked brightness and focus. The high voltage was low, so I tried several 1B3's and checked all components in the high-voltage circuit—all to no avail.

By this time the set decided to act up intermittently. A blue glow appeared in the 1B3 and was traced to an intermittent arcover in the 12LP4A picture tube. Replacing the picture tube cured the intermittent condition. However, as before, the high voltage was still low. Advancing the horizontal drive control brought the high voltage up but also brought back the instability and overdrive.

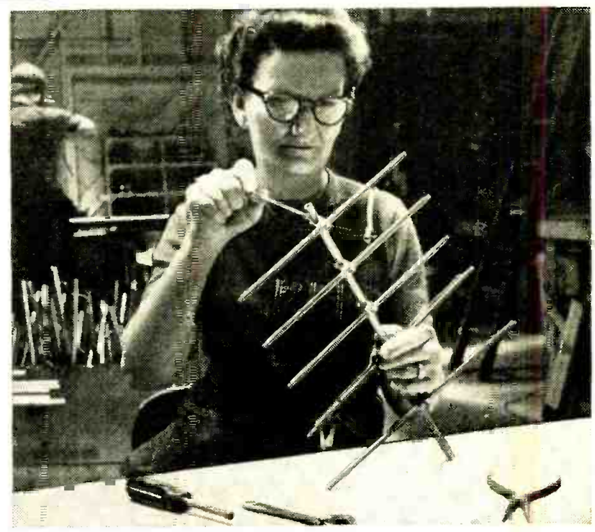
After prolonged checking and self-consultation I asked: "Could the trouble be in the *new* horizontal output transformer as well as in the original?" I decided to substitute another exact replacement—it cured the trouble.—*G. P. Oberto*

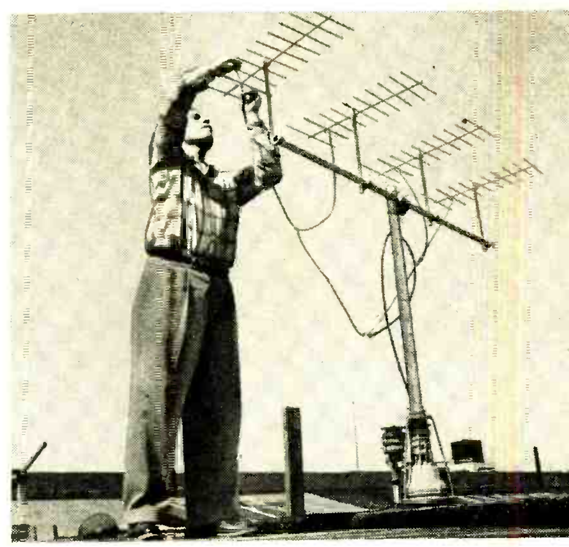


"My boss doesn't understand me."

DIPOLES and YAGIS

This is the first of a series of articles on the practical aspects of antenna installation. This installment presents the facts about stacking antennas and the effects of such stacking





By Engineering Staff, Scala Radio Co.

Fig. 1 (above right)—Scale-model Yagi antenna is constructed with careful attention to detail.

Fig. 2 (right)—Yagi antennas are tested with installation which approaches ideal.

Fig. 3 (above left)—Radiation patterns are checked on accurate laboratory equipment. Electronic patterns are traced on scope screen.

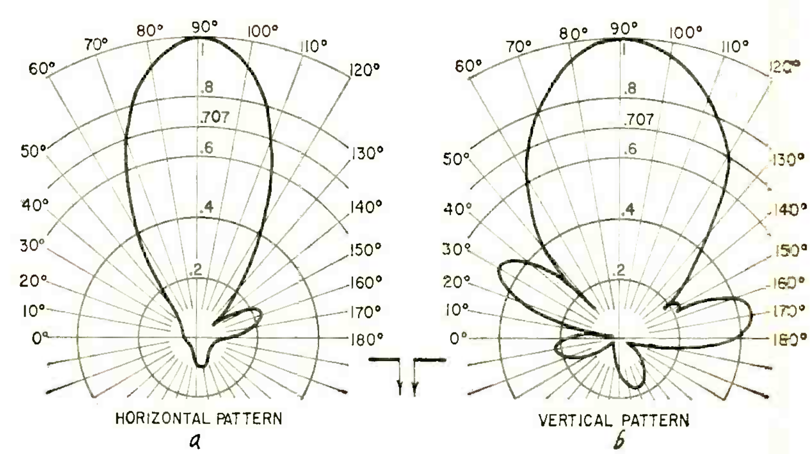
Fig. 4 (below)—Polar patterns of single 10-element Yagi antenna: a — horizontal; b—vertical.

THERE are many good books on antenna theory. However, very few data are available on antenna installation techniques. Technical problems met in practical work have been almost completely avoided.

Generally, we stack antennas to increase gain. In practice a gain of approximately 3 db is possible each time the number of antennas is doubled. Two dipoles stacked vertically or horizontally have an approximate gain of 3 db over a simple half-wave dipole. A 4-bay antenna has a gain of approximately 6 db, an 8-bay job yields a gain of approximately 9 db and a 12-db approximate gain is possible from a 16-bay array. In stacking antennas we also automatically increase the directivity in the plane in which the antennas are stacked.

Basic dipole principles

A dipole is bi-directional. The two major lobes are at right angles to the elements. No energy is radiated from the ends of the dipole. Dipoles can be stacked vertically, and this confines the energy on the vertical plane. It gives a sharper radiating pattern on the vertical plane, without affecting the horizontal plane.



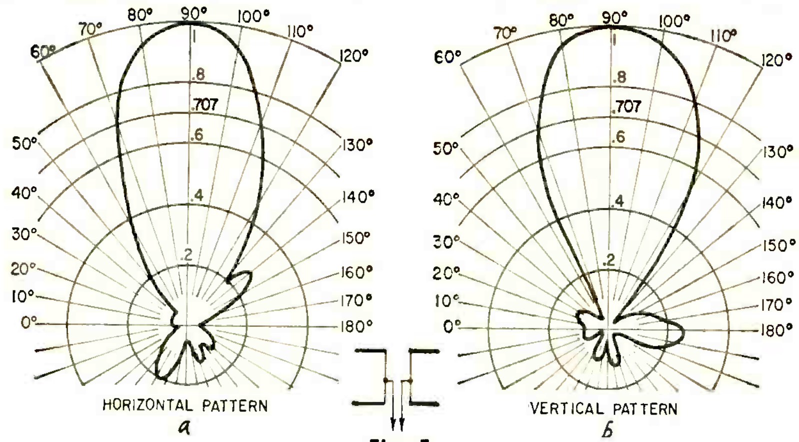


Fig. 5

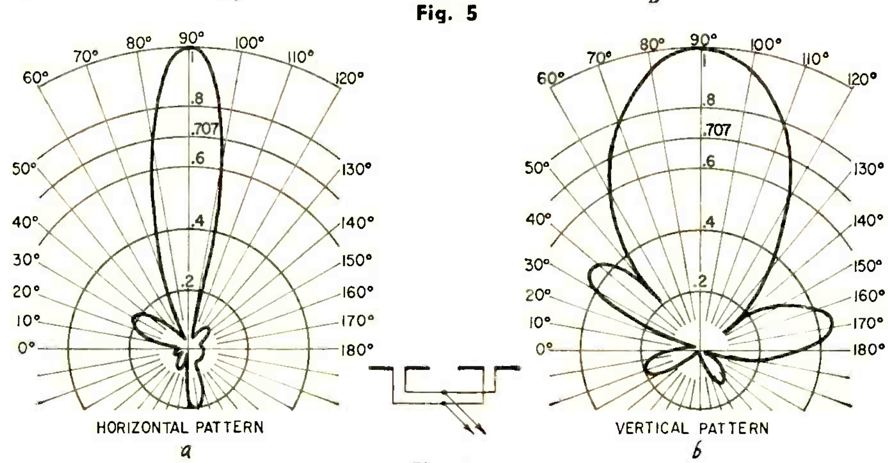


Fig. 6

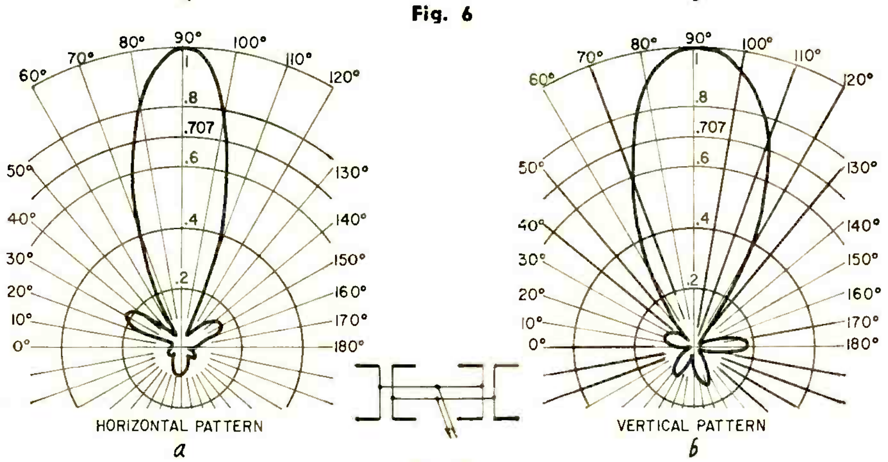


Fig. 7

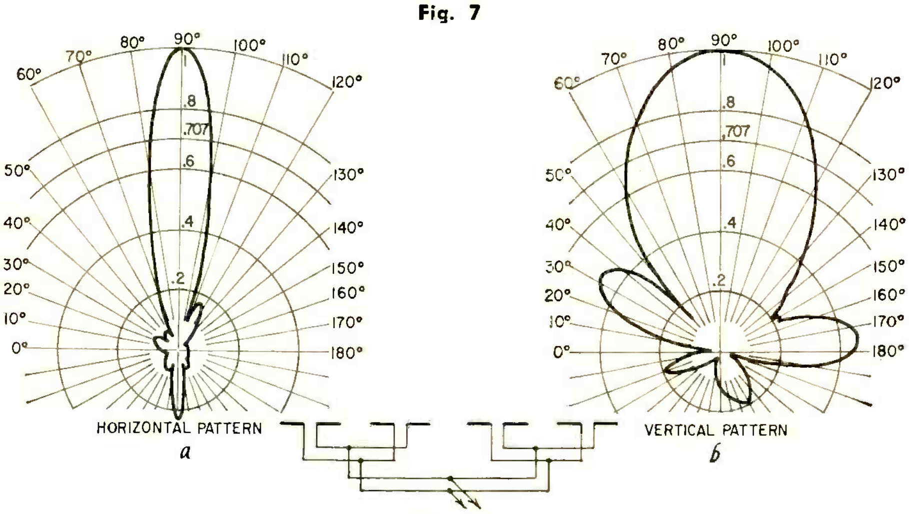


Fig. 8

Stacking dipoles horizontally confines the horizontal radiating pattern, without affecting the vertical pattern. When dipoles are stacked both vertically and horizontally, energy is confined to both planes. A gain of about 5 db is obtained by merely adding a director to a dipole. A little more gain is obtained by using a reflector instead.

The forward radiating pattern of a dipole with reflector is reasonably similar to that of a dipole with a director. However, the effect on the rear lobe is more pronounced, and a higher front-to-back ratio is obtained with a reflector.

Properly terminated antennas do not cause radiation from the transmission line or noise pickup. This applies to a perfect termination, however, which may be difficult to obtain in practice. These considerations will be discussed in detail later.

Assuming a solid wavefront, when a given number of Yagi antennas are stacked, the same gain should be obtained whether stacking is vertical or horizontal. If the expected gain is not obtained the installation has been made incorrectly. Note that the *method* of stacking changes the directional characteristics greatly. Incorrect stacking can cause complete failure.

Hence, a study of both the horizontal and vertical radiating pattern was made on exact 10-to-1 scale models of 10-element Yagis. This means making *all* dimensions of the antenna 1/10 in size and energizing the structure at 10 times the frequency of the reference antenna. Fig. 1 shows such a test antenna.

The stacked antennas are then mounted on a test stand with rotator as shown in Fig. 2. Finally, the response is measured on a radiation pattern indicator, as illustrated in Fig. 3.

Radiation patterns of Yagis

The radiation patterns of a single Yagi are seen in Fig. 4. Note that the horizontal pattern in Fig. 4-a is symmetrical, except for a small lobe on the right. This disturbance is intentional and shows the effect of an unwanted signal. At a later point, it is shown how this disturbance can be reduced greatly by proper stacking.

Fig. 4-b depicts the vertical radiation pattern of the same antenna. The smaller lobes on either side of the major lobes are typical of a single Yagi. They result from side radiation of the driven element. We will show how these lobes are also eliminated by proper stacking.

If two Yagis are stacked vertically,

Fig. 5—Pattern of 2-bay vertically stacked Yagis: a—horizontal plane; b—vertical plane.

Fig. 6—Two-bay horizontal stack: a—horizontal pattern; b—vertical pattern.

Fig. 7—Four-bay array stacked horizontally and vertically: a—horizontal pattern; b—vertical pattern.

Fig. 8—Horizontally stacked, 4-bay array: a—horizontal pattern: b—vertical pattern.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the pattern changes little horizontally. The half-power point (0.707 voltage point) is still at 40°. However, the vertical pattern is considerably changed. The half-power point is no longer at 60°; the pattern is now much sharper, and the two side lobes in Fig 4-b are greatly reduced (see Fig. 5).

Now, consider two Yagis stacked horizontally. You will note from Fig. 6-b that the vertical pattern is unaffected. It remains the same as for a single antenna. The horizontal radiating pattern (Fig. 6-a) is considerably changed. The half-power point is now 20°, not 40° as in Figs. 5-a and 4-a.

These tests show that the radiating patterns of antennas are changed only in the plane of stacking. Thus, if two antennas are stacked horizontally, the horizontal pattern is changed—the vertical pattern is not. Likewise, if two antennas are stacked vertically, the vertical pattern is changed—the horizontal pattern is not.

Controlling both planes

Installations often require polar control of both horizontal and vertical patterns. Hence, we give next the result of stacking four antennas. Two were stacked vertically and two horizontally. The two banks were phased together and the patterns observed in vertical and horizontal planes.

Fig. 7-b shows how the half-power point in the vertical plane becomes 38° in this configuration. The half-power point in the horizontal plane becomes 25°. It is interesting to note the similarity between the Fig. 7-b quad stack and the Fig. 5-b two-bay vertical stack. The same similarity is seen between the Fig. 7-a quad stack and the Fig. 6-a two bay horizontal stack.

The possibilities which can be realized by the field technician are further illustrated by stacking four antennas in the horizontal plane. Fig. 8-a shows the horizontal polar diagram of this configuration. Note the narrow beam width of 15°. Note also that the side lobe of Fig. 4-a has almost vanished.

The vertical pattern (Fig. 8-b) is practically unaffected and remains the same as in Fig. 4-b. As might be anticipated, similar tests results can be expanded to any number of antennas. However, the practical worker is seldom concerned with more than four.

If you observe the polar patterns which have been illustrated, you will be able to solve many practical problems easily. For example, if you have co-channel interference from the side, you can eliminate it by stacking antennas horizontally. Noise which arrives from below the installation can be reduced or eliminated by stacking the antennas in a vertical plane. If interference arrives from both sides and below or above the antenna site, stack antennas horizontally and vertically.

Following installments will explain how to control co-channel interference, reflections, space loss and similar practical field problems. END

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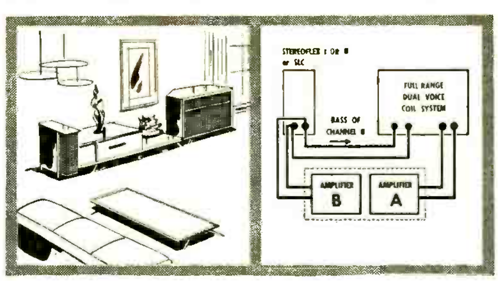
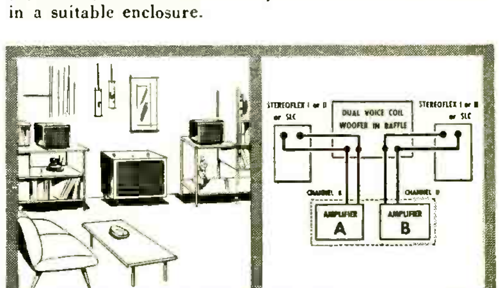
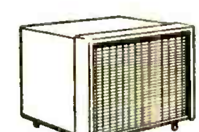


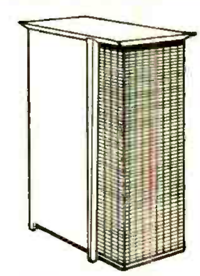
These illustrations are typical of how any of the University stereo adapter speakers may be used in 2-speaker and 3-speaker stereo system combinations. Above, is a Stereoflex II connected to a full-range speaker system. Below, are two Stereoflex I's used with just a dual voice coil woofer in a suitable enclosure.



See your dealer for any desired additional information, or write to Desk J-6, Technical Service Department, University Loudspeakers, Inc., White Plains, N.Y.



STEREOFLEX I: Double horn-loaded, with 6" mid-range driver and 2000 cps crossover wide-angle tweeter. Response: 150-15,000 cps. Hardwood furniture finishes. 11½"h.x12½"w. x10½"d. User net: Mahogany—$54.50, Blond or Walnut—$56.50.



STEREOFLEX II: Double horn-loaded, using an extended air column mid-range with heavy duty compression driver and 3000 cps crossover wide-angle tweeter. Built-in BRILLIANCE control. Response: 150 cps to beyond audibility. Hardwood furniture finishes. 25½"h. x 10"w. x 19½"d. User net: Mahogany — $110.00, Blond or Walnut—$113.00.

MODEL SLC: Same as Stereoflex I, but with decorator charcoal gray fibreglass housing and gold anodized front grille and adjustable tilting stand. 11½"h. x 12¾"w. x 10⅝"d. User net: $43.50.

STEREO ADAPTER NETWORK A-1: Available for use with any brand of speaker system not having a dual voice coil woofer. Not needed with University speaker systems: Debonaire-12, Senior, Master, Troubador, Dean, Classic, Ultra Linear-12 or -15. User net: $30.00.

fm tv dx

By ROBERT B. COOPER, JR.

IN last year's television DX columns (fall–winter, 1957) F2 television reception was covered piece-meal fashion. Unlike other forms of dx reception, F2 calls for making a few minor or major (depending on your experience in TV) modifications to the TV set, antenna system and your dxing habits. Unfortunately, too few dxers realized the possibilities of F2 reception and made no attempt to go out of their way to receive the numerous TV transmissions which bridged the Atlantic from England, France, Italy, Denmark, Russia and Germany.

To those who did bother with the circuit modifications, antenna installations and a study of what makes F2 tick, the results were by far the most noteworthy dx loggings reported in many seasons.

Foremost among the F2 dxers is Gordon Simkin of Loma Linda, Calif. Dxer Simkin has been most helpful to aspiring F2 dxers, offering information on receiver modifications, antennas and when and where to look for signals. On the opposite side of the continent, Ronald Boyd of Truro, Nova Scotia, Canada, has reported in detail his luck with English, French and Danish TV transmissions.

It remained for Stanley J. Penc, of Utica, N. Y., however, to provide us with a set of what we consider good to excellent photographs of F2 TV reception, as seen on *this* side of the Atlantic. Stan Penc has been dxing for several years in Utica, with a total of 124 stations in 30 states, Puerto Rico, Mexico, Cuba and Canada and now, thanks to F2, England, France and Germany.

Stan's setup is typical of the *Simkin modifications* found in use throughout the country. The heart of his system is a Heathkit FM-3A tuner feeding a Setchell-Carlson receiver. Many modifications (in fact a whole rebuilding job) were performed on the FM-3A, and will not be discussed at this time.

A conical antenna with a 45-mc center frequency (European TV operation begins at 41.25 mc), mounted with a conventional rotator some 30 feet above ground, is used. It is vertically polarized to match BBC TV transmissions in this frequency range. For the 48–54-mc range, a 6-meter amateur antenna is used. It covers BBC channel 2 and other dx stations in this range.

For detailed data on picking up European TV dx see "Looking in on London," RADIO-ELECTRONICS, September, 1958, page 52.

Unusual but true

The longest distance covered on a regular basis on the TV channels? 200 miles? Perhaps 300? In which case you guess it to be from a mountain-top receiving site? Try 700–1,000 miles for size. That's right . . . 700–1,000 miles!

Alberto A. Garcia of Merida, Yucatan State, Mexico, reports: "We have been doing some dxing of American stations for some time—usually we can get Texas or Louisiana stations. . . ." He continues, "We have been able to dx to the highest perfection with certain regularity KTBS-TV (3), Shreveport, La., and KTBC-TV (7), Austin; KRIS-TV (6) and KSIX-TV (10) Corpus Christi; KPRC-TV (2), Houston and WOAI-TV (4) San Antonio, Tex., and sometimes we get KTHV (11), Little Rock, Ark."

Not to be overlooked is the excellent over-water path which these signals follow along the western Gulf Coast, over most of the distance.

Also of dxer interest is a report from Joh. Richter of San Salvador, El Salvador, Central America. He reports that KPRC-TV (2), Houston, was received with good E-skip signals during the early evening of July 20, and many unidentified stations were seen on the evening of July 19. However, of particular note is San Salvador's channel 6 transmitter, a worthwhile shot for Southern dxers in the states.

Two unusual trops hauls

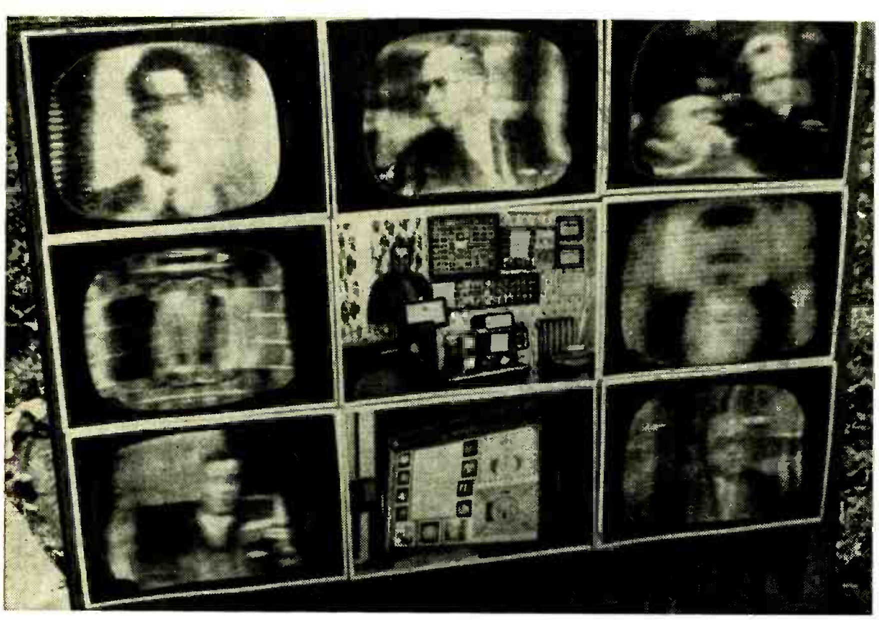
June 28–30 was generally a period of excellent ground-wave conditions throughout the Midwest and the mid-South Gulf states. Hundreds of loggings in the 300–500-mile range have been reported, and two noteworthy hauls of greater distances have turned up. Of particular interest, however, is the lack of reports for uhf loggings in excess of 250 miles during this time.

A new reporting station to this column is that of Mr. and Mrs. W. L. Bush of Mexico, Mo. They found the low and high bands (2–6, 7–13, respectively) loaded with stations in the 300–500-mile range when they flipped on the receiver at 0730 EST June 30. At 0735 WGR-TV (2), Buffalo, N. Y., overrode the channel 2 pileup long enough to be identified, a nice low-band ground-wave haul of 745 miles. Also seen were WWJ-TV (4), Detroit, and WOOD-TV (8), Grand Rapids, Mich.

Bill Eckberg of Walnut, Ill., also found June 28–30 profitable, although dx was not nearly as widespread at his location. At 2130 on the 28th, Bill intercepted 2 hours of reception from KGUL-TV (11), Galveston, Tex., 918 miles south of his location. Not a record, but a very nice logging.

FM dx

Our first FM dx report from Canada highlights the FM department this month. Lawrence G. Molish of Winnepeg, Manitoba, noted FM dx from KRLD-FM (92.5 mc) and KRR-FM (101.1 mc), both in Dallas, Tex., in the morning hours of July 6. Also heard were many unidentified FM stations between 88 and 102 mc. It is interesting to note that the only TV dx observed during this period came from KMID-TV (2), Midland, Tex., and KNAC-TV (5), Fort Smith, Ark. The receiving



F2 television is very ghosty at best. Even against this problem, dxer Stanley J. Penc of Utica, N. Y., has surrounded himself and his equipment with several good photos of these elusive BBC transmissions. The center photo is of Penc himself.

antenna is a simple pair of rabbit ears, with a Mallory FM tuner feeding a Crosley TV receiver.

Dx predictions

In the past months, impressions received indicate that the predictions portion of this column may not be of too great value. If this is true we would like to know, so we can make the best use of the available space.

The month of November is normally very poor for Es work. Any E skip which does occur appears in the early evening hours, generally in southern latitudes.

Watch the lowest channels (2–4) for signs of *venetian blinds* (see "Tips from a Tv-Dxer's Notebook," RADIO-ELECTRONICS, November, 1957, page 58) in a direction not normally occupied by local and fringe-area stations.

Auroral Es occurs for the most part along the border area of the United States and Canada, on east–west paths. Dxers throughout the northern United States and southern Canada should be aware of any garbled-fading signals on channels 2–6 during the early evening hours (1700–2000 local standard time) and late evening (2200–2400 LST). This is especially true when visible Auroral Borealis displays appear in the northern skies.

Beginning as early as 0700 LST some days and continuing as late as 1500 LST on peak afternoons, British, French, and German TV broadcasts should be received via F2 with good strength throughout November and the first two weeks of December in most every sector of North America. Possible reception of Russian, Italian, Swedish and Swiss TV stations should not be overlooked either.

Last call for totals

All dxers are urged to send their complete station totals to the TV Dx Column before Nov. 1, 1958. Be sure to include the total number of stations you have logged (including local stations), the greatest distance logged on each of the three bands (2–6, 7–13, uhf) and the number of uhf stations to your credit. All listings totaling 50 or more stations will find their way into the annual Tv dx review listing of the Over 50 TV Dx Club. Even if you report to the column on a regular basis, a last-minute postcard with the totals information will insure that your listing is accurate and up to date in the January, 1959, TV Dx column.

Report forms

As for the past 14 TV dx columns, RADIO-ELECTRONICS offers dxers a set of blank TV dx forms, to be used when reporting TV dx to this column. The forms are free and make convenient logging forms. Send a postcard with your name, address and the phrase "TV Dx Forms" to TV Dx Column, RADIO-ELECTRONICS Magazine, 154 West 14th St., New York 11, N. Y. (PS—they are excellent FM logging forms.) END

TV Service Clinic

conducted by
ROBERT G. MIDDLETON
TELEVISION CONSULTANT

INTEREST in dc restorer circuits continues, judging by our incoming mail. Hence, we are pointing out some further principles of this unique circuit.

Although a dc restorer boosts the low video frequencies, it must not be confused with a bass-boost type of circuit. It is entirely different, being a nonlinear device, with *clamping* action on the sync tips. A bass-boost circuit, on the other hand, is a linear configuration without clamping action. *It will not work as a dc restorer.*

The function of the dc restorer in reproducing true backgrounds has been previously noted and is illustrated in Fig. 1. It keeps the correct background level by clamping the sync tips at CRT cutoff, as shown in Fig. 2.

A complete circuit diagram for an efficient dc restorer is in Fig. 3. It can easily be added to an ac-coupled video amplifier lacking dc restoration.

This circuit is for a grid-driven picture tube. If cathode-driven, reverse the diode.

It is sometimes supposed that a cathode-driven picture tube does not require dc restoration. This is not true. Whether grid- or cathode-driven, the picture will not reproduce large gray areas correctly if ac-coupled without dc restoration.

If you do not wish to add a tube for dc restoration, use a 1N34-A crystal diode. The published ratings for the 1N34-A may make you look askance at this application, but these are dc ratings. They can be exceeded by a large percentage in pulse operation, with no damage to the diode. This is particularly true for the maximum peak inverse voltage rating.

It is advisable to select diodes for high back resistance in dc restorer circuits. A suitable diode will have at least 750,000 ohms back resistance at −10 volts, and at least 250,000 ohms back resistance at −50 volts.

Trouble with the agc

I am having trouble with a Raytheon 21T25. When the agc lead is disconnected from the tuner, the lug on the tuner has −1 volt present. Shouldn't it measure zero? The voltage on the agc line is −4 with a strong signal. A tunable buzz is present, particularly on a light picture. The peak-to-peak output from the picture detector is 4 volts, instead of 2 volts. Please advise how to locate the trouble.—G. G. M., Troy, W. Va.

The −1 volt that you measure (see Fig. 4) is called contact potential. A floating grid will normally measure

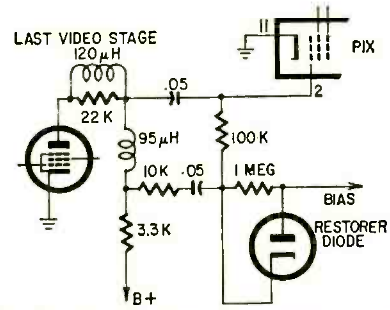


Fig. 3—An efficient dc restorer circuit, working from a grid-driven CRT.

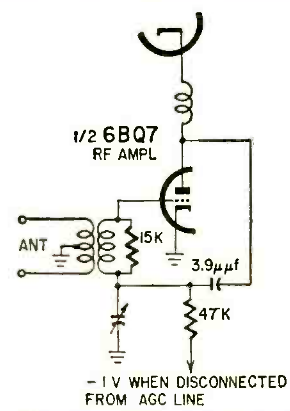


Fig. 4—Floating grid shows contact potential of −1 volt (on vtvm).

about −1 volt on a vtvm. Measuring 4 volts peak-to-peak at the picture-detector output indicates if overload and low agc bias. It is difficult to say exactly how much bias should be found, without knowing the actual signal strength. Try using override bias to see if normal reception results. This will verify suspicion of agc trouble. This receiver passes the intercarrier sound signal through the video amplifier. Hence, overload in the video amplifier could also cause buzz. A leaky coupling capacitor or low supply voltage to the video amplifier tube could be responsible. Also check the setting of the buzz control in the FM detector circuit.

Vertical foldover

A Brunswick receiver has a bad foldover at the bottom of the picture. Width and height are good, and vertical hold is very tight. Tubes have been replaced, and all capacitors and resistors in the output section, along with yoke and oscillator transformer. All voltages are within limits except the plate of the 6S4, which is low. Any informa-

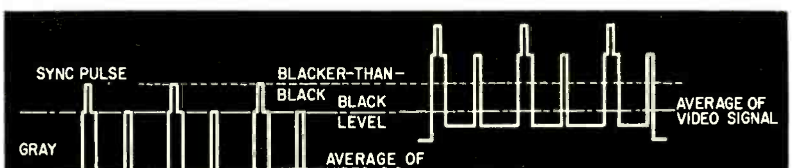


Fig. 1—Lack of dc restoration causes the video signal to operate at a false black level.

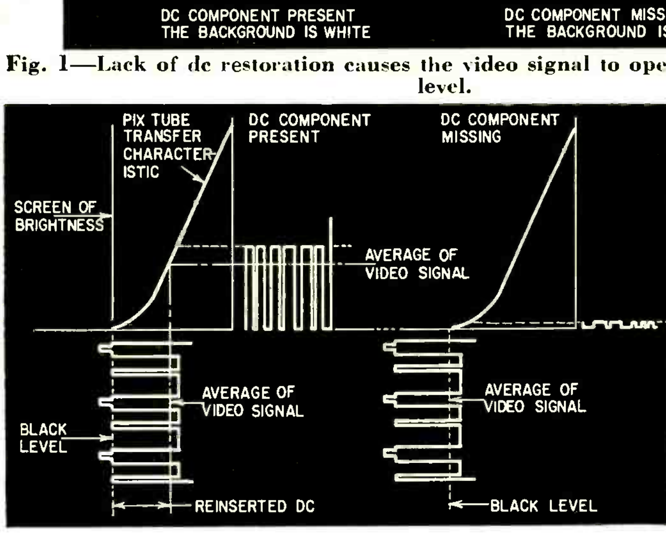


Fig. 2 — When sync tips are clamped to the CRT cutoff level, black, white and grays are correctly reproduced.

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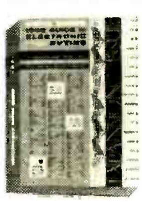

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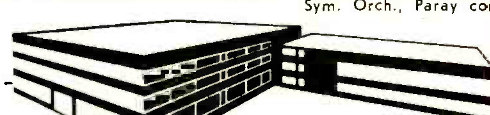

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tion will be greatly appreciated.—A. W. B., Brooklyn, N. Y.

The immediate clue here is the low plate voltage, which is a frequent culprit in foldover symptoms. Run down the cause of the low plate voltage, and I am certain that the foldover will disappear.

Dc restoration?

Has it been your experience that improvement results from adding dc restoration to circuits supposed to operate without it? Usually, a cathode-driven picture tube works well without dc restoration.—J. A. S., Philadelphia, Pa.

When a receiver uses ac-coupled video amplification, dc restoration is needed for best picture quality, whether the picture tube is grid-driven or cathode-driven. Dc restorers were used on all early TV receivers. Cost-cutting resulted in elimination of the dc restorer, because the public is not too critical of incorrect background reproduction. Nowadays, the design factors for dc-coupled video amplifiers are well known and have been rather widely adopted. Dc-coupled video amplifiers do not require dc restoration.

Co-channel interference

I would appreciate advice on co-channel interference. Most summer nights reception is bad, without a clear channel on the dial. The antennas are beamed at New York City, 70 miles away. Co-channel interference comes from all points on the map. Would a highly directional antenna help, or would an attenuator be better?—J. A. McD., Bellaire, N. Y.

This is basically an antenna problem. You need more directivity to minimize co-channel interference. You will need to stack several Yagi antennas, cut to channel. The antennas will have to be stacked in the vertical or horizontal plane, or tilted, as required by your field characteristics. Attenuators will not help.

Slow warmup

A G-E 21T30 does not come up to full brightness and contrast for at least 15 minutes after it is turned on. Where is the trouble likely to be?—B. J. O., Chicago, Ill.

Your report does not state whether you have tried a new picture tube. This is the most likely cause of the slow warmup. It would also be advisable to measure the heater voltage at the picture-tube socket and see if it is low. Also, make a test with a high-voltage dc probe and voltmeter to see how the high voltage comes up.

Intermittent pix and sound

A Motorola TS-119-B was brought to the bench with a complaint of intermittent picture and sound. At the bench there was only a raster. The 6AH6 video amplifier, 12AU7 video detector/first sound if, and 6CB6 first picture if tubes were shorted. I replaced the tubes, but picture and sound were still absent. Then, when the 12AU7

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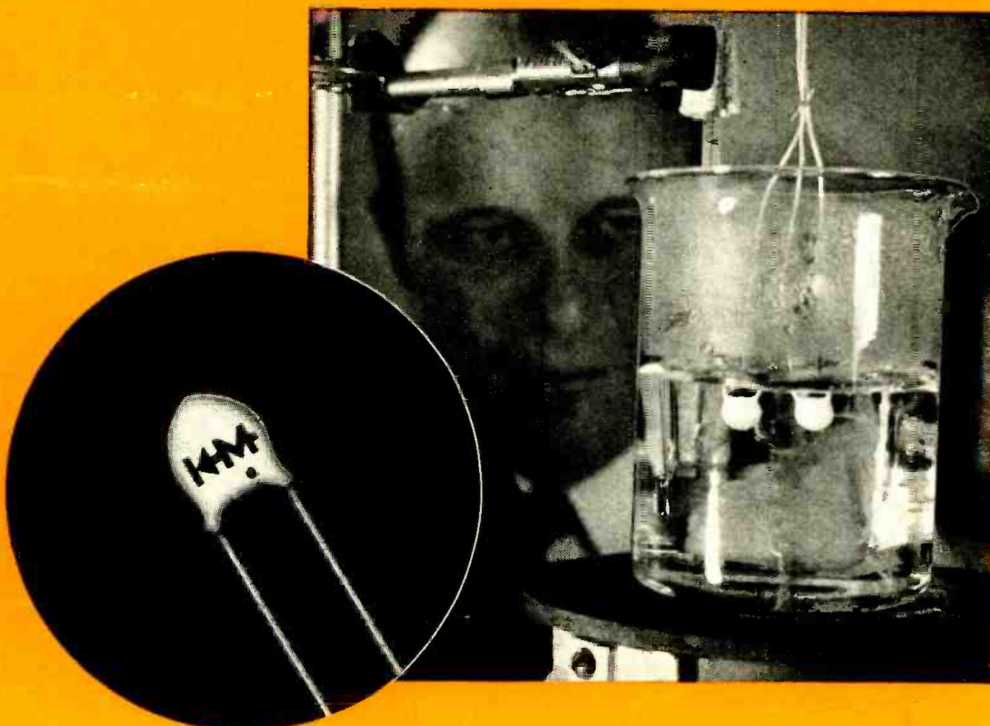

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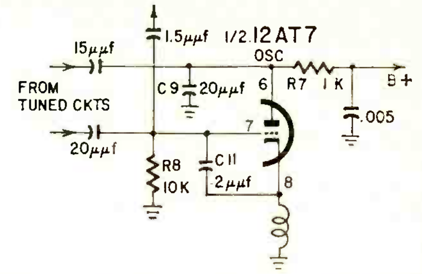


Fig. 5—12AU7 oscillates, but 12AT7 for which the circuit is intended doesn't.

was switched with the 12AT7 mixer, the chassis operated OK. What is the explanation?—W. L. H., Washington, D. C.

The 12AU7 and 12AT7 are similar, but the 12AU7 has about half the g_m of the 12AT7, and also operates with a different grid bias. The basic trouble, of course, is that the oscillator-mixer operates with the 12AU7, but not with the 12AT7. You might try some other 12AT7 tubes in the mixer to see if this helps. If not, there is trouble in the oscillator circuit. Check the plate voltage and R7 (see Fig. 5), and also R8, C9 and C11, if necessary.

Which flyback

What horizontal output transformer do you recommend for a 21EP4-B picture tube in an RCA 630-TS chassis?—H. E. A., Romulus, Mich.

The Merit HV07 transformer for 90° tubes will work well with the 21EP4-B. To get good linearity and full scan you will also require a 90° yoke. The present vertical output transformer will not be entirely satisfactory, and a heavier transformer should be used.

Correction

There is an error in the September TV clinic, page 59. The item, Big Screen to Bigger Screen, states that the 21AMP4-A is a 70° tube. Actually it is a 90° tube and therefore the mentioned conversion can be made without any need for circuit changes. Our thanks to Peter A. Keller of Alamogordo, N. M., for spotting the error.

Short tube life

I have a Westinghouse chassis that has a starting surge causing the 12B4 vertical output tube to light up much too brightly. The plate voltage at first is 290 volts, and in 5 seconds goes down to normal. Tube life is only about 3 weeks. What do you suggest?—H. C., Winter Haven, Fla.

This type of problem can be corrected easily by using a Surgistor in series with the power cord to the receiver. A Surgistor has 100 ohms of resistance for the first 10 seconds after the receiver is switched on, and prevents a heavy starting surge. At the end of 10 seconds, a bi-metal strip shorts out the resistor, and applies full line voltage to the receiver. END

TECHNICIANS' NEWS

NATESA CONVENTION

Warranty policies of some TV–radio–hi-fi manufacturers were unanimously condemned for "curtailing competition" in the service industry by more than 600 delegates representing 112 technicians' associations at the annual convention of the National Alliance of Television Electronic Service Associations (NATESA) in Chicago. A resolution attacked set makers "who have seen fit through their combination parts-and-service warranties to set a precedent in the establishment of fees for service."

At the recommendation of a special NATESA committee, the convention delegates decided to postpone any action on the issue of labeling new and rebuilt picture tubes.

Two new "Friends of Service Management" plaques were presented to the Merit Coil & Transformer Corp. and Tung-Sol Electric, Inc. Voted "Continuing Friends of Service Management" were CBS-Hytron, Raytheon, Sylvania and Howard W. Sams & Co. A special citation was awarded to station WWL-TV, New Orleans, for cooperating with Louisiana service associations in promoting a state-wide licensing law.

Vincent Lutz, of Lutz TV, St. Louis, was elected NATESA president, succeeding Russ Harmon, Weber TV, Cincinnati. Re-elected were secretary Mac Metoyer, A One TV, Kansas City, and treasurer Nelson Burns, Burns TV, Memphis.

The following were elected regional officers: Bert Bregenzer, Penn TV Service, Pittsburgh, Pa., eastern vice president; Irving Toner, Toner Radio & TV, Buffalo, N. Y., eastern secretary; Cordell Britt, May TV, Nashville, Tenn., east central vice president; Albert Mirus, Mirus TV, Cincinnati, Ohio, east central secretary; Wayne Lemons, A One TV, Buffalo, Mo., west central vice president; W. E. Johnson, Johnson Radio–TV, Beaumont, Tex., west central secretary; Winston Haines, E & H TV Co., Burlingame, Calif., western vice president; O. W. Andrews, Rocky Mountain Radio–TV, Denver, secretary.

Frank Moch was re-elected for a 2-year term as executive director, without opposition. The delegates selected Nashville as the site for the spring 1959 convention.

The Association Activities Forum was devoted principally to a series of questions posed by Frank Tesky of the Indianapolis Television Technicians Association (ITTA) and editor of the *Hoosier Test Probe* concerning the operations and finances of NATESA,

of which ITTA is not a member. Mr. Tesky indicated that all questions had been answered to his satisfaction.

KESCO MEET

Thirty-three papers on technical and business subjects were read and exhibits of 23 manufacturers, distributors, broadcast stations and electronic organizations were on view at the Keystone Electronic Service Conference and Exhibition held in Pittsburgh Sept. 10–13. Technical subjects accounted for 24 of the papers; 9 were on business management and practices.

Among the outstanding addresses was that of Dr. Ellsworth D. Cook, of General Electric, who discussed "The Economic and Technical Aspects of Industrial Electronics." Six others papers dealt with industrial electronics, the leading subject at two of the convention sessions.

The meetings were held in Carnegie Hall, and more than one visitor alternated between the electronic exhibits and those in the Carnegie Museum. The meeting terminated in a banquet in the Webster Hall Hotel, attended by 150 people. Total registrations at the meeting exceeded 450.

FIRST STATE LICENSE LAW

Louisiana became the first state to have a TV–radio technician licensing law when its State Legislature passed a watered-down version of a bill which was backed by most of the state's organized technicians. Amendments added to the bill on the House floor limited the licensing to cities of 20,000 population or more and gave three seats on the state licensing board to the International Brotherhood of Electrical Workers.

As finally passed, the law will apply to technicians in seven cities and provides that technicians must take an examination and be licensed by the State Radio & Television Technicians Board. Besides three union representatives, it will have eight members representing the servicing industry.

APPRENTICE PLAN STUDIED

To help assure a steady supply of competent trained service technicians and a standardized pay scale, the Radio–Television Association of Santa Clara Valley (RTASCV) has taken the first steps toward institution of an apprenticeship program.

President Richard J. Kelso named Al Limberatos to head an apprenticeship study committee to meet with state officials on the issue. Charles R. Mulkey, RTASCV educational advisor and electronics coordinator of the San Jose Unified School District, is adviser to the committee.

The apprenticeship program would be a form of on-the-job training involving up to 40 hours a week of practical paid shop work coupled with school training. Employers would pay a standard wage to apprentices for their work in the shop, but not for school time. According to Mulkey, the program would funnel more trained men into the TV–radio service industry, and, because minimum wages would be standardized for apprentices and journeymen, it would tend to "stabilize the industry locally by setting up a pay scale that reflects local conditions."

WAR DECLARED ON GYPS

Acting swiftly following front-page stories on "TV repair cheats" in the *Los Angeles Mirror News* (RADIO-ELECTRONICS, September, 1958, page 126), the Los Angeles County Television Servicemen's Association launched a drive "to police out of existence those who reflect on the integrity of the entire industry by fleecing the public."

The first step in the campaign was a mass meeting attended by more than 250 independent technicians to draft a code of ethics which binds association members to "perform only work that needs to be done, to sell only quality parts and to collect only a fair charge for their labor."

The meeting was addressed by William Snelling of the Better Business Bureau.

The *Mirror-News* series stirred up plenty of controversy among technicians. A letter to the editor by Howard Bogue, secretary of the Board of Delegates of the California State Electronics Association (CSEA), praised the newspaper for stressing that the vast majority of technicians are ethical, while at least one other letter accused the paper of maligning technicians for the sake of sensationalism.

GLADU HEADS R.I. GROUP

The newly elected officers of the Electronic Dealers of Rhode Island are: Norman F. Gladu, East Providence, president; Donald DiBiaso, Providence, vice president; Len Erickson, East Providence, secretary; Ray Cohen, Providence, corresponding secretary and Ben Lauretti, Lonsdale, treasurer.

TSA'S HOSPITAL PROJECT

A community service that paid off in goodwill and personal satisfaction will be repeated as a continuing project by the Television Service Association (TSA) of Detroit. Technicians from 10 member organizations repaired all inoperative TV sets at the Veterans Memorial Hospital without charge. The entire job was accomplished in about 2 hours.

TSA received a special commendation from the hospital administration, and, as noted in *TSA News*, "after going through the corridors and various wards, the men agreed that the satisfaction derived was far greater than the small amount of time expended and that they would be happy to volunteer again."

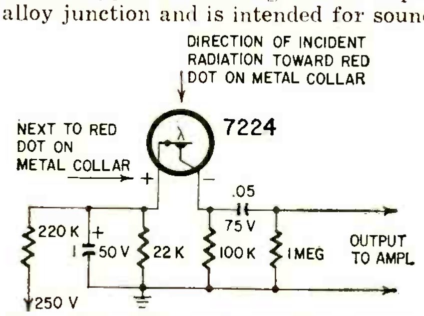
Hearing of the project, Tung-Sol Electric Co. offered to furnish all circuit and picture tubes needed at the hospital. END

NEW TUBES and SEMI-CONDUCTORS

FEATURED this month is a tiny photojunction cell, about the size of a pencil eraser. A line of 50-amp Zener diodes, two medium-power transistors and a high-frequency alloy-junction silicon transistor round out the month's releases.

7224

Less than a ½ inch high (excluding leads), this photojunction cell is of the side-on type. It uses a germanium p-n alloy junction and is intended for sound



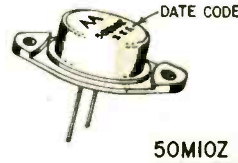
pickup from film and computer applications. Signal output is approximately proportional to the intensity of the incident radiation. The diagram shows a typical circuit using this unit.

Other design features include an illumination sensitivity of 0.7 μa per foot-candle and a power-dissipation capability of .030 watt. Spectral response of the 7224 covers the range from about 3,500 to nearly 19,000 angstroms. Maximum response is at about 15,000 angstroms. Therefore, it has high sensitivity to red and infra-red radiation as well as good response over the visible portion of the spectrum. The 7224 photojunction cell is made by RCA.

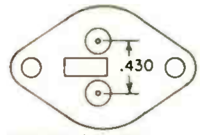
50M10Z–50M200Z

These 50-watt Zener diodes have a voltage drop that is essentially independent of current and are designed for optimum performance over a wide range of conditions. The large power-handling capability and low Zener impedance of these units permit reducing circuit complexity of regulated power supplies, especially those using transistors.

Zener voltages range from 10–200 in 40 steps. The number after 50M tells you the Zener voltage of the particular Motorola unit. You have a choice of anode or cathode connected to the diode



50M10Z TO 50M200Z



RED DOT, CATHODE
BLACK DOT, ANODE
CONNECTED TO CASE

base. Both pins connect to the same end of the diode (cathode or anode). The suffix R indicates cathode to base. Maximum Zener current runs from 4.3 amps for the 50M10Z to 200 ma for the 50M200Z.

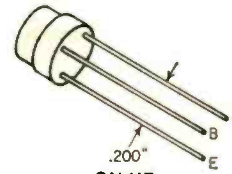
If these units are used with a socket, the unregulated line should feed into one pin through a suitable current-limiting resistor and the load should be connected to the other pin. This will break the circuit to the load when the unit is removed.

2N413

A p-n-p alloy junction transistor designed and tested for use in high-frequency amplifier applications up to 3 mc. The case has a welded hermetic seal and a standard basing design which facilitates automatic mounting with printed circuits.

Maximum ratings of this Tung-Sol transistor at 25°C are:

V_{CBO}	30
V_{EBO}	20
V_{CEO}	18
V_{CE} (V_{BE} = 0.1)	25
I_C (dc) (ma)	200
I_C (peak) (ma)	400



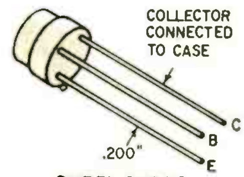
2N413

Design-center characteristics of the 2N413 are:

I_{CBO} (μa) 2 (V_{CB} = 6, I_E = 1 ma, f = 1 kc)
h_{ib} (ohms) 25 (V_{CB} = 6, I_E = 1 ma, f = 1 kc)
h_{fe} 30 (V_{CE} = 6)
f_{ab} (mc) 2.5 (V_{CB} = 6, I_E = 1 ma, f = 1 kc)
NF (db) 7 (V_{CE} = 6, f = 1.5 mc)
G_p (db) 10 (V_{CE} = 6, f = 1.5 mc)

2N551, 2N552

These two n-p-n silicon transistors are designed for medium-power switching and amplifying applications. These uses include output stages, servomotor



2N551, 2N552

control, dc-to-dc converters, solenoid operation and medium-power oscillators.

Maximum ratings of these Transistron units are:

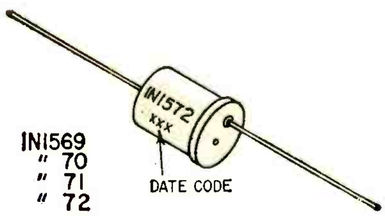
	2N551	2N552
V_{CE}	60	30
V_{CB}	60	30
V_{EB}	10	10
P_{total} (watts)		
at 100°C (case)	5	5
200°C (case)	0.5	0.5
100°C (amb)	0.6	0.6
200°C (amb)	.05	.05

Typical characteristics at 25°C are:

h_{FE} 30 (I_C =50 ma., V_{CE} =6)
h_{fe} 3 (V_{CB} =20, I_E =50 ma, f=1 mc)

1N1569, 1N1570, 1N1571, 1N1572

A group of lead-mounted, axial, diffused-junction silicon rectifiers. All units handle 1 amp average half-wave rectified forward current at 25°C. This drops to 0.5 amp at 100°C. Peak half-cycle forward surge current (60 cycles, 25°C ambient) is 70 amps and peak recurrent forward current is 10 amps, again for all units. The cathode is connected to the case.



1N1569
" 70
" 71
" 72

Voltage ratings of these Motorola rectifiers are:

	1N1569	-70	71	-72
Max continuous dc inverse	100	200	300	400
Max peak inverse	100	200	300	400
Max sine-wave rms input	71	141	212	283

Others

Power transistors capable of handling 65 watts and 15 amps were announced by Clevite Corp. Identified as CTP 1511, 1512, 1513 and 1514, all are germanium p-n-p types and are available with solder lugs for easy wiring.

Bell Telephone Labs has introduced a high-speed diffused silicon switching diode, the 1N696. It has a switching time of about 1 millimicrosecond. Diffusion techniques play a large part in making this possible.

SF (*S*emi-*F*lat) extra-short picture tubes have been released by Philco. They are the 17DAP4/SF17, a 17-inch rectangular tube which is 11 inches long, and the 21EAP4/SF21A, a 21-inch rectangular tube less than 13 inches long.

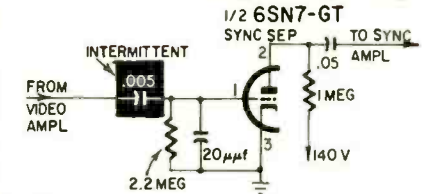
A Sensistor temperature probe was announced by Texas Instruments. This solid-state unit is made from a silicon crystal and has a positive temperature coefficient that results in a constant rate of change on the order of 0.7% per °C. END

Technotes

MOTOROLA TS-118A

Symptom: erratic sync.

Cause: the .005-μf coupling capacitor which feeds the composite sync signal to the sync separator tube opens intermittently. Obviously, the result is no sync whenever the capacitor opens. Replace with a molded 600-volt unit.—*J. R. Vought*



PIX TUBE OPENS

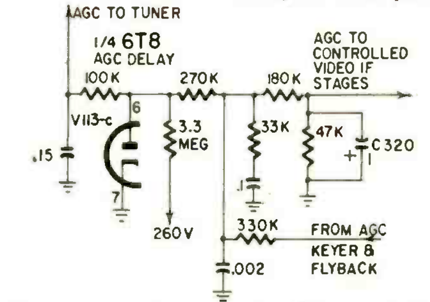
It's easy enough to check for a short or leakage on the grid or cathode of a picture tube, but opens are another story. Here's one way to check for them.

While the picture tube heater is hot, pull its socket off and put an ohmmeter across the cathode and grid (pins 2 and 11), with the positive probe to the grid. A fairly low resistance reading should result. If the prods are now reversed, the meter should read infinity. The cathode and grid are being used as a diode, through which a small conduction current will flow when the ohmmeter applies a small positive voltage to the "plate."—*R. C. Eldridge*

G-E 21T20

Complaint: intermittent horizontal jitter, occurring on strong stations and more pronounced in the evening.

Fault: loss of capacitance in agc filter C320, a 1-μf electrolytic with positive ground to chassis. Value of the defective unit had gone down to .02 μf.



How it happened: spurious modulation of the if signal in the first and second if stages by sync pulses on the agc line. C320 normally smooths these pulses.—*E. A. Chung*

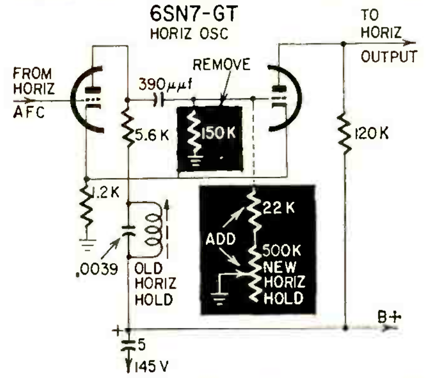
ZENITH 19Y22

The complaint was intermittent raster trouble with no high voltage. Visual inspection showed that the damper tube would sometimes turn red.

The trouble was traced to the horizontal section of the yoke, which was shorting intermittently to the width control, a brass sleeve mounted on the neck of the picture tube. Pulling the sleeve farther out from the yoke cured the trouble without affecting the width. —*G. P. Oberto*

MONTGOMERY-WARD MODEL GSE5010A

This set developed critical horizontal hold which could be alleviated slightly by tube substitution. The slug of the ringing coil is used as the horizontal-



hold control and the resistance in the multivibrator grid circuit is fixed.

As the partial schematic shows, the 150,000-ohm grid resistor was removed and a 500,000-ohm pot in series with a 22,000-ohm resistor installed in its place. Adjusting this pot provided the necessary range for the horizontal-hold control.—*Lucian Palmer*

DUMONT RA-112

Weak sound in these sets sometimes has a strange cause. A length of ribbon line is used as a small fixed capacitor (2.5 μμf) to couple the sound if to the video if. One wire of the line is connected to the sound if while the other is connected to the video if, thus forming the necessary capacitance.

Severe audio attenuation may result if this line is dressed too close to the chassis or the if transformer cans which are grounded to the chassis. For weak sound in these receivers check the lead dress before spending time examining the audio circuits. It could save you a lot of work.—*Alfred Roberts*

USE A FUSED PLUG

Whenever we get a job that calls for replacing the set's power transformer, we always make it a point to include a fused plug along with the chassis on delivery. A customer finds it hard to tolerate an unrelated breakdown in a set, but will never forgive a "looks like the same thing" breakdown.

We find it much simpler to fuse the line than to try to explain another transformer job or other major overhauling because some filter capacitor decides to pop or a 5U4 shorts out.—*Frank A. Salerno* END

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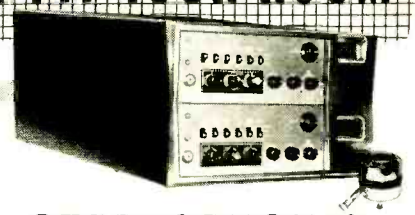

MONOPHONIC STEREOPHONIC

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FEATURING AAS*

The finest amplifiers are "linear" in the lab, but not in the living room! That's because room acoustics play the most important part in amplifier performance.

Now, for the first time, you can actually tailor the performance of a superb amplifier to suit the acoustics of your room! AAS* – the Acoustical Analyzer System – Precise Development's exclusive new feature accomplishes this amazing feat. And AAS* is found only in the great, new **ORPHEON** amplifier. Using an Acoustical Analyzer Probe, you can actually adjust the low and high frequencies separately to match the mid-range tones, and provide perfect linearity to match the acoustics of your own living room! And once the adjustment is set, the **ORPHEON** remains in balance unless there are major changes of furniture or drapes in the room.

To match the musical tastes of everyone, Precise Developments Inc. provides two versions of the great new **ORPHEON** – one Monophonic, and the other Stereophonic. The **MONOPHONIC ORPHEON** offers 40 watts of undistorted listening pleasure plus every important feature you'd expect to find in a luxury-class amplifier. The **STEREOPHONIC ORPHEON** provides the greatest flexibility ever offered an audiophile. It comprises two systems in a single chassis – each one identical with the monophonic version described above. They may be used together to reproduce brilliant, clean, linear stereophonic sound, or may be used separately to serve two separate areas monophonically with different music . . . or they may be used together as an elaborate mixer for recording.

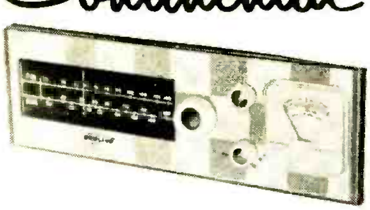
Before you buy stereo, be sure to hear this great new amplifier concept. It's a revelation of the ultimate in high fidelity engineering!

. . . Just Look At These Amazing Features . . .

- 40 watts monophonic output (peak 80 watts)
- 80 watts stereo output (peak 160 watts)
- Inputs for radio, TV, tape, microphone and magnetic or crystal phono on each system segment
- Tape and monitor outputs on each system segment
- Calibrated Microphonic Acoustical Probe for AAS*, can also be used as public address microphone or for tape recording
- 24 positions of equalization for each system segment
- DC on input filaments
- At least 18 db of bass and treble boost attenuation plus additional 20 db with AAS*
- Volume and Loudness controls on each system segment; 5 mv full output
- Rumble filter
- Muting filter
- Output meter reads power output in watts or tape output in volts on each system segment. It is also a Sound-level Meter with AAS*
- Separate tape output level potentiometer on each system segment
- Cathode-follower tape output on each system segment
- Internal grid bias hum control (–80 db for radio, –60 db for phono)

Model STAM80A—40 watt stereo system (160 watt peak, monophonic), with AAS*—factory-wired, complete $289.50
Model STAM40A—20-watt stereo system (80 watt peak, monophonic), with AAS*—factory-wired, complete $249.50
Model ST40—20-watt stereo system (80 watt peak, monaural), without AAS* and Acoustical Probe, factory-wired, complete $189.50
Model AM40A—Monophonic, 40 watts (80 watt peak), with AAS*—factory-wired complete $169.50
*PATENT APPLIED FOR

THE Continental



A superb AM and FM tuner providing matched performance and great beauty. Coupled with variable automatic frequency control and metered output, it brings in the weakest stations and provides razor-sharp selectivity. Rich gold-and-silver trim. Hear the Continental . . . discover how inexpensively you can own one of the finest tuners made today.

FM – 88 to 108 MC; AM – 500 to 1600 KC. Output tuning meter; cathode-follower output; convenience outlet; phono, FM, AM, TV switch and inputs; Foster-Seeley discriminator; flywheel tuning; 2 limiters; Ferri-loop; 3-gang variable condenser; logging scale. 13" x 4¼" x 9¾". Cage at additional cost.

Model TUMK, Kit $49.95
Model TUMW, Factory-wired $69.95

THE Mozart

A superb 40-watt amplifier which supports a symphony orchestra with live, crisp, brilliant, distortion-free reproduction.

24 positions of equalization; DC on input tube filaments; Volume or Loudness Control; 5 mv full output; rumble filter; muting switch; convenience outlet; output meter reads power output in watts, tape output in volts; separate and independent tape output level potentiometer; cathode-follower tape output; internal grid bias, grid balance and hum balancing controls (–80 db for radio, –60 db for phono); output selector for different impedance speakers; A-AB-B speaker selector; special patent-pending output transformer; silver-plated, etched-front panel; 10 tubes; fused supply. 13" x 4¼" x 12".

Model AMK, Kit $69.95
Model AMW, Factory-wired $89.95

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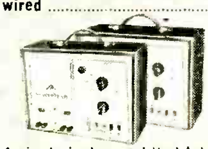
. . . that's the opinion of leading electronic engineers, radio service people and amateur radio enthusiasts. And Precise has achieved this reputation, too, because of its efforts to bring you the best possible equipment at the lowest possible prices. You can depend on Precise for quality – based upon ingenuity, originality, and production "know-how."

Mutual Conductance and Emission

TUBE TESTER

Here is a tester that actually checks a tube for its application, not whether it is just good or bad. GM and emission are checked separately. It is the first and only device that measures 600-mil tubes on a meter. Sweeps from 0 through the normal testing range when making measurements to give an average evaluation of the tube over an extended range of operation. Selected for use by the United States Department of Standards.

MODEL 111K, Kit, $79.95; MODEL 111W, Factory-wired $139.95



Precise Development's

POWER-LAB

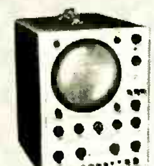
A single instrument that takes the place of eleven pieces of equipment. Operates as A BATTERY ELIMINATOR, BATTERY CHARGER, HIGH CURRENT (20-AMP.) LINE VOLTAGE VARIAC, AC LINE VOLTAGE METER, AC LINE AMMETER, AC LINE WATTMETER, AC LINE ISOLATION TRANSFORMER, LOW-VOLTAGE HIGH-CURRENT AC SUPPLY, DC LINE VOLTAGE VARIABLE SUPPLY, DC HIGH CURRENT AMMETER, AGC BIAS BOX. Large, professional meter – it's fantastic – and what a value! With 100 watts of isolation: MODEL 711, kit, **$49.95;** MODEL 711W, Factory-wired, **$64.95.** With 300 watts of isolation: MODEL 713K, Kit, **$62.95;** MODEL 713W, Factory-wired **$79.95**

Printed-Circuit, Voltage-Regulated, Peak-to-Peak

VTVM

With Tilting Meter Movement and Magic Lead Switch.

Here's another all-new Precise-engineered instrument, designed with you in mind . . . to make it easier and more convenient as you test. All-new features include voltage regulation, printed circuitry, etched front panel **PLUS** the exclusive Meter Movement Tilt that permits you to turn the meter to face eye-level, no matter where you place the instrument on the bench . . . **AND** the Magic Lead Switch that permits you to short and open leads automatically for zero or infinite adjust without removing the leads from the circuit under test! **MODEL 904K, Kit, $34.95; MODEL 904W, Factory-wired, $49.95**



Precise Development's

COLOR TV OSCILLOSCOPE

No other oscilloscope at any price, high or low, offers so many desired features! Providing a big 7-inch tube, this fabulous instrument is designed to help you solve any color TV problem. It contains low-loss components and has an over-designed fused power supply for additional circuitry. You'll find such special features as a Sweep Magnifier, Triggered Sweep Sync Amplifier, Differential Inputs, Gated and Saw-tooth Outputs, etc. This amazing new scope is the result of over 12,000 hours of engineering. It shows more, tells more and gives more than all other commercial scopes. MODEL 300K, Kit, **$99.95!** MODEL 300W, Factory-wired **$199.50**

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On the Market

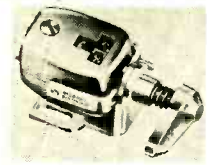
RECORDER-HEAD CLEANER, *Kleen-Tape.* Specially impregnated fabric tape on standard recorder reel cleans heads in 2 minutes without tools. When

"played," it dissolves and removes oxide accumulation and picks up dust and other foreign materials. Reusable. — **Walsco Electronics Manufacturing Co.,** 100 W. Green St., Rockford, Ill.

STEREO CONVERSION KITS. *Model CK-2,* complete record-changer replacement, including stereo cartridge with diamond/sapphire styli. *Model SA-2,* speaker-amplifier unit in mahogany-grained table cabinet. *Model SH-3,* amplifier and 3-speaker sound system in console cabinet. *Model SK-2,* modification parts kit including stereo cartridge with diamond/sapphire styli. *Model AK-1,* ac-dc dual-channel amplifier.—**RCA Victor Radio & "Victrola" Div.,** Camden, N.J.

STEREO TAPE DECK, *Telectro series 900.* Records and plays back stereo with 4-track head which accommodates both 2- and 4-channel stereo tapes and 2-track monaural tapes. Pushbutton controls. 3 speeds. Separate record and playback heads for simultaneous monitoring. Flutter and wow less than 0.25%. Signal-to-noise ratio better than 50 db. Response 40–15,000 cycles at 7½ ips, 40–12,000 at 3¾, 40–6,000 at 1⅞. May be mounted vertically or horizontally. Matching record and playback preamps available. — **Telectrosonic Corp.,** 35-18 37 St., Long Island City, N. Y.

STEREO CARTRIDGE, *series RG745.* Magnetic turnover type.



RG745-1SD has 0.7-mil stereo-LP diamond and 1-mil sapphire LP "standby" monophonic stylus. *RG745-3SD* has 0.7-mil diamond and 3-mil sapphire.—**Recoton Corp.,** 52-35 Barnett Ave., Long Island City 4, N. Y.

TURNTABLE KIT, *Model K-33.* 33⅓-rpm crown spindle belt drive; custom-made endless woven fabric belt. Noise level 47

db below average recording level. 4-pole induction motor. Built-in strobe. Assembly time about 30 minutes.—**Rek-O-Kut Co.,** 38-19 108 St., Corona 68, N. Y.

TRANSCRIPTION TURNTABLE, *Collaro model 4TR200.* Weighs 8½ lb for flywheel effect.

Heavy-duty 4-pole motor; rotor dynamically balanced to zero. Motor mounted on 3 tension springs. Shaft in self-lubricating bearing with steel ball pressed into lower end to take total thrust of turntable. 4-speed. Also new stereo manual player *model TP59* and 3 stereo changers *TSC-640, TSC-740* and *TSC-840.* — **Rockbar Corp.,** 650 Halstead Ave., Mamaroneck, N. Y.

STEREO COMPONENTS, *Premiere* series. Pedestal styling in

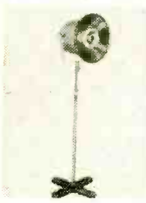
gold and white, leatherette cases. New models include *40PG* stereo amplifier, *209* stereo preamp, *240* basic stereo amplifier, *103GT* AM-FM tuner, *120 GAT* tuner-amplifier.—**Grommes,** Div. of Precision Electronics Inc., 9101 King St., Franklin Park, Ill.

HI-FI CHANGER KIT, *Heathkit RP-3.* Flutter and wow less than 0.18% rms. Turntable

pauses during change cycle; change mechanism disengages during play. Stylus pressure constant within 0.9 gram between first and last record.

Automatic speed selector permits intermixing 33⅓- and 45-rpm records. R-C filter prevents pop when turned off; muting switch eliminates noise during change. Supplied with *GE VR-II* cartridge, diamond LP and sapphire 78 styli.—**Heath Co.**, Benton Harbor, Mich.

LOUDSPEAKER STAND, *model SS-4.* Telescoping support, for



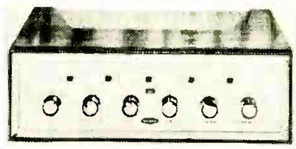
use with all medium-weight speakers, designed for rental installation. Cast-iron base, full chrome upright. Top adapter permits quick removal of speaker.—**Atlas Sound Corp.**, 1451 39 St., Brooklyn 18, N. Y.

COMMUNICATIONS MICROPHONE, *"Ten-Four."* Extremely rugged. Encased in synthetic resin. Weighs 8½ oz., half as much as die-cast microphone. Won't chip or scratch. No shock hazard. Retains impact strength from −40° to 165°F.—**Shure Brothers, Inc.**, 222 Hartley Ave., Evanston, Ill.

STEREO TUNER, *Masterflex model 28.* Flywheel tuning. Multiplex adapter tap. AM sensitivity 100 μv, delayed agc,

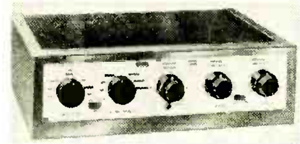
broadband tuning. FM sensitivity 2 μv, afc plus agc; transformer isolation; de-emphasis network; cascode rf stage, 4 if stages; cathode-follower takeoff.—**Tech-Master**, 75 Front St., Brooklyn 1, N.Y.

HI-FI AMPLIFIER, *model 209.* Power 36 watts. Response 19–35,000 cycles ±0.5 db. Peak power rating 72 watts. Harmonic distortion less than 0.5% at full



power output. Includes preamp, with provision for operation of 2 amplifiers in tandem using *Stereodapter.* Acoustic level control permits proper operation of loudness control regardless of type of speaker system. Tape recorder facilities for record and playback.—**H. H. Scott Inc.**, 111 Powdermill Rd., Maynard, Mass.

STEREO PREAMP, *Eico model HF 85.* Kit or wired. Separate



low- and high-level inputs for each channel, including FM multiplex. Independent level, bass and treble controls in each channel may be operated together with built-in clutch. Function selector. Response ±0.3 db 5–200,000 cycles. Sensitivity (input for 2 volts rms output at 1 kc) magnetic phono and microphone 1 mv, tape head 0.5 mv, high-level 0.17 volt. IM distortion maximum 0.17% at 5 volts rms output.—**Electronic Instrument Co.**, 33-00 Northern Blvd., Long Island City 1, N. Y.

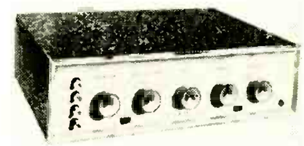
STEREO PREAMP KIT, *KT-600.* Dual (input-output) bridge control for balancing channels by audible "null." Third-channel output for middle amplifier-speaker. Tape head equalization for 3¾- and 7½-ips half-track tapes. Clutch type master gain control. Separate turnover and rolloff controls provide 24 positions of equalization on each channel. Response 10–25,000 cycles ±0.5 db. IM distortion less

than .03% at 2.5 volts output, less than 0.1% at 5 volts; harmonic less than 0.1% at 5 volts.—**Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N. Y.

STEREO PREAMP, *model SP-210.* Ganged controls. Dc heater supply to all tubes. 12 inputs, 6 on each channel. Outputs for

audio and tape. Response ±1 db, 20-20,000 cycles. Premium-type low-noise triodes used in low-signal-level stages. May be powered from *Pilot* stereo amplifiers or power supply *P-10.*—**Pilot Radio Corp.**, 37-06 36 St., Long Island City 1, N. Y.

AMP–PREAMP, *model S-1060.* Power output 60 watts at 1.5% IM distortion. Handles peak



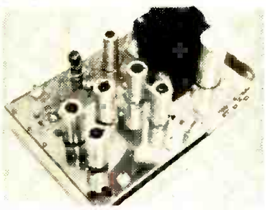
powers up to 160 watts. Response ±1 db, 20–30,000 cycles. Sensitivity, radio 0.25 volt, phono 2.5 mv. Maximum hum and noise: radio input 80 db below 20 watts, phono input 60 db below 20 watts. Inputs: phono, tape, 3 high-level, tape monitor. Outputs: 4, 8, 16 ohms and cathode-follower recording. Power consumption 110 watts.—**Sher-**

wood **Electronic Laboratories,** 430 N. California Ave., Chicago.

WIRELESS PHONO OSCILLATOR, *Gold Bug SDK-101* for use with stereo cartridge-equipped phono and separate radio, using amplifier and speaker of radio as second channel. No wiring to radio. Self-contained battery, transistor circuit. Adjustable to any unused frequency on standard broadcast band. Available in

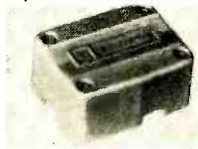
kit with stereo cartridge.—**Stereo-Ette Co.,** 4908 N. Lincoln Ave., Chicago 25, Ill.

TV-FM AMPLIFIER, *Uniband* with power supply. For community antenna systems and other multiple installations. High-gain wide-band channel



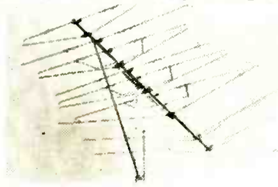
2-13 and FM band amplifier. 75- or 300-ohm single input, 75-ohm single output. Minimum gain 37 db. 6 tubes. New circuit requires no alignment.—**Benco Television Associates, Ltd.,** 27 Taber Rd., Rexdale, Ont., Canada.

MULTISET COUPLERS, *Exact-Match. Model A-102* feeds 2 TV or FM receivers from one antenna or mixes 2 antennas into one line; 12–20-db isolation, 3.5-



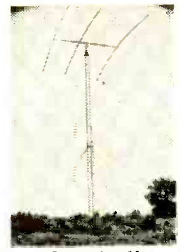
db loss. *A-104* feeds 4 sets; 12–20-db isolation, 7.5-db loss. Weatherproof, nonbreakable cases. *A-100* mounting kit for mounting couplers on antenna mast.—**Blonder-Tongue Laboratories Inc.,** 9 Alling St., Newark 2, N. J.

TV ANTENNA, *Color Royal.* All-channel. *No-Strip* lead-in connector, *Dyna-Coil* phasing fac-



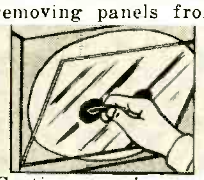
tory assembled. Braced reflectors. *Quik-Lok* clamps eliminate bolts and nuts. No soldering required. Terminal points protected from weather.—**Trio Manufacturing Co.,** Griggsville, Ill.

"FOLD-OVER" TOWER for amateur radio and experimentation. Antenna and rotator may be serviced on ground. Heights up to 70 feet. Tower sections 12½-inch equiangular triangle design with zig-zag steel cross-



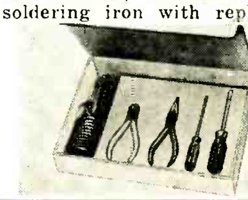
bracing, electrically welded. Sections 10 feet long.—**Rohn Manufacturing Co.,** 116 Limestone, Bellevue, Peoria, Ill.

SAFETY - GLASS REMOVER. For removing panels from TV



sets. Suction cups insure safety and speed, prevent fingerprints and damage to glass.—**Walsco Electronics Manufacturing Co.,** 100 W. Green St., Rockford, Ill.

TOOL KIT, *Heathkit TK-1.* All the tools needed for kit building. Two screwdrivers, pliers and sidecutters with insulating rubber handles, *American Beauty* soldering iron with replaceable



tip.—**Heath Co.,** Benton Harbor, Mich.

BATTERY CHARGER KIT, *Tabkit BCK-1.* Charges 2-, 4-, 6- or 12-volt storage batteries.

Initial current to discharged 12-volt batteries is 4 amps, to 6-volt 3½ amps. Self-regulating. Components premounted in cabinet. — **Technical Apparatus Builders,** 109 Liberty St., New York 6, N. Y.

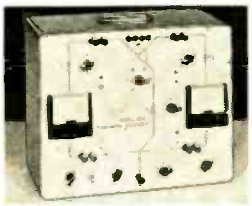
THERM-O-METER, *model 389-3L.* For measuring temperatures of gases, liquids or solids.

Ranges −50° to 100° and 100° to 250°F. Overall accuracy ±3°F. 7-inch meter. Thermistor lead.—**Simpson Electric Co.,** 5200 W. Kinzie St., Chicago 44, Ill.

VOM-AMMETER SET, *model 100.* Contains *model 310* hand-sized vom for checking ac and dc volts (dc at 20,000 ohms/volt), ohms, megohms, microamps and milliamps. Adapts instantly into clamp-on ammeter by addition of *model 10* adapter. Line separator to divide 2-conductor cords. Leather carrying

case included.—**Triplett Electrical Instrument Co.**, Bluffton, Ohio.

TRANSISTOR ANALYZER, *model 850*. Accuracy limited only by indicating meters, within ±2% of full scale. Wide range



of applied voltages available by substitution for breadboard configurations—common base, common emitter and common collector. Under any circuit use conditions, checks for collector leakage (common base or emitter) beta gain, alpha gain, input or output resistance, power gain, linearity.—**Hickok Electrical Instrument Co.**, 10531 Dupont Ave., Cleveland 3, Ohio.

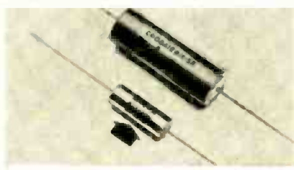
AUDIO OSCILLATORS. Printed-circuit transistor units furnish audio signals of approximately 1 kc and 400 cycles at 0 and −60-db output levels at 600 ohms impedance for equipment testing. *Model PO-2* (shown) has output phone jacks to fit standard patch plug, turns on automatically when inserted. *CO-2* has clip-lead output for

circuit testing. Self-contained battery has 40-hour operating life.—**Dunlap Electronics Inc.**, 764 Ninth St., Des Moines, Ia.

SELENIUM-SILICON TESTER, *Omni-Chex model OC-1*. Checks crystal diodes, power transistors, vibrators and phases speakers.

Direct reading of rectifier quality under load.—**Hallmark Electronics Corp.**, 31-04 Spring Garden St., Philadelphia, Pa.

TRANSISTOR CAPACITORS,



type P1232NNG (arrow). Metallized paper units rated at 50 volts dc. Glass terminal seals. Operate at temperatures from −65° to −85° C at full voltage rating.—**Aerovox Corp.**, Application Engineering Dept. New Bedford, Mass.

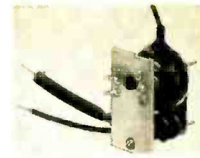
CAPACITOR KIT. Contains 76 most-needed *Tobemite* molded-plastic tubular capacitors for use by technicians, in transparent

plastic box. Capacitors are 50% smaller than conventional units at equal ratings.—**Tobe Deutschmann Corp.**, Service Div., 2900 Columbia Ave., Indianapolis, Ind.

PRINTED-CIRCUIT ELECTROLYTICS for all printed-circuit requirements. Offset index lug permits insertion right way only. Long- and short-pin and

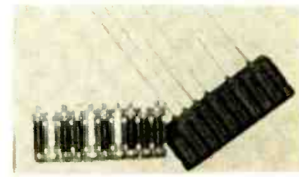
snap-in types.—**Cornell-Dubilier Electric Corp.**, South Plainfield, N. J.

FLYBACK TRANSFORMER, *Stancor HO-288*. Exact replacement for G-E and Hotpoint



RTO-196 used in T series chassis in 6 models.—**Chicago Standard Transformer Corp.**, 3501 W. Addison St., Chicago, Ill.

PREASSEMBLED COMPONENTS *(PAC)* with wire leads for universal wiring. Leads mechanically crimped and soldered to individual component clips. Capacitor - resistor networks with capacitance of 10 μμf–.01



μf (ceramic), .01–.1 μf (mylar), resistance 10 ohms – 50 megs.—**Erie Resistor Corp.**, 644 W. 12 St., Erie, Pa.

PRECISION RESISTORS, *series 77* metal-film units. Smaller, but with higher resistance than previous models. Tubular and flat-side shapes. 25 ohms to 400K. Tolerance ±1% (can be furnished as low as 0.1%). Rated at ¼ watt to 150°C.—**Ohmite Manufacturing Co.**, 3695 Howard St., Skokie, Ill. END

All specifications on these pages are from manufacturers' data.

BUILD 16 RADIO

CIRCUITS AT HOME

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PROGRESSIVE RADIO "EDU-KIT"®

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- ★ **CODE OSCILLATOR**

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● SOLDERING IRON ● ELECTRONICS TESTER • TESTER INSTRUCTION MANUAL • HIGH FIDELITY GUIDE • QUIZZES • TELEVISION BOOK • RADIO TROUBLE-SHOOTING BOOK • MEMBERSHIP IN RADIO-TV CLUB: CONSULTATION SERVICE • FCC AMATEUR LICENSE TRAINING • PRINTED CIRCUITRY • PLIERS-CUTTERS • ALIGNMENT TOOL • CERTIFICATE OF MERIT • VALUABLE DISCOUNT CARD • WRENCH SET

NO NEED TO SPEND HUNDREDS OF DOLLARS FOR A RADIO COURSE

The "Edu-Kit" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our Kit is designed to train Radio & Electronics Technicians, making use of the most modern methods of home training. You will learn radio theory, construction practice and servicing.

You will learn how to build radios, using regular schematics; how to wire and solder in a professional manner; how to service radios. You will work with the standard type of punched metal chassis as well as the latest development of Printed Circuit chassis.

You will learn the basic principles of radio. You will construct, study and work with RF and AF amplifiers and oscillators, detectors, rectifiers, test equipment. You will learn and practice code, using the Progressive Code Oscillator. You will learn and practice trouble-shooting, using the Progressive Signal Tracer, Progressive Signal Injector, Progressive Dynamic Radio & Electronics Tester and the accompanying instructional material.

You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build 16 Receiver, Transmitter, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for Television.

Absolutely no previous knowledge of radio or science is required. The "Edu-Kit" is the product of many years of teaching and engineering experience. The "Edu-Kit" will provide you with a basic education in Electronics and Radio, worth many times the complete price of $22.95. The Signal Tracer alone is worth more than the price of the entire Kit.

THE KIT FOR EVERYONE

You do not need the slightest background in radio or science. Whether you are interested in Radio & Electronics because you want an interesting hobby, a well paying business or a job with a future, you will find the "Edu-Kit" a worth-while investment.

Many thousands of individuals of all ages and backgrounds have successfully used the "Edu-Kit" in more than 79 countries of the world. The "Edu-Kit" has been carefully designed, step by step, so that you cannot make a mistake. The "Edu-Kit" allows you to teach yourself at your own rate. No instructor is necessary.

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The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble-shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are sixteen Receiver, Transmitter, Code Oscillator, Signal Tracer, and Signal Injector circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

A COMPLETE RADIO COURSE—NOTHING ELSE TO BUY

You will receive all parts and instructions necessary to build 16 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, wire, solder, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio & Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive all parts, tools, instructions, etc. There is nothing else to buy. Everything is yours to keep.

SERVICING LESSONS

You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of troubles in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

J. Stataitis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

FROM OUR MAIL BAG

Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits: the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Troubleshooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

Unconditional Money-Back Guarantee

The Progressive Radio "Edu-Kit" has been sold to many thousands of individuals, schools and organizations, public and private, throughout the world. It is recognized internationally as the ideal radio course.

By popular demand, the Progressive Radio "Edu-Kit" is now available in Spanish as well as English.

It is understood and agreed that should the Progressive Radio "Edu-Kit" be returned to Progressive "Edu-Kit" Inc. for any reason whatever, the purchase price will be refunded in full, without quibble or question, and without delay.

The high recognition which Progressive "Edu-Kits" Inc. has earned through its many years of service to the public is due to its unconditional insistence upon the maintenance of perfect engineering, the highest instructional standards, and 100% adherance to its Unconditional Money-Back Guarantee. As a result, we do not have a single dissatisfied customer throughout the entire world.

- ☐ Send "Edu-Kit" Postpaid. I enclose full payment of $22.95.
- ☐ Send "Edu-Kit" C.O.D. I will pay $22.95 plus postage.
- ☐ Send me FREE additional information describing "Edu-Kit."

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PROGRESSIVE "EDU-KITS" INC.

1186 Broadway, Dept. 146G, Hewlett, N.Y.

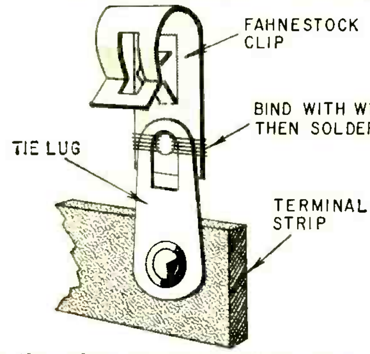
STICKY YOKES

Occasionally a yoke will stick to the neck of a picture tube so tightly that it seems nothing will dislodge it. Rather than resort to a hammer or pipe wrench, I pour a liberal quantity of rubber cement thinner or benzine along the neck of the tube from the socket end. This usually does the job without affecting the insulation or enamel on the wire. Caution: rubber cement thinner and benzine are extremely inflammable.—*Thomas A. Dunn*

TRANSISTOR MOUNTING CLIPS

Many transistors have pigtail leads and are usually soldered into a circuit. However, while this is fine for a 5-cent resistor or 10-cent capacitor, it is hardly recommended for a delicate unit that can cost several dollars, especially in experimental work where circuits are changed often. Not only do the leads become messed up after several solderings and unsolderings, but there is always the chance of heat damage.

To avoid these problems and protect my investment in transitors, I fasten three Fahnestock clips to the lugs of



a three-lug terminal strip. The clips are firmly bound to the lugs with short pieces of wire and soldered together. Circuit leads are then soldered to the clips and the transistor leads are inserted in them after all soldering is completed.—*Charles Erwin Cohn*

CHECK 'EM HOT

When checking tubes in a TV set with a parallel heater circuit, a lot of time can be saved if the set is left on during the job. This can be done safely by using any *one* of the following methods:

Remove all low-voltage rectifiers.

If the set is a selenium rectifier type, remove the plug-in fuse resistor.

Remove the high-voltage fuse.

Remove the high-voltage rectifier or rectifiers.

The rest of the procedure consists of setting up the tube checker, removing a tube and plugging it immediately into the checker. You can then check the tube without waiting for it to warm up.—*Carleton A. Phillips.*

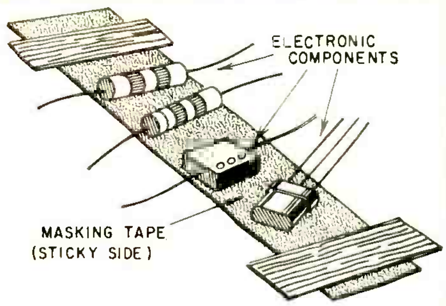
COIL INSULATION

Sometimes the experimenter, constructor or ham operator winding a coil or small transformer finds himse'f up against it for a suitable cambric, paper or cloth to insulate the windings. This problem can often be solved by resorting to the common plastic bag, found in the cupboard, tucked away in a corner of the refrigerator or wrapped around the shirts you just had dry-cleaned.

The average plastic bag is thin, resilient, lightweight, moisture-resistant and tough. When this plastic is used in low-wattage units, it provides very satisfactory insulation. At the same time, readily available as it is, it costs you nothing.—*George D. Philpott*

KIT-BUILDING KINK

When building electronic devices from kits, you can save yourself considerable time and get more enjoyment out of the hobby if you sort out all the small components (resistors, capacitors,



etc.), and lay them out in an orderly manner on a strip of masking tape taped sticky-side up to the bench top. Small easily lost hardware can be safely held in the same manner for easy selection.—*John A. Comstock*

MAT ON THE BENCH

I use a rubber utility mat on the bench in my shop for a number of odd jobs. It makes a handy pix-tube pad when I have to lay a chassis on its side and a catch-all for screws, nuts and other small parts removed from a set. When I have to empty a box of parts to find one of the value I need, I pour them out on the mat. After I get the right one, the mat is folded and the parts easily poured back into their container. Can't you think of some other uses for one of these mats on your bench?—*Scot Mock*

PHILLIPS SCREWDRIVERS

Occasionally use a triangular file on the head of your Phillips screwdrivers to remove nicks and burrs. This lets them get a tight grip and prevents stripping the screw heads.—*Wm. M. Atkinson*

END

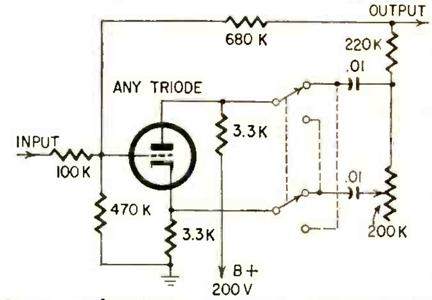
NOTEWORTHY CIRCUITS

HUM SQUELCHER AND TONE CONTROL

In these days of negative feedback phase shift has an evil sound, yet like most things it has its good points too. For instance, many equalizer circuits use phase shift. If you notice a reduction in hum at some settings of your equalizer switch, you are probably using an out-of-phase voltage that bucks the hum. An old, but still used, circuit uses an amplified ac voltage (ripple from the B-plus filter) passed through a cathode follower, to cancel hum on low-level grids.

Now, suppose we use the ac signal voltage from our radio tuner or record player for out-of-phase hum bucking? We can put this circuit at the end of our preamp (a standard cathode follower is easily modified for this purpose) or even in the main amplifier and cancel out (or greatly reduce) all the accumulated hum of the preceding stages. Best of all, it will also reduce turntable rumble. Even the rumble from a cheap two-pole motor can be reduced to near inaudibility. With better motors, the noise disappears entirely.

When used as a noise reducer, the circuit can be tucked away anywhere. Hum reduction is regulated by the 200,000-ohm pot, and once set it need not be changed. The setting for best sound may not coincide with greatest



hum reduction, so some compromise may be necessary. However, the noise-reducing potential is so great at any bearable listening level that this point is seldom of much consequence.

This circuit also makes an effective tone control, with some sound variations no other circuit I know of can produce. It gives either high- or low-frequency boost, but not both at the same setting, so it is best used with the regular bass and treble controls. However, very pleasing sound can be obtained with this control alone.

For tone control use it is best to

wire in a dpdt reversing switch, as shown by the dotted lines, for wider sound variation. Also, when using a straight noise control, try reversing these two leads, and use the one which works best in your particular amplifier.

There is one drawback to this circuit. It has considerable insertion loss—the amount depending on the setting of the variable resistor and the reversing switch, if one is used. If you now operate your volume control in the first half of its arc, you will have enough reserve volume for this circuit. If not, perhaps you can use higher-gain tubes in some other part of the circuit, or install a dual triode, using one half as the hum squelcher and the other half as a straight voltage amplifier (being sure to decouple the B-plus). The new stage should follow the noise control stage (first half of the twin triode) and use a grid resistor of at least 250,000 ohms. The cathode follower does not work very well with low-impedance inputs.

However you manage, you will find your trouble well worth while. The low-frequency noise reduction of this simple circuit, accomplished with negligible bass loss, is unequaled by practically anything except the low-frequency gate of a many, many times more expensive dynamic noise suppressor.—*R. C. Sandison*

VIDEO SHARPENING CIRCUIT

Some recent German *Blaupunkt* TV receivers have an efficient sharpening circuit (see Fig. 1) for improving picture detail. Its principle is illustrated in Fig. 2. The perfect rectangular transient A appears distorted as B at the receiver's output. By differentiation through a short time constant, signal C is obtained. Amplification then delivers signal D. Signal D is then subtracted (added after phase reversal)

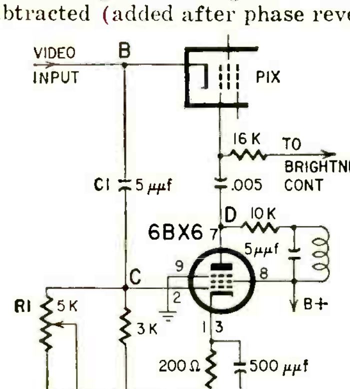


Fig.1

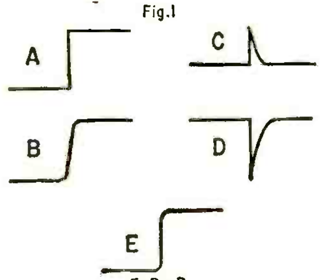


Fig.2

from signal B, and the total result is E, a much better approximation of the ideal A than signal B itself.

In the circuit, video signal B is applied to the cathode of the picture tube. Simultaneously, it is coupled to the grid of the 6BX6 through the short adjustable time-constant circuit R1–C1 to produce the differentiation and create signal C. This signal appears amplified and inverted as D at the 6BX6's plate, and is then applied to the picture tube's control grid.

The resulting total modulating voltage on the picture tube is then the difference between the cathode and control grid voltages, or B − D, or E.

The resulting overamplification of the high video frequencies makes a noticeable improvement in the sharpness of the picture.—*A. V. J. Martin*

HUM SUPPRESSION

There are several effective, but not too well known, ways of suppressing hum. Basically they consist of injecting into the circuit a voltage 180° out of phase with the hum voltage. Fig. 1 shows how some voltage from the power transformer is fed to the grid of one of the tubes—usually a preamplifier. If the hum increases, reverse the connections on the heater winding. The value of the 4,700-ohm resistor can be increased or decreased for fine adjustment.

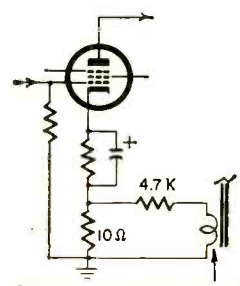


Fig.1

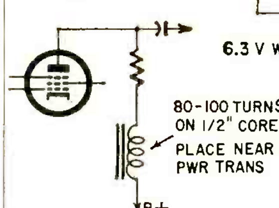


Fig.2

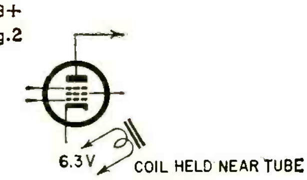
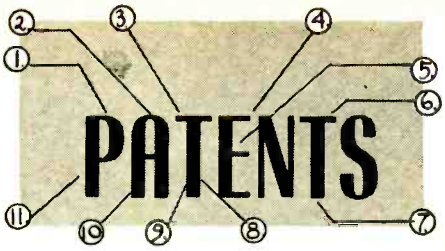


Fig.3

Fig. 2 shows a small coil of between 80–100 turns wound on a ½-inch core which can be placed in either the plate, grid or cathode circuit and held near the power transformer and rotated until the hum diminishes.

The Fig. 3 arrangement is used for tubes with heavy heater-current drain. The coil is 500 turns of fine wire wound on a ½-inch core. (The coil and core of a 6-volt ac relay should work nicely. —*Editor*) Be sure the core does not touch the metal shell of the tube.—*Carl Hennig* END

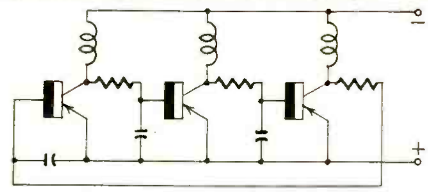


3-PHASE GENERATOR

Patent No. 2,810,843

Carl-Erik Granqvist, Lidingo, Sweden (Assigned to Svenska Aktiebolaget Gasaccumulator, Lidingo, Sweden)

The circuit shown here may be identified as a 3-stage phase-shift oscillator. When each stage is designed to produce a shift of 60° there is an overall difference of 180° between input and output therefore oscillation. This particular circuit has a new twist. Each of the coils forms a stator winding of a three-phase motor. This can be done because each coil current is 60° out of phase with that of its neighbors.



A particular application of this circuit deals with a three-phase gyroscope motor. Being quite compact the entire circuit fits easily within the gyroscope itself close to the center of rotation. The oscillator is energized by dc which is commonly available on planes and ships. The output three-phase is commonly 400 cycles.

PRECISE CLOCK

Patent No. 2,820,338

Jacob Rabinow, Takoma Park, Md.

This servo clock is highly precise. The front view (Fig. 1) shows an outer pendulum P1, an inner pendulum P2 and a driving mechanism. While P1 and P2 are coupled indirectly, they tend to swing together. The drive consists of a metal weight M, magnet L1 and its pivoted armature, which normally slants downward against the pin and upward against extension F of weight M.

As P1 swings toward the right, it meets M to close a battery circuit through XX and L2 (Fig. 2). L1 lifts its armature away from extension F. Thus P1 is under the gentle drive of M for a longer period during the swing to the *left* than to the right.

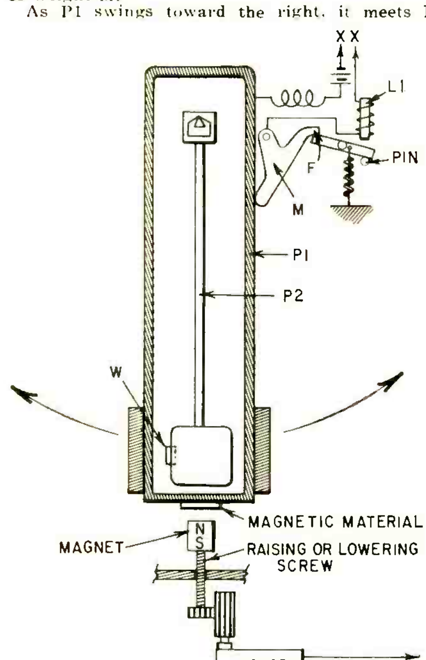


FIG.1

P1 can be retarded by a magnet mounted just below it. The distance between them is controlled by a reversible motor. When P1, P2 are in exact step, the motor is idle since there is no need to speed or slow the outer pendulum. Signal for the motor input is derived from a

PATENTS *(Continued)*

light beam that shines through W. This window is exposed exactly halfway when P1, P2 are in exact sync. The amount of light through W changes when P2 lags or leads P1.

Fig. 2 shows an edge view of the clock. The lamp shining through W is flashed when L2

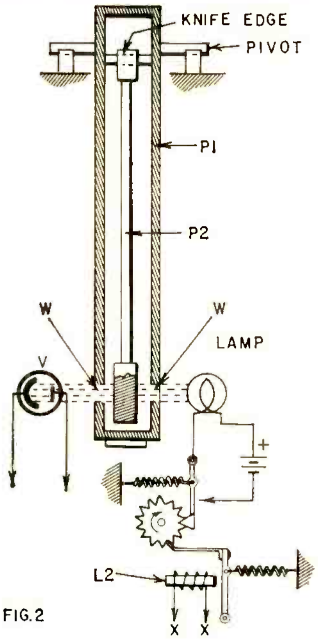


FIG. 2

is energized. Note that this magnet is in series with L1 (Fig. 1). Output from the photocell V is amplified (not shown here) then applied to the controlling motor, which rotates in the required direction to correct P1.

By using a separate pendulum P2, unloaded and uncoupled, precision timing results. P2 is mounted on a frictionless knife edge. END

50 Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In November, 1908, *Modern Electrics*

The Production of Sustained High Frequency Oscillations, by M. A. Deviny.
Iron Pipe Aerial, by Carl Chupp.
Suspension and Insulation of Aerials, by A. C. Austin, Jr.
Wireless in Balloon.
Two New Detectors, by Our Berlin Correspondent.
The Micro-Ceraunograph, by B. Wm. H. Capen.
How to Make an Electrolytic Detector, by C. C. Whittaker.
Antenna Phenomenae, by Sewall Cabot.
Selective Tuner with Weeding Out Circuit, by H. H. Holden.

HELP WANTED!

I hired a new man
He really did goof;
Installed an antenna
But on the *wrong* roof!

By Phyllis Barlow

BUSINESS and PEOPLE

Norman L. Harvey (left) is now vice president–engineering of CBS-Hytron, Danvers, Mass. He comes to the company from Sylvania where he was manager of special tube opera-


tions. **Lindsey R. Perry** (right) is now product manager of special-purpose tubes and hi-fi components of CBS-Hytron. He had been manager of the Newburyport, Mass., TV picture-tube plant. **John E. Cunningham**, supervisor of field engineering, New England, was advanced to New England regional manager of equipment tube sales.

Dr. William J. Pietenpol joined Sylvania as vice president and general manager of the Semiconductor Div., Woburn, Mass. He leaves Bell Labs, where he was director of development–semiconductor devices.

Robert Sackman (left) vice president and general manager of Ampex Corp.,


Redwood City, Calif., was elected to board of directors of ORRadio Industries, Opelika, Ala., tape manufacturer. **John M. Leslie, Jr.** of Ampex becomes ORRadio general manager.

Charles D. Manhart (left) was elected vice president, Government relations, for Raytheon Manufacturing Co., Waltham, Mass. He recently resigned as director of military and Government


sales at Bendix Aviation Corp. **Fred H. O'Kelley** joined Raytheon as Eastern regional manager for sales of receiving tubes, industrial tubes, and semiconductor devices to original equipment manufacturers. His headquarters are in New York. He had been with Du-Kane Corp. and General Electric.

Walter F. Greenwood (upper left), marketing manager of the General Electric Rectifier Dept., was advanced

to manager of marketing for the Receiving-Tube Dept., Owensboro, Ky. **Stephen J. Welsh** (upper right), New York City district sales manager for the Electronics Components Div., was promoted to manager of marketing for hi-fi components in the Specialty Electronic Components Dept. **Henry B. Nelson, Jr.** (right) is now manager of trade relations and electronic components distributor development in Owensboro. He had been a district sales manager for tubes and components.

B. V. Dale, chief engineer of the former RCA Components Div., was promoted to manager–modules engineering of the Engineering Dept. of the Semiconductor and Materials Div., Somerville, N. J. **Dr. F. E. Vinal** was upped to manager–materials engineering, and **D. H. Wamsley** becomes manager of semiconductor engineering.

Edwin Cornfield, former executive secretary of the Institute of High Fidelity Manufacturers, joined British Industries, Port Washington, N. Y., as sales manager for a number of divisions including Wharfedale loudspeakers, River Edge cabinets and enclosures, Genalex audio tubes and Widney-Dorlec scientific cabinet components.

Gordon E. Parker is the new production manager for the Vermontville, Mich., plant of Michigan Magnetics, Inc. He has been an industrial management-engineer for 16 years. **Jack L. Metz**, an experienced engineer, joined the firm as chief research engineer. **Paul F. Leopold** (above), ex-Pentron and Crescent Industries, joined Michigan Magnetics as sales manager of the new Distributor Div., with headquarters in Chicago.

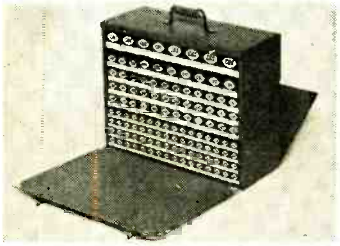
Harold P. Field, general manager of Stromberg-Carlson's plants in San Diego, assumes additional responsibilites as director of marketing of the Electronics Div.

Alfred P. Wertz joined Weller Electric Corp. as European sales manager. He will maintain headquarters in Easton, Pa., and Düsseldorf, Germany. He comes to Weller from Messinger Manufacturing Co., where he was sales and export manager.

Wen Products Inc. Chicago, launched a king-size advertising campaign for the fall and Christmas seasons. Here Nick Anton (seated), president of Wen, discusses the program with Jim Cody,

Burton Browne Advertising Agency vice president (right), as Wen sales manager, Miles Blunt (left) and agency manager Bob Abbott look on.

CBS-Hytron, Danvers, Mass., is offering service technicians a new junior



version of its famous tube-and-tool caddy.

Ralph Bellamy (left), stage, screen and TV actor is shown with Stan Neufeld, sales manager of **Rockbar Corp.**,

Mamaroneck, N. Y. with the new Collaro stereo changer. The actor will be featured in the fall advertising campaign for Collaro in advertisements in trade and consumer publications.

JFD Electronics Corp., Brooklyn, N. Y., kicked off a Harvest of Profits advertising campaign, the heaviest in its history, to push sales of its Satellite-Helix antennas. END

LITERATURE

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

RESISTANCE DECADE BOXES of 9 different types are pictured in 8-page *Catalog 20D*, which also contains a decade-box selection chart and listing of performance characteristics.—**Cinema Engineering Div., Aerovox Corp.**, Sales Promotion Dept., 1100 Chestnut St., Burbank, Calif.

ELECTRONIC ITEMS by the hundred, from capacitors and tubes to closed-circuit TV cameras and microwave components, are offered in 28-page *Green Sheet*, listing both new and surplus equipment.—**Barry Electronics Corp.**, 512 Broadway, New York 12, N. Y.

METAL FILM RESISTORS for precision applications, in the new Riteohm 77 series are detailed in *Bulletin 155*.—**Ohmite Manufacturing Co.**, 3696 W. Howard St., Skokie, Ill.

ELECTRONICS CATALOG, *No. 590*. This 260-page book lists stereo and hi-fi equipment of major manufacturers as well as Lafayette's own products—also TV and radio parts, transistor kits and miniaturized components, antennas and installation accessories, amateur gear and tools, as well as sections on industrial equipment, precision scientific instruments and public-address systems.—**Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N. Y.

SOLDERLESS TERMINALS and crimping tools are completely illustrated and described in 12-page *Catalog No. T-70*. Also shown are merchandising displays and special-purpose plastic service kits. —**Vaco Products Co.**, 317 E. Ontario St., Chicago 11, Ill.

HI-FI CATALOG *No. 101* contains photographs and specifications of a complete line of amplifiers, tape transports and tuners, together with questions and answers about hi fi and stereo.—**Bell Sound Systems Inc.**, 555 Marion Rd., Columbus, Ohio.

TRANSISTOR CIRCUITS for hams and hobbyists are described in a how-to-build-it brochure, with schematics of transistor audio power amplifier, power control, battery charger, model power supply, regulated power supply, model train control, Geiger counter and dc-to-dc converter. All use type 2N554 power transistors.—**Motorola Inc.**, Semiconductor Products Div., 5005 E. McDowell Rd., Phoenix, Ariz., or Motorola semiconductor distributors.

AUTO RADIO TRANSFORMERS and their exact replacements are listed for more than 400 models of 37 brands, including a special section on transistor radios, in 16-page *Catalog No. 500, Stancor Auto-Radio Transformer Replacement Guide.* Replacement data for vibrator, audio, driver and interstage transformers are given for all models.—**Chicago Standard Transformer Corp.**, 3501 Addison St., Chicago 18, Ill.

STEREO CARTRIDGE DATA, *Bulletin E-289,* gives complete specifications, with outline drawing, frequency response curve and installation instructions, for the Columbia cartridge Model SC-1.—**CBS-Hytron Advertising Service**, Parker St., Newburyport, Mass.

REPLACEMENT CAPACITORS for all TV sets manufactured from 1946 through 1957 are listed in 56-page *TV Replacement Capacitor Manual K-103.* The ninth edition of this popular book lists thousands of sets arranged alphabetically under nearly 100 TV trade names. In the back of the book are complete listings of Sprague capacitors.—**Sprague Products Co.**, 81 Marshall St., North Adams, Mass. **10c. Free** from Sprague distributors.

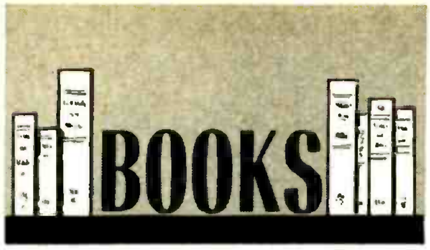
INDUSTRIAL TUBE CHART, *T-24.* Handy 30-page flip-style chart, printed on heavy-duty coated paper, indexes industrial tubes by class, briefly explains the use of each class and gives technical information for each type.—**Tung-Sol Electric Inc.**, 95 8th Ave., Newark 4, N. J.

TEST INSTRUMENTS are described and illustrated, with schematics, in 8-page 2-color *Sencore Catalog No. 119.*—**Service Instruments Corp.**, 171 Official Rd., Addison, Ill.

IGNITION INTERFERENCE in automobiles and boats and how to suppress it is treated in a 4-page brochure, *Electrical Interference Suppression for Two-Way Radio Installations,* valuable to anyone who has interference problems in mobile or auto radio.—**Electric Auto-Lite Co.**, Toledo 1, Ohio.

TEST EQUIPMENT catalog, 12 pages, describes in detail 3 models of *Kingston Absorption Analyzers* and accessory equipment, featuring electrostatic pickup for waveform analysis of circuits in 3–240-mc range.—**Kingston Electronic Corp.**, Medfield, Mass.

MOBILE RECEIVERS *M-40* and *M-160,* tunable in the 30–50- and 152–174-mc bands, are the subjects of a spec sheet.—**Monitoradio Div., I.D.E.A. Inc.**, 7900 Pendleton Pike, Indianapolis, Ind. END



PRINCIPLES OF NOISE, by J. J. Freeman. John Wiley & Sons, Inc., 440 Fourth Ave., N. Y. 16, N. Y. 6 x 9¼ in., 299 pp. $9.25.

A highly mathematical and technical presentation of the principles, facts and techniques used in noise analysis. Definitely for the advanced student, dealing with such topics as probability, power spectra and noise factor of various circuits.—*LS*

ATOMIC RADIATION. RCA Service Co., Camden 8, N. J. 8½ x 11 in., 110 pp. $1.60.

This is a revised reprint of an earlier book. It deals with radiation theory, biological effects and medical treatment. Workers who may expose themselves to radiation must know the safety rules contained here if they are to avoid injury.

The book begins with the theory of charged particles and how they affect various parts of the body. One chapter illustrates and describes counters and dosimeters and tells how to use them. The symptoms of excess radiation and its treatment are given in detail. The all-important matter of permissible levels is given in the final chapter.

Each chapter includes numerous references for further study.

INDUSTRIAL ELECTRONICS HANDBOOK, by R. Kretzmann. Philosophical Library, 15 E. 40 St., N. Y. 16, N. Y. 6 x 9 in., 298 pp. $12.

An enlarged and revised edition of an earlier book, this manual is translated from the Dutch and is part of the Philips' Technical Library. Using European tube designations and circuits, its chapters deal with various types of relays, counting circuits, timers, rectifiers, lamp dimmers, speed and temperature controls, resistance welding, motor control, inductive and capacitive heating and special-purpose apparatus.

ENGINEERING ELECTROMAGNETICS, by William H. Hayt, Jr. McGraw-Hill Book Co., Inc., 330 W. 42 St., N. Y. 36, N. Y. 6 x 9 in., 328 pp. $8.50.

Modern science and engineering would be impractical without the shorthand of math. Certain topics like electric and magnetic fields require a very *concise* shorthand. This is provided by a special branch of math called vector analysis. This author discusses steady and varying fields and shows how to use vectors.

The text is based on Maxwell's laws as derived from early experiments. Gradient, divergence and curl are explained clearly for beginners. Some examples are worked out, others are left for the student. Calculation of capacitance, field mapping, radiation, circuit theory and relativistic effects are described. A text for readers who wish to study advanced engineering.—*IQ*

PIN POINT COLOR TV TROUBLES IN 15 MINUTES, edited by Harold P. Manly. Book Publishing Div., Coyne Electrical School, 500 S. Paulina St., Chicago 12, Ill. 5½ x 8¼ in., 548 pp. $5.95.

A practical book on troubleshooting color TV intended for the practicing technician. A thousand faults which cause a total of 150 troubles are listed. Check charts are used to help point out possible trouble spots. Every section of the modern color TV receiver is treated in detail, with oscillograms of important waveforms and partial schematics where needed.—*LS*

REPAIRING PORTABLE AND CLOCK RADIOS, by Ben Crisses and David Gnessin. John F. Rider Publisher, Inc., 116 W. 14 St., N. Y. 11, N. Y. 5½ x 8½ in., 120 pp. $2.75.

The radio repair business is highly competitive. Only skilled and alert technicians can survive. This book is designed to help them to speed up the repair, alignment and improvement of portable and clock radios. It discusses clearly the basic problems: filament circuitry, three-way power supplies, miniature components, printed layouts, as well as more conventional troubles.

The authors have incorporated practical information on transistors, semiconductor rectifiers, batteries and full alignment procedure. They show how to modernize a set by adding a phone jack, installing a selenium rectifier, converting to a ferrite loopstick, etc. The final chapter on clock radios shows how to maintain and service the mechanism. —*IQ*

RADIO ELECTRONICS, by Samuel Seely. McGraw-Hill Book Co., Inc., 330 W. 42 St., N. Y. 36, N. Y. 6 x 9 in., 487 pp. $7.

This excellent text for reference or study discusses electron tubes and the circuits in which they are used. Emphasis is on the methods of analysis, with mathematics used freely. Each chapter ends with practical design problems.

Tubes, amplifiers, oscillators and modulators are covered in detail. There are also chapters on information theory, filters and detectors. A chapter on FM (transmitters and receivers) studies in detail all detectors including the ratio, Bradley, gated-beam, etc.—*IQ*

DAVE RICE'S OFFICIAL PRICING DIGEST, Vol. 3, No. 1. Electronic Publishing Co., 180 N. Wacker Dr., Chicago 6, Ill. 3¾ x 9¾ in., 245 pp. $2.50.

This new edition of the pocket-size handbook for TV–radio technicians lists suggested retail prices of more than 60,000 items, including tubes, batteries, antennas and components. It also contains a special section showing regional and national average service charges for typical television repair jobs.

END

EDITORIAL *(Continued from page 31)*

headed by Stavid Engineering as captain of a team including some much bigger companies. For the Army, Stavid now is making a missile beacon telemetering system; for the Navy, a submarine command guidance system for the Regulus missile, fire control systems, electronic beachmarking systems, sonar data links; for the Air Force, a radar toss-bombing system and a subminiature radar beacon for the experimental X-15 rocket plane. In addition to such military projects, Stavid is now embarked on a plan to devote 50% of its capacity to civilian work, and has acquired rights to Radio WEB, a French air navigation system, which it hopes to manufacture in this country. One out of every four of the company's employees is a scientist or engineer, and it stresses the hiring of retired persons.

J. RAYMOND POPKIN-CLURMAN, of Amityville, N.Y., was senior engineer for Hazeltine Corp., working on color television research, when it occurred to him that a demand for color TV test equipment would exist long before the FCC even decided on color standards. Accordingly, in 1950, at the age of 34, he founded Telechrome Manufacturing Corp. with a policy based on making whatever anybody wanted, incorporating any standards desired. The policy of Telechrome, which now has 70 employees and annual sales of $1,000,000, hasn't changed: it still strives to manufacture equipment *before* there's a market. It will make "one of anything," will develop it from an idea to complete equipment in 60 to 90 days where some others might take 6 to 9 months. As a result of this flexibility, it is now in the field of broadcast test equipment, telemetering for guided missiles, electro-optical tooling for aviation and industry, spectrophotometers, and its customers include the Government and some of the largest manufacturers in the country. Telechrome claims to be the only firm which ever made a profit on color TV.

—H.G.

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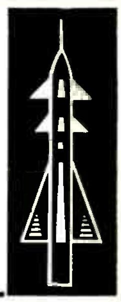

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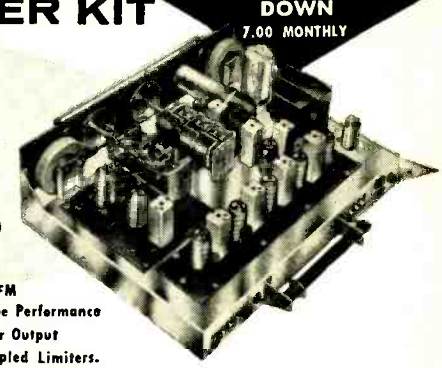

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More than a year of research, planning and engineering went into the making of the Lafayette Stereo Tuner. Its unique flexibility permits the reception of binaural broadcasting (simultaneous transmission on both FM and AM), the independent operation of both the FM and AM sections at the same time, and the ordinary reception of either FM or AM. The AM and FM sections are separately tuned, each with a separate 3-gang tuning condenser, separate flywheel tuning and separate volume control for proper balancing when used for binaural programs. Simplified accurate knife-edge tuning is provided by magic eye which operates independently on FM and AM. Automatic frequency control "locks in" FM signal permanently. Aside from its unique flexibility, this is, above all else, a quality high-fidelity tuner incorporating features found exclusively in the highest priced tuners.

FM specifications include grounded-grid triode low noise front end with triode mixer, double-tuned dual limiters with Foster-Seeley discriminator, less than 1% harmonic distortion, frequency response 20-20,000 cps ± ½ db, full 200 kc bandwidth and sensitivity of 2 microvolts for 30 db quieting with full limiting at one microvolt. AM specifications include 3 stages of AVC, 10 kc whistle filter, built-in ferrite loop antenna, less than 1% harmonic distortion, sensitivity of 5 microvolts, 8-kc bandwidth and frequency response 20-5000 cps ± 3 db.

The 5 controls of the KT-500 are FM Volume, AM Volume, FM Tuning, AM Tuning and 5-position Function Selector Switch. Tastefully styled with gold-brass escutcheon having dark maroon background plus matching maroon knobs with gold inserts. The Lafayette Stereo Tuner was designed with the builder in mind. Two separate printed circuit boards make construction and wiring simple, even for such a complex unit. Complete kit includes all parts and metal cover, a step-by-step instruction manual, schematic and pictorial diagrams. Size is 13¾" W x 10⅜" D x 4½" H. Shpg. wt., 22 lbs.

The new Lafayette Model KT-500 Stereo FM-AM Tuner is a companion piece to the Models KT-300 Audio Control Center Kit and KT-400 70-watt Basic Amplifier Kit and the "Triumvirate" of these 3 units form the heart of a top quality stereo hi-fi system.

KT-500 .... Net **74.50**
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- RESPONSE 10-25,000 CPS ± 0.5 DB
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- 6 CONCENTRIC FRONT PANEL CONTROLS
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A REVOLUTIONARY DEVELOPMENT IN STEREO HIGH FIDELITY. Provides such unusual features as a Bridge Control, for variable cross-channel feed for elimination of "ping-pong" (exaggerated channel separation) effects and for control of a 3d-channel output for 3-speaker stereo systems; the 3d-channel output also serves for converting stereo program material to high quality monaural for recording or to play a stereo program monaurally through a separate amplifier and speaker system. The KT-600 also has full input mixing of monaural program sources (such as tape recorder and phonograph, etc.), a special "null" stereo balancing and calibrating system (better than meters), 24 equalization positions per channel, 12 db per octave rumble and scratch filters, and a loudness on-off switch. Has clutch-type dual concentric volume controls which operate independently for balancing or simultaneously as the Master Level Control. Other features include channel reverse, 180° phase reversal, input level controls at all inputs. Sensitivity is 1.78 millivolts for 1 volt out. Dual low impedance outputs ("plate followers," 1300 ohms) are provided. Frequency response is 10-25,000 cps ± 0.5 db; less than .03% IM distortion. Uses 7 new 7025 low-noise dual triodes. Size 14" x 4½" x 10⅛". Shpg. wt., 16 lbs. Complete with printed circuit board, modern-styling metal chassis and cage, profusely illustrated instructions, all necessary parts.

LAFAYETTE KT-600 Stereo Preamplifier Kit .... Net **79.50**

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KT-310

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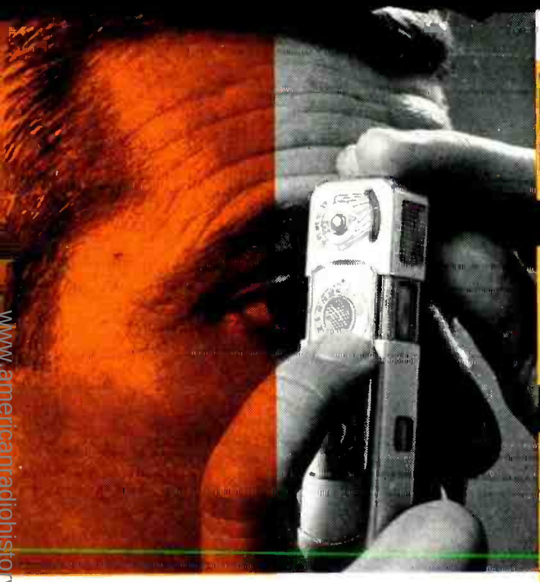

Picture your speaker system with E-V Building-Block Kits.* You can start with a single, full-range Electro-Voice Loudspeaker and expand it step-by-step to a multi-way system as your budget permits.

Electro-Voice enclosures are ready for future addition of high-frequency and mid-range speakers. Your E-V enclosure can never be obsolete because there's *always* room to expand your system.

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2. Or, begin your system with an E-V integrated 3-way speaker; merely add-on the E-V mid-range Building-Block Kit to achieve a *separate* three-way system.

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BB3 BUILDING-BLOCK KIT includes T10A Driver, 8HD Horn, X825 Crossover, AT37 Level Control, Wiring Harness........net $86

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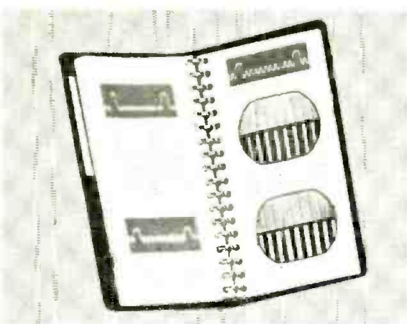

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